STATUS OF PRIVATE CYPRESS WETLAND FORESTS IN GEORGIA

Alternatives for Conservation and Restoration

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REPORT SUMMARY

STUDY GOALS AND APPROACH

Georgia's coastal plain is home to a wide array of cypress-dominated wetland ecosystems. Some cypress wetlands are found in broad flood plains along rivers, while others are located in small depressions, scattered throughout the coastal plain. Wherever cypress ecosystems are found, they perform valuable functions. These ecosystems capture and store floodwaters, buffer storm surges, provide habitat to fish and wildlife, and facilitate groundwater recharge. Additionally, these areas provide recreational opportunities for sight-seeing, boating, birding, hunting, and fishing. And, if managed correctly, certain cypress ecosystems can be a renewable source of high quality commercial wood products.

Unfortunately, there are numerous threats to Georgia's cypress ecosystems. The U.S. Environmental Protection Agency (EPA) funded this study to assess Georgia's cypress ecosystems and identify any needed conservation measures. Specifically, the goals of this study were to 1) evaluate the status of private cypress-dominated wetlands in Georgia using existing data; 2) identify any gaps in the information needed to characterize this resource and ensure its long-term health; and 3) develop recommendations for the conservation and restoration of these ecosystems.

The focus of this study was on whether Georgia is losing—in quantity and quality—a valuable and irreplaceable ecosystem. The focus was not on whether Georgia is maximizing harvestable cypress timber, but on the conservation of cypress forest ecosystems. For instance, mature cypress trees provide important habitat for wildlife. While harvesting old-growth cypress may increase the ecosystem's initial rate of growth, such actions remove habitat that can be lost if cypress regeneration is unsuccessful.

KEY STUDY FINDINGS

To achieve the goals of this study, we 1) analyzed data on cypress, evaluated a case study site, and considered anecdotal information; 2) evaluated applicable laws, regulations, and policies (including forestry Best Management Practices or BMPs); and 3) prepared recommendations designed to increase the protection of cypress ecosystems. We summarize our findings in the sections below:

Scientific Literature Review and Case Study Findings

The existing scientific literature and the case study we conducted reveal that we should be concerned about the long-term health of cypress ecosystems in Georgia. Many of the concerns described below warrant immediate attention.

- **Regeneration.** Cypress forests are rarely replanted after they are harvested. Foresters generally believe that cypress trees will regrow from stump sprouts. As the scientific literature and our case study reveal, however, stump sprouts are not a reliable form of cypress regeneration and in many cases cypress needs to be replanted to ensure re-growth.
- **Hydrologic Modifications.** Reservoirs, impoundments, ditches, canals, water withdrawal structures, and outfall structures have altered how water flows across Georgia's coastal plain. The need for water supplies to support growing metropolitan areas such as Atlanta, Macon and the coastal region means the prospect of continued hydrologic changes is likely. When these modifications result in prolonged high water levels, cypress seedlings cannot take root. The Georgia Department of Natural Resources has found upstream dams have already impacted cypress

Figure 1

swamps along the Altamaha, Savannah, and Ogeechee Rivers, and as a result, the agency has identified cypress-gum swamps as the number-one priority conservation habitat for Georgia's southern coastal plain.[1]

- **Development and Insufficient Legal Protection.** As the economy recovers and more people move to the coast, pressure will increase to fill in cypress swamps to build residential and commercial developments. We have found that some developers abuse the Clean Water Act's (CWA) silviculture permit exemption when they convert cypress forests into developments. Others are misusing the silviculture exemption by harvesting cypress ecosystems without forest management or other ongoing forestry practices. The CWA silvicultural exemption applies only to sites that are sustainably managed. We have found that the forestry BMPs are inadequate to ensure cypress harvest sustainability.
- **Conversion to Pine Plantations.** Small, depressional cypress ecosystems are being converted to pine plantations. The current drive to develop alternative fuel sources has lead to Georgia maximizing its silviculture production so it can become a world leader in biofuel production.
- **Increased Harvesting and Mortality.** An overall increase in harvesting and cypress mulch production is an additional concern for the long-term health of cypress ecosystems in Georgia. Periods of prolonged drought in Georgia may be contributing to increased accessibility to cypress ecosystems for harvesting. Increased mortality caused by natural disturbances may also contribute to cypress forest losses. Additional research is needed into the relationship between climatological conditions and cypress harvesting rates, as well as into the higher mortality rates.

Forestry Data Analysis Findings

To assess the status of cypress ecosystems in Georgia, we examined the best forestry data available. The data included the U.S. Forest Service's (Forest Service) Forest Inventory Analysis (FIA) data and the Forest Service's Timber Product Output (TPO) data, the U.S. Fish and Wildlife Service's (FWS) National Wetlands Inventory (NWI) data, and land-cover data based on satellite imagery.

GIS Data Analysis

We also conducted a Geographical Information System (GIS) analysis using the U.S. Fish and Wildlife Service's National Wetlands Inventory database. We compared NWI data, which is based on aerial photographs, to Georgia Land Use Trends Land Cover of Georgia Data based on satellite imagery for the period from 1991 to 2005 (See Appendix 3). This analysis reveals the following:

- ***Acreage.*** The cypress ecosystem acreage indentified by NWI in Georgia may have suffered a decline of 16 percent during the period from 1991-2005.
- ***Geographically Isolated Wetlands:*** The apparent decline includes the loss of more than half of all geographically isolated cypress wetlands identified by NWI data.

FIA Data Analysis

It is important to note limitations to the use of FIA data. For some FIA variables such as acreage, estimated sampling error percentages are high due to a low number of sample plots for cypress. Due to this shortcoming, we recommend increased FIA funding targeting cypress plots to conclusively define the resource and trends. Absent sufficient funding for FIA to satisfactorily monitor cypress ecosystems, substitute sources of more reliable data should be developed for future assessments. Since data development was outside of the scope of this project, and due to the lack of existing sources of alternative data, we included a spectrum of FIA data variables in this report. Most of the variables indicate a decline, although given the high level of estimated error associated with some of the data, an alternative source of data should be developed to provide a better assessment of cypress in the future.[2]

First, we analyzed the data from an ecosystem perspective. That is, since older, large-diameter cypress trees contain the cavities and crevices that insects and wildlife tend to inhabit, these forests can provide irreplaceable habitat. As a result, the harvesting of these larger trees can have more severe effects on cypress ecosystems than the loss of smaller diameter cypress. Consequently, we chose to evaluate trends for large diameter trees in addition to all cypress trees. Generally, large diameter trees, as categorized by FIA for cypress, are 9 inches or greater in diameter.

Second, we focused on private timberland[3] as opposed to all forestland[4] because private lands are the most vulnerable to changes in legal protection, conversion to other uses, and marketplace forces.[5] Moreover, we focused our assessment on timberland because FIA forest data for most variables are available for timberland back to 1972 whereas forestland statistics are available only since 1997.

[1] Ga. Dep't of Natural Resources, Wildlife Resources Div., Comprehensive Wildlife Conservation Strategy (2005), available at http://www.gadnr.org/cwcs/PDF/13_SouthernCoastalPlain.pdf.

[2] Because sampling error is high for numerous cypress variables, it cannot be definitively stated that the resource experienced a signficant change and that cypress may or may not be experiencing a decline. Additional data should be collected to determine the status of the resource.

[3] Timberland is defined by the U.S. Forest Service as "Forest land capable of producing 20 cubic feet of industrial wood per acre per year and not withdrawn from timber utilization." (See Appendix 1).

[4] The Forest Service defines forestland as "land at least 10 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. The minimum area considered for classification is 1 acre. Forested strips must be at least 120 feet wide." (See Appendix 1).

[5] For the reasons stated, it should be noted that all cypress data available for the entire resource in Georgia was not used, and this in some cases increased error in the data presented in this report.

Third, we focused on pond cypress for part of our analysis. There are two types of cypress that occur naturally in Georgia—baldcypress and pondcypress. Baldcypress are typically found either alone or mixed with water tupelo and other species in floodplain (alluvial) ecosystems. Pondcypress is more prevalent in nonalluvial ecosystems such as cypress ponds and domes.[6] Because of recent changes in the federal law governing wetlands protection, geographically isolated wetlands, like some cypress ponds and domes, may or may not receive protection under the CWA.[7] As a result, we examined whether pondcypress-dominated ecosystems may be more vulnerable than baldcypress-dominated ecosystems.

Fourth, we focused on the southeastern corner of the state for part of our analysis because it is home to 49 percent of the state's existing cypress ecosystems. Due to the concentration of cypress resources in this section of the state, in addition to a statewide assessment, we evaluated the FIA data from this area, which the Forest Service calls Unit 1.[8] For the purposes of this study we refer to Unit 1 as the "Southeastern Unit" to be more descriptive. (Figure 1 shows the boundary of the Southeastern Unit.)

Last, we attempted to use as much historical data as possible in our analysis. With the exception of FIA acreage data, the FIA data are readily available for cypress from 1972 to 2010. FIA acreage data for cypress only covers the period from 1997 to 2010.

Some of the key findings based on the FIA data are described below. All sampling errors are reported for the 67% confidence level. Each is discussed in greater detail, as are all of our findings, in Chapter Two:

- **Extent** (Sampling error—0.6 to 57 percent) Cypress forests comprise just over one percent of all of Georgia's forestland. There are an estimated 24.8 million acres of forestland in the state. Of that forestland, 300,000 acres are cypress; 78 percent of those cypress acres are in private ownership.
- **Number of Trees** (Data available from 1972 to 2010. Sampling error—9 to 13 percent.) FIA data indicates the number of all cypress trees on private timberland has declined 40 percent statewide since 1972. In 2010, there were 108.3 million fewer cypress trees statewide than in 1972.
- **Growth Rate** (Data available from 1972 to 2010. Sampling error—13 to 25 percent.) FIA data also indicates that the growth rate of cypress statewide on private timberland has declined by 35 percent between 1972 and 2010, falling from 13.8 million cubic feet to 9 million cubic feet.
- **Acreage** (Data available from 1997 to 2010. Sampling error—19 to 26 percent.) The Forest Service reports acreage for two types of cypress forests—baldcypress/pondcypress and baldcypress/tupelo. The number of acres of both of these cypress forest types on private timberland statewide decreased by 15 percent or 43,912 acres, while large diameter cypress on private timberland fell 28 percent or 63,801 acres according to FIA data.[9]
- **Mortality** (Data available from 1972 to 2010. Sampling error—31 to 33 percent.) FIA data also shows that the loss of cypress trees on private timberland from causes unrelated to harvesting more than doubled statewide between 1972 (1.2 million cubic feet) and 2010 (2.3 million cubic feet).
- **Harvesting** (Data available from 1972 to 2010. Sampling error—29 to 34 percent.) FIA data indicates that between 1972 and 2004, cypress harvesting on private timberland rose substantially statewide. By 2004, harvesting levels had more than quadrupled to 16.7 million cubic feet per year. Between 2004 and 2010, the rate of cypress harvesting dropped steadily, yet it remains 46 percent higher than 1972 levels. Harvest removals in 2010 were 5.1 million cubic feet.
- **Sustainability** (Data available from 1972 to 2010. Sampling error—13 to 34 percent). Finally, FIA data shows that in 2004, the statewide harvest rate on timberland was unsustainable in that removals exceeded growth by 1.0 million cubic feet. Since 2004, harvesting statewide has dropped to sustainable levels. In the Southeastern Unit, harvest levels exceeded growth in the following years: 1989, 1997, 2004, 2005, 2006 and 2007. In 1972, 1982, 2008, 2009 and 2010, harvesting was sustainable in the Southeastern Unit.

TPO Data Analysis

In examining the Timber Product Output (TPO) data, which is derived from data collected at wood-using industries, our primary inquiry concerned how much of the cypress harvested was being processed into mulch. Data concerning mulch production was available for the period from 1992 to 2007. The data reveals the following:

- **Mulch** The volume of cypress trees processed for mulch statewide climbed more than twenty-fold from

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6 Charles H. Wharton. The Natural Environments of Georgia. Georgia Department of Natural Resources, Environmental Protection Division, Georgia Geologic Survey Bulletin 114. Reprinted 2005.

7 There is considerable confusion over whether geographically isolated wetlands retain federal protection under the Clean Water Act. Nothing in this report should be read to speak to this issue. Hence, when we use the term "geographically isolated" wetland, it is not our intent to comment one way or the other on whether a particular wetland is protected under the Clean Water Act.

8 It should be noted that reducing a small sample size further increases the potential for error and reduces reliability of the data.

9 Also see W. Brad Smith et al., U.S. Department of Agriculture, Forest Service, Forest Resources of the United States, 2007 (Table 16) 2009. (Reveals that the oak-gum cypress forest type declined in number of acres across the South from 34,498,000 in 1953 to 28,495,000 in 1997, and to 20,403,000 in 2007.)

0.1 million cubic feet in 1989 to 2.9 million cubic feet in 2007. In 1989, just 5 percent of all cypress harvested in the state was ground into mulch. In 2007, this figure rose to 30 percent.

The three independent sources of data discussed above (FIA, GIS, and TPO) reveal that there may be cause for concern over the long-term health of cypress-dominated wetlands on private lands in Georgia. They show demand for cypress goes up and down. Whether these crests and troughs are due to the economic climate or other factors such as periods of drought that make the swamps more accessible, it is critical that the concerns over cypress discussed in this report are understood and addressed so that the sustainability of cypress can be ensured.

ACTIONS NEEDED TO ADDRESS CYPRESS VULNERABILITY

To address concerns over the long-term health of cypress, we recommend the following actions in six key areas to ensure continued monitoring of the resource as well as the implementation of measures that will provide long-term cypress conservation in Georgia (see Chapter 5 for a full discussion of these conservation measures):

Monitoring and Research

The EPA and the Forest Service should fund additional research into the status of cypress to determine if declines and regeneration problems are occurring. It would be helpful to be able to track cypress forest changes as part of Georgia's land cover mapping program. Local environmental groups could work with the Georgia Forestry Commission to ensure compliance with the federal CWA requirements and BMPs, and to identify high-value tracts of cypress for preservation.

Certification and Consumer Awareness

The EPA, Forest Service, Georgia Forestry Commission, the environmental community, and other stakeholders should develop a certification for cypress mulch that is produced in sustainably-managed, restored cypress forests. Pressures on cypress forests could be eased if discussions among the government agencies, the environmental community, and cypress mulch retailers result in discontinuing the sale of non-certified mulch.

Technical Training

A joint program by the Forest Service and Georgia Forestry Commission should train forestry professionals in sustainable cypress harvesting and replanting techniques. Information regarding cypress forest issues should be distributed and cypress-specific Silvicultural Recommendations adopted. The Georgia Forestry Commission should help landowners evaluate the regeneration potential of their cypress forests and encourage their permanent conservation wherever timbering would be unsustainable. The U.S. Army Corps of Engineers (Corps) should also advise landowners that harvesting on non-regenerating lands does not fall within the CWA silviculture exemption.

Best Management Practices

It is essential that the Georgia Forestry Commission develop and adopt BMPs that address the specific needs of cypress and other wetlands species in order to protect water quality within these ecosystems. Georgia's current wetland BMPs provide protection for water quality through the use of streamside management zones (SMZs) and other techniques designed to minimize disturbance within wetlands. Because harvesting of cypress often involves cutting trees located within Georgia water bodies (forests with periodic or permanent standing water), special BMPs should be developed to protect water quality and ensure sustainability within cypress and similar ecosystems.

Regulation and Enforcement

It is crucial that the Corps and EPA consider the increasing scarcity of cypress wetlands when evaluating potential enforcement cases if further studies demonstrate a loss of cypress. Similarly, the Corps should more carefully scrutinize permit applications that involve cypress stands to ensure that wetlands labeled geographically isolated by the applicant do not in fact meet applicable requirements for CWA jurisdiction. A state wetland protection program should be adopted that provides protection for all of Georgia wetlands, including geographically isolated wetlands. Finally, the Corps should apply a heightened level of scrutiny to applications for the conversion of cypress forests to pine plantations given the potential for declines in the resource.

Cypress Resource Alliance

The Longleaf Alliance has achieved great success in increasing the longleaf pine resource throughout the South. Similarly, cypress stakeholders should be encouraged to engage in a process to develop and implement a conservation plan to increase cypress ecosystems throughout their historic range.

The measures outlined above, and more thoroughly discussed in the final section of this report, require action on the part of government agencies, cypress product retailers, producers, environmental groups, and consumers. However, unless these steps are taken at once to address cypress losses, the future of this important resource may become irreversibly impaired.

CHAPTER 1

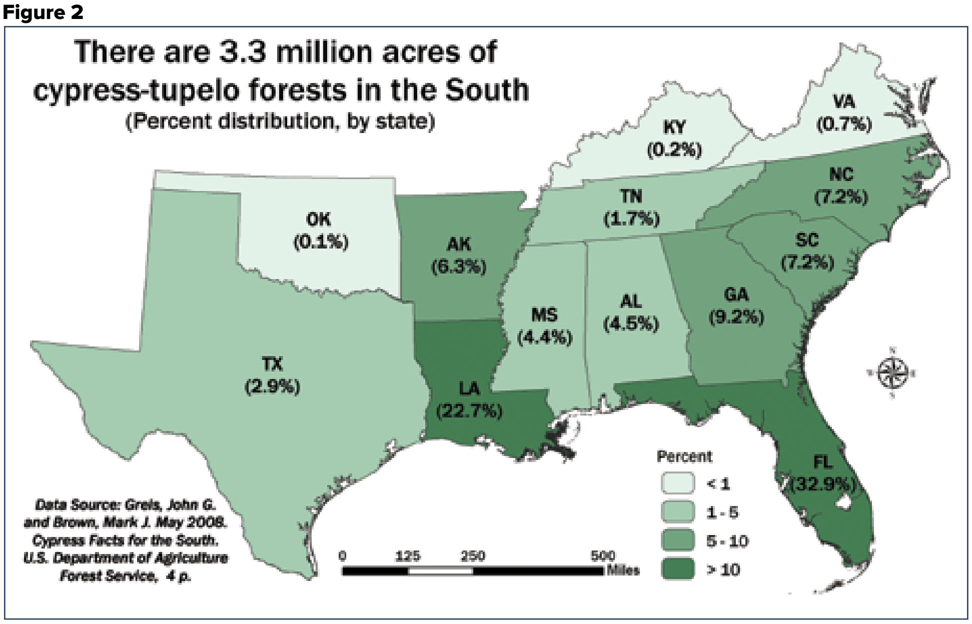
THE IMPORTANCE OF CYPRESS FORESTS

GEORGIA'S COAST AND ITS CYPRESS RESOURCE

From an ecological perspective, Georgia's coastal region is significant on a state and national level. Georgia ranks third nationally in the acreage of cypress forests (Figure 2). As shown in Figure 3, the Georgia coast supports greater species diversity than anywhere else in the state. In a nation-wide report analyzing species data for each state, Georgia ranked second in the nation in its diversity of amphibian species and third in its diversity of fish.[10] Many of these species are located in the coastal region. Alarmingly, however, Georgia ranked near the top—fifth nationally—in the number of species already lost to extinction. Many more species in Georgia are threatened with extinction. These species are concentrated in the coastal counties, which contain more threatened and endangered species than any other region of the state.

Cypress forests are majestic reminders of the coastal region's natural heritage. Cypress trees can live up to 1,500 years and can grow up to 150 feet tall.[11] In Georgia, cypress trees have been recorded up to 44 feet in circumference. Cypress swamps provide habitat to many wildlife species, including some that are rare and endangered, such as wood storks. The abundance of hollow trees in mature stands provides homes for many birds and mammals. In addition to serving the usual functions of wetlands, such as removing pollutants and reducing flooding, cypress swamps support the Georgia economy by attracting tourists. Thousands of wildlife enthusiasts visit the Okefenokee Swamp—the largest swamp in North America—each year to see the alligators, sand hill cranes, and ibises living among the impressive cypress.

Figure 2



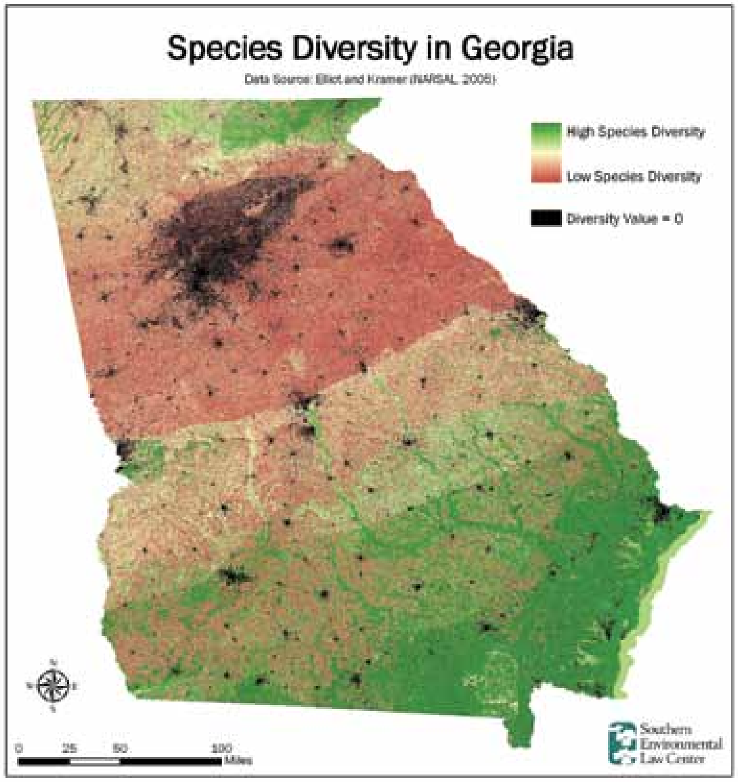
CYPRESS FORESTS AND THEIR VARIOUS TYPES

There are two varieties of cypress trees found in the coastal plain of Georgia—baldcypress (*Taxodium distichum* var. *distichum*) and pondcypress (*Taxodium distichum* var. *nutans*). Both are deciduous conifers and both are known for their tolerance of flooding through physiological adaptations including root outgrowths (knees) and swollen buttressed trunks.[12] Baldcypress grow on river floodplains, along spring runs, and on lake margins—sites with moderate water flow, high nutrient availability, and infrequent fire.[13] Pondcypress generally grow in geographically isolated, shallow ponds and poorly drained areas of the coastal plain where water is still or slow moving, low in nutrients, and low in oxygen. Both cypress variations depend upon periods of dryness in order for seeds to germinate successfully. For pondcypress ponds and domes, dry periods also permit occasional fires to enter from neighboring pine flatwoods and other fire-adapted habitats that commonly surround these forests. With its thicker bark, pondcypress is much more fire-resistant than baldcypress.[14]

The most common type of cypress forest in Georgia, comprising 42 percent of all cypress forests as identified by the NWI, is the semi-permanently flooded, cypress-tupelo gum swamp. The second most common type, comprising 17 percent of all cypress forests, is semi-permanently flooded, pure stands of cypress.

[10] Bruce A. Stein, *States of the Union: Ranking America's Biodiversity* 20–21 (2002), *available at* http://www.natureserve.org/Reports/stateofunions.pdf.
[11] Suncoast Native Plant Society, *Cypress Mulch: Why Kill a Tree to Grow a Flower?*, *available at* http://suncoast.fnpschapters.org/pdffiles/mulch.pdf.
[12] Susan W. Vince & Mary L. Duryea, *Planting Cypress*, University of Florida, Institute of Food and Agricultural Sciences Extension Circular 1458, at 9.
[13] *Id.*
[14] *Id.*

Figure 3



Cypress forests occur in Georgia's coastal plain in a remarkably wide range of different natural wetland settings.[15] The wetland systems include: coastal plain springs (spring-fed streams), blackwater rivers and swamps (slow-moving organic-acid-rice-floodplain streams and swamps), blackwater branches or creek swamps (headwater areas of middle and upper coastal plain streams), alluvial rivers and swamps (rivers and sloughs of the Altamaha, Oconee, and Ocmulgee Rivers), tidewater rivers and swamps (lower, tidally-influenced, areas of coastal plain rivers), backwater streams (lowest stream sections that empty into large rivers where natural levees create a damming effect), Carolina bays (elliptical or oval, depressional wetlands), bay swamps (flat, shallow areas with heavy groundwater seepage from surrounding slopes), cypress bay bog swamps (areas of significant peat deposits), cypress savannahs (flat, wet savannahs of pond cypress mixed with pitcher plants, orchids, lilies, and a number of grasses and sedges), limesinks (areas underlain by limestone rock or dolomite), cypress ponds (irregularly shaped cypress pockets) and cypress domes (round pockets with tall trees in the center).

Many cypress forests in Georgia lack an obvious surface water connection to streams and rivers, but are typically connected hydrologically via groundwater to other wetlands and to rivers and streams.[16] Due to changes in federal jurisdiction resulting from recent court cases, wetlands lacking a surface water connection to a waterbody may no longer receive protection under the CWA. These geographically isolated swamps provide unique habitat values not provided by other wetlands as described in the following excerpt:

> Cypress ponds and related communities, cypress strands, cypress domes, sinkhole ponds, cypress-gum ponds and cypress savannahs, are all non-alluvial wetlands, dominated by pond cypress. These wetlands are a common feature of the southeastern coastal plain occurring in [Georgia]. These wetlands range widely in size from less than 1 [hectare] (0.25 acres) to greater than 10 [hectares] (25 acres), but within the landscape, small wetlands are much more common than are large wetlands. These wetlands are situated in basins or depressions and generally have no connection to aboveground streams or river systems. Fire plays an important role in shaping these communities….
>
> Rain, runoff and shallow groundwater are the dominant sources of water in pond cypress wetlands, with the exception of sinkhole ponds, which are sometimes connected to deeper aquifers….
>
> Cypress domes are … named because of their domed appearance with tallest trees at the center and shortest vegetation at the edges…. Some domes contain non-forested areas of nearly permanent standing water in the deepest center portions of the dome. This community type is most common in … southern Georgia.…
>
> The ephemeral nature of most pondcypress wetlands tends to prohibit the development of an extensive fish fauna, although fish populations can be important in wetlands with permanent or semi-permanent water. [The presence or absence] of fish is related to the period of flooding and the proximity of the wetland to permanent wetlands from which fish emigrate during floods.
>
> A particularly important component of these small, isolated, temporary ponds is [the presence of] amphibians and reptiles. The general lack of predatory fish creates an environment important for amphibian breeding and larval development. Reptiles utilize these wetlands for cover, foraging and hibernation. High diversity and densities of amphibians and reptiles using small isolated wetlands have been documented all over the Southeastern coastal plain.

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15 Charles H. Wharton, *Natural Environments of Georgia*, Department of Natural Resources Environmental Protection Division: Georgia Geologic Survey, Bulletin 114 (1978).

16 Ralph W. Tiner et al., U.S. Dep't of the Interior, Fish & Wildlife Serv., Northeast Region, *Geographically Isolated Wetlands: A Preliminary Assessment of their Characteristics and Status in Selected Areas of the United States* (June 2002).

> There are documented 26 species of amphibians and 36 species of reptiles utilizing these wetlands. Similar numbers of reptile and amphibian species have been found in other isolated wetlands in the southeastern costal plain. Frogs and toads are particularly numerous. Various species of salamanders also utilize these wetlands including the federally threatened flatwoods salamander and the striped newt, a candidate for [federal endangered species] listing.[17]

A FWS report points out that cypress domes are also important for maintaining regional biodiversity.[18] In addition, these wetlands hold water for long periods, and therefore "help prevent flooding of local areas and aid in groundwater recharge." The report goes on to state that "the drainage of [cypress] domes could lead to increased local flooding."[19] Due to the unique habitat and important water-storage and water-quality functions they provide, cypress wetlands should receive heightened consideration.

THE FUTURE OF GEORGIA'S CYPRESS FORESTS

Development has been changing the coastal region's landscape, replacing natural areas with subdivisions and strip malls. Geographically isolated cypress ponds and domes are being hit especially hard by coastal development. Construction in these areas has been facilitated, as is further discussed in Chapter 4, by confusion over whether cypress ponds and domes are protected under the Clean Water Act. Developers may take advantage of this confusion and fill in cypress wetlands without seeking wetlands permits.

Cypress wetlands also suffer indirect consequences from development. Studies have shown that cypress ponds are fire-adapted wetland communities. In the absence of fire, hardwoods out compete cypress, and pond-cypress-dominated wetlands succeed to hardwood swamps.[20] Shrub invasion has also been documented where dome hydrology was altered due to ditching and where fires were excluded. Therefore, as development in the coastal plain continues, anthropogenic alterations to the natural fire regime also contribute to cypress forest losses.

Cypress wetlands suffer additional indirect impacts from impoundments constructed to create municipal, industrial, and agricultural water sources. Although the flooding from impoundments typically does not kill the cypress trees, inundation can prevent regeneration. Despite potential regeneration problems, land owners continue to harvest cypress.

An increased demand for cypress mulch also contributes to pressures on this resource. Prior to the 1990s, landscaping mulch was produced from sawlog byproducts. Recently, however, there has been a surge in demand for mulch made from cypress. To meet this demand, timber companies are also harvesting cypress trees solely for mulch.[21] In addition, scientists at the University of Florida Extension Service have found that timber companies are harvesting younger and younger trees—some as small as a foot in diameter—to grind up into mulch.[22] Such practices may contribute to the vulnerability of cypress resources.

In Chapter 3, we discuss in more detail the factors contributing to the vulnerability of cypress forests in Georgia, including increased mulch production and coastal development. Before we discuss the causes of this vulnerability, we examine the data that assesses cypress forest conditions in Georgia.

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[17] K. McPherson, *Distribution and Composition of Cypress Ponds*, Forest Encyclopedia Network Encyclopedia ID: p. 261, http://www.forestencyclopedia.net/p/p261/ (last visited Jan. 14, 2010) (citations omitted).
[18] *See supra* n.16.
[19] *Id.*
[20] Mary L. Duryea & L. Annie Hermansen, *Cypress: Florida's Majestic and Beneficial Wetlands Tree*, Univ. of Fla., Inst. of Food & Agricultural Sci. Extension Circular 1186, *available at* http://edis.ifas.ufl.edu/FR008 (1997, revised 2000).
[21] *Id.*
[22] *Id.*

CHAPTER 2

CYPRESS STATUS AND TRENDS

DATA ANALYSES

Cypress Trends from the Forest Inventory and Analysis

The USDA Forest Service conducts an ongoing field investigation of forest resources known as the Forest Inventory and Analysis (FIA) to obtain data on the extent, condition, and classification of forest land nationwide. Historic periodic field surveys and annual surveys are conducted under the Forest and Rangeland Renewable Resources Research Act of 1978. Data compiled from ground plots, distributed across the state on a systematic, random grid, are reported as a statistical expansion. According to the Forest Service, the primary objective of the FIA surveys "is to develop and maintain the resource information needed to formulate sound forest policies and programs."[23]

In previous years, the Forest Service collected field data for the state of Georgia and published reports periodically. These include FIA reports completed in 1936, 1953, 1961, 1972, 1982, 1989, 1997, and 2004. These reports provide statistics for measuring changes and trends over time. However, the Forest Service has modified at various times the methods it uses to collect and report these forest statistics. As a result, not all statistics can be compared to historic data. Often, changes in data reporting methods limit data comparisons to the most recent FIA surveys.

Other changes to the FIA are noteworthy. Recently, the Forest Service began continuous monitoring and is making data available under a new collection methodology. Data are now available annually beginning in 1997. Plot data are systematically collected over a 5-year period to complete a full survey cycle for Georgia. Each year 20 percent of the plots are remeasured and compiled with the previous four years of data to estimate the current status.

As with any sampling design, the precision of estimates is limited by plot intensity (spacing) and the distribution of the population of interest (trees). Cypress stands occur in linear riparian areas along rivers and flood plains and as wetland ponds and domes across the landscape. The linear distribution can decrease the probability of capturing the cypress resource completely using the systematic design (plot distribution). Therefore, cypress variables may be underestimated. These data by far represent the best available and most comprehensive information on the status and trends of Georgia's forests. An independent study of FIA stated that "[i]n general, these statistics accurately represent the resource, especially at the inventory-unit and state levels."[24]

For the purposes of FIA data collection and reporting, Georgia is divided into five survey units. Cypress forests occur in the three units nearest the coast. These are units 01, 02, and 03, also known as the Southeastern, Southwestern, and the Central survey units, respectively (see Figure 1 showing the location of the units). The Southeastern Unit contains the greatest concentration of cypress in the state; 49 percent of all cypress timberland acreage is located within this unit. In discussing the data and findings below, we refer to either the Southeastern Unit alone, or the state as a whole, which includes all three Coastal Plain Units. We do not report any FIA data for the Southwestern or Central Units individually because the amount of cypress found in these units is relatively small and the associated sampling error is high.

For the purposes of this study, we obtained all available FIA data for the state of Georgia beginning with the first study in 1936. Due to changes in data collection, plot design and methodology, we were not always able to compare current data with the oldest surveys. Generally, we found data to be more consistently described in FIA reports beginning in 1972 for volume and number of trees. Wherever possible, we reported as much data from 1972 (e.g., number of trees and volume) and subsequent surveys as were available for the variables of interest. However, the Forest Service compiled some types of data for the first time in the 1997 FIA surveys (e.g., acreage). All of the data presented here are shown according to the earliest date of availability.

The Forest Service recently redesigned FIA data methodology. The redesign required a quasi-systematic sample. As a result, some plots were eliminated to meet the sample requirement of one plot per approximately 6000 acres. For uncommon forest types and tree species, such as cypress, sampling errors are high. Queries for private ownership were filtered by forest type and

[23] James H. Perdue, Foreword, in Michael T. Thompson & Larry W. Thompson, *Georgia's Forests, 1997*, U.S.D.A. Forest Service, Southern Research Station, Resource Bulletin, SRS–72 (June 2002) (reporting results of field survey of 1995-1998), *available at* http://www.srs.fs.U.S.D.A.gov/pubs/rb/rb_srs072.pdf.
[24] William Luppold & William H. McWilliams, *Avoiding Spurious Conclusions from Forest Service Estimates of Timber Volume, Growth, Removal, and Mortality*, 21 N. J. Applied Forestry 194, 194 (2004).

filtered again for large diameters (≥9.0" diameter breast height). Then these queries were filtered for the Southeast Unit area. Each time a filter is applied, sampling error increases and the number of plots available for compilation decreases. As an example, sampling error for cypress forest type ranged from 25 percent to as high as 75 percent (95% confidence interval). Because sampling error is high for many cypress variables, it cannot be definitively stated that the resource experienced a significant change. Unless FIA funding is increased to provide adequate sampling for cypress, an alternate means of tracking cypress will need to be developed for future assessments. At this time, FIA remains one of the few sources of data available for evaluating the status of cypress ecosystems in Georgia.

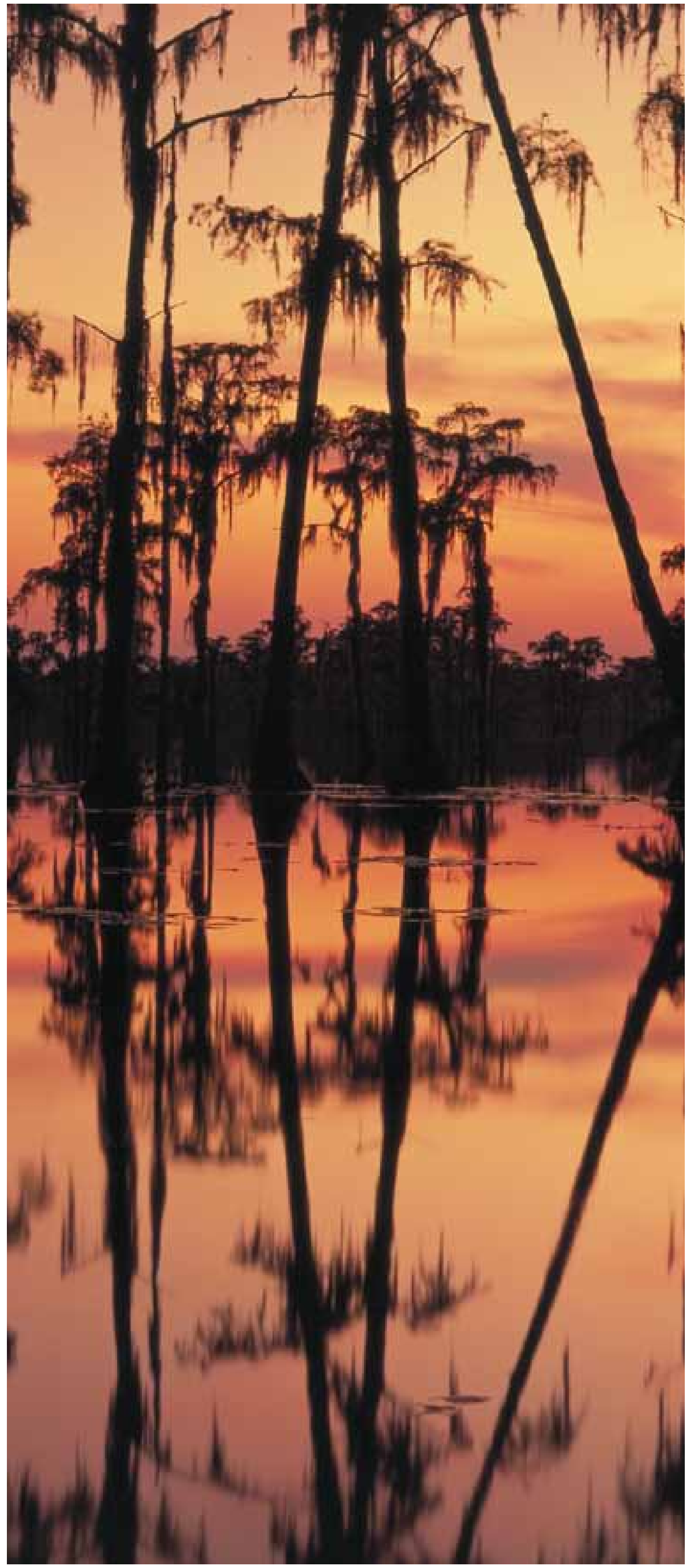
It should be noted that a number of tracts have been removed from private ownership and placed into public ownership and therefore incorrectly appear as a "loss" in private acreage. According to the Georgia Forestry Commission, the number of acres that have changed from private to public ownership is less than 200 acres.[25] Furthermore, it is important to note that public forestland only comprises 8 percent of the forestland in Georgia.[26]

We analyzed the FIA data from an ecosystem perspective. That is, since older large-diameter cypress trees can contain the cavities and crevices that insects and wildlife tend to inhabit, areas with larger older trees provide important habitat. As a result, harvesting of these larger trees can have more severe effects on cypress ecosystems than the loss of smaller diameter cypress. Consequently, we chose to evaluate trends by filtering data for large diameter trees in addition to all cypress trees. Generally, large diameter cypress trees, as categorized by FIA, are 9 inches (diameter breast height or 4.5 feet above the ground) or greater in diameter. Additionally, a portion of our analysis focuses on evaluating the specific status of pondcypress-dominated ecosystems because these forests often occur in cypress ponds or domes that can be more vulnerable to development due to their landscape position.

Below is a description of our findings along with a discussion of the potential implications and prospects for the future of cypress resources given current trends.[27] A glossary of FIA terms is found in Appendix 1 and references for the FIA surveys are found in Appendix 2.

Extent

Cypress forests comprise just over one percent of all of Georgia's forestland according to 2010 FIA data. There are an estimated 24.8 million acres of forestland


CRAIG TANNER (WWW.TMELIVE.COM)

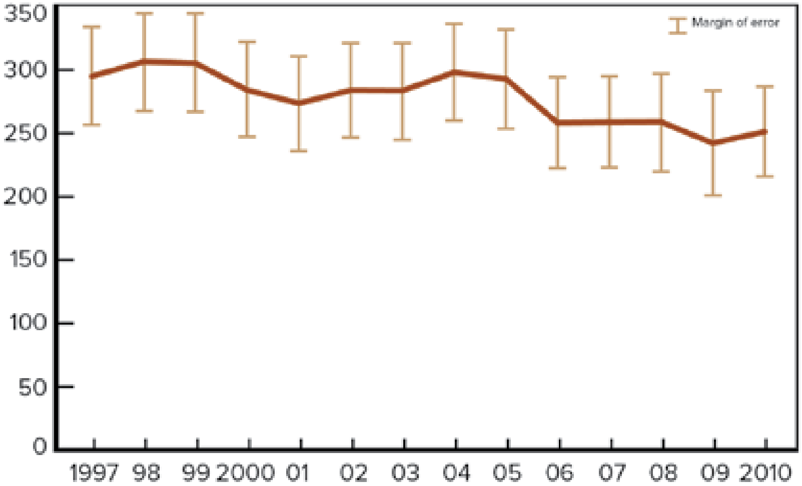
[25] Personal communication, Frank Green, Georgia Forestry Commission, March 10, 2011.

[26] Georgia Forestry Commission, Georgia Forest Facts (undated), citing U.S. Forest Service, Forest Inventory Analysis, 2008.

[27] All estimated sampling errors shown are for the 67% confidence level.

Figure 4

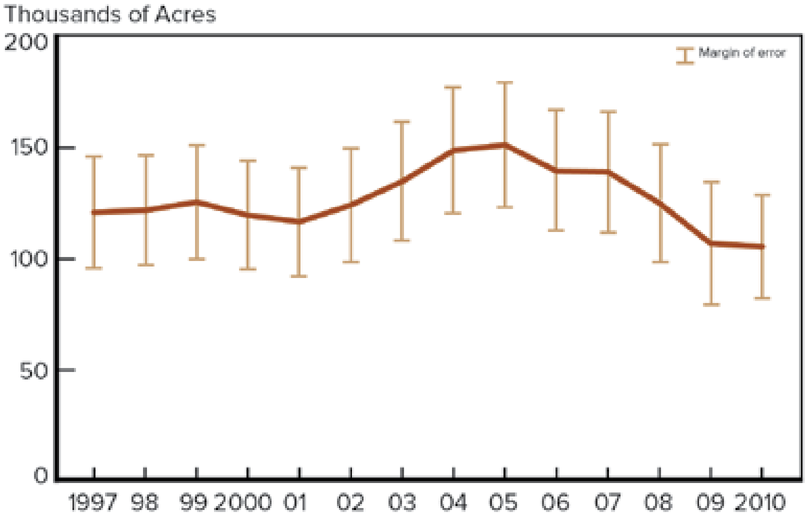
Cypress Forests Statewide, 1997-2010



CARL GALIE

Figure 5

Bald Cypress/Tupelo Forests Statewide, 1997-2010



in the state of which 0.3 million acres are cypress forests. Of these cypress forests, 78 percent are in private ownership.

Acreage (Data only available since 1997)

The Forest Service FIA data show acreage for two types of cypress forests—baldcypress/pondcypress (>50% stocking of cypress) and baldcypress/tupelo (25-50% stocking of cypress). The number of acres of both of these cypress forest types combined statewide decreased by 15 percent or 43,912 acres between 1997 and 2010 (Figure 4). The timberland acreage of both these forest types that contain large diameter cypress trees fell 28 percent or 63,801 acres over that same period of time.

Looking at the two different cypress forest types individually, between 1997 and 2010, baldcypress/pondcypress forests, the most prevalent type of cypress forest in Georgia, decreased by 28,562 acres or 16 percent statewide. This is an average loss of 2,197 acres per year. Baldcypress/pondcypress forests containing large diameter trees indicate a 32 percent decline in acreage (a loss of 41,897 acres) statewide. In the Southeastern Unit, there was a 24 percent decrease in the number of acres of baldcypress/pondcypress forests (a loss of 21,135 acres) between 1997 and 2010.

Baldcypress/tupelo forests in the state decreased by 13 percent (a loss of 15,350 acres) (Figure 5). Large diameter baldcypress/tupelo forests experienced a 22 percent decline statewide (a loss of 21,904 acres). For the Southeastern Unit, baldcypress/tupelo forests increased by 4 percent (a gain of 1,760 acres).

Harvesting

For the period between 1972 and 2004, there was a marked increase in cypress harvesting that peaked in 2004 (Figure 6). Harvesting levels in 2004 were 16.7 million cubic feet per, which was more than four times the rate in 1972. Furthermore, harvest removals for 2004 exceeded growth for that year by 1.0 million cubic feet. Since 2004, the rate of cypress harvesting has dropped steadily, yet nevertheless remains 46 percent above 1972 levels. Harvest removals in 2010 were 5.1 million cubic feet.

In the Southeastern Unit, harvesting more than tripled from 3.2 million cubic feet in 1972 to 12.1 million in 2004—a rate that exceeded annual growth by 4.9 million cubic feet. Harvesting levels exceeded growth for the Southeastern Unit in the 1989,1997, 2004, 2005, 2006, and 2007 FIA surveys. Since 2004, harvesting in the Southeastern Unit has dropped. FIA data for 2010 indicate the present harvest rate is sustainable at 3.1 million cubic feet per year, with annual growth exceeding removals by 2.1 million cubic feet per year.

Sustainability

A common measure of sustainability in forestry is the comparison of growth and removal rates. Generally, when a growth/removal ratio equals one or greater, harvesting rates are sustainable. When the growth/removal ratio falls below one, harvesting is unsustainable, with removals outpacing growth. From 1972 to 2004, the growth/removal ratio for cypress declined statewide from 3.94 to 0.94 and then rose to 1.76 in 2010 (Figure 7).

In the Southeastern Unit, the growth/removal ratio declined from 1.87 in 1972 to 0.48 in 2005. Growth/Removal ratios were unsustainable in the Southeastern Unit in 1989, 1997, 2004, 2005, 2006, and 2007 FIA survey years. The growth/removal ratios were 0.95, 0.99, 0.59, 0.48, 0.49, and 0.74 respectively for those years. The growth/removal ratio in the Southeastern Unit has returned to a sustainable level of 1.66 in 2010.

Number of Trees

All cypress trees (both baldcypress and pondcypress) on private land declined 40 percent throughout the state between 1972 and 2010 (Figure 8). In 2010, there were 108.3 million fewer cypress trees statewide than in 1972. The number of large diameter (≥9.0 inches) cypress trees increased between 1972 and 1997 from 23.5 million to 28.6 million. However, since 1997, the number has steadily declined to 25.1 million. As a result, between 1997 and 2010, large diameter cypress trees have decreased 12 percent, but increased 7 percent since 1972. In the Southeastern Unit, the number of all cypress trees declined 43 percent between 1972 and 2010.

Between 1972 and 2010, the number of pondcypress trees declined 43 percent statewide (a loss of 109.3 million trees). Although the number of large diameter pondcypress trees increased between 1972 and 1997 (an increase of 5.0 million trees), the number has steadily declined since 1997 from 24.0 to 19.9 million trees—a 17 percent decline.

Mortality

The loss of cypress trees from causes unrelated to harvesting (mortality) more than doubled statewide between 1972 and 2010. In 1972, the annual mortality rate for cypress in Georgia was 1.2 million

Figure 6

Harvesting Levels Statewide, 1972-2010

Millions of Acres

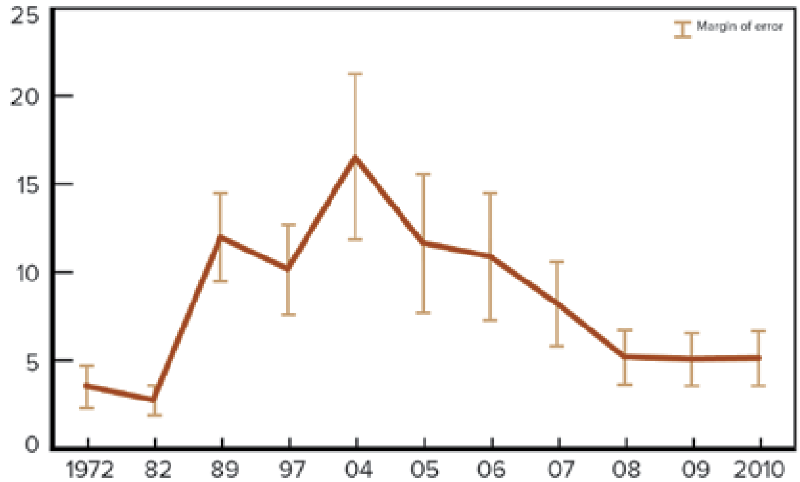


Figure 7

Growth/Removal Ratios Statewide, 1972-2010

Ratio of Growth/Removal

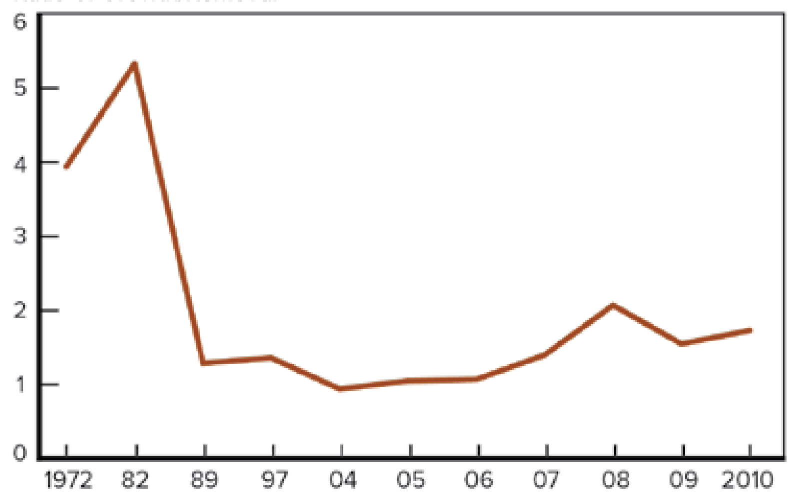


Figure 8

Total Number of Cypress Trees on Private Land, 1972-2010

Millions of Trees

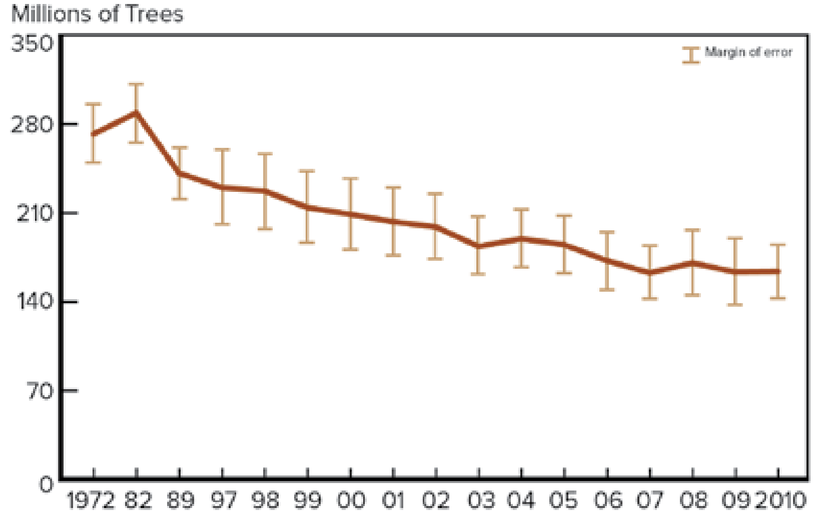


Figure 9

Cypress Mortality Statewide, 1972-2010

Thousands of Trees

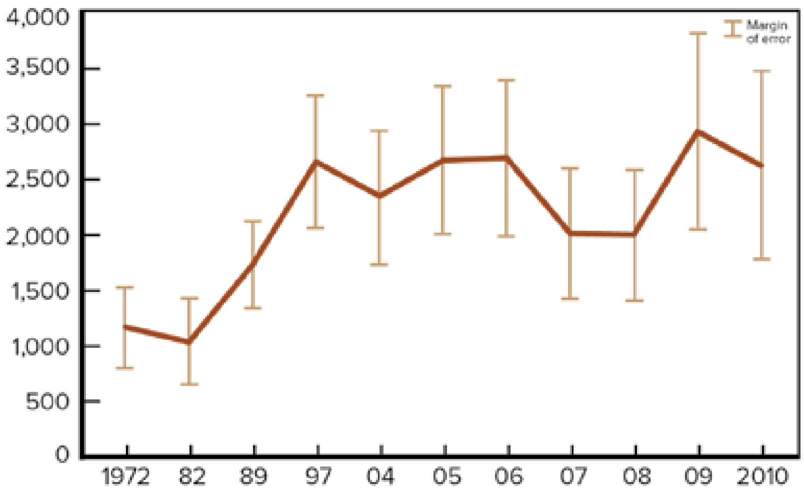


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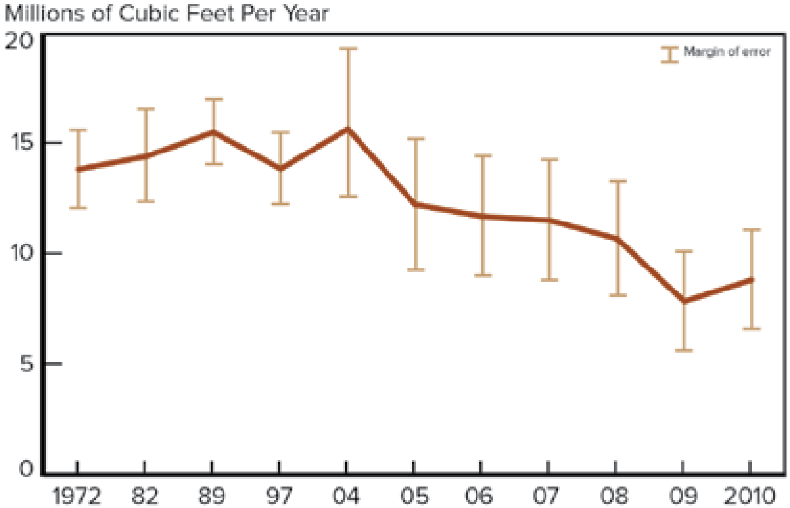
Figure 10

Cypress Forest Growth Rate Statewide, 1972-2010

Millions of Cubic Feet Per Year



cubic feet per year, as compared to 2.3 million cubic feet per year in 2010 (Figure 9). Mortality in the Southeastern Unit increased 142 percent (from 0.7 to 1.8 million cubic feet) between 1972 and 2010. The causes of mortality include a number of factors such as weather. However, because the error associated with these data sets is high, additional research is needed to evaluate the cause of increased mortality. Such studies will be critically important to the future management of the resource.

Growth Rate

Between 1972 and 2010, the growth rate for cypress statewide decreased 35 percent from 13.8 million cubic feet to 9.0 million cubic feet per year. There was an increase in the growth rate of cypress forests statewide between 1972 and 2004. This increase peaked in 2004 at 15.7 million cubic feet per year. Since 2004, the growth rate has declined to 9.0 million cubic feet per year in 2010 (Figure 10). It is possible that the declining trend in growth is related to other factors such as the decline in number of trees and an increase in mortality.

Inventory Volume

The volume of cypress increased between 1972 and 1989 and then declined 10 percent from 1989 to 2010. Overall, volume reported for 2010 was 19 percent higher than the volume reported in 1972. It is possible that the downward trend after 1989 is related to increased harvesting rates for that time period. It appears that prior to that time, existing cypress forests were increasing in volume as those stands matured. Once removal rates increased, however, the expected trend toward increased volume was interrupted.

It is important for the future health of cypress ecosystems to develop methods for more accurately assessing the resource, because current FIA data suggest that cypress and perhaps other wetland species are not being managed in a sustainable manner. The FIA data also suggest that BMPs should be developed to address these concerns to protect water quality. Further investigation into the need for these changes is clearly warranted.

FOREST SERVICE TIMBER PRODUCT AND OUTPUT

Every two years in Georgia, the Forest Service conducts a canvas survey of lumber mills. These data are collected as part of regional and national surveys that track the production of wood products in the United States. The FIA Research Work Unit of the Forest

Service developed the Timber Product Output (TPO) Database Retrieval System to track the data long term. For Georgia, the information is published periodically under the title "Georgia's Timber Industry—An Assessment of Timber Product Output and Use."

The TPO reports show that cypress mulch was not being produced in Georgia as a product until sometime between 1989 and 1992. In 1989, all cypress going to Georgia primary wood product mills was processed for products other than mulch, such as saw logs and pulpwood. The saw mill residues (such as slabs, bark, and sawdust) were chipped and used for product or to generate energy. The 1992 TPO report for Georgia shows for the first time that cypress was processed in the category of "other mills."[28] According to the Forest Service, the "other mills" category produces cypress mulch and chips exclusively.[29]

Mulch Production Trends

The trends in cypress harvesting described above appear to be tied, in part, to the production of cypress mulch. Statewide, mulch production has increased considerably, going from 0.1 million feet in 1989 to 2.9 million cubic feet in 2007 (Figure 11). This represents a more than twenty-fold increase since 1989, when mulch production was first recorded in the state. In 1989, mulch made up just 5 percent of all cypress milled in the state. In 2007, mulch comprised 30 percent of all cypress processed in Georgia (Figure 12). Mulch production peaked in Georgia in 2003 at 7.3 million cubic feet. At that time, mulch made up 52 percent of cypress processed in Georgia. Mulch production levels have dropped in recent years, as the nation has experienced an economic recession. Mulch production may rise again as new construction is spurred by future economic growth.

GIS ANALYSIS

The data collected by the Forest Service are important to the continued monitoring of cypress forests in Georgia. However, spatial data provide an important additional source of information regarding the distribution of changes within the coastal region. Therefore, in addition to analyzing the Forest Service's FIA and TPO data, we also employed GIS techniques to analyze Georgia land cover maps and NWI Data. For a more detailed discussion of GIS Methods used in this study, including limitations and potential errors with using non-ground verified GIS data, see Appendix 3.

The UGA Natural Resources Spatial Analysis Lab (NARSAL) has developed a Georgia-specific land clas-

Figure 11

Cypress Processed Statewide, 1989-2007

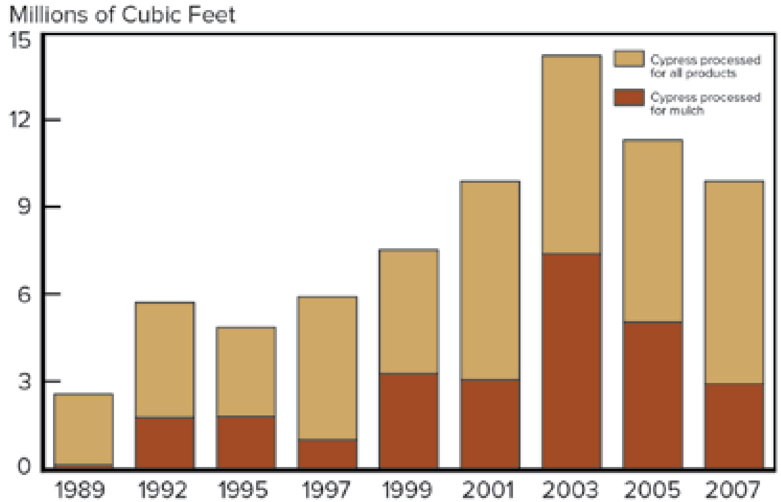
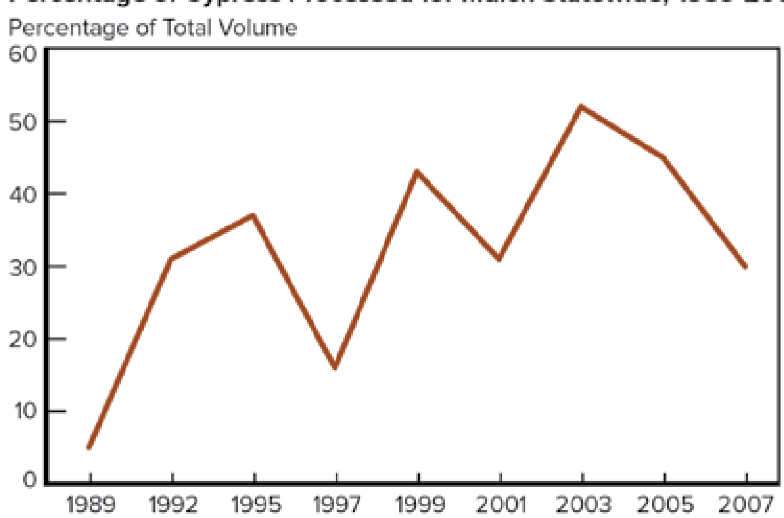


Figure 12

Percentage of Cypress Processed for Mulch Statewide, 1989-2007



[28] Tony G. Johnson, *Georgia's Timber Industry: An Assessment of Timber Product Output and Use*, 1992 (1994), *available at* http://www.srs.fs.U.S.D.A.gov/pubs/rb/rb_se144.pdf.
[29] Tony Johnson, personal communication, Feb. 4, 2008.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sification system that it has applied to multiple years of satellite imagery. The maps provide us with snapshots of land cover conditions at regular intervals. Thus far, land cover maps for 1974, 1985, 1991, 1998, 2001 and 2005 have been created. Because the satellite data utilized to develop the maps are systematically classified, these maps are very useful in tracking changes in land cover over time. For future land cover maps, NARSAL should develop a separate land cover class type for cypress wetlands as a subset of the freshwater forested wetlands class in order to facilitate ongoing cypress monitoring. It is possible that the unique reflective signature for cypress, as Georgia's only needle-leafed deciduous forests, would make such a classification feasible.

As part of our analysis, we prepared three maps. The first map (Figure 13) shows the location of cypress wetlands according to the NWI, and the second shows the status of the NWI cypress wetlands using 2005 land cover data (Figure 14). Lastly, for comparison purposes, we prepared a map showing changes in all wetland types in the coastal region in order to display the distribution of changes in wetland resources overall in contrast to changes in cypress forests (Figure 15).

This effort resulted in some notable findings. The NWI maps identify 249,430 acres of cypress forests in the Georgia coastal plain. These maps were created using photointerpretation of remotely-sensed images taken in the 1980's. The NWI cypress acreage is less than the total cypress acreage reported by the FIA of 312,105 in 1997. The reasons for this discrepancy can be attributed to the differences in the way the data were developed—photointerpretation versus field sampling.

There are a number of inherent sources of error in the photointerpretation methods used by NWI. Tiner reports that these errors include problems associated with minimum mapping size and systematic under-mapping of forested wetlands.[30] NWI maps tend to be more under-inclusive (Type I errors) rather than over-inclusive (Type II errors). Some wetland types are systematically underreported, such as temporarily flooded wetlands, and other wetland types are excluded, such as small, geographically isolated wetlands under 5 acres in size.[31] NWI maps have a target mapping unit (tmu) which is the size class of the smallest group of wetlands that NWI attempts to map consistently. For the Southeast, the NWI tmu is between 1 and 5 acres.[32] As a result, it is likely that many cypress wetlands in Georgia, particularly those that are not permanently flooded or are 5 or fewer acres in size, do not appear on NWI maps.

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30 Ralph W. Tiner, *NWI Maps: What They Tell Us*, 19 National Wetlands Newsletter 7 (1997).
31 *Id.*
32 *Id.*

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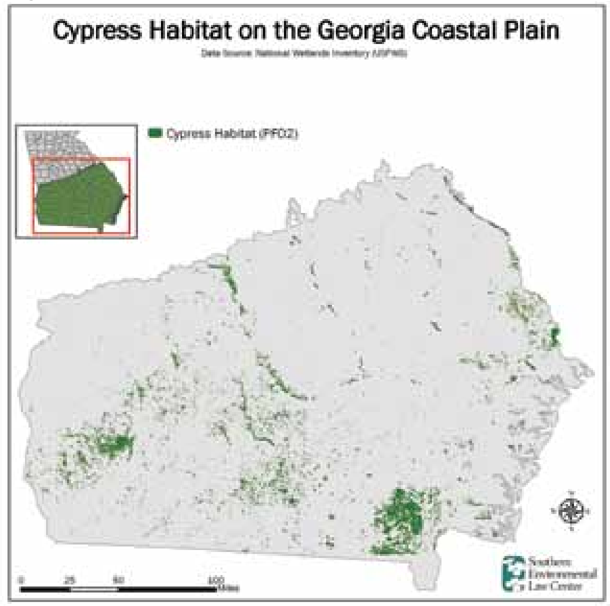
Due to the prevalence of smaller cypress forests in the Georgia coastal region, we would expect substantial underreporting of cypress forest acreage using NWI maps. This systematic underreporting may account for the difference in acreage between NWI maps and FIA surveys. It is possible that due to the confusion regarding the extent of federal authority over many geographically isolated wetlands, we are seeing a disproportionate loss of small cypress domes and ponds. Further investigation into the changes that are taking place in these ecosystems is needed to verify present trends.

It is important to note that despite the shortcomings of NWI in identifying smaller geographically isolated wetlands, the change analysis performed using that data is nevertheless insightful. This change analysis reveals that, of those wetlands that were mapped originally, over half of all geographically isolated cypress wetlands no longer exist. Therefore, this GIS analysis provides further evidence that much of the cypress loss in Georgia is occurring in geographically isolated cypress wetlands.

Figure 13



Summary of GIS Results

According to the NWI, there were 249,430 acres of cypress habitat in the Georgia coastal plain at the time those data were collected—between 1979 and 1986. By 1991, that original area was reduced to 215,347 acres. The area was further reduced to 199,937 acres by 2005. However, 10,053 acres of those wetland acres lost by 1991 had returned to a forested wetland status by 2005 based upon our analysis of the land cover data. Taking that gain into account, the area of cypress habitat in the Georgia coastal plain in 2005 was 209,990 acres, which is 16 percent less area than the baseline assessment that ended in 1986. Perhaps the most significant finding is that these losses account for more than half of all geographically isolated cypress wetlands identified by NWI. Therefore, it appears that much of the loss is occurring in geographically isolated cypress forests, which are more vulnerable due to the uncertainty in federal wetlands law.

Other Noteworthy GIS Results

A review of the cypress loss map (Figure 14) reveals noticeable areas of losses within the Okefenokee Swamp. This raises a question about what could be responsible for such losses in seemingly protected forest areas. One possibility is provided by research done in the Okefenokee Swamp, which found that over 90 percent of the pondcypress has been harvested, and, because of poor pondcypress regeneration, these areas have regrown with non-cypress species in mixed or bay swamps.[33] If the results provided by this GIS analysis are correct, then regeneration failure is impacting cypress forests everywhere in Georgia—not just on private

[33] David B. Hamilton, *Plant Succession and the Influence of Disturbance in Okefenokee Swamp*, *in* The Okefenokee Swamp: Its Natural History, Geology, and Geochemistry 86 (A.D. Cohen et al. eds. 1984).

Figure 14

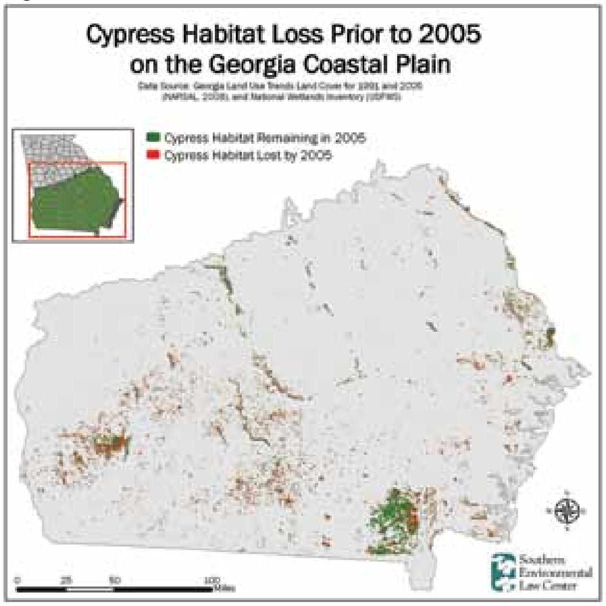
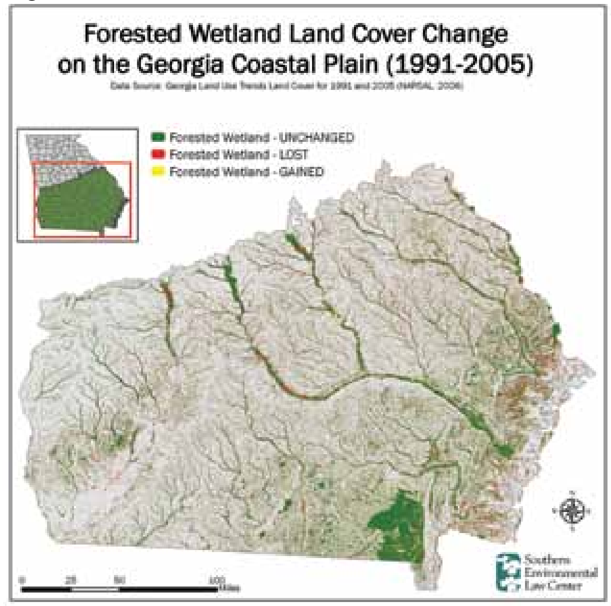


Figure 15



lands. It also raises concerns over the failed protection of these wetlands, even in an area generally deemed to serve as a significant preserve for this important ecosystem.

Fish & Wildlife Service Status and Trends Report

The GIS results discussed above are also supported by the FWS's recent report to Congress on wetlands. The report, which is entitled Status and Trends of Wetlands in the Coterminous United States 2004-2009, is one of a series of such reports to Congress that the FWS compiles every five years. The purpose of the reports is to inform Congress as to whether the coterminous United States is losing or gaining wetland acres. In completing the latest report, the FWS found that between 2004 to 2009: "Wetland losses to silviculture increased considerably since 2004. [And] [s]ilviculture accounted for 56 percent of all wetland losses from 2004 to 2009."[34] Although the study does not contain a breakdown of Georgia's forested wetlands, it also does not provide any reason to believe that Georgia's results would differ significantly from the national data.

LOCAL CYPRESS TRENDS

The results of our assessment of Forest Service and GIS data raise concerns for the long-term health of cypress resources in Georgia. These concerns are bolstered by anecdotal observations being collected by local environmental organizations. For the purposes of this project, we asked the four Riverkeeper groups operating in Georgia's coastal region about cypress trends in their basins. The Altamaha, Ogeechee, Satilla, and Savannah Riverkeepers all confirmed that acreage loss trends identified through our FIA data analyses reflect on-the-ground conditions in their watersheds. These conditions include increased harvesting, mulch production, and development in cypress wetlands, particularly geographically isolated cypress forests. Below is a description of these four major coastal river systems and some of the problems they face, along with a few examples of the activities being observed by the Riverkeepers. The sites described by the Riverkeepers were all harvested within the last few years.

Savannah River

The Savannah River forms most of the boundary between Georgia and South Carolina. Two major cities are found along its course—Augusta and Savannah. The Nature Conservancy describes the Savannah River basin's abundant diversity of life as rivaling that of a South American rainforest.[35] Notwithstanding the river's scenic beauty and natural diversity, the ecological health of the Savannah River system is imperiled for various reasons, including upstream impoundments that have negatively altered the river's flow, dredging that has affected the freshwater-saltwater composition of the estuary, and industrial dischargers that have caused toxic and radioactive contamination. The Savannah River Site and Plant Vogtle, which are both located on the Savannah River, release radionuclides, such as cobalt and tritium, that contaminate fish.[36] Mercury from Georgia Power's coal-fired power plants and from Olin Corporation's chlor-alkali plant also pollutes the river.[37]

[34] Thomas E. Dahl, U.S. Dep't of Interior, Fish & Wildlife Serv., 42 *Status and Trends of Wetlands in the Coterminous United States 2004-2009* (2011).
[35] The New Georgia Encyclopedia, *Tidal Marshes*, http://www.georgiaencyclopedia.com/nge/Article.jsp?id=h-1183 (last visited June 19, 2007).
[36] Radionuclides represent both a human and animal health hazard. *See* Caroline McFarlin & Dr. Merryl Alber, *Assessment of Coastal Water Resources and Watershed Conditions at Fort Pulaski National Monument, Georgia* (2005), *available at* http://www.nature.nps.gov/water/watershed_reports/fopu_final_01092006.pdf.
[37] Savannah Riverkeeper, Projects: Chlor-Alkali Mercury-Free Campaign, http://www.savannahriverkeeper.org/projects.shtml#mercury (last visited June 19, 2007).

Altered Hydrology in the Savannah River Basin

Altered hydrology in the Savannah River basin has been shown to have significant impacts on cypress forests. Recent studies have revealed that dams on the Savannah River have caused a reduction in cypress recruitment and productivity.[38] The timing, duration, and magnitude of floods play an integral role in the establishment and survival of tree seedlings. Floods during the winter months are important for seed dispersal in cypress forests. Flooding during the growing season, however, can cause mortality of newly germinated seeds.

One study documented that post-dam mean monthly flows in the Savannah River have been higher during spring and summer months, resulting in a reduction in germination and survival of cypress seedlings.[39] Another study of cypress along the Savannah found few young trees smaller than 4 inches in diameter. This reflects low recruitment in recent decades.[40] This study also found that the altered hydrologic regime strongly affected regeneration by restricting seed distribution, seedling establishment, and seedling growth.[41] Such hydrologic changes, especially the desynchronization of flooding events, directly influence availability and successful establishment of seeds, both those produced in previous years, which are stored in the soil, and seeds currently dispersing into the community.

Cypress disperse their seeds beginning in late September, peaking in November and ending in early spring. Water typically flows through the Savannah's swamps during the entire flood season. The flood waters transport seeds downstream. According to the study, 70-90 percent of the cypress seedlings that take root later perish due to releases from the Savannah reservoirs that cause higher than normal floods.[42] These results demonstrate the importance to Georgia cypress forests of wisely managing hydrologic regimes in modified river systems so that they are synchronous with natural ecosystem processes. These findings should be considered when agencies are evaluating modification to the schedules of water releases from major federal dams on the Savannah and other rivers.

Figure 16

STACEY KRONQUEST

Figure 17

STACEY KRONQUEST

Figure 18

JOHN CARSWELL, WATERSHED SPECIALIST, SATILLA RIVERKEEPER/FLIGHT BY SOUTHWINGS

[38] Monica M. Palta et al., *Effects of Altered Flow Regimes on Floodplain Forest Processes in the Savannah River Basin*, *in* Proceedings of the 2003 Georgia Water Resources Conference, University of Georgia (Kathryn J. Hatcher, ed. 2003).

[39] *Id.*

[40] Rebecca R. Sharitz et al., *Composition and Regeneration of a Disturbed River Floodplain Forest in South Carolina*, *in* Ecological Processes and Cumulative Impacts: Illustrated by Bottomland Hardwood Wetland Ecosystems 195 (James G. Gosselink et al., eds. 1990).

[41] *Id.*

[42] *Id.*

Observations in the Savannah River Basin

The Savannah River basin is home to Ebenezer Creek, which is designated as a National Natural Landmark and one of Georgia's four Wild and Scenic Rivers. Ebenezer's swamp consists of unusually large cypress, with swollen buttresses that measure eight to twelve feet wide. Some of the trees are estimated to be more than one thousand years old.[43] In January 2008, approximately 100 acres located within Ebenezer swamp were clearcut. The majority of the trees cut were cypress. Figures 16 and 17 show aerial photographs of the site. Other cypress timbering activity has been recently observed in the Savannah River basin, including additional harvesting in the Ebenezer swamp region.

Satilla River

The Satilla River is a blackwater river. It begins in riverine coastal plain swamps and empties into St. Andrew Sound on the Georgia coast. Blackwater rivers are naturally high in organic concentrations from decaying vegetation that produce tannic acids. These acids give the river a dark burgundy color called "blackwater." The Satilla's watershed was covered at one time by extensive longleaf pine and bottomland hardwood forests. These areas were gradually converted to agriculture prior to the twentieth century. Over the past 100 years, much of the land of the Satilla watershed has been converted from agricultural fields to pine plantations. A number of ongoing studies are evaluating the effects of these land-use changes; however, the impacts have not yet been adequately determined.[44]

Observations in the Satilla River Basin

There are numerous sites within the Satilla River basin where cypress were clearcut for forestry and development purposes. Several of these sites are described below with accompanying photographs.

Cypress dome harvesting as part of a subdivision development

Figure 18 shows development in the headwaters of the Little Satilla River, in Brantley County, between the coast and the Okefenokee Swamp. The entire headwater area is perched among sandy ridges, drained by linear wetlands and imbedded with cypress domes. The development in this picture shows the impact development can have on cypres domes.

Riparian cypress harvesting

Figure 19 is of an area in the Big Satilla floodplain that has been clearcut. It is a bottomland hardwood floodplain swamp containing mixed tupelo/gum, loblolly, cypress, and swamp shrubs. This site is privately owned. It is in Pierce County, Georgia, not far downstream from Waycross.

Figure 19

JOHN CARSWELL, WATERSHED SPECIALIST, SATILLA RIVERKEEPER/FLIGHT BY SOUTHWINGS

Figure 20

JOHN CARSWELL, WATERSHED SPECIALIST, SATILLA RIVERKEEPER/FLIGHT BY SOUTHWINGS

Cypress harvesting on public land

This site is owned by Appling County and located in the headwaters of Sweetwater Creek. The site was harvested under the CWA's agricultural exemption (Figure 20).

Pine plantation with cypress ponds

Figure 21 shows a pine-plantation with imbedded cypress ponds, one of which has been cut, and the others of which remain wooded.

Altamaha River

The Altamaha River's watershed is one of the three largest river basins on the Atlantic Seaboard, draining approxi-

[43] *See* The New Georgia Encyclopedia, *supra* n.35.

[44] M. Alber et al., *The Satilla River Estuarine System: The Current State of Knowledge* (2003), *available at* http://www.satillariverkeeper.org/current.pdf.

Figure 21

JOHN CARSWELL, WATERSHED SPECIALIST, SATILLA RIVERKEEPER/FLIGHT BY SOUTHWINGS

Figure 22

JAMES HOLLAND

mately one-quarter of the state of Georgia. Emptying about 100,000 gallons of freshwater into the Atlantic Ocean every second, the Altamaha is truly "Georgia's Mightiest River."[45]

The Altamaha River watershed ranks among the most biologically rich river systems on the East Coast and supports over 120 species of rare or endangered plants and animals, including seven species of imperiled mussels found nowhere else in the world. These characteristics have prompted The Nature Conservancy to identify it as one of "America's Last Great Places."[46]

Unfortunately, land cover in the Altamaha river basin has changed significantly over the last several decades. Between 1991 and 2005, impervious surfaces increased in the river basin by 52 percent.[47] Other significant land use changes in the Altamaha basin include the conversion of hardwood wetland forests to pine plantations. Over 30,000 acres of forested wetlands (or 13 percent) in the lower basin were converted to pine plantations between 1980 and 2001.[48] The impacts from these land use changes on the ecology of the Altamaha should be researched.

Observations in the Altamaha River Basin

Two recent cypress harvests in the Altamaha River basin include sites along the Ocmulgee and Buffalo Rivers. Both sites may have been harvested for timber production. The Buffalo River site, however, may have been harvested for the additional reason of clearing the way for development. Figure 22 shows a clearcut of the headwaters of the Buffalo River in Glynn County. This area is a freshwater tidal site and is located about 12 miles north of the city of Brunswick. Figures 23 and 24 show the Ocmulgee River site.

Figure 23

JAMES HOLLAND

Figure 24

JAMES HOLLAND

[45] The Nature Conservancy, *The Altamaha River*, http://www.nature.org/wherewework/northamerica/states/georgia/preserves/art6633.html (last visited June 19, 2007).
[46] *See* The New Georgia Encyclopedia, *supra* n.35.
[47] Georgia Land Use Trends (GLUT) Project, College of Agricultural & Environmental Sciences, Natural Resources Spatial Analysis Lab, University of Georgia. Information available at http://narsal.uga.edu/glut/watershed.php.
[48] Laura Fabrizio & Eric Ringler, *Assessing Wetland Status and Trends in the Altamaha River Watershed Using TM Imagery* (July 16, 2002).

Ogeechee River

The Ogeechee River is a blackwater system that has been considered for inclusion as a component of the Georgia Scenic River system and was nominated as a potential National Wild and Scenic River due to its ecological and recreational value. The Ogeechee is relatively free of major development except in the lower portions of the basin. Nevertheless, there have been significant development-related water quality problems from a number of sources. One of the biggest problems is excessive nutrient inputs from faulty septic systems and failing sewage treatment systems.[49] These increased nutrient loads disturb the delicate balance in this blackwater river and cause algal blooms and increased aquatic vegetation. In some instances, the pH of the river is altered, upsetting a fundamental characteristic of this blackwater river system—its low pH. Mercury contamination is another prominent issue.[50] Studies show that fish in the Ogeechee have high levels of mercury. More studies are needed to determine the effects of residential and industrial development in the basin and to quantify changes in water quality resulting from development activities on the Ogeechee River estuarine system.

Observations in the Ogeechee River Basin

Recent cypress harvests in the Ogeechee River basin include two sites where the purpose of the cuts—either for timber production or development—is unclear. The first site is located in Emanuel County and was a cypress pond (Figure 25). The second site is a floodplain area along a tributary that ultimately drains into the Ogeechee River (Figure 26).

Figure 25

CHANDRA BROWN

Figure 26

CHANDRA BROWN

CASE STUDY SITE INVESTIGATION

Background and Physiographic Features

The purpose of the Case Study Investigation was to provide an evaluation of cypress regeneration at a Georgia site. We selected the Wilkinson County site as a case study for this project because the site had extensive cypress resources on the property, because the site was accessible, and because the owners had maintained a detailed record of the most recent harvesting activity, which occurred in the winter of 2003-2004. The site comprises 544 acres of land located just below the fall line in the Upper Coastal Plain of Georgia along the Oconee River. The site contains a series of old river channels, an oxbow lake, and several sloughs. The U.S. Geological Survey topographic map of the site shows a series of old river meanders including one labeled Dead River (Figure 27). These channels contribute to a complex topography at the site that includes a series of drainage features that appear to channel both floodwater and precipitation directly to the Oconee and toward a stream that flows along the western perimeter of the site. The U.S. Natural Resources Conservation Service (NRCS) has identified this stream as perennial. The stream flows directly into the Oconee at the southern end of the site (Figure 28). This stream is referred to as "Tobe Lake" by the landowners. The topographic map also indicates that some of the sloughs and the oxbow drain directly into the Oconee.

[49] Ga. Dep't of Natural Resources, Environmental Protection Div., *Ogeechee River Basin Watershed Protection Plan* (2001), *available at* http://www.gaepd.org/Documents/ogeechee.html.
[50] *Id.*

Terrestrial Communities

The site is within the active floodplain of the Oconee River. The NWI map covering the site identifies the area as being comprised of a mosaic of semi-permanently, seasonally, and temporarily flooded wetlands consisting of cypress and other wetland tree species (Figure 29). Much of the site was clearcut in December 2003 and January 2004. At the time of the site visits, in many locations there was a mixture of weedy undergrowth covering tree debris and stumps of cypress and tupelo. In a few areas, the cypress-dominated forests were not harvested in 2004. They are primarily baldcypress and tupelo gum [also known as water tupelo (*Nyssa aquatica*)] and are frequently inundated with water. A few semi-permanently flooded, pure cypress stands remain on the site as well (Figure 30).

Land Use and Soils

The site is mapped by the NRCS as containing three different soil unit types: Chewacla-Chastain association, Chewacla-Congaree association, and Bibb and Kinston sandy loams. According to NRCS, all of these soils are poor for development "because of wetness and the hazard of flooding."[51] A 1991 land cover image of the site and surrounding vicinity shows the area was heavily forested (Figure 31). A 2005 land cover image of the same extent shows much of the tree cover was removed at the site and from surrounding areas (Figure 32). Figure 33 shows a recent aerial photograph of the site and surrounding area.

Site Conditions and Field Methodology

A team conducted an initial field investigation of the site on January 23-24, 2004. Figures 34-43 document site conditions present at that time. A re-evaluation of the site was conducted on October 23, 2007, to determine whether the cypress had grown back. The results of the re-evaluation are summarized below.

Site Re-Evaluation October 23, 2007

By the time we conducted the site re-evaluation, four growing seasons had elapsed since the site was harvested. During the harvest, the area was clearcut of baldcypress and water tupelo, and few baldcypress were left to act as seed trees. We visited six locations at the site, five of which had been harvested. The entire site had been under a drought and every location but the last was free of water, so conditions for natural regeneration to occur had been ideal.

Location 1 was a slough-like area. It was evident that it flooded on a regular basis. There were numerous baldcypress stumps in the central portion of the channel, but very few stump sprouts (Figure 44). Baldcypress

Figure 27

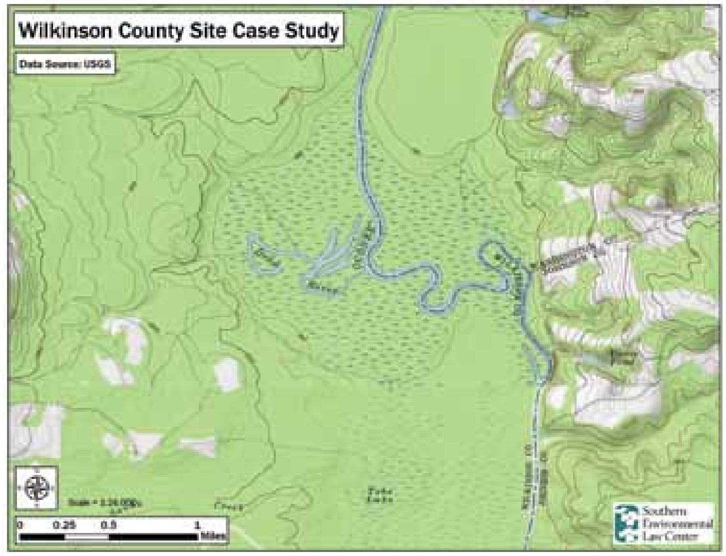


Figure 28

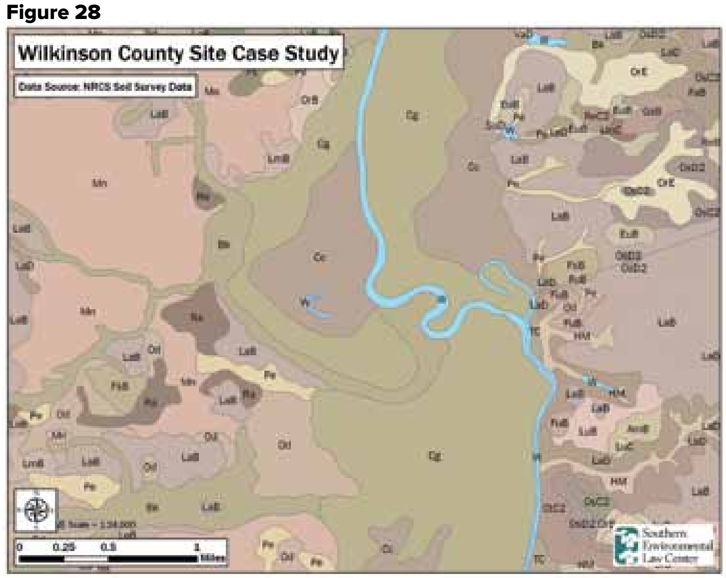
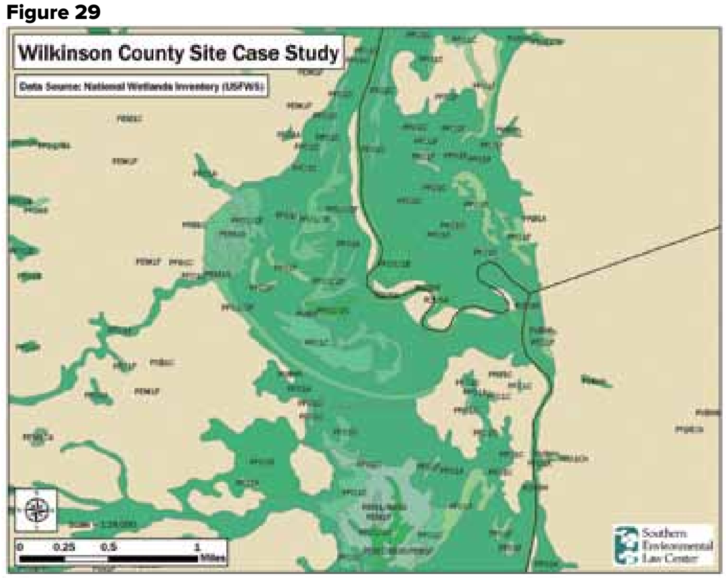


Figure 29



[51] U.S.D.A. Soil Conservation Service, Soil Survey of Washington and Wilkinson Counties Georgia (1985).

Figure 30

seeds are primarily dispersed by water.[52] Baldcypress produce seed or fruit that float for extended periods.[53] The seeds remain viable under prolonged anaerobiosis when oxygen is lacking.[54] Studies have indicated that baldcypress cones or scale clusters float for an average of 18 days, while baldcypress seeds float for an average of 42 days.[55] Baldcypress seeds are dispersed non-randomly, with dispersal being driven by the timing, magnitude, and flow direction of the floodwaters.[56] As shown in Figure 45, seeds were obviously available at the time of logging and had settled out along the edges of the water course. As a result, baldcypress seedlings were growing along those edges.

Figure 31

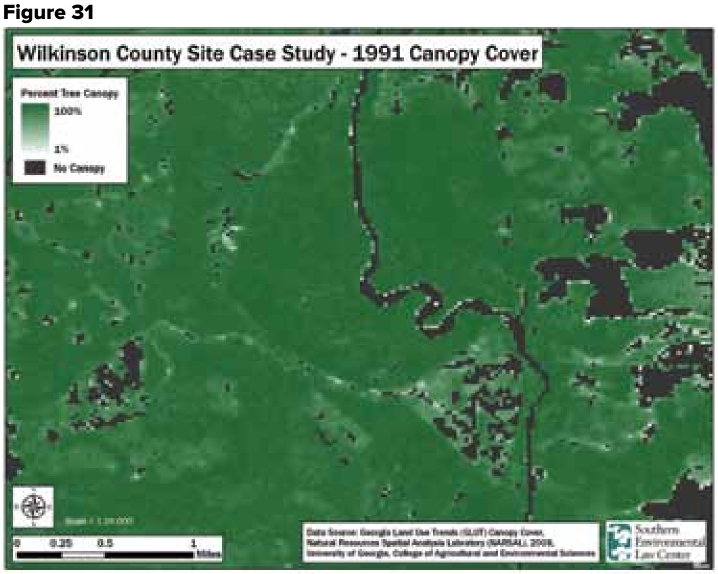


Figure 32

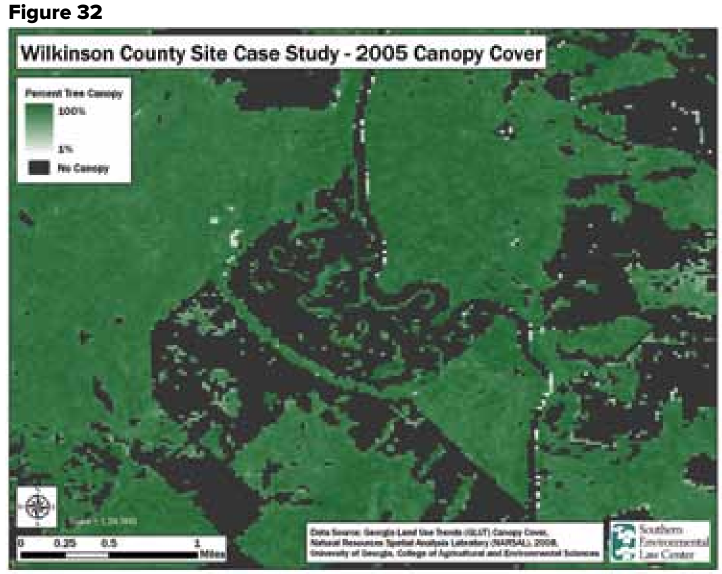


Figure 33

Figure 34

[52] R.L. Johnson, *Nyssa aquatica L. Water tupelo*, *in* Silvics of North America, Vol. 2, Hardwoods 474 (R.M. Burns & B.H. Honkala, tech. coords., U.S.D.A. Forest Service Agriculture Handbook No. 654 1990); L.P. Wilhite and J.R. Toliver, *Taxodium distichum (L.) Rich. Baldcypress*, *in* Silvics of North America, Vol. 1, Conifers 563 (R.M. Burns & B.H. Honkala, tech. coords., U.S.D.A. Forest Service Agriculture Handbook No. 654 1990).

[53] Rebecca L. Schneider & Rebecca R. Sharitz, *Hydrochory and Regeneration in a Baldcypress-Water Tupelo Swamp Forest*, 69 Ecology 1055 (1988).

[54] M.B. Applequist, *Longevity of Submerged Tupelo Gum and Baldcypress Seed*, LUST Forestry Notes, Note 27 (1959).

[55] Schneider & Sharitz, *supra* n.53.

[56] *Id.*

Figure 35

Figure 36

Figure 37

Figure 38

Figure 39

Figure 40

Location 2 was an old channel of Tobe Lake that had been logged right up to and into the channel. Even though this channel was labeled a perennial stream on the NRCS soil maps, the channel was dry at the time of our visit and much of it was vegetated with herbaceous plants (Figure 46). We observed very few baldcypress (or any tree) seedlings and no stump sprouts.

Location 3 was another dry stream course where herbaceous growth was abundant. While some baldcypress stump sprouts were present (Figure 47), the majority of them were dead (Figure 48). Figure 49 is an example of a small and large baldcypress stump side-by-side. At first appearance, it looks as if the larger stump has a very vigorous set of stump sprouts. Upon closer examination, however, we found that the larger stump had no sprouts, while the smaller, younger stump (6-8 inches in diameter) contained many sprouts (Figure 50). This is consistent with the research findings we discuss in the next section.

Location 4 contained a remnant of cypress forest that provides an illustration of what the site looked like prior to logging. This location was scheduled to be logged but was not. The area contains many water tupelo and cypress trees (Figure 51) with at least one old-growth tree (Figure 52). There was little to no herbaceous ground cover due to dense shade from the tree canopy. From the older water tupelo stems, it could be seen that the area had been logged in the past. Many of the water tupelo were multiple stemmed and had rotten or hollowed out bases (Figure 53). These characteristics are indications of previous stump sprouting following past logging.

Location 5 was immediately adjacent to the uncut Location 4. The contrast between ground cover was dramatic. Location 5 was an excellent example of successful natural regeneration from seed (Figure 54). However, stump sprouting was minimal like the other locations. We estimated that probably less than one-third of stumps contained sprouts overall throughout the site, and those with vigorous sprouts were the smaller stumps (Figure 55).

At Location 6, water was still present in the central channel. The majority of the stumps that we could see in this area were water tupelo with fewer cypress. There were no stump sprouts, but we did see some baldcypress seedlings along the edges of the channel.

Case Study Summary

The Wilkinson County logging site is representative of what has been observed at other sites throughout the southeastern United States. Sometimes natural regeneration is successful (as at Location 5), but at other times, it is not (such as at Locations 1-3 and 6). The major problem contributing to regeneration failure is the lack of stump sprouts. Many people assume that stump sprouting, or

Figure 41

Figure 42

Figure 43

Figure 44

Baldcypress stumps at Location 1. Notice the lack of stump sprouts.

Figure 45

Baldcypress seedlings growing on the edge of the channel at Location 1.

Figure 46

Tobe Lake channel (Location 2) showing the proliferation of herbaceous growth.

Figure 47

Baldcypress stump sprouts at Location 3.

Figure 48

Baldcypress stump with dead sprouts.

Figure 49

Figure 50

What appears at first to be a large stump with vigorous sprouts (Figure 49), turns out to be a small stump covering the larger stump (Figure 50).

coppice regeneration, can be sufficient to restore a logged area to its former tree canopy. However, especially at sites that are frequently flooded for long periods, stump sprouts cannot be relied upon. A more comprehensive discussion regarding the limitations of stump sprouting is provided below.

In some areas such as Locations 1, 3, and 6, where no regeneration was observed, baldcypress and water tupelo can be planted to reestablish these forests. Innovative planting methods are required for these areas because of standing water and unconsolidated sediments. Appendix 4 discusses these cypress-specific planting methods in detail.

Other Research

Other research supports the case study conclusions regarding the insufficiency of stump sprouting and the importance of seed germination and replanting to reestablish cypress stands. Although baldcypress tree stumps often sprout, a number of researchers have observed poor vigor and high mortality rates of stump sprouts. Consequently, these researchers have concluded that baldcypress sprouting should not be relied on in regeneration plans.[57]

A study conducted on the stump sprouting of baldcypress following timber harvests in Louisiana in the 1980s found that 80 percent of all stumps sprouted initially after logging, but fewer than 25 percent retained live sprouts four years after harvest.[58] Another report evaluated data from a number of studies in Louisiana following partial harvesting.[59] This report found that stump sprouting was variable, but generally low to insufficient. Similarly, researchers have reported only 17 percent survival of pondcypress stump sprouts a few years after harvests in Florida swamps.[60] Another study found baldcypress sites were characterized by a low percentage of stems originating from stump sprouts.[61] This study also indicated that only small trees impacted by beavers sprouted well. A survey of cypress stands in southeastern Louisiana that were partially logged 10-41 years ago reported a study-wide mean of only 13.9 percent sprout survival.[62]

Several factors limit the coppicing ability of cypress stumps, which can lead to highly variable success rates. Consequently, some studies have shown higher rates of success for stump sprouting. For example, research on pondcypress natural reestablishment rates found stump sprouting success rates to be high in cypress domes.[63] Yet, in another study baldcypress was shown to stump sprout

Figure 51

Uncut stand of water tupelo and baldcypress.

Figure 52

Old-growth baldcypress.

[57] John A. Putnam et al., U.S.D.A. Forest Service, Agriculture Handbook No. 181, *Management and Inventory of Southern Hardwoods* (1960).
[58] William H. Conner et al., *Natural Regeneration of Baldcypress (Taxodium distichum (L.)Rich.) in a Louisiana Swamp*, 14 Forest Ecology and Management 305 (1986).
[59] William H. Conner, *Natural and Artificial Regeneration of Baldcypress (Taxodium distichum [L.] Rich.) in the Barataria Basins of Louisiana* (unpublished Ph.D. dissertation, Louisiana State University 1988).
[60] Katherine C. Ewel, *Sprouting by Pondcypress (Taxodium distichum var. nutans) After Logging*, 20 S. J. Applied Forestry 209 (1996); Emile S. Gardiner et al., *Impacts of Mechanical Tree Felling on Development of Water Tupelo Regeneration in the Mobile Delta, Alabama*, 24 S. J. Applied Forestry 65 (2000).
[61] David R. Spencer et al., *Early Secondary Succession in Bottomland Hardwood Forests of Southeastern Virginia*. 27 Environmental Management 559 (2001).
[62] Richard F. Keim et al., *Long-Term Success of Stump Sprouts in High-Graded Baldcypress-Water Tupelo Swamps in the Mississippi Delta*, 234 Forest Ecology & Management 24 (2006).
[63] Valery J. Terwilliger & Katherine C. Ewel, *Regeneration and Growth After Logging Florida Pondcypress Domes*, 32 Forest Sci. 493 (1986).

Figure 53

An example of old water tupelo stump sprout. The stump has rotted away leaving the two stems.

Figure 54

Location 5 contained large clusters of baldcypress seedlings that originated from seed throughout the area.

Figure 55

Stump sprout on small baldcypress stump.

with considerable variability in ten Florida swamps, leading one researcher to call for a better understanding of the factors that control coppice regeneration.[64]

The amount of overstory removal in a Louisiana second-growth cypress-tupelo forest was found to affect the number of live sprouts found three years after harvest.[65] Stump sprouting was shown to be less successful in dense stands. Overall, survival was very poor just three years after harvest, and the sprouts were not expected to develop into quality trees because of frequent and prolonged flooding.

Sprouting is most prolific on young stumps from stems harvested during the dormant season. One study indicated that baldcypress stumps 10-14 inches in diameter reliably sprout when trees are harvested in the fall or winter.[66] Similarly, another researcher found good regeneration by sprouts following clearcutting in a Florida baldcypress swamp where the average diameter of harvested trees was 12.5 inches.[67] In contrast, however, a separate study reported that stumps of vigorous stock up to 60 years old can generally be counted on to send up healthy sprouts.[68] Therefore, though the weight of research points towards greater sprouting success in younger trees, more research should be conducted to identify conditions that may lead to increased sprouting success in older stands.

In addition to age and season of harvest, stump height, felling method, and harvesting level can influence the viability of stumps and vigor of sprouts.[69] Even with ideal

[64] Katherine C. Ewel et al., *Recovery of Florida Cypress Swamps from Clearcutting*, 13 S. J. Applied Forestry 123 (1989).

[65] Robert S. Prenger, Jr., *Response of a Second-Growth Natural Stand of Baldcypress Trees (Taxodium distichum (L.) Rich.) to Various Intensities of Thinning* (1985) (unpublished M.S. thesis, Louisiana State University).

[66] O. Gordon Langdon, *Silvical Characteristics of Baldcypress*. U.S.D.A. Southeastern Forest Experiment Station, Station Paper No. 94 (1958); H.L. Williston et al., *Cypress Management: A Forgotten Opportunity*, U.S.D.A. Forest Service, Southeastern Area, Forestry Report SA-FR 8 (1980).

[67] R.W. McGarity, *Ten-Year Results of Thinning and Clearcutting in a Muck Swamp Timber Type*, 3 S. J. Applied Forestry 64 (1979).

[68] W.R. Mattoon, *The Southern Cypress*, U.S.D.A. Agriculture Bulletin No. 272 (1915).

[69] Ewel, *supra* n.60; Gardiner et al., *supra* n.60.

conditions, stump sprouting still remains an unreliable method of forest regeneration. A study of cypress regeneration after clearcutting in the Mobile-Tensas River Delta of Alabama found seedling regeneration to be high, but stump sprouting to be low (representing only 7 percent of the first year regeneration), despite ideal site conditions.[70] No long-term measurements were reported, but stump sprout survival would be expected to decline over time.

Regeneration from Seed

Due to the limitations of stump sprouting, seed germination is an important part of regeneration. Previous studies of regeneration have concluded that natural establishment of seedlings is closely tied to hydrological and light conditions,[71] as well as herbivory.[72] Where natural flood regimes and water levels have been altered due to impoundments and other structures, seed regeneration is limited.[73] On sites where seeds are limited at the time of harvesting due to the timing of the cut or other factors, stump sprouting may possibly provide a supplemental source of seeds within a few years. A report published by the Florida Forestry Association supports the view that cypress stands can regenerate in part from seed produced by stump sprouts. Stump sprouts typically start to produce seeds in the first few years after harvesting.[74] This "coppice seeding" augments regeneration from stump sprouts and seeding from residual uncut trees. Thus, even if stump sprouts die after a few seasons, they may survive long enough to produce seeds.

Additional research should be undertaken to evaluate the degree to which coppice seeding can successfully augment regeneration from stump sprouts and seeding from residual uncut trees. This information could be used in developing BMPs to ensure that adequate seed sources are present on sites left to regenerate naturally. Based upon our understanding of the limitations of stump sprouting, the agencies responsible for the regulation and management of activities in cypress wetlands should require replanting or prohibit harvesting in areas where seed regeneration will be impeded.

[70] Gardiner et al., *supra* n.60.
[71] James S. Meadows & John A. Stanturf, *Silvicultural Systems for Southern Bottomland Hardwood Forests*, 90 Forest Ecology & Management 127 (1997).
[72] R.M. Blair & M.J. Langlinais, *Nutria and Swamp Rabbits Damage Baldcypress Seedlings*, 58 J. Forestry 388 (1960); W.H. Conner & J.R. Toliver, *The Problem of Planting Louisiana Swamplands When Nutria (Myocastor coypus) Are Present*, *in* Proceedings Third Eastern Wildlife Damage Control Conference, Alabama Cooperative Extension Service, Auburn University 42 (N.R. Holler ed. 1988); W.H. Conner & J.R. Toliver, *Use of "Vexar" Seedling Protectors Not Effective in Reducing Nutria Damage to Planted Baldcypress Seedlings*, 38 Tree Planters' Notes 26 (1987).
[73] William H. Conner & J.R. Toliver, *Long-Term Trends in the Baldcypress (Taxodium distichum (L.) Rich.) Resource in Louisiana*, 33/34 Forest Ecology and Management 543 (1990).
[74] Peacock and Associates, Inc., Cypress Task Force Report (2002).

CHAPTER 3

THE MULTIPLE CAUSES OF CYPRESS VULNERABILITY

INCREASED DEMAND FOR CYPRESS MULCH

Prior to the inception of this study, research in Louisiana and Florida confirmed that pressures on cypress forests in those states had grown in recent years and their cypress stands had increasingly been harvested for the production of cypress mulch. One of the purposes of this study was to determine if Georgia's cypress forests are under a similar threat and whether manufacturers of cypress mulch are turning to Georgia forests as Louisiana and Florida resources decline. The data analyzed for this project indicate that production of cypress mulch in Georgia has contributed to increased harvesting. As described above, TPO data from the Forest Service shows that the processing of cypress trees for mulch climbed close to twentyfold from 0.1 million cubic feet in 1992 to 1.7 million cubic feet in 2007.

Consumer Demand

One primary factor contributing to the popularity of cypress mulch as a landscaping product is a prevailing misconception that it is better than other mulches. Many retailers tout cypress mulch as a long-lasting, insect- and rot-resistant mulch. In addition, cypress mulch is advertised as a premium mulch for playgrounds because it supposedly is softer than other mulches. Cypress mulch is also promoted as a quality bedding material for pet and zoo amphibians and reptiles. These opinions have caused cypress mulch to become a leading mulch type.

The University of Florida Cooperative Extension Service (UFCES) reports 60 percent of Florida's landscape mulch sold at home and garden centers is cypress, 20 percent is pine-bark mulch with other types of mulch making up the remaining 20 percent.[75] Originally, the cypress mulch industry began by using waste wood produced from sawing operations. But with an expansion of cypress mulch use in the last several years, the amount of waste wood available has become inadequate to meet demand. As a result, mulch is now being produced directly from whole trees of all sizes, including those considered too small to be merchantable.[76]

Research by the UFCES shows that cypress mulch performs no better than other mulches.[77] The study evaluated 15 different kinds of landscaping mulches over a six-month period to compare the effectiveness of alternative mulches. The results showed three mulches—wood chips, pine bark, and pine straw—rated just as high as cypress.[78] This research also showed that cypress mulch, when used in full sunlight, can form a type of crust that restricts water movement and reduces the amount of water received by plant roots.

Consumers often buy cypress mulch under an incorrect assumption that it is more durable and longer-lasting.[79] Although the heartwood of very large, older trees contains chemicals that act as preservatives, resulting in greater wood durability and rot resistance, such trees are reserved for saw timber. Mulch is made from younger trees that do not have the heartwood found in older trees; so today's cypress mulch is not likely to be longer lasting than any of the other mulches.[80]

Anecdotally, consumers have posted many complaints about their experiences with cypress mulch. Despite this, online gardening information sources are filled with advice to readers telling them that cypress mulch is superior to other mulches. In addition, numerous internet retailers proclaim the advantages of using cypress mulch.

For the purposes of this assessment, we searched the internet for cypress mulch retailers and found over three hundred seventy-five of them. Many vendors label cypress mulch as a premium product. In addition to online retailers, there are numerous store retailers. The "Green Industry Search Professional" engine (available at http://www.giyp.com/) listed an additional 176 mulch suppliers.

A number of these retail websites promote the use of cypress mulch. In addition, numerous gardening forums, such as Southern Living Garden Know-How and iVillage Garden Weed Forum, have posted information from users detailing the various benefits of cypress mulch products.

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75 *See* Duryea & Hermansen, *supra* n.20.
76 *See* Suncoast Native Plant Society, *supra* n.11.
77 Mary L. Duryea, *Landscape Mulches: How Long Do They Retain Their Color?*, University of Florida, IFAS Extension, document # FOR 68 (1999, reviewed 2006).
78 Sylvia K. Beauchamp, *Cypress: From Wetlands and Wildlife Habitat To Flowerbeds And Front Yards*, University of Florida News, Thursday, April 11, 1996, *available at* http://news.ufl.edu/1996/04/11/mulch/.
79 According to Susan Vince, visiting assistant professor at the University of Florida, School of Forest Resources and Conservation, cited in *id.*
80 *Id.*

Alternative Products

Alternatives to cypress mulch are also being marketed. Of note, the Go Mulch Company deserves special commendation for offering an environmentally sensitive alternative known as FloriMulch®, which is made out of Melaleuca.[81] Also noteworthy is Custom Cypress, a company that claims all of its mulch is produced as a by-product from its sawmill operation.[82]

There are a few articles on the internet that advise gardeners and others to use alternative products for ecological reasons. These consumer education pieces include several articles from the UFCES recommending alternative products such as melaleuca chips, pine nuggets, and pine straw. Other articles challenge the notion that cypress mulch is superior to other mulches and cite poor durability as well as other factors that make it inferior to pine bark.[83] More outreach is needed on this issue in order to raise awareness and change consumer habits. Given the availability of alternative products on the market, this should not be difficult. However, if consumers continue to be told that cypress is a superior mulch, and cypress continues to be readily available, the cypress mulch industry will continue to grow.

Mulch Producers in Georgia

The Georgia Forestry Commission maintains a listing called the "Wood Using Industries Online Directory." This database lists companies that claim to use various different tree species for their products. There are 71 companies listed as using cypress in Georgia. In addition, there are 12 cypress chip mills listed, of which 11 are also listed as cypress mulch mills. If we consider this information along with the Forest Service TPO data, these 11 mills have the capacity to process 1.7 million cubic feet of mulch or chips per year.

Cypress Mulch in Florida

As an indication of what could happen in Georgia, we looked at the cypress industry in Florida. Statewide in Florida, 129,000 tons of cypress mulch and 145,000 tons of cypress lumber are produced per year from wetland cypress trees.[84] Per year, 20.4 million cubic feet of cypress are cut, but the cypress growth rate is only 17.1 million cubic feet.[85] Therefore, harvest rates are not sustainable. In addition to the ecological concerns regarding unsustainable harvesting, there is a social price as well. Unsustainable cypress management practices deprive future generations of the benefits of this important resource and of recreational opportunities provided by stands of mature cypress.[86]

Initiatives to Address Mulch Supply

The Save Our Cypress Coalition in Louisiana reached an agreement with Wal-Mart to no longer buy or sell cypress mulch that is harvested, bagged, or manufactured in Louisiana. The agreement became effective January 1, 2008. The Save Our Cypress Coalition has also held discussions with two other major retailers, Home Depot and Lowe's, to stop selling cypress mulch. As a result of these negotiations, Lowe's and Home Depot have implemented a purchasing moratorium on mulch from cypress harvested south of I-10/I-12 in Louisiana, excluding the Pearl River Basin. Unfortunately, it is very difficult to ensure that timber harvesters are complying with these agreements as no system of certification or tracking is currently in place. Save Our Cypress has indicated that there are chain-of-custody concerns with suppliers to the retailers and that many of the brands of mulch produced in Louisiana are labeled with addresses in Florida, Texas, and Arkansas.

HYDROLOGIC CHANGES

Although cypress forests have become increasingly attractive for mulch production in recent years, increased flooding of these forests is preventing some stands from regenerating naturally by seed.[87] Increased flooding can be a severe limitation on regeneration, because baldcypress seeds do not germinate under water and seedlings cannot survive prolonged inundation.[88] For cypress seeds to germinate, a number of site conditions must be right. The timing of the harvest is critically important, as well as the timing, extent, and duration of flooding. Seeds require a flood for dispersal, then a subsequent dry period for establishment. Seed trees must be spared during the harvest to provide seeds, or stump sprouts must mature sufficiently to produce seed. Ideally, trees should be felled after the seeds have fallen for that year. If no seed trees have been left at a site and stump sprouts fail to yield seeds, a site may fail to

[81] *See* the vendor's website at: http://www.gomulch.com/index.cfm/name-cont.askanexpert/app_qid-9. Information from the website states the product is: 1) made from 100 percent Melaleuca, an invasive tree to native wetlands; 2) uniquely cured to eliminate burrowing nematodes; 3) State Certified Nematode Free by the Florida Department of Agricultural; 4) Tested by the University of Florida to be termite resistant; and 5) Endorsed by Friends of the Everglades using standards defined by Florida's Native Plant Society.

[82] *See* http://www.customcypress.com/.

[83] D. Swain, *Five Disadvantages of Cypress Mulch*, Sept. 28, 2007 at http://www.associatedcontent.com/article/391575/five_disadvantages_of_cypress_mulch.html.

[84] B.J. Jarvis, *Mulches - Why Extension Recommends That You NOT Use Cypress Mulch in Your Landscape*, Pasco County Cooperative Extension Horticulture Agent, University of Florida, Institute of Food and Agricultural Sciences, Extension Service, *available at*: http://gardeningpasco.ifas.ufl.edu/mulches.shtml.

[85] *Id.*

[86] Paddling down Ebenezer Creek near Savannah, Georgia, would be a different experience without the cypress canopy overhead.

[87] Conner & Toliver, *supra* n.68; William H. Conner et al., *Comparison of the Vegetation of Three Louisiana Swamp Sites with Different Flooding Regimes*, 68 Amer. J. Botany 320 (1981); Conner et al., *supra* n.54; Coastal Wetland Forest Conservation & Use Science Working Group, Conservation, Protection and Utilization of Louisiana's Coastal Wetland Forests (April 30, 2005).

[88] Delzie Demaree, *Submerging Experiments with Taxodium*, 13 Ecology 258 (1932); Rebecca Faye Souther & Gary P. Shaffer, *The Effects of Submergence and Light on Two Age Classes of Baldcypress (Taxodium distichum (L.) Richard) Seedlings*, 20 Wetlands 697 (2000).

regenerate. If seed is present but the ground is flooded for an extended period of time, the seeds may rot before they settle on the soil. Hydrological modifications make this latter scenario more common.

In 2005, the Coastal Wetland Forest Conservation and Use Science Working Group (SWG) that was studying cypress harvests in Louisiana found that up to 80 percent of harvested cypress stands will not regenerate because of increased water levels.[89] As the number of water impoundments affecting Georgia's coastal region continues to multiply with development, impediments to cypress regeneration due to altered hydrology can be expected to increase.

REGENERATION

As explained above, far too many foresters forgo replanting and rely on stump sprouts to regenerate their cypress stands. Georgia foresters have stated that cypress trees will successfully regenerate from stump sprouts.[90] However, the research discussed in the previous chapter shows that even though some stumps do sprout after harvesting, those sprouts slough off after four or five years and do not ultimately succeed. Due to decomposition, rotting stumps provide a poor substrate for sprouting trees. Consequently, in most cases, stump sprouting is inadequate to regenerate harvested sites, so that seed regeneration and supplemental planting is needed. The results of these studies are confirmed by our observations at the Wilkinson County case study site described above. The SWG also reached the same conclusion regarding the ineffectiveness of stump sprouting.[91] The SWG concluded that the use of early sprouting results often highly inflates actual long-term regeneration estimates and probably leads to unreliable predictions of success. This misleading information is likely responsible for the technical misconceptions that prevail. It is our hope that this report will help to correct the misconceptions surrounding cypress stump sprouting.

COASTAL DEVELOPMENT

Development has been contributing to cypress wetland losses. As discussed in the next chapter, geographically isolated cypress ponds and domes are especially vulnerable due to two recent U.S. Supreme Court decisions that have created confusion over the limits of CWA protections.

It is undisputed that the coast's population has experienced tremendous growth. In 2006, the Coastal Georgia Regional Development Center (CGRDC) contracted with Georgia Tech to make population projections through the year 2030 for a ten-county area in the coastal region. The study found that the ten-county area jumped in population by 62 percent between 1970 and 2000 and will increase another 51 percent by 2030.[92] The study also predicted explosive growth for individual counties, such as Long County (119 percent), Effingham County (113 percent), and Bryan County (96.4 percent). Figure 56 depicts the results of the CGRDC's study and shows projected population growth for eight of the coastal counties. Although these trends may have been slowed by the economic recession, these predictions could be indicative of future growth.

Land Availability for Development

Despite a slowing economy, development continues to stretch up and down the Georgia coast spurred on by access to readily available land. Developers are capitalizing on significant land acquisition opportunities such as land that is being sold by timber companies that are divesting large land holdings. As has increasingly become the case, once market conditions in an area become favorable for development, timber growers sell their land to developers or develop the areas themselves. These companies recognize that selling their properties or developing their lands themselves can bring greater profits than growing trees.

A spokeswoman for International Paper Company, which has large holdings in coastal Georgia, reported in 2006 that the company was "contemplating selling some or all" of its 6.8 million acres of forest lands in the United States.[93] As of January 3, 2006, International Paper owned 571,000 acres in Georgia.[94] Since 2006, International Paper has sold almost all its land in Georgia.[95] Other timber companies have large land holdings in Georgia, too. Plum Creek owns about 742,000 acres[96] and MeadWestvaco owns about 200,000 acres in Georgia.[97] As these holdings are sold, they will become increasingly vulnerable to development. Rayonier is actively seeking to sell 200,000 acres of land along the Georgia and Florida coasts.[98]

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89 Coastal Wetland Forest Conservation & Use Science Working Group, *supra* n.5.

90 Mike Morrison, *Mulchers Debate Use of Cypress, Overharvesting Could Damage Marsh, Some Say*, Morris News Service, May 8, 2007; Mary Landers, *Ebenezer's Ancient Cypress Fall*, Morris News Service, Feb. 17, 2008.

91 *See* Coastal Wetland Forest Conservation & Use Science Working Group, *Conservation, Protection and Utilization of Louisiana's Coastal Wetland Forests: Final Report to the Governor of Louisiana from the Coastal Wetland Forest Conservation and Use Science Working Group* (Apr. 30, 2005).

92 *See* Ctr. for Quality Growth & Reg'l Development, Ga. Inst. of Tech., *Georgia Coast 2030: Population Projections for the 10-County Coastal Region 3* (2006), *available at* http://www.crc.ga.gov/docs/cgrdc_population_report_101806.pdf.

93 Juliet Eilperin, *Timber Firms' Sell Off Worries Groups*, Wash. Post, Mar. 21, 2006, at A01.

94 *See* http://www.redlodgeclearinghouse.org/news/01_03_06_stakes.html (last visited June 5, 2007).

95 Personal telephone communication, January 12, 2012, Robert Tobermann, International Paper Realty Corporation.

96 *See* http://www.plumcreek.com/timberlands/arcesbystate/tabid/65/Default.aspx?#table (last visited Dec. 29, 2011).

97 MeadWestvaco, Forest Land Managed in Acres as of 12/31/2006, http://www.meadwestvaco.com/sustainability.nsf/v/page_1 (last visited June 5, 2007).

98 See Press Release, Rayonier Completes Acquisition of 250,000 Acres (Nov. 29, 2011), available at http://finance.yahoo.com/news/Rayonier-Complete-bw-1305678925.html (last visited on Dec. 28, 2011).

Figure 56

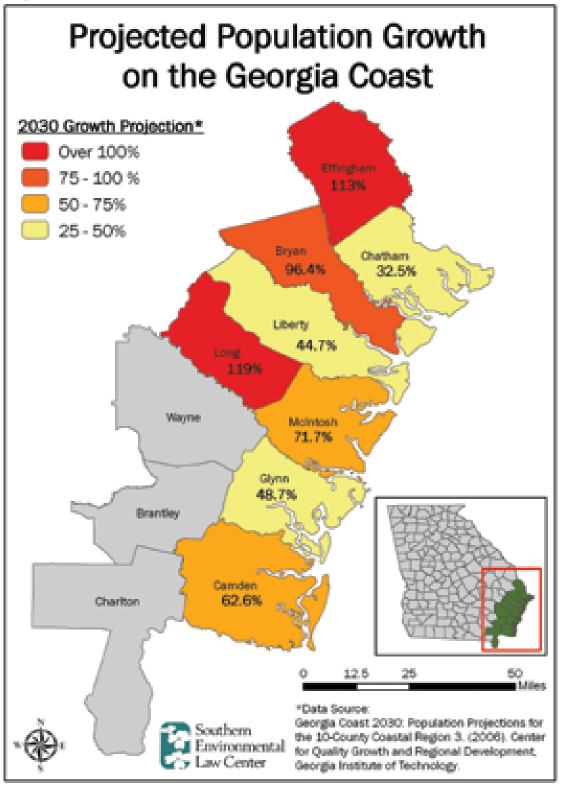
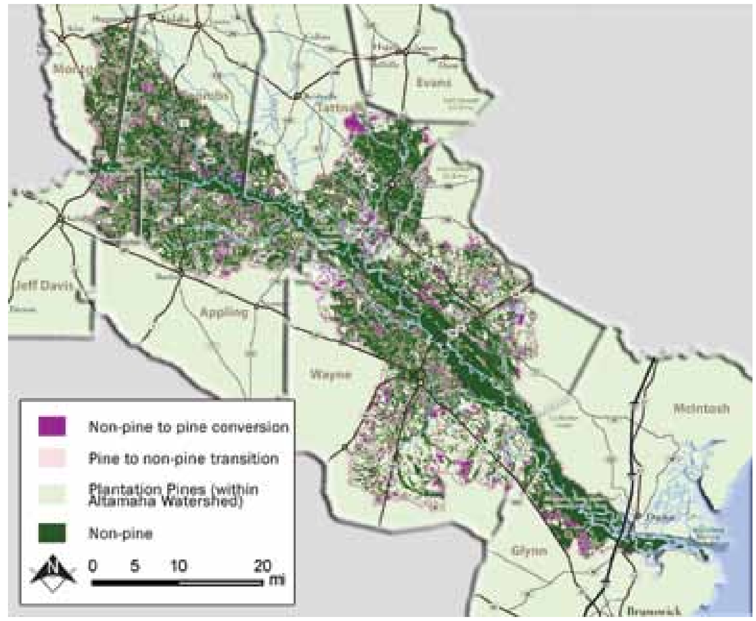


Figure 57



CONVERSION TO PINE PLANTATIONS

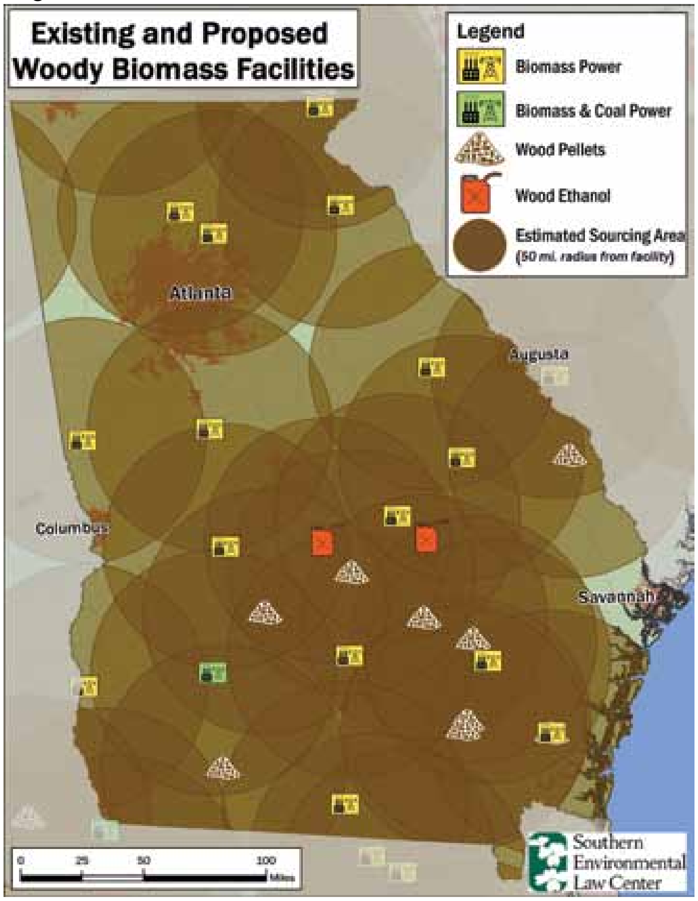
In addition to losses of forested wetlands from development, the FWS has documented direct forestry impacts. The FWS 2000 wetland status and trends report found that of the freshwater wetland decline overall, 26 percent of the loss was attributable to agriculture and 23 percent to silviculture. The report further states, "[c]onversion from bottomland forest to managed pine plantations accounts for most of the changes in the freshwater forested [wetland] category in the Southeastern United States."[99] Widespread conversion to pine plantations can result in cypress forest acreage loss. As mentioned above, a GIS study estimated that over 30,000 acres of forested wetlands in the lower Altamaha River basin alone had been converted to pine plantations between 1980 and 2001 (Figure 57) (Appendix 5). In the most recent FWS status and trends report, the FWS discusses how forested wetlands sites can be dried out through the "installation of drainage ditches . . . bedding of sites; subsurface drainage; and levee construction, filling, and channelization."[101] The FWS then goes on to explain that even skidder created ditches "can widen over time and drain wetlands."[102] And that "[e]ven when BMPs for silviculture operations are followed, wetlands habitats and community structure may still be seriously degraded and forested wetlands functions adversely affected."[103]

Presently, there may be increased interest in converting land, including cypress forests, to pine plantations in Georgia. With much attention being given to finding alternative fuel sources, Georgia is pushing to become a world leader in woody biomass for energy production (electricity and liquid fuel). A map of existing and proposed woody biomass production facilities in Georgia as of 2012 is shown in Figure 58. The majority of pine production for bio-energy within Georgia will come from plantations located within much of the coastal region. Although managed forests in the coastal region may be more desirable than development, forestry practices, particularly intensive plantation management, can lead to a reduction in some highly valuable, as well as vulnerable, wetland types, such as cypress wetlands.

The health of our coastal wetlands, including our cypress forests, has critical implications for the well-being of our rivers and estuaries. As cypress wetlands are converted to development or pine plantations, or suffer temporal or permanent losses due to timbering within a river basin, declines in water quality can manifest. Along with freshwater, coastal river systems transport a number of pollutants to the estuaries, some from as far away as Atlanta. All

[99] Thomas E. Dahl, U.S. Dep't of the Interior, Fish & Wildlife Serv., *Status and Trends of Wetlands in the Conterminous United States 1986 to 1997* (2000).
[100] *Id.*
[101] Thomas E. Dahl, U.S. Dep't of Interior, Fish & Wildlife Serv., 65 Status and Trends of Wetlands in the Coterminous United States 2004-2009 (2011).
[102] *Id.*
[103] *Id. Citing* North Carolina State University, 2008 (Major causes of wetland loss and degradation, On-line resource: http://www.water.ncsu.edu/watershedss/info/wetlands/wetloss.html) and Wear, D.N. and J.G. Greis. Eds. Southern Forest Resource Assessment. Final Report Technical SRS-53. U.S. Department of Agriculture, Forest Service (2002).

Figure 58



five of the major rivers emptying into Georgia's estuaries already have significant water quality problems and are listed by the state as impaired, meaning they do not support their designated uses due to poor water quality.

OTHER SOURCES OF LOSS

In addition to increased mulch production, development, poor management, and modified hydrology, cypress forests in Georgia are sustaining losses from a variety of other sources. These include losses from hurricanes and fires.[104] Increases in the salinity of estuarine waters also impact cypress. Studies have shown that cypress tree germination rates decrease as salinity levels increase. A recent study of cypress forests along the Northeast Cape Fear River in North Carolina, for example, indicates that natural regeneration of cypress only occurs where salinity is < 0.1 parts per thousand.[105] In the Savannah River, harbor deepening has caused saltwater intrusion to extend further up the Savannah River. Sea level rise may exacerbate such increases in salinity levels. Such saltwater intrusion will likely restrict cypress regeneration in tidal swamps throughout the lower reaches of Georgia's coastal river systems.

The cumulative effect of increased demand for cypress mulch, hydrologic changes, poor natural regeneration, coastal development, conversion to pine plantations, and other sources of loss all contribute to cypress vulnerability. As we will discuss in the next chapter, these factors need to be addressed in a focused and coordinated fashion if cypress sustainability is to be ensured.

[104] Personal written communication, August 24, 2009, C. Rhett Jackson, Professor of Hydrology, Warnell Sch. of Forestry & Natural Resources, Univ. of Ga., Memorandum to USEPA Region 4 and SELC personnel involved in "Status of Cypress Wetland Forests in Georgia" report, Review of "Status of Cypress Wetlands in Georgia" Draft of May 2009.

[105] Erin L. Fleckenstein, *The Influence of Salinity on the Germination and Distribution of Taxodium Distichum (L.) Rich, Bald Cypress, Along the Northeast Cape Fear River* (2007) (unpublished M.S. thesis, University of North Carolina Wilmington), *available at* http://libres.uncg.edu/ir/uncw/f/fleckensteine2007-1.pdf.

CHAPTER 4

INSUFFICIENT LEGAL PROTECTION FOR GEORGIA'S CYPRESS FORESTS

FEDERAL CLEAN WATER ACT SECTION 404

One of the most important regulatory tools for protecting coastal wetland resources is Section 404 of the federal CWA, which authorizes the Corps to issue permits for the discharge of dredged or fill materials into wetlands or other waters of the United States.[106] The Section 404 permit program is a vital regulatory tool for a number of reasons.

First, the regulations governing the Section 404 permit program are designed to steer development activities away from wetlands. The rules require the Corps to deny permit applications where less damaging alternatives to wetlands destruction exist. If the Section 404 program were working as intended, most development would be kept out of the coast's extensive wetland systems.

Second, the need to obtain a Section 404 permit triggers other important regulatory reviews. For example, if a developer is required to obtain a Section 404 permit to construct a subdivision, this triggers review under the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA). These two federal statutes require additional analysis by the Corps and other federal agencies, such as the FWS, to evaluate impacts to the surrounding environment.

Third, the Section 404 program is especially important in Georgia because there is no state program in place to protect freshwater wetlands. Without proper implementation of the Section 404 program, it is not possible to protect the state's extensive freshwater wetland resources.

CONFUSION OVER GEOGRAPHICALLY ISOLATED CYPRESS WETLANDS

For the first thirty years of its history, the CWA was interpreted to apply to virtually all wetlands, including geographically isolated wetlands. In 2001, however, in *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers (SWANCC)*,[107] the U.S. Supreme Court issued a decision that has called into question the ability of the federal government to protect geographically isolated wetlands. Prior to this decision, the Corps asserted jurisdiction under the CWA over all waters that a migratory bird could use as habitat. The *SWANCC* decision excludes from jurisdiction those wetlands that lack an apparent surface connection to navigable streams and rivers when the only basis for jurisdiction is the wetland's potential use by migratory birds.

In 2006, the U.S. Supreme Court created more confusion over federal wetland jurisdiction when it decided *Rapanos v. United States*.[108] The 11th Circuit Court of Appeals, which includes Georgia, has interpreted this decision to mean that CWA federal jurisdiction extends only to wetlands and waterbodies that have a "significant nexus" or influence on downstream waters that are "navigable in the traditional sense."[109]

Since the *SWANCC* and *Rapanos* decisions were handed down, the Corps has denied jurisdiction to many wetlands that lack a visible surface connection to other jurisdictional waters. This is of critical importance to cypress forests because, when the Corps denies jurisdiction over a wetland, a developer does not have to obtain a Section 404 permit to fill it. It also means that the developer does not have to make any attempt to avoid, minimize, or mitigate the damage done to the wetland. Further, the protections provided by other laws such as the NEPA and the ESA do not get triggered if a Section 404 permit is not required.

Usually, a developer hires an environmental consultant to identify wetlands as either non-jurisdictional or jurisdictional. The Corps then reviews the environmental consultant's report to make a "jurisdictional determination." With the new *SWANCC* and *Rapanos* tests, delineators exercise a lot of discretion in the jurisdictional calls that they make. Because so many cypress wetlands occur as ponds and domes, it is imperative that the Corps review with increased diligence applications that label cypress wetlands as isolated. All cypress wetlands identified by applicants as isolated should be carefully evaluated for a significant nexus to other jurisdictional waters. Considering the ecological value of cypress wetlands and their vulnerability, all cypress wetlands labeled non-jurisdictional by consultants should receive the highest degree of scrutiny from the Corps.

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[106] 33 U.S.C. §1344(a) (2006).
[107] 531 U.S. 159 (2001).
[108] 547 U.S. 715 (2006).
[109] *Id.* at 786; *U.S. v. Robison*, 505 F.3d 1208(11th Cor. 2007).

The Corps should also more carefully review permit requests for converting cypress forests to pine plantations. In addition, priority should be given for enforcement investigations at sites containing cypress. To facilitate identification of cypress forests, the baseline map of cypress resources in this report could be enhanced. As stated above, in future years, the Georgia DNR should develop a land cover class for cypress wetlands. Once land cover maps are produced with a separate cypress class, the Corps should consult the state's land cover maps in evaluating permit applications.

Unlike Georgia, a number of other southern states, including North Carolina, Virginia, Tennessee, and Florida, have recognized the importance of wetland resources including those geographically isolated wetlands considered to be non-jurisdictional by the Corps. As a result, these states have adopted their own programs to protect freshwater wetlands. Thus, when the Corps determines it does not have jurisdiction over a wetland, there is a state program in place to fill the gap in federal protection. Because Georgia does not have a wetlands protection program, hundreds of thousands of acres of Georgia's wetlands are exposed to unrestricted development. Georgia should adopt a statewide wetland program or consider using its water quality standards to protect cypress forests and other important wetland resources.

SILVICULTURE AND FOREST ROAD EXEMPTIONS

Another source of unregulated losses of cypress habitat stems from exempted discharges. Under CWA Section 404(f), a permit is not required if discharges of dredged or fill material are associated with normal forestry activities that are part of an ongoing silvicultural operation. Similarly, the construction of forest roads through wetlands is exempt if the roads are used for legitimate forest management activities. The forestry exemption is lost if the activity results in the conversion of the wetland to an upland or if the size of the wetland is reduced. In light of the fact that these exemptions were originally intended by Congress to be narrowly interpreted by the Corps, it is important that the Corps keep that original intent in mind as it makes permitting decisions. The Corps and EPA are responsible for ensuring these exemptions are used properly under the CWA.

Activities that can change the hydrology of a wetland site, but are considered to result in only "minor drainage," are permissible. Practices such as ditching, bedding, and intensive pine plantation management, however, can gradually dry out wetlands over time making them more desirable for development purposes. In addition, altered wetlands that have been subjected to intensive silvicultural operations over a period of years are often considered to be of lesser environmental value. These sites generally receive a less stringent level of regulatory review during the Section 404 permit process. After years of timber management, these forests are frequently considered by the Corps to be wetlands of diminished value, and thus, require less in the way of mitigation.

For this reason, once market prices in an area become favorable for development, timbered parcels become desirable to developers. This type of incidental facilitation of development through wetland modifications brought about by forestry operations is especially damaging when combined with the extensive sale of land holdings by the timber industry. As large swaths of forestlands have come on to the market, developers sometimes turn former wetlands into subdivisions and shopping centers. Although this trend has slowed recently, this process could result in large-scale wetland losses along Georgia's coast.

GEORGIA FORESTRY COMMISSION AND BEST MANAGEMENT PRACTICES

In order to qualify for the silviculture exemption, one must comply with the 15 federal BMPs. To protect water quality, the state of Georgia has a similar list of BMPs. BMPs are techniques designed to minimize impacts to water quality from forestry practices. According to the Georgia Forestry Commission's website, the Commission's role in administering BMPs is:

> To minimize erosion and stream sedimentation from forestry practices. The Georgia Forestry Commission (GFC) has an agreement with the Environmental Protection Division (EPD) of the Georgia Department of Natural Resources to educate the forestry community and promote the use of forestry Best Management Practices (BMPs). Under the same agreement with the EPD and through an understanding with the U.S. Environmental Protection Agency (EPA) and the Army Corps of Engineers, the GFC also monitors BMP implementation and investigates and mediates water quality and wetland complaints resulting from forestry practices.[110]

In addition to monitoring compliance with BMPs and educating forestry practitioners, the Georgia Forestry Commission is responsible for developing, adopting, and publishing Georgia's forestry BMPs. In 2002, the Georgia Forestry Commission developed a series of Floodplain BMPs, which we describe below.

GEORGIA'S FLOODPLAIN BMPs

Georgia Forestry Commission's Floodplain BMPs have recently been incorporated into Georgia's revised

[110] http://www.GFC.state.ga.us/ForestManagement/bmp.cfm (last visited May 26, 2008).

BMP manual.[111] The Georgia Forestry Commission has developed the Floodplain BMPs with the stated purposes of:

1. preventing movement of soil, fertilizer, and herbicide from forest operation areas into the surface water system;
2. maintaining water temperatures and dissolved oxygen levels adequate for biotic survival;
3. maintaining inputs of organic matter and coarse woody debris into water bodies; and
4. maintaining structural integrity of floodplain features.

There are several different types of floodplain features addressed by the BMPs. Those floodplain features identified in the BMPs that may contain cypress are:

1. perennial, intermittent, and ponded sloughs that include springs and seeps;
2. braided channels, floodways and river bottom flats, backwater paleo channels; and
3. backwater swamps, isolated depressions, and oxbows and ponds.[112]

PROTECTION UNDER THE FLOODPLAIN BMPs

Under the existing BMPs, cypress forests receive different levels of recommended treatment depending on the type of geomorphic setting in which they are found. For cypress stands with surface water, either standing or flowing, Streamside Managements Zones (SMZs) are recommended.[113] Those with standing water are to be treated as perennial streams if they could potentially move sediments or other pollutants off site.[114] Cypress that are intermittently flooded, would also be protected, but would receive a lesser level of recommended buffer and streambank protection, namely, a 50 percent canopy cover within banks and protection of bank trees.[115] Ponded cypress stands that are not continually flooded with deepwater (> 2 feet) are treated as wetlands[116] under the BMPs and can be harvested.[117]

CURRENT WETLAND BMPs

In addition to the Floodplain BMPs, Georgia's BMP manual includes a limited number of recommendations for protecting all types of wetlands during timber harvesting. In addition, the manual describes the requirements for eligibility for the silviculture exemption under Section 404 and lists the fifteen baseline provisions for forest road construction and maintenance in and across waters of the United States. Below is a compilation of relevant BMPs for wetlands in the current BMP manual:

> **Section 4.7.1 BMPs for Harvesting Forested Wetlands**
>
> 1. Plan the timber harvest for the dry season of the year when possible.
> 2. Use site-specific equipment and methods to minimize water quality impacts, including high-flotation, low-pressure harvesting equipment, shovel logging, or cable yarding.
> 3. Concentrate skid trails and use logging slash, mats or other techniques to minimize soil compaction and rutting.
> 4. Use practices conducive to rapid regeneration.
> 5. Follow federally mandated stream and wetland crossings.[118]
>
> **Section 2.2.9 Wetlands**
>
> To properly manage forested wetlands: plan for regeneration; consider the areas beyond the actual harvest site; and remember that special harvesting techniques may be necessary to protect water quality. Any stream channels should be identified and the appropriate SMZs established. The BMPs that apply to any other forest type generally apply to forested wetlands.[119]

Mechanical site preparation in wetlands receives added attention in the BMPs due to the Memorandum of Agreement between the EPA and the Corps governing the conversion of hardwood-dominated wetlands, including cypress forests, to pine plantations.[120] Such activities require a permit under Section 404 under the Memorandum's directive. The BMP manual states the following on this topic:

> **Section 5.2 Mechanical Site Preparation in Wetlands**
>
> Forested wetlands offer unique challenges for site preparation. The EPA and Army Corps of Engineers have determined that major drainage in jurisdictional wetlands will require a Section 404 permit

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[111] Ga. Forestry Comm'n, Georgia's Best Management Practices for Forestry, June 2009, available at http://www.gfc.state.ga.us/ForestManagement/documents/BMPManualGA0609.pdf; Personal communication, Frank Green, Georgia Forestry Commission, May 22, 2008.
[112] Ga. Forestry Comm'n, *supra* n.106.
[113] *Id.*
[114] *Id.*
[115] *Id.*
[116] *Id.*
[117] *Id.*
[118] *Id.* at 42-43 (emphases omitted).
[119] *Id.* at 23-24 (emphases omitted).
[120] EPA & U.S. Army Corps of Engineers, Memorandum, Application of Best Management Practices to Mechanical Silvicultural Site Preparation Activities for the Establishment of Pine Plantations in the Southeast (Nov. 28, 1995), *available at* http://www.epa.gov/owow/wetlands/guidance/silv2.html.

from the Army Corps of Engineers. Also, a [Section] 404 permit may be required for mechanical site preparation for pine establishment in [certain] forested wetland types, unless they no longer exhibit their unique distinguishing characteristics due to past practices.[121]

These types include the following:

Permanently flooded, intermittently exposed and semi-permanently flooded wetlands, riverine bottomland hardwood wetlands, white cedar swamps, Carolina Bay wetlands, non-riverine forest wetlands, wet hardwood forests, swamp forests, low pocossin wetlands, wet marl forests, tidal freshwater marshes, maritime grasslands, and shrub swamps.[122]

Section 5.2.1 Other Wetlands

Other jurisdictional forested wetlands do not require a Section 404 permit if [mechanical site preparation is] conducted according to the following six federally mandated minimum BMPs.

Section 5.2.1.1 Federally Mandated BMPs for Mechanical Site Preparation in Wetlands

1. Position shear blades or rakes at or near the soil surface. Windrow, pile, and move logs and logging debris by methods that reduce dragging or pushing through the soil to minimize soil disturbance associated with shearing, raking and moving trees, stumps, brush, and other unwanted vegetation.
2. Activities should avoid excessive soil compaction and maintain soil tilth.
3. Arrange windrows to limit erosion, overland flow, and runoff.
4. Prevent disposal or storage of logs or logging debris in SMZs.
5. Maintain the site's natural contour and ensure that activities do not immediately or gradually convert the wetland to a non-wetland.
6. Conduct activities with appropriate water management mechanisms to minimize off-site water quality impacts.[123]

FORESTED WETLANDS BMPs NEEDED

As already discussed, regeneration failure in cypress forests can contribute to water quality degradation because of the water quality functions these ecosystems provide. Therefore, maintaining cypress forest health, extent, and distribution in Georgia is important for water quality, habitat, social, and economical reasons due to the host of important functions these forests provide.

Although Georgia's BMPs provide some protections for wetland forests, these protections are inadequate to address cypress regeneration problems. In light of the concerns for cypress forests in the state, it is crucial for the Georgia Forestry Commission to develop BMPs that ensure water quality protection and ecosystem sustainability for such forests. The classification system developed for cypress wetlands by the SWG should be evaluated for adoption as part of the BMPs. The system contains a description of three site conditions, with recommended timbering practices appropriate to each condition.

Additionally, as appropriate, supplemental silvicultural guidelines could be developed to assist foresters in successful wetland ecosystem management.

The following excerpt from the SWG report describes the system:

Class I: Sites with Potential for Natural Regeneration

These sites are generally connected to a source of fresh surface or ground water and are flooded or ponded periodically on an annual basis (pulsing). They must have seasonal flooding and dry cycles (regular flushing with freshwater), and should have both sediment and nutrient inputs. These sites have some level of positive tree growth, thereby providing increasing or stable biomass production and organic input. Sites in this category that are subject to increased flood frequency and duration, or water depths, may eventually move into Class II unless action is taken to remedy these detrimental conditions.

Class II: Sites with Potential for Artificial Regeneration Only

These sites may have overstory trees with full crowns and few signs of canopy deterioration, but are either permanently flooded (which prevents seed germination and seedling establishment) or are flooded deeply enough that when natural regeneration does occur during low water, seedlings cannot grow tall enough between flood events for at least 50 percent of their crown to remain above the high water level during the growing season. These conditions require artificial regeneration, (i.e., planting of tree seedlings). Water depth for sites in this category is restricted to a maximum of two feet for practical

[121] Ga. Forestry Comm'n, *supra* n.111, at 46 (emphases omitted).
[122] *See id.* at 46-47.
[123] *Id.* at 47-48 (emphases omitted).

reasons related to planting of tree seedlings. Planted seedlings should have at least 12 inches of crown (length of main stem with branches and foliage present) and must be tall enough for at least 50 percent of the crown to remain above the high water level during the growing season. Sites with increasing average annual water depth may eventually move into Class III unless action is taken to remedy this detrimental condition.

Class III: Sites with No Potential for either Natural or Artificial Regeneration

These sites are either flooded for periods long enough to prevent natural regeneration and practical artificial regeneration or are subject to saltwater intrusion with salinity levels that are toxic to cypress forests. These sites include transitioning coastal forests: 1) freshwater forests transitioning to either floating marsh or open fresh water, or 2) forested areas with saltwater intrusion that are transitioning to open brackish or saltwater (marsh may be an intermediate condition).

If this approach were adopted in Georgia, Georgia's BMPs would recommend proper classification based upon the likelihood of regeneration according to this system. For Class I sites, BMPs would allow for timbering with natural regeneration; however, harvests would be conducted when seeds are most available. For Class II sites, BMPs would include the use of artificial planting techniques that have been proven effective for cypress on flooded sites as outlined in Appendix 4. These include using heavily root-pruned seedlings, using plastic tree shelters to prevent excessive browsing by deer, and planting one-year-old cypress seedlings at least 3.3 feet tall and with root collar diameters larger than 0.5 inches. BMPs would not allow harvesting on Class III sites or any sites that cannot be regenerated.

Due to the wide variety of landscape positions where cypress ecosystems occur in Georgia, BMPs must be carefully developed to ensure sustainable forestry practices are applied to cypress ecosystems.

OTHER GEORGIA FORESTRY COMMISSION PROGRAMS

The Georgia Forestry Commission's Master Timber Harvester Program provides a good opportunity for improving cypress management. The Georgia Forestry Commission should provide workshops for loggers and foresters through the Master Timber Harvester Program that are designed to educate practitioners about cypress regeneration issues, BMPs, and planting techniques. According to the Georgia Forestry Commission, many forest product companies operating in Georgia prefer to work with contractors who participate in logger education programs. As a result, many loggers and foresters are going through this program. Since 1995, more than 2,600 loggers and foresters each year have attended the Georgia Master Timber Harvester logger education program. Because of the opportunity to reach so many forestry professionals, information on cypress forest BMPs should be incorporated in the curriculum. The program could train foresters in the SWG cypress classification system so that cypress forests could be evaluated in terms of regeneration potential. Timbering plans could provide that Class III lands will not be harvested, and Class II lands will be replanted using approved techniques.

It also may be necessary to develop a suitable certification program for cypress products. The Georgia Forestry Commission could play a major role in developing such a program and ensuring that land owners are aware of the opportunities available under such a program.

To date, discussions among the EPA, state and federal agencies (including the Georgia Forestry Commission), the environmental community, and cypress mulch retailers indicate that adoption of a cypress mulch certification program is feasible based upon the experience of retailers with other certification programs. Incentive programs could enhance cypress conservation. Additionally, a "Cypress Alliance," similar to the Longleaf Alliance, should be pursued to encourage technical research, preservation, and outreach for sustainable cypress management.

CHAPTER 5

ACTIONS NEEDED TO ENSURE CYPRESS SUSTAINABILITY

As documented in this report, Georgia's cypress forests are vulnerable. If a new course is to be charted, one which will ensure stable cypress forest trends, sustainable harvest rates, and healthy forest conditions, then key measures to address current concerns should be implemented. In this concluding chapter, we outline the steps needed to address the existing problems.

At a minimum, cypress must be carefully monitored and researched in order to answer critical questions concerning drops in acreage and increased mortality. We must also educate practitioners and advise landowners to discourage harvesting in areas where regeneration is unlikely to be successful. We must work to dispel misconceptions regarding the rigor of cypress stump sprouts. We must emphasize the need for artificial planting to supplement natural regeneration. We must also continue to work diligently to develop Georgia-specific planting techniques to ensure greater success in cypress forest reestablishment.

Charting a new course for cypress in Georgia also means developing and implementing BMPs that ensure cypress ecosystems are managed sustainably within Class I and II areas to protect water quality. Landowners must be made aware that timbering on Class III lands does not qualify for the CWA Section 404 silviculture or forest road exemptions because these lands cannot be regenerated and, when harvested, will not be part of an ongoing forestry operation. In addition, retailers must be persuaded to sell only cypress mulch that is certified as being obtained from regenerated cypress forests. Consumers must be educated about cypress mulch issues and encouraged to purchase sustainable products.

The environmental community, perhaps as part of a Cypress Alliance, can play an important role in ensuring a better future for Georgia's cypress by identifying high-quality cypress forests that should be permanently preserved. In addition, continued monitoring by the environmental community for illegal activities in cypress forests and coordination with enforcement officials would be invaluable.

One thing is clear: no one group alone will be able to ensure the sustainability of Georgia's cypress. It will take a concerted effort by state, federal, private, and non-profit organizations working together to address concerns over the status of cypress forests documented in this report. Such a coordinated and extensive effort will take planning, commitment, cooperation, dedication, and funding. Only in this way, can we hope to better preserve this precious part of Georgia's natural heritage.

It is our recommendation that the following specific steps be taken to protect Georgia's cypress resources:

MONITORING AND RESEARCH

1. The EPA should fund continued monitoring of cypress trends in Georgia including harvesting and utilization.
2. The EPA and the Forest Service should fund research into the regeneration problems of cypress forests and identify the most successful methods for reforesting harvested areas. These methods should be designed to ensure that certified cypress products are sustainably produced.
3. The Forest Service and EPA should fund additional research into the status of cypress ecosystems throughout the southeast and develop solutions to improve cypress conservation.
4. The Forest Service and EPA should fund site-level research into the causes of mortality recorded by FIA.
5. Local environmental groups should work with the Georgia Forestry Commission and the Corps to monitor forestry and development activities in cypress forests to identify those that are not in compliance with BMPs or the Section 404 permit program. The Georgia Forestry Commission could be funded to expand current aerial watershed monitoring to include additional BMP compliance.
6. The State should develop a land cover class for cypress wetlands within its standardized classification system, potentially using the unique reflective signature of these needle-leaved deciduous trees, to provide the means to track the distribution of changes within the coastal plain region. Maps of cypress ecosystems refined to the tract level could be provided by the Georgia Forestry Commission to land managers and foresters for use in forest management plan development. The Georgia Forestry Commission could target technical outreach work to highlight managing cypress to landowners.

7. The environmental community should identify high-value tracks of cypress that are unlikely to regenerate if harvested so that they can be preserved through conservation easements or fee simple purchase by the conservation community.

CONSUMER AWARENESS AND MARKET PRACTICES

1. The EPA and the environmental community should work together to continue the development and distribution of consumer awareness materials that encourage the use of sustainable mulch products.
2. The EPA and the environmental community should continue discussions with cypress mulch vendors to discontinue the sale of products produced using unsustainable practices on lands where regeneration is unlikely to be successful.
3. The EPA, Forest Service, Georgia Forestry Commission, and the environmental community should work with cypress mulch producers and vendors to ensure that all cypress mulch sold is certified as produced on sustainably-managed, restored cypress forests.

TECHNICAL TRAINING AND CERTIFICATIONS

1. The Forest Service and Georgia Forestry Commission should develop a program for cypress harvesting and replanting education that provides training to professionals to correct mistaken beliefs regarding regeneration, such as that cypress will always stump sprout successfully. Professionals should be trained to evaluate sites using the classification system developed by the SWG[124] to identify hydrological conditions that can interfere with regeneration. Cypress-specific replanting techniques should also be included in the training.
2. The Georgia Forestry Commission should make information about cypress issues available through outreach materials.
3. The Georgia Forestry Commission should ensure that lands enrolled in certification programs have been evaluated for cypress conservation needs and have sustainable practices for cypress management applied to them.
4. The Georgia Forestry Commission should help landowners evaluate the regeneration potential of their forests and, wherever timbering of cypress lands is unsustainable due to impediments to regeneration, encourage their permanent conservation. Landowners should also be advised that harvesting on these lands does not fall within the silviculture and forest road exemptions contained in the Section 404 permit program.
5. The EPA, Forest Service, Georgia Forestry Commission, and environmental community should work cooperatively with vendors to develop a program for certifying cypress products that have been harvested on sustainably managed, restored cypress lands.

BEST MANAGEMENT PRACTICES

1. The Georgia Forestry Commission should develop and adopt BMPs to ensure sustainable forestry practices are utilized for cypress ecosystems and incorporate them into the Georgia BMP manual.
2. The Georgia Forestry Commission should consider adopting the cypress regeneration classification system developed by the Coastal Wetland Forest Conservation and Use Science Working Group.
   a. For Class I sites under this system, harvesting with natural regeneration should be allowed. Harvest should be done during the winter months when seeds and stump spouts are most likely to survive.
   b. For Class II sites, artificial planting should be required using techniques effective for cypress on flooded sites. These include using heavily root-pruned seedlings, utilizing plastic tree shelters to prevent excessive browsing by deer, and planting one-year-old cypress seedlings at least 3.3 feet tall with root collar diameters larger than 0.5 inches.
   c. Georgia's BMPs should discourage cypress harvesting on Class III sites because timbering where regeneration cannot successfully occur is an unsustainable practice that is inconsistent with ongoing silviculture and is ecologically unsound.

REGULATION AND ENFORCEMENT

1. The Corps and EPA should modify their system for evaluating potential enforcement cases based upon information gathered in this report regarding the vulnerability of cypress resources in Georgia. These reviews should reflect the potential increased scarcity of this wetland type.
2. Because so many cypress wetlands occur as depressional wetlands, it is important that the Corps and EPA increase their level of diligence in reviewing wetland permit applications that label cypress wetlands as "isolated." All wetlands containing cypress that are identified by the applicant as geographically isolated should be clearly demarcated as cypress wetlands on proposed delineation maps. During review, the potential for surface connections should be more carefully evaluated for these wetlands.

[124] Coastal Wetland Forest Conservation & Use Science Working Group, *supra* n.87.

3. The State should adopt a program to provide protection for all state wetlands, including geographically isolated wetlands.
4. Applications for the conversion of cypress forests to pine plantations should receive a heightened level of scrutiny by the Corps because of documented cypress issues.
5. The Corps and EPA should prioritize enforcement investigations at sites being developed with water amenities in areas containing cypress. Where wetland type is unknown, the baseline map of cypress resources prepared for this report should be referenced. In future years, the land cover maps produced by the Georgia DNR should be used if a cypress land cover class is developed.

CYPRESS ALLIANCE

In 2009, the Regional Working Group for America's Longleaf published a comprehensive plan for restoring longleaf pines in the southeast. The *Range-Wide Conservation Plan for Longleaf Pine* was the culmination of the effort and input of more than 120 resource professionals over several years. The Conservation Plan takes advantage of the synergies among longleaf pine conservation groups throughout the entire historic range of the longleaf pine. In light of the great success the Longleaf Alliance has achieved by bringing stakeholders together to preserve and enhance the longleaf pine resource in the South,[125] it may make sense to use this model to achieve similar success in the context of cypress. Such an approach should be examined closely by the cypress stakeholders.

Although all of the measures outlined above are important to ensuring the long-term sustainability of cypress, the most immediate need is for more monitoring and research of the cypress resource. It is the hope of the authors of this report that this document will provide the foundation for further inquiry and action on cypress issues. Through such cooperative action among all stakeholders, cypress can remain an icon of the South.

[125] *See* Regional Working Group for America's Longleaf, *Range-Wide Conservation Plan for Longleaf Pine* (2009).

APPENDIX 1

FIA DEFINITIONS

Definitions are from Forest Statistics for Georgia, 1997, Resource Bulletin SRS-36, Michael T. Thompson, United States Department of Agriculture, Forest Service Southern Research Station, December 1998.

Average annual mortality. Average annual volume of trees 5.0 inches d.b.h. and larger that died from natural causes during the intersurvey period.

Average annual removals. Average annual volume of trees 5.0 inches d.b.h. and larger removed from the inventory by harvesting, cultural operations (such as timber-stand improvement), land clearing, or changes in land use during the intersurvey period.

Average net annual growth. Average annual net change in volume of trees 5.0 inches d.b.h. and larger in the absence of cutting (gross growth minus mortality) during the intersurvey period.

D.b.h. Tree diameter in inches (outside bark) at breast height (4.5 feet aboveground).

Diameter class. A classification of trees based on tree d.b.h. Two-inch diameter classes are commonly used by Forest Inventory and Analysis, with the even inch as the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

Forest land. Land at least 10 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. The minimum area considered for classification is 1 acre. Forested strips must be at least 120 feet wide.

Growing-stock trees. Living trees of commercial species classified as sawtimber, poletimber, saplings, and seedlings. Trees must contain at least one 12-foot or two 8-foot logs in the saw-log portion, currently or potentially (if too small to qualify), to be classed as growing stock. The log(s) must meet dimension and merchantability standards to qualify. Trees must also have, currently or potentially, one-third of the gross board-foot volume in sound wood.

Growing-stock volume. The cubic-foot volume of sound wood in growing-stock trees at least 5.0 inches d.b.h. from a 1-foot stump to a minimum 4.0-inch top diameter outside bark (d.o.b). of the central stem.

Live trees. All living trees. All size classes, all tree classes, and both commercial and noncommercial species are included.

Nonforest land. Land that has never supported forests and land formerly forested where timber production is precluded by development for other uses. Nonstocked stands. Stands less than 10 percent stocked with live trees.

Saplings. Live trees 1.0 to 5.0 inches d.b.h.

Seedlings. Trees less than 1.0 inch d.b.h. and greater than 1 foot tall for hardwoods, greater than 6 inches tall for softwood, and greater than 0.5 inch in diameter at ground level for longleaf pine.

Timberland. Forest land capable of producing 20 cubic feet of industrial wood per acre per year and not withdrawn from timber utilization.

Volume of live trees. The cubic-foot volume of sound wood in live trees at least 5.0 inches d.b.h. from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem.

APPENDIX 2

CITATIONS FOR FIA AND TPO REPORTS

USDA Forest Service, Georgia Forest Resources and Industries. Miscellaneous Publication No. 501, 1936.

USDA Forest Service, Forest Statistics for Georgia, 1951-53. J.F. McCormack and James Cruikshank. Southeastern Forest Experiment Station, Forest Survey Release No. 44, November 1954.

USDA Forest Service, Georgia's Timber. Robert W. Larson and Benjamin Spada. Southeastern Forest Experiment Station, Resource Bulletin SE-1. (Reports the findings of the 1961 Survey.) 1963.

USDA Forest Service, Georgia's Timber, 1972. Herbert A. Knight and Joe P. McClure. Forest Service Resource Bulletin SE-27. May 1974.

USDA Forest Service, Georgia's Forests. Raymond M. Sheffield and Herbert A. Knight. Southeastern Forest Experiment Station, Resource Bulletin SE-73. (Reports results of field survey of 1980-1983.) May 1984.

USDA Forest Service, Georgia's Forests, 1989. Raymond M. Sheffield and Tony G. Johnson. Southeastern Forest Experiment Station, Resource Bulletin SE-133. Forest Inventory and Analysis. (Reports results of field survey of 1987-1989.) April 1993.

USDA Forest Service, Georgia's Forests, 1997. Michael T. Thompson and Larry W. Thompson. Southern Research Station, Resource Bulletin, SRS–72. (Reports results of field survey of 1995-1998.) June 2002.

USDA Forest Service, Forest inventory mapmaker web-application version 3.0. Patrick D. Miles. Retrievals from September 26, 2007-April 7, 2008. North Central Research Station, St. Paul, MN. [Available only on internet: www.ncrs2.fs.fed.us/4801/fiadb/index.htm] (Data are reported for the 1989, 1997, 2004 and 2005 FIA Surveys.)

TPO reports:

USDA Forest Service, Georgia's Timber Industry: An Assessment of Timber Product Output and Use, 1989. John B. Tansey and Carolyn D. Steppleton. Southeastern Forest Experiment Station, Resource Bulletin SE-126. December 1991.

USDA Forest Service, Georgia's Timber Industry: An Assessment of Timber Product Output and Use, 1992. Tony G. Johnson. Southeastern Forest Experiment Station, Resource Bulletin, SE-144. June 1994.

USDA Forest Service, Georgia's Timber Industry: An Assessment of Timber Product Output and Use, 1995. Tony G. Johnson, Anne Jenkins, and John L. Wells. Southern Research Station, Resource Bulletin SRS-14. May 1997.

USDA Forest Service, Georgia's Timber Industry: An Assessment of Timber Product Output and Use, 1997. Tony G. Johnson and John L. Wells. Southern Research Station, Resource Bulletin SRS-38. June 1999.

USDA Forest Service, Georgia's Timber Industry: An Assessment of Timber Product Output and Use, 1999. Tony G. Johnson and John L. Wells. Southern Research Station, Resource Bulletin SRS-68. February 2002.

USDA Forest Service, Georgia's Timber Industry: An Assessment of Timber Product Output and Use, 2001. Tony G. Johnson and John L. Wells. Southern Research Station, Resource Bulletin SRS-92. April 2004.

USDA Forest Service, Georgia's Timber Industry: An Assessment of Timber Product Output and Use, 2003. Tony G. Johnson and John L. Wells. Southern Research Station, Resource Bulletin SRS-104. November 2005.

USDA Forest Service, Georgia's Timber Industry: An Assessment of Timber Product Output and Use, 2005. Tony G. Johnson, Nathan McClure, and John L. Wells. Southern Research Station, Resource Bulletin SRS-123. November 2007.

GIS METHODS

Cypress Habitat on the Georgia Coastal Plain

This map, shown in Figure 13, was created by taking the NWI data[126] and selecting all subclasses of Palustrine Forested Needle-Leaved Deciduous (PFO2) from a NWI coverage of the Georgia coastal plain.

Cypress Habitat Loss Prior to 2005 on the Georgia Coastal Plain

This map is shown in Figure 14. After the land cover change analysis (See Figure 15 description in the next paragraph) was completed for all forested wetlands, the forested wetland land cover change data was then clipped to the spatial extent of the NWI derived cypress habitat using ArcView 9.2. The result was a data set which was analyzed to show land cover change specifically within the NWI derived cypress habitat. Thus, from the baseline of the NWI, it was determined where cypress habitat was gained, lost, or remained the same, and by how much.

Forested Wetland Land Cover Change on the Georgia Coastal Plain (1991 to 2005)

This map is shown in Figure 15. The Natural Resources Spatial Analysis Lab (NARSAL) has created a uniform classification scheme for the Georgia Land Use Trends Land Cover dataset which they have applied to 1974, 1985, 1991, 2001, and 2005 land cover data.[127] In the land cover data maps, the class "Forested Wetlands" is the land cover class that contains cypress habitat. The land cover change for all forested wetlands was evaluated to compare with changes in cypress forests alone. Additionally, changes in forested wetlands were assumed to be to some extent indicative of the changes in cypress habitat. For this level of analysis, 1974 and 1985 land cover data sets were not examined for two reasons. First, the NWI provides a more accurate baseline assessment for cypress forest than the land cover data sets. Also, the 1975 and 1984 land cover data sets have 60 meter pixel resolution, while 1991, 2001, and 2005 have a pixel resolution of 30 meters, so comparison between these spatial resolutions would have questionable accuracy despite their uniform classification.

The land cover data sets for 1991 and 2005 were joined using the Union function in ArcView 9.2. By performing a Union, the change in land cover for each original wetland polygon can be determined, which allowed us to determine not only maintained, gained, or lost status as forested wetlands, but also which other land cover classes were being converted to forested wetlands and which were replacing forested wetlands.

Potential GIS Error and Data Discrepancies

Potential sources of error for this GIS analysis of land cover and NWI data can be attributed to one of several sources. Land cover data is based on 30m^2 resolution satellite imagery. If there were different meteorological occurrences in the 1991 and 2005 imagery, e.g., flooding or drought, there would be variations in water and saturation levels in forested wetlands that could cause them to be misclassified as uplands or vice-versa. This classification is by no means limited to any single land cover type and error is possible across the entire classification. Given the spatial extent of this error, the results are still presumed valid, because generalizations are necessary and nearly impossible to avoid over large spatial data sets. Had this been an analysis of one county, additional error reduction would have been necessary to validate the results.

[126] The NWI project, administered by the U.S. Fish and Wildlife Service (USFWS), was established to generate information about the characteristics, extent, and status of the Nation's wetlands and deepwater habitats. This data set represents the extent, approximate location, and type of wetlands and deepwater habitats in the conterminous United States. These data delineate the areal extent of wetlands and surface waters as defined by Cowardin et al. (1979). For additional information see: http://www.fws.gov/wetlands/.

[127] Metadata for the Georgia Land Use Trends (GLUT) dataset specifies that land cover was derived from NASA Landsat Thematic Mapper (TM) satellite imagery by employing a classification and decision tree method and ancillary datasets. The Natural Resources Spatial Analysis Laboratory (NARSAL) is located at the University of Georgia, College of Agricultural and Environmental Sciences. More information at http://narsal.uga.edu/glut.

APPENDIX 4

PLANTING GUIDELINES

When site hydrology limits the ability of a cypress forest to regenerate naturally, successful site reestablishment requires the artificial planting of cypress seedlings using special methods developed for cypress, flooded sites conditions, and unconsolidated sediments. One method of planting that has been tested extensively in the southern United States by Clemson University and University of Georgia researchers is to use heavily root pruned seedlings so that they may be planted by grasping the seedling at the root collar and simply inserting it into the soil or sediment, without digging a hole.[128] Habitats planted successfully in this manner have ranged from standing water (backwater) to flowing water (stream), coastal to inland, and from wetlands to agricultural fields. Bareroot seedlings of baldcypress and water tupelo have been successfully planted using this technique in Louisiana, South Carolina, and North Carolina.

The SWG also recommends using heavily root pruned as well as one-year-old cypress seedlings at least 3.3 feet tall and with root collar diameters larger than 0.5 inches to improve early survival and growth.[129] In order to minimize clipping by rabbits and browsing by deer, the use of plastic tree shelters is considered essential. All of these techniques have been demonstrated to increase survival rates for cypress.[130]

In order to evaluate the success of reforestation efforts, a sampling program can be established for planted sites. Sampling methodology for seedling survival will depend on the size of the area planted and the number of seedlings planted. Sites of 1-2 acres in size with 500 seedlings/acre can be monitored by counting and measuring height growth of every seedling. In larger sites with more seedlings, transects and/or plots can be used. These transects/plots should be permanently marked to ensure remeasuring the same area and seedlings each time in order to provide information on trends in survival and growth. Ideally, it is best to permanently mark 10-25 percent of the planted seedlings and remeasure those at least once each year. The shape and size of plots vary tremendously depending upon the density of the seedlings and the size of the area planted. Circular, square, and rectangular plots have been used and range in size from 1/1,000 acre (typical of regeneration study plots) to 1/5 acre (more typical of timber tree inventory). Sites with very few seedlings require a greater number of plots or larger plots to lessen the variability in seedlings encountered. For sites with very high densities of seedlings, 1/1,000 acre plots can be used.

Additional Planting Guidelines

Additional planting guidelines have been developed by the University of Florida Cooperative Extension Service (Extension Service) and are summarized below.[131] Note that the Extension Service guidelines suggest the minimum size of cypress seedlings should be at least 12 inches in height with the diameter of the root collar at least 1/4 inch. These are general requirements for planting. However, the size of the bareroot seedlings to be planted depends upon the site conditions where they are being planted. Bareroot hardwood and cypress seedlings should have a top height of at least 18 inches and a diameter of 1/4 inches according to Allen et al. (2001),[132] but they recommend that, when possible,

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[128] Evaden F. Brantley & William H. Conner, *Growth of Root-Pruned Seedlings in a Thermally Impacted Area of South Carolina*, 48 Tree Planter's Notes 76 (1997); William H. Conner, *Natural and Artificial Regeneration of Baldcypress (Taxodium distichum [L.] Rich.) in the Barataria and Verret Basins of Louisiana* (1988) (unpublished Ph.D. dissertation, Louisiana State University); W.H. Conner, *Artificial Regeneration of Baldcypress in Three South Carolina Forested Wetland Areas After Hurricane Hugo*, in Proceedings of the Seventh Biennial Southern Silvicultural Research Conference, General Technical Report GTR-SO-93, U.S. Dep't of Agriculture, Forest Service, Southern Forest Experiment Station 185 (J.C. Brissette, ed. 1993); William H. Conner & Kathryn Flynn, *Growth and Survival of Baldcypress (Taxodium distichum (L.) Rich.) Planted Across a Flooding Gradient in a Louisiana Bottomland Forest*, 9 Wetlands 207 (1989); Michael R. Reed & Kenneth W. McLeod, *Planting Unconsolidated Sediments with Flood-Tolerant Species*, in Proceedings of the Twenty-first Annual Conference on Wetlands Restoration and Creation, Hillsborough Community College 137 (F.J. Webb, Jr., ed. 1994); I.D. Hesse et al., *Herbivory Impacts on the Regeneration of Forested Wetlands*, in Proceedings of the Southern Forested Wetland Management and Ecology conference, Clemson University 23 (K.M. Flynn, ed. 1996).

[129] Patricia Faulkner et al., *Genetic Variation Among Open-Pollinated Families of Baldcypress Seedlings Planted on Two Different Sites*, *in* Proceedings of the 18th Southern Forest Tree Improvement Conference, Sponsored Publication No. 40, Long Beach, Miss. 267(1985).

[130] *See* Coastal Wetland Forest Conservation & Use Science Working Group, *supra* n.5; Conner, *supra* n.124; Randall S. Myers et al., *Baldcypress (Taxodium distichum (L.) Rich.) Restoration in Southeastern Louisiana: The Relative Effects of Herbivory, Flooding, Competition, and Macronutrients*, 15 Wetlands 141 (1995); Reed & McLeod, *supra* n.129; Callie Jo Schweitzer et al, *Methods to Improve Establishment and Growth of Bottomland Hardwood Artificial Regeneration*, in Proceedings of the 12th Central Hardwood Forest Conference, General Technical Report SRS-24, U.S. Dep't of Agriculture, Forest Service, Southern Research Station 209 (Jeffrey W. Stringer and David L. Loftis, eds. 1999).

[131] Vince & Duryea, supra n.12.

[132] J.A. Allen et al., A Guide to Bottomland Hardwood Restoration, USGS, Biological Resources Division Information and Technology Report USGS/BRD/ITR-2000-001, U.S.D.A. Forest Service, Southern Research Station, General Technical Report SRS-40 (2001).

the top height should be 24 inches and minimum root collar diameter 1/2 inches. The SWG recommendations should be followed for sites where standing water may be present during planting. For that reason, the SWG recommendations call for the larger (3.3 feet tall and 1/2 inches diameter) seedlings. This larger size seedling ensures that the seedling crown is out of the water and that the seedling is sturdy enough to stay upright.

Hydrology

The most critical factor in selecting an appropriate wetland site is hydrology. If the duration of flooding is less than six months, then cypress is likely to be out-competed by hardwoods. During the growing season, the soils should be inundated or saturated, with the water table close to the ground surface. Too much water is also detrimental to cypress growth. Cypress trees tolerate short periods of deep flooding, particularly during the winter, but cypress seedlings usually cannot withstand more than a month of total submergence with water over the terminal bud. Sites that are periodically flooded by stream overflow are favorable for baldcypress, whereas geographically isolated depressions with stagnant water, mainly from rainfall, are better suited to pondcypress.

Soils

Cypress grows on a wide variety of soils, ranging from sands to clays to mucks and peat, provided that moisture is adequate. Probably the best soils are moderately well-drained, moist sandy loams, but these are likely to favor other tree species as well. Cypress can grow on poorly drained clays, and pondcypress, especially, can grow well on acidic, organic soils. Growth of cypress is slow if planted over shallow limerock or hardpan. As stated above, geographically isolated depressions with stagnant water, mainly from rainfall, are better suited to pondcypress. The latter sites are likely to have organic, acidic soils and be more exposed to fire and drought, conditions that are better tolerated by pondcypress than baldcypress.

Vegetation

In addition to hydrology and soils, the extent and type of existing vegetation should be considered during site selection. Cypress is only moderately tolerant of shade; so for best growth, cypress seedlings should not be planted under a dense stand of trees. If a thick overstory is present, then some trees will need to be removed to provide adequate sunlight. Another concern is whether the site is bounded by plant communities that burn frequently. The thin bark of baldcypress offers little protection against fire and so pondcypress should be the variety planted on these sites. However, intense fires that burn into the forest floor can kill both varieties.

Site Preparation

Site preparation is usually not necessary before planting cypress. On harvested sites, plant seedlings as soon as possible after logging. Mechanical site preparation—by chopping, disking, or shearing—should be done only on dry sites when necessary to remove dense shrubs and should be conducted no more than two months prior to planting. On some sites, prescribed fire may be a useful alternative method for removing unwanted vegetation.

Sources and Types of Seedlings

Direct seeding of cypress in the field is not recommended because seedling establishment is unreliable. Cypress seeds germinate only on moist soil: they are susceptible not only to dry soil conditions but to flooding as well. The seedlings, too, require wet soil for optimal growth, yet in most cases they cannot survive more than a few weeks of total submergence. Thus, successful seeding requires a long period of drawdown during the growing season.

Nursery-grown plants are obtainable as bare-root or containerized seedlings. Bare-root seedlings are grown in soil in nursery beds and lifted at the time of sale. Seedling size and quality are important determinants of survival and growth. The top of a bare-root cypress seedling should be at least 12 inches in height; the diameter of the root collar should be at least 1/4 inch, and the roots should be well developed with numerous fibrous roots. Roots should be undercut at about 6 to 8 inches in the nursery beds and not pruned after lifting.

Containerized seedlings are usually enclosed in plastic tubes, cones, or pots. Containerized seedlings are less susceptible to transport and planting shock than bare-root seedlings. Additionally, site conditions may warrant additional investment in older, taller seedlings. Where deep flooding is expected, height is of particular concern; cypress seedlings should be tall enough to avoid being overtopped by water. On sites with flowing water, the developed root system of larger seedlings may provide a more secure hold. Larger seedlings may also be good insurance against mortality from grazing or trampling by animals such as deer, rabbits, and hogs.

Planting Steps

Successful establishment of cypress seedlings depends on the selection of an appropriate site, acquisition of good quality seedlings, proper handling of the seedlings, and use of correct planting techniques. Careless or incorrect planting can result in failure of the project. In wetlands, foot and equipment traffic should be kept to a minimum to avoid soil compaction, which results in altered physical and chemical properties and reduced capacity to sustain plant growth.

Timing of Planting

The best time to plant bare-root cypress seedlings is while they are dormant (November to March). Freezing temperatures should be avoided because the roots are sensitive and will die if frozen. The most important consideration is avoiding the exposure of newly planted cypress seedlings to drought. Seedlings should be planted when the soil is moist or shallowly flooded and likely to remain so for several months. Planting cypress in water is fine, provided that the seedlings are not completely submerged.

Tree seedlings should be protected from temperature extremes and never be allowed to dry out. A refrigerated truck is the best means of transporting seedlings from the nursery to the field site. If seedlings are carried in an open vehicle, they should be covered with a reflective tarp to prevent drying or overheating.

Cypress seedlings should be planted immediately upon receipt from the nursery. If that is not possible, store the seedlings in a cool, dark place, preferably in a refrigerated storage unit. Dense shade or a shed will do for a few days, provided the roots are not allowed to dry out or freeze. Bare-root seedlings are especially vulnerable and require careful handling. They are packed in bundles of 50 to 200 and should be watered to prevent drying unless they have already been coated with absorbent material and are completely enclosed in lined bags or boxes. Bare-root cypress seedlings retained in cold storage have a higher post-planting survival rate than those held in tubs of water.

Only as many seedlings should be taken to the field as can be planted in a day. Planting bags and containerized seedlings should be left in the shade (preferably under a reflective tarp) until ready to plant. Work should be conducted quickly once the seedlings, especially the roots, are exposed to air and sunlight.

Spacing

Planting density depends on landowner objectives and, in the case of harvested swamps, the likelihood of natural cypress regeneration from seed and remaining stumps. When fiber production is the primary objective, a common recommendation for spacing of cypress seedlings is 8 x 8 feet, requiring 680 seedlings per acre. A less dense spacing of 10 x 10 feet, 437 seedlings per acre, is likely to be sufficient if sawtimber production is the overriding goal. Even lower densities can satisfy other landowner objectives, such as enhancement of wildlife habitat.

Most wetlands have gradients of water levels and uneven topography. The best strategy is to plant seedlings throughout a site, provided that they are not likely to be fully submerged or subjected to long periods of dry soil conditions.

Planting

Cypress seedlings are usually planted by hand. The cost of mechanical planters is too high for most small reforestation projects, and on wetland sites, flooded conditions may prevent their use during much of the year. Various tools can be used for hand planting cypress, including dibbles, bars, and shovels. Once the hole is created, the seedling should be inserted with the root collar at or just below the ground surface. Roots of bare-root seedlings should be placed so that they can spread out naturally, without twisting or bending. The hole should then be closed and soil packed firmly around the seedling. When planting into soft, flooded soil, the seedling should be held at the root collar and pushed into the soil.

Although planting a tree by hand is a simple task, it is often done incorrectly. Frequent mistakes include: planting the seedling either too deep or not deep enough; digging a hole too shallow for proper placement of the roots; planting the seedling in a non-vertical position; and leaving an air pocket near the roots after closing the hole, which may allow the roots to dry out.

Seedling Management

For two years after planting, survival of the seedlings should be closely monitored. This period is critical; if a reforestation project fails, it most likely happens during this time. A common cause of death of cypress seedlings is extended drought in the post-planting period. Other causes include inundation coupled with high temperatures, poor quality seedlings, poor planting practices, animal predation, and fire. If fewer trees remain than expected after two years, replanting may be necessary.

The most frequent predators of cypress seedlings are rabbits, deer, and feral hogs. Planting large cypress seedlings (3 gallon container or greater), which can survive grazing and produce new sprouts in response, is an alternative method of protecting seedlings against these predators. However, unless dense predator populations exist at the site, these protection measures may not be worth the expense.

Both baldcypress and pondcypress seedlings are susceptible to fire; so the newly planted site should be protected if burning is expected nearby. A fire break should be created around the site by disking, and maintained periodically, especially during extended dry periods. In addition, post-planting weed control is recommended for cypress plantings. Vegetation management is usually achieved by using approved chemical herbicides, hand cutting, or mowing, or through controlled flooding if water control structures are available.

APPENDIX 5

REFERENCED ARTICLE

Assessing Wetland Status and Trends in the Altamaha River Watershed Using TM Imagery July 16, 2002

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While agriculture had traditionally been identified as one of the leading causes of wetland loss, wetland status and trend data indicate that since the mid 1970s losses due to silvicultural practices are on par with those caused by agriculture. The 2000 wetland status and trends report prepared by the U.S. Fish and Wildlife Service found that of freshwater wetland decline overall, 26% of the loss was attributable to agriculture and 23% to silviculture. The report further states "[c]onversion from bottomland forest to managed pine plantations accounts for most of the changes in the freshwater forested [wetland] category in the Southeastern United States." Conversion to pine plantations can result in wetland degradation and loss. The goal of this project was to develop a practical method for determining the extent of wetland conversion to pine plantations in the southeast Atlantic coastal plain. The Altamaha River watershed in Georgia was selected as a manageable and representative area for use in method development.

National Wetlands Inventory data (ca. 1982-84) were chosen as the baseline data set. NWI data precede a period of rapid increase in pine plantations in the study area, offer comprehensive coverage, and were rigorously developed. Selected land cover datasets were assessed for suitability. Analysis of LandSat Thematic Mapper (TM) data were identified as likely to produce useful results, applicable at a region-wide level. It was found by inspection that actively growing vegetation in a TM scene is easily identified using TM bands 4 and 3 (near-IR) combined in a composite or ratio. Actively growing vegetation is known to strongly absorb in band 3 (red) and strongly reflect in band 4 (near-IR). Combinations of the two bands strongly highlight the most actively growing vegetation and were used to distinguish between pine and nonpine areas by comparing winter and summer scenes. For NWI wetlands, results were calculated in two ways: (1) with NWI as a basis and (2) with 1984/5 TM data as a basis and the analysis restricted to NWI wetlands. Both base data sets were compared against 2001 TM data. The study identified a total of 113 km^2 (27,900 acres) of nonpine wetlands as converted to pine during the study period. Results show that a significant portion of the watershed as a whole (nearly 20 percent) has been converted from nonpine to pine since 1984. Nearly 10 percent of wetlands appear to have been converted from nonpine to pine. The results of this study indicate landscape changes in wetland forests are occurring that justify further investigation to assess the extent to which regional wetland functions may be affected.

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