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An Interim Old-Growth Definition for Cypress-Tupelo Communities in the Southeast

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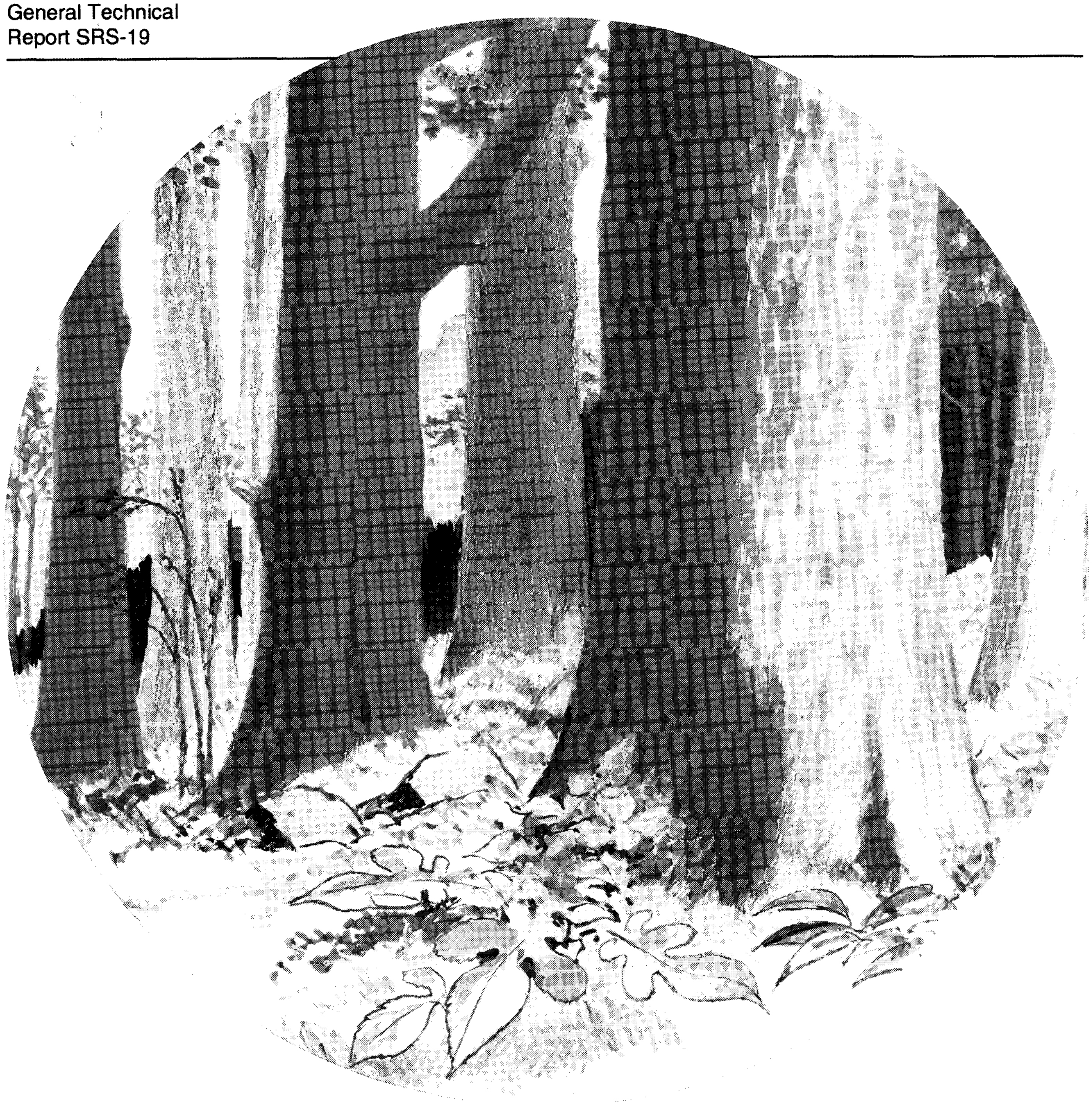

A Section of the Old-Growth Definition Series

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Preface

Old growth is widely acknowledged today as an essential part of managed forests, particularly on public lands. However, this concept is relatively new, evolving since the 1970's when a grassroots movement in the Pacific Northwest began in earnest to define old growth. In response to changes in public attitude, the U.S. Department of Agriculture, Forest Service, began reevaluating its policy regarding old-growth forests in the 1980's. Indeed, the ecological significance of old growth and its contribution to biodiversity were apparent. It was also evident that definitions were needed to adequately assess and manage the old-growth resource. However, definitions of old growth varied widely among scientists. To address this discrepancy and other old-growth issues, the National Old-Growth Task Group was formed in 1988. At the recommendation of this committee, old growth was officially recognized as a distinct resource by the Forest Service, greatly enhancing its status in forest management planning. The committee devised "The Generic Definition and Description of Old-Growth Forests" to serve as a basis for further work and to ensure uniformity among Forest Service Stations and Regions. Emphasis was placed on the quantification of old-growth attributes.

At the urging of the Chief of the Forest Service, all Forest Service Stations and Regions began developing old-growth definitions for specific forest types. Because the Southern and Eastern Regions share many forest communities (together they encompass the entire Eastern United States), their efforts were combined, and a cooperative agreement was established with The Nature Conservancy for technical support. The resulting project represents the first large-scale effort to define old growth for all forests in the Eastern United States. This project helped bring the old-growth issue to public attention in the East.

Definitions will first be developed for broad forest types and based mainly on published information and so must be viewed accordingly. Refinements will be made by the Forest Service as new information becomes available. This document represents 1 of 35 forest types for which old-growth definitions will be drafted.

In preparing individual old-growth definitions, authors followed National Old-Growth Task Group guidelines, which differ from the standard General Technical Report format in two ways-the abstract (missing in this report) and the literature citations (listed in Southern Journal of Applied Forestry style). Allowing for these deviations will ensure consistency across organizational and geographic boundaries.

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Introduction

Forested wetlands [cypress-tupelo *(Taxodium* spp.-*Nyssa* spp.)] as well as some bottomland hardwood forests, are of increasing interest in the South. They are important in water management, wildlife conservation, habitat diversity, and high quality timber (Ewe1 and Odom 1984). The acreage of such forests in the region has declined dramatically; for example, at the time of European colonization, Louisiana had an estimated 11 to 12 million acres [4.4 to 4.8 million hectares (ha)] of forested wetlands. At that time, wetlands were considered useful only after they had been drained. The Swamp Land Acts of 1849-50 granted Federally owned swamp lands to the States to be reclaimed and disposed of, and, by 1974, only about 49 percent of the original acreage remained (Turner and Craig 1980).

Virgin cypress swamps were an important source of timber for early settlers. Cutting of cypress began as soon as the French and Spanish arrived in the gulf coastal area, and, by 1723, they were exporting some cypress lumber. However, logging in swamps was difficult, and, although cypress lumbering slowly increased during the colonial period, only the best trees in the most accessible locations were cut. Industrial logging of cypress began around 1890; the dwindling northern lumber industry, availability of cheap land, and development of new logging and milling techniques caused a dramatic increase in the utilization of cypress. However, industrial exploitation of cypress was short-lived, and, by 1925, only a few stands of commercial importance remained (Mancil 1972). By the late 1930's, virgin cypress was extremely scarce. A memorandum written in 1939 by L. Cook, Chief of Forestry of the National Park Service, states: "In Louisiana, cypress logs that have been lying on the ground for many years are now being salvaged due to the growing scarcity of standing timber of large size."

Description

Cypress-tupelo forests occur mainly in the Coastal Plain physiographic province (after Fenneman 1938) from southern Delaware through southern Florida to southeastern Texas and extend northward along the Mississippi River and its major tributaries to southern Illinois. Most cypress is within 98.4 feet [30 meters (m)] above sea level (Harlow and Harrar 1969). This forest type is found almost exclusively in low areas prone to frequent flooding such as swamps, deep sloughs, alluvial flats of major river floodplains, swamps of tidal estuaries, margins of coastal marshes, and isolated depressions of the Coastal Plain. Fine-textured mineral soils predominate in alluvial bottoms, whereas nonalluvial swamps and depressions have surfaces of muck or shallow peat. Most soils are poorly aerated due to saturated conditions.

Principal tree species include baldcypress [*Taxodium distichum* (L.) Rich.], pondcypress *(T. ascendens* Brong.), water tupelo (*N. aquatica* L.), and swamp tupelo (*N. biflora* Walt.). Swamps may be. composed of any of these species (Hall and Penfound 1939b). Baldcypress grows larger and faster than pondcypress and is usually associated with flowing water. Pondcypress ordinarily dominates shallow ponds, edges of strands, and other locations where water collects and stands for part of the year (Ewe1 and Odom 1984). Hall and Penfound (1939b) mention that pondcypress and slash pine (*Pinus elliottii* Engelm.) may be major components of the pine flatwoods of the lower Coastal Plain. Baldcypress is an important component of bottomland hardwood communities, but those forest types are not considered here.

Tree species associated with baldcypress include red maple (*Acer rubrum* L.), sweetbay (*Magnolia virginiana* L.), southern magnolia (*M. grandiflora* L.), sweetgum (*Liquidambar styraciflua* L.), and various oaks *(Quercus* spp.), ashes *(Fraxinus* spp.), and pines (*Pinus* spp). Small trees and shrubs include buttonbush (*Cephalanthus occidentalis* L.), poison-ivy [*Toxicodendron radicans* (L.) Kuntze-S], muscadine grape (*Vitis rotundifolia* Michaux), Spanish moss (*Tillandsia usneioides* L.), cattail (*Typa latifolia* L.), lizardtail (*Saururus cemuus* L.), and various hollies (*Ilex* spp.), viburnums (*Viburnum* spp.), lyonias (*Lyonia* spp.), sedges, grasses, and ferns (Wilhite and Toliver 1990).

Species associated with water tupelo are black willow (*Salix nigra* Marshall), swamp cottonwood (*Populus heferophyllu* L.), red maple, waterlocust (*Gleditsia aquatica* Marshall), water-elm (*Planer-u aquatica* Walter ex J.F. Gmelin.), overcup oak (Q. *lyrata* Walter), water oak (Q. *nigra* L.), water hickory [*Carya aquatica* (Michaux f.)] green and pumpkin ash (*F. pennsylvanica* Marshall and *F. profunda* Bush-S), sweetgum, and redbay [*Persea borbonia* (L.) Sprengel.]. Small trees and shrubs associated with water tupelo include swamp-privet [*Forestieru acuminata* (Michaux) Poiret], buttonbush, sweetbay, Carolina ash (*F. caroliniana* Miller), poison sumac [*T. vernix* (L.) Kuntze—S], southern bayberry (*Myrica cerifera* L.), and dahoon (*Ilex cassine* L.) (Johnson 1990).

Swamp tupelo often occurs in pure stands, although cypress and water tupelo may be associated with it. The species is confined to ponds and sloughs and to the deltas of streams (Hall and Penfound 1939b). Other common associates of swamp tupelo are red maple, buttonbush, buckwheat tree [*Cliftonia monophylla* (Lam.) Britton ex Sarg.], dogwood (*Cornus* spp.), swamp cyrilla (*Cyrilla racemiflora* L.), swamp-privet, Carolina ash, loblolly-bay [*Gordonia lasianthus* (L.) Ellis], dahoon, inkberry [I. *glabra* (L.) Gray], yaupon (I. *vomitoriu* Aiton), fetterbush lyonia [*Lyonia lucida (Lam.)* K. Koch], and bayberry (Outcalt 1990).

Pondcypress is commonly found in shallow ponds of the Coastal Plain associated with swamp tupelo. Other species found along the margins and on slightly elevated positions in the ponds are pines, red maple, sweetbay, and loblolly-bay. Small trees and shrubs found in this habitat include buttonbush, yaupon, swamp cyrilla, viburnums, swamp-privet, bayberry, inkberry, ferns, and vines. Pondcypress is also found in some swamps along black-water rivers and creeks, in Carolina bays, in the Okefenokee Swamp, and in pondcypress savannahs. On these sites, it may be associated with the species listed above and many others (Wilhite and Toliver 1990).

Although these species are not considered shade tolerant, the forest type as a whole is considered successional stable (climax) on most sites because prolonged periods of deep flooding prevent seed germination and curtail invasion by more shade-tolerant species. However, where either sediment accumulates or the frequency of flooding diminishes, or both, this forest type may be replaced by others (e.g., bottomland hardwoods). Historically, low intensity, small-scale disturbances were probably most common in these forests, although proximity to the coast ensured occasional large-scale disturbance from storms.

Due to hydric conditions, fire is unusual in these forests except during periods of drought. The principal tree species typically have long life spans; baldcypress, for instance, can live longer than 1,600 years (Earley 1990). Wide age distribution was probably characteristic of original old-growth stands, including trees 200 to 800 years old (Ewe1 and Odom 1984).

Associated Cover Types

Following are the Society of American Foresters (SAF) forest cover types (Eyre 1980) and Region 8 and Southern Research Station forest types that correspond to the cypress-tupelo community:

Crosswalk with SAF forest cover types:

100—pondcypress
101—baldcypress
102—baldcypress-tupelo
103—water tupelo-swamp tupelo

USDA Forest Service Region 8 forest types:

23-pondcypress
24-baldcypress
67-baldcypress-water tupelo

Southern Research Station forest type:

67—cypress-water tupelo

Old-Growth Conditions

Living Tree Component

Botanists and foresters have been interested in the size of old-growth trees (Brown 1984) (table 1). Mattoon (1915) found baldcypress trees with diameters up to 12 feet (3.6 m) above the swollen buttress and heights of 118 to 128 feet (36 to 39 m). Moore (1967) mentions that Andrew Brown purchased logs for his sawmill in Natchez, MS, that were 4 to 12 feet (1.2 to 3.6 m) in diameter with clear boles as long as 69 feet (2 1 m). In the early days of cypress logging, the largest trees were left in the forest because they were impossible to cut with the equipment available (Brown 1984). Later, only defective trees were left.

Pondcypress is a much smaller tree than baldcypress; it has a slender bole, usually not over 3 feet (1 m) in diameter, with rounded to flat-topped crowns (Brown 1984). Water tupelo is also much smaller than baldcypress. It is a

Table 1 (English units)—Standardized table of old-growth attributes for cypress-tupelo communities in the Southeast

Quantifiable attribute	Data	No. of stands”	References
	Live trees in main canopy		
Stand density	***(No./acre)***		
Taxodium distichum **>1** in. **d.b.h.**	240	1	Hall and **Penfound 1939a**[b]
T. distichum ≥**1** in. **d.b.h.**	36-252	1	Hall and **Penfound 1939b**[c]
Nyssa aquatica ≥**4** in. d.b.h.	5	1	Martin and Smith **1991**[d]
N. ***aquatica*** ≥**20** in. d.b.h.	3	1	Martin and Smith **1991**[d]
N. ***aquatica*** **>1** in. d.b.h.	300	1	Hall and **Penfound 1939a**
	48-342	1	Hall and **Penfound** 1939b
N. biflora **>1** in. d.b.h.	840	1	Hall and **Penfound** 1939a
	O-216	1	Hall and **Penfound 1939b**
	302	1	Hall and **Penfound** 1943’
T. ascendens **>1.6** in. d.b.h.	**1,447–7,702**	1	Schlesinger 1978
Mixed species **>4** in. d.b.h.	1.618	4	**Gresham,** personal communicatiod
	1,495	4	Gresham, personal communication’
	551	1	Gresham, persona1 communication*
Mixed species **>50** in. **d.b.h.**	445	4	Gresham, personal communicatiod
	138	4	**Gresham,** personal communication[8]
	74	1	Gresham, personal communication*
Stand basal area	***(Ft²/acre)***		
T. distichum **>1** in. **d.b.h.**	203	1	Hall and **Penfound 1939a**
N. ***biflora*** **>1** in. d.b.h.	139.5’	1	Hall and **Penfound 1939a**
	1,095[j]	1	Hall and **Penfound** 1939b
T. ascendens	202.5-443.4’	1	Schlesinger 1978
Mixed species **>4** in. d.b.h.	493.9	4	Gresham, personal communicatiod
	240.9	4	Gresham, personal communication[8]
	81.0	1	Gresham, personal communication [h]
Mixed species **>50** in. d.b.h.	384.1	4	Gresham personal communicatiod
	321.0	4	Gresham, personal **communication**[g]
	41.9	1	Gresham, personal communication*
Average age of large trees’	***(Years)***		
T. distichum	**500–1,000** max.		Lynch 1991
	700-800		**Porcher** 198 **1**
	400–600 (up to **1,200**)		Harlow and Harrar 1969
	200-800		Ewel and Odum 1984
N. aquatica	93		Martin and Smith 1991
T. ascendens	120-200 (up to 900)		Schlesinger 1978
N. biflom	200		Hall and **Penfound 1939b**
	Variation in tree diameter		
D.b.h. of largest trees	***(Inches)***		
T. distichum	**36–60**		Harlow and Harrar 1969
	72 d.n.[m]		Lynch et al. **1991**[n]
	48-60, rarely 144		Sargent 1965
	108-120		Lindsey et al. 1961
	63.8		Gresham, personal communicatiod
	30.2		Gresham, personal **communication**[g]
	33.8		Gresham. personal communication*
N. aquatica	3648		Harlow and Harrar 1969
	25-30		Martin and Smith 199 **1**
	36-48		Lynch et al. 1991”
	3648		Sargent 1965
	46. 23.9		Gresham, personal **communication**[g]
N. biflora	24-36		Harlow and Harrar 1969
	26.9		Gresham, personal communication’
T. ascendens	8-27.5 **d.n., 78**		Schlesinger 1978

Table 1 (English units&Standardized table of old-growth attributes for cypress-tupelo communities in the Southeast (continued)

Quantifiable attribute	Data	No. of stands"	References
	Dead trees-coarse woody debris		
Standing snags	***(No./acre)***		
T. distichum	**Several/3ac**		Martin and Smith 1991
N. aquatica	**Several/3 ac**		Martin and Smith 1991
T. ascendens >1.6 in. d.b.h.	**667**		Schlesinger 1978
N. ***biflora*** >1 in	**34**		Hall and Penfound 1943
Mixed species, all sizes	**321**		Gresham, personal communicatiod
	156		Gresham, personal communication[g]
	287		Gresham, personal communication[h]
Downed logs	***(Ft²/acre)***		
T. distichum	Several/3 ac		Martin and Smith 1991
N. aquatica	Several/3 ac		Martin and Smith 1991
Mixed species, all sizes	**489**		Gresham, personal communicatiod
	178		Gresham, personal communication[g]
	830		Gresham, personal communication [h]
	Tree **canopy structure**		
layers	Main canopy/subcanopy/shrub		Hall and Penfound 1939a
	Main canopy/shrub		Schlesinger 1978
	Main canopy/minimal shrub &herb		Hall and Penfound 1943
Percent canopy in gaps[o]			
(Percent cover)[p]	O-19 20-39 40-59 60-79 SO-100		
	54 5 6 35 47		Gresham, personal communicatiod
	0 2 3 9 86		Gresham, personal communications
	23 11 11 19 35		Gresham, personal communication[h]
	Other important features		
Height	***(Feet)***		
T. distichum	100-120		Harlow and Harrar 1969
N. aquatica	SO-90		
N. biflora	50-60		

[a] Number of stands may not equal number of citations.
[b] No evidence of cutting or drainage.
[c] Little human influence on stand.
[d] Virgin stand not subject to drainage or cutting.
[e] No evidence of cutting or burning.
‘Personal communication. February 16, 1995. Charles A. Gresham Associate Professor, College of Forest and Recreation Resources, The Belle W. Baruch Forest Science Institute, Clemson University, Georgetown, SC 29442. Data from four stands in Beidler Forest.
[g] Personal communication. February 16, 1995. Charles A. Gresham, Associate Professor, College of Forest and Recreation Resources, The Belle W. Baruch Forest Science Institute, Clemson University, Georgetown, SC 29442. Data from four stands in Congaree Swamp National Monument.
[h] Personal communication. February 16, 1995. Charles A. Gresham, Associate Professor, College of Forest and Recreation Resources, The Belle W. Baruch Forest Science Institute, Clemson University, Georgetown, SC 29442. Data from a stand in Santee Experimental Forest, Francis Marion National Forest.
[i] Measured at head height.
[j] Measured above swell.
[k] Measured 3 feet above swell.
[l] Dominant and codominant overstory trees.
[m] d.n. = diameter normal (18" above butt swell).
[n] Lynch, Baker, T. Foti, and L Peacock. 1991. The White River-Lower Arkansas River megasite: A preserve design project. 95 p. Draft unpublished report. On file with: Arkansas Nature Conservancy, 601 N. University, Little Rock, AR 72205.
[o] 100 measurements per stand.
[p] Percent of upward vertical view of canopy that was leaves and branches.
[q] Five out of 100 measurement points had O-198 of canopy occupied by leaves and branches.

Table 1 (metric units&Standardized table of old-growth attributes for cypress-tupelo communities in the Southeast

Quantifiable attribute	Data	No. of stands”	References
	Live trees in main canopy		
Stand density	***(No./ha)***		
Taxodium distichum >2.5 cm d.b.h.	**240**	1	Hall and Penfound 1939a[b]
T. distichum ≥2.5 cm d.b.h.	36252	1	Hall and Penfound 1939b[c]
Nyssa aquatica ≥10 *cm* d.b.h.	5	1	Martin and Smith 1991[d]
N. aquatica ≥50 cm d.b.h.	3	1	Martin and Smith 1991[d]
N. aquatica >2.5 cm d.b.h.	300	1	Hall and Penfound 1939a
	48-342	1	Hall and Penfound 1939b
N. *biflora* >2.5 cm d.b.h.	**840**	1	Hall and Penfound 1939a
	O-216	1	Hall and Penfound 1939b
	302	1	Hall and Penfound 1943[e]
T. ascendens >4 cm d.b.h.	**586–3,117**	1	Schlesinger 1978
Mixed species >10 cm d.b.h.	655	4	Gresham, personal communicatiod
	605	4	Gresham, personal communication[g]
	223	1	Gresham, personal communication*
Mixed species >50 cm d.b.h.	180	4	Gresham, personal communicatiod
	56	4	Gresham, personal communication[8]
	30	1	Gresham, personal communication”
Stand basal area	***(m²/ha)***		
T. distichum >2.5 cm d.b.h.	46.6	1	Hall and Penfound 1939a
N. *bijlom* >2.5 cm d.b.h.	32’	1	Hall and Penfound 1939a
	77.6, 25 1.4’	1	Hall and Penfound 1939b
T. ascendens	**46.5–101.8**[k]	1	Schlesinger 1978
Mixed species >10 cm d.b.h.	113.4	4	Gresham, personal communicationf
	55.3	4	Gresham, personal communication[g]
	18.6	1	Gresham, *personal* communication[h]
Mixed species >50 cm d.b.h.	88.2	4	Gresham personal communicationf
	73.7	4	Gresham, personal communication[g]
	11.0	1	Gresham, personal communication[h]
Average age of large trees’	***(Years)***		
T. distichum	**500–1,000** *max.*		Lynch 1991
	700-800		Porcher 198 1
	400–600 (up to 1,200)		Harlow and Harrar 1969
	200-800		Ewel and Odum 1984
N. aquatica	*93*		Martin and Smith 199 1
T. ascendens	**120–200** (up to 900)		Schlesinger 1978
N. *biflora*	**200**		Hall and Penfound 1939b
	Variation in tree diameter		
D.b.h. of largest trees	***(cm)***		
T. distichum	91-152		Harlow and Harrar 1969
	183 d.n.[m]		Lynch et al. 1991”
	122-152, rarely 366		Sargent 1965
	275–305		Lindsey et al. 1961
	162		Gresham personal communicatiod
	76.7		Gresham, personal communication[g]
	85.9		Gresham, personal communication*
N. aquatica	91-122		Harlow and Harrar 1969
	64-76		Martin and Smith 199 l
	91-122		Lynch et al. 1991”
	91-122		Sargent 1965
	117		Gresham, personal communication[g]
N. biflora	61-92		Harlow and Harrar 1969
	68.4		Gresham, personal communications
T. ascendens	20-70 d.n., 2 m		Schlesinger 1978

Table 1 (Metric units)—Standardized table of old-growth attributes for cypress-tupelo communities in the Southeast (continued)

Quantifiable attribute	Data	No. of stands’	References
	Dead trees—coarse woody debris		
Standing snags	***(No./ha)***		
T. distichum	**Several**		Martin and Smith 1991
N. aquatica	**Several**		Martin and Smith 1991
T. ascendens >4 cm d.b.h.	**270**		Schlesinger 1978
N. ***biflora*** >2.5 cm d.b.h.	**34**		Hall and Penfound 1943
Mixed species, all sizes	**130**		Gresham, personal communicatiod
	63		Gresham, personal communication’
	116		Gresham, personal communication[h]
Downed logs	***(m^3/ha)***		
T. ***distichum***	**Several**		Martin and Smith 1991
N. aquatica	**Several**		Martin and Smith 1991
Mixed species, all sizes	**198**		Gresham, personal communicatiod
	72		Gresham, personal communication’
	336		Gresham, personal communication[h]
	Tree canopy structure		
Layers	Main canopy/&canopy/shrub		Hall and Penfound 1939a
	Main canopy/shrub		Schlesinger 1978
	Main canopy/minimal shrub &herb		Hall and Penfound 1943
Percent canopy in gaps’ (Percent cover)[p]	O-19 / 20-39 / 40-59 / 60-79 / 80-100		
	5[q] / 5 / 6 / 35 / 47		Gresham, personal communicatiod
	0 / 2 / 3 / 9 / 86		Gresham. personal communication’
	23 / 11 / 11 / 19 / 35		Gresham personal communication[h]
	Other important features		
Height	***(m)***		
T. distichum	***30.5-36.6***		Harlow and Harrar 1969
N. ***aquatica***	***24.4–27.4***		
N. biflora	***15.2-18.3***		

[a] Number of stands may not equal number of citations.
[b] No evidence of cutting or drainage.
[c] Little human influence on stand.
[d] Virgin stand not subject to drainage or cutting.
[e] No evidence of cutting or burning.
‘Personal communication. February 16, 1995. Charles A. Gresham, Associate Professor, College of Forest and Recreation Resources, The Belle W. Baruch Forest Science Institute, Clemson University, Georgetown, SC 29442. Data from four stands in Beidler Forest.
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[n] Lynch, Baker, T. Foti, and L Peacock. 1991. The White River-Lower Arkansas River megasite: A preserve design project. 95 p. Draft unpublished report. On file with: Arkansas Nature Conservancy, 601 N. University, Little Rock, AR 72205.
[o] 100 measurements per stand.
[p] Percent of upward vertical view of canopy that was leaves and branches.
[q] Five out of 100 measurement points had 0 to 19% of canopy occupied by leaves and branches.

medium-to-large tree 79 to 92 feet high (24 to 28 m) and 3 to 4 feet [100 to 122 centimeters (cm)] in diameter at breast height (d.b.h.) The maximum in height is 110 feet (33.5 m) and 6 feet (183 cm) in d.b.h. Water tupelo is found on sites that are periodically under water (Harlow and Harrar 1969). Swamp tupelo is a small-to-medium-sized tree that inhabits swampy lake shores (Brown 1965). Both species have swollen buttresses and looping roots.

Many early botanists visited cypress swamps, and numerous descriptions of the community type have been published. However, little quantitative data exist. In 1876, Ridgway (Lindsey et al. 1961) described Little Cypress Swamp across the Wabash River from Mt. Cannel, IN. He stated that the swamp'covered 20,000 acres (8094 ha), timbered mostly with baldcypress. The largest trees [9 to 10 feet (2.7 to 3 m) in diameter] had been cut usually at the beginning of the cylindrical portion of the tree. Ridgway wrote that the swollen buttresses of the trees were "growing so near together that the intervening spaces are entirely taken up by the knees, the whole surface thus being an irregular wooden one, with soil or water only in the depressions." Lindsey et al. (1961) published a photograph of a huge baldcypress tree, taken near the mouth of the White River by Ridgway in 1888, and labeled "average size mature *Taxodium*."

Williams, Inc. harvested several stands of virgin baldcypress from swamps in south Louisiana around 19 19. The number of board feet per tree harvested ranged from 555 to 2,84 1 (1.3 1 to 6.70 m^3) for live baldcypress, 288 to 1,458 (0.68 to 3.42 m^3) for dead baldcypress, and 407 to 729 (0.96 to 1.72 m^3) for water tupelo. During 1903 to 1907, an average volume of 38,926 board feet per acre (226.76 m^3 per ha) was harvested from 3,800 acres (1537 ha) of cypress-tupelo swamp in the Bay Wallace area.[1]

Hall and Penfound (1939b) studied a 200-year-old virgin swamp tupelo (*N. biflora*) swamp at the edge of the Pearl River Valley in southeastern Louisiana. The trees, 82 feet (25 m) high, were slender above the conspicuous swollen buttresses; they had numerous looping roots. The d.b.h. averaged 25.7 inches (65.3 cm), whereas diameter above the buttresses [10 feet (3 m)] averaged 14.5 inches (36.8 cm). Swamp tupelo was the only important tree component.

Hall and Penfound (1939a) also investigated a virgin baldcypress-tupelo swamp that had invaded marshlands along the Pearl River. The authors measured trees >1 inch (>2.5 cm) at head height, just above the swollen buttress, so that better comparisons could be made with other forest types (diameter at the bottleneck). They state that although Indian Village swamp was considered a baldcypress-gum swamp, it was really a *Nyssa biflora* consocies, with swamp tupelo the dominant species (55 percent of trees per acre and 65 percent of crown cover). The authors note that the basal area of the community 203 square feet per acre (46.6 m^2 per ha) was approximately equal to that of a mature virgin longleaf pine community 205 square feet per acre (47 m^2 per ha). Swamp tupelo had a basal area of 139.5 square feet per acre (32 m^2 per ha) and occupied 69 percent of the basal area; baldcypress, 16 percent; water tupelo, 14 percent; and red maple, 1 percent. Average age of baldcypress was 85 years. The understory included individuals of the canopy species as well as pumpkin ash and buttonbush.

Age Characteristics

Harlow and Harrar (1969) reported that baldcypress trees in virgin stands averaged 400 to 600 years old with some up to 1,200 years old. Other authors also describe baldcypress trees 500 to 1,000 years old (table 1). Although few baldcypress trees of that age are living today, Van Deusen et al. (1993) cored living baldcypress trees up to 1,270 years of age in swamps in Louisiana and Mississippi.

Canopy Characteristics

Old baldcypress trees have broad, low, rounded crowns often 98 feet (30 m) across. Usually baldcypress makes up the canopy in this community, whereas water tupelo or swamp tupelo make up the subcanopy. However, other combinations may also be found.

Beidler Swamp is a 799-acre (728.5-ha) original growth tract with three climax bottom-land forests: swamp forest, hardwood bottom, and ridge bottom. The canopy baldcypress trees are 120 feet (36.6 m) tall, whereas the water tupelo subcanopy is approximately 80 feet (24.4 m) tall. The largest baldcypress trees are 5 to 6 feet (150 to 180 cm) in diameter and 700 to 800 years old (Porcher 1981).[2] Baldcypress and tupelo occur in pure stands in the lowest parts of the swamp, but, in the higher parts, other tree species occur. Carolina ash forms a subcanopy below the tupelo in some areas, usually growing from the bases of the baldcypress or water tupelo trees. Swamp tupelo is scattered

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[1] Personal communication. 1992. Rudy Sparks, Vice President, Williams, Inc., 107 McGee Drive, Patterson. LA 70392.

[2] Dennis, J.V. 1970. Four Holes Swamp, Berkeley and Dorchester Counties, SC: Study of the natural history and matters pertaining to acquisition of one of the last large virgin bottomland swamps in the South. 55 p. Unpublished report. On file with: The Nature Conservancy, 1815 N. Lynn Street, Arlington, VA 22209.

throughout the forest and occasionally reaches the canopy (Porcher 1981).

In Indian Village Swamp (Hall and Penfound 1939a), total crown cover just as buds were opening was 20 percent. Swamp tupelo made up approximately 65 percent of the cover, whereas the rest was formed by other canopy species. When the trees were fully leafed out, crown cover was 60 percent.

Schlesinger (1978) studied 17 stands in the Okefenokee Swamp in Georgia. The forests were along the middle fork of the Suwannee River and are thought to be undisturbed remnants of the former extensive forest. Canopy trees were 8 to'28 inches (20 to 70 cm) in d.b.h. and 66 feet (20 m) tall. Water depth ranged from 6 inches to 3 feet (15 cm to 1 m). Pondcypress was by far the dominant species in the overstory, although density and basal area of cypress varied among sites by 1,448 to 7,702 stems per acre (586 to 3,119 stems per ha) and 202 to 444 square feet per acre (46.5 to 101.8 m^2 per ha), diameter was measured above the swell-about 3 feet (1 m) above the water level.

Dead Tree Component

Standing Snags-Little data are available on the dead tree component of the cypress-tupelo community. Hall and Penfound (1939b) state that 302 living trees and 34 dead trees per acre (122 and 14 per ha) occurred in a swamp near Pearl River in southeastern Louisiana. Several of the early workers in swamps mentioned that herbaceous vegetation germinates and grows on logs and stumps because the swamp floor is too wet or flooded.

Down Woody Debris--Very little data have been collected on large woody debris, but some studies of litterfall have been carried out. Annual litterfall in Okefenokee Swamp (Schlesinger 1978) was 0.067 pounds per square foot [328 grams (g) per m^2], with 68 percent falling between October and December. Of the total, 0.046 pounds per square foot (222 g per m^2) (68 percent) was cypress needles, 0.002 1 pounds per square foot (10.23 g per m^2) was cypress twigs, and 0.0089 pounds per square foot (43.37 g per m^2) was bark.

Understory Characteristics

Cypress seeds do not germinate in water (Mattoon 19 16, Demaree 1932), so dense stands of cypress seedlings are established during periodic drought when large areas of unoccupied soil are exposed. Distinct cohorts of equal-sized individuals are present as young trees. The cohorts reaching the canopy converge in size to form a canopy 11 to 16 inches (28 to 40 cm) in diameter. As these trees age, separate groups merge, and old stands are dominated by a number of large individuals. Schlesinger (1978) found that the size of the average tree at a site grew sixfold as density was reduced, but forest biomass per ha remained the same.

The large tupelo seeds are distributed by water. They become stranded in the mud as the water recedes, and many germinate. Seedlings on poorly drained sites grow slowly but are not as likely to be suppressed by other species as those that germinate in better drained sites (Harlow and Harrar 1969). Shade-tolerant seedlings generally cannot invade cypress-tupelo swamps because of prolonged flooding. The shrub and herbaceous layers are often sparse, also because of flooding, whereas woody vines and epiphytes, especially Spanish moss, are common. Schlesinger (1978) reported that the biomass of Spanish moss in Okefenokee Swamp equaledthe total biomass of herbaceous plants in most upland temperate forests. In deep water cypress-tupelo swamps, logs and stumps may support distinctive vegetation, and floating mats of litter or peat may serve the same purpose (Huenneke and Sharitz 1986).

Woody species found in Indian Village Swamp (Hall and Penfound 1939a) include swamp tupelo, water tupelo, baldcypress, red maple, pumpkin ash, Virginia willow, and buttonbush, which the authors considered true swamp species. Border species that occurred on elevated portions of the swamp floor, around the bases of trees and on knees, as well as vines that climbed on the dominant swamp species were: yellow jessamine ***[Gelsemium sempervirens*** (L.) Aiton f.], poison ivy, bayberry, greenbrier (***Smilax walteri*** Pursh.), wisteria [Wisteria ***frutescens var. macrostachya*** **(Nutt.) T.&** G.], **storax** (***Styrax americana Lam.),*** pepper-vine ***[Ampefopsis arboreu*** (L.) Koehne], greenbrier (***Smilax laurifolia*** L.), Carolina ash, Virginia creeper [***Parthenocissus quinquefoliu*** (L.) Planchon], dogwood (***Cornus*** spp.), sweet pepperbush (***Clethra alnifolia*** L.), possum haw (***Ilex decidua*** Walter), **blackberry** ***Rubus*** spp., and holly (***Ilex opaca*** Aiton).

Small individuals of waterlocust and water-elm occur throughout the Beidler Swamp, sometimes growing from the bases of baldcypress or tupelo and sometimes rooted in the soil. Four other tree species occur in the forest rooted on fallen logs, large cypress knees, and buttresses: laurel oak (Q. ***laurzfolia*** Michaux), red maple, and American elm (***Ulmus americana*** L.). The shrub layer in the Beidler Swamp is well developed on the high portion of the swamp forest, with the plants growing in the soil and on buttresses, knees, fallen logs, and stumps. Species include: Virginia willow, storax, fetterbush [*Leucothoe racemosa* (L.) Gray], fetterbush lyonia, swamp dogwood (C. *stricta* Lam.), buttonbush, viburnum, and possum haw, as well as vines and occasional canopy and subcanopy species. Where standing water occurs most of the year, the shrub layer is sparse, with Virginia willow, storax, buttonbush, fetterbush, and fetterbush lyonia growing from buttresses (Porcher 1981).

Density of shrubs >3 feet high (1 m) ranged from 36,818 to 105,759 stems per acre (14,900 to 42,800 stems per ha) in the Okefenokee Swamp. Four species accounted for 71 percent of the importance value: Virginia willow, fetterbush lyonia, fetterbush, and sweet pepperbush. There was little relation between the character of the shrub layer and the overstory.

The herbaceous flora of the Beidler Swamp forest is particularly rich and varied. In the deep areas of the swamp, herbs are confined to floating logs, stumps, knees, and buttresses. Three species found only in this portion of the swamp are: skullcap (*Scutellaria latiflora* L.), lycopus (*Lycopus rubellus* Moench.), and St. Johns wort (*Hypericum virginicum* L.). Other species that occur here as well as in higher areas of the swamp and adjacent communities include: netted chain-fern [*Woodwardia aerolata* (L.) Moore], false nettle [*Boehmeria cylindricu* (L.) Swartz], butterweed (*Senecio glabellus* Poiret), sensitive fern (*Onoclea sensiblis* L.), cardinal flower (*Lobelia cardinalis* L.), diodia (*Diodia virginiana* L.), and St. Johns wort. Pokeweed (*Phytolacca americana* L.) and dog-fennel (*Eupatorium compositifolium* Walter), two weed species, are occasionally found here. Where high areas occur, the following herbs are found: obedient plant [*Dracocephalum purpureum* (Walter) McClintock], water pimpemell (*Samolus parviflorus* Raf.), milkweed (*Asclepias perennis* Walter), golden club (*Orontium aquaticum* L.), peltandra [*Peltandra virginica* (L.) Kunth.], bulrush (*Scirpus divaricatus* Ell.), bulrush (S. *fontinalis* Harper), proserpinaca (*Proserpinaca palustris* L.), and cardinal flower. An occasional spruce pine (*P. glabra* Walter) sapling occurs here. It is apparent that this is a mature, climax forest because of the great size variation among dominant trees and the numerous fire-scarred stumps and trunks of live trees (Porcher 1981).

Only a few herbaceous species were found in Indian Village Swamp (Hall and Penfound 1939a) due to the low light intensity and long hydroperiod. The most common species were proserpinaca, spider lily [*Hymenocallis occidentalis* (Le Conte) Kunth.], micranthemum [*Globifera umbrosa* (Walter) J.F. Gmelin-S], and bladderwort [*Utricularia macrorhizu* (Le Conte)—S]. Species occurring rarely included pumpkin ash (seedlings), buttonbush (young), bacopa [*Hydrotrida caroliniana* (Walter) Small-S], justicia [*Justicia ovata var. lanceolata* (Chapm.) R.W. Long], and greenbrier (S. *walteri* Pursh). Resurrection fern [*Polypodium polypodiodies* (L.) Watt] occasionally grew on the trunks of the trees and Spanish moss was conspicuous on the trees, especially on the mature trees. Little shrub or herbaceous cover was found (<2 percent, four species) in the nearby tupelo swamp (Hall and Penfound 1939b); this was attributed to the long hydroperiod, a great range in water level of 0 to 12 feet (0 to 3.7 m), and dense shade. The authors state that this is common in primeval swamps. Three conspicuous epiphytes were present: resurrection fern, green fly orchid [*Amphiglottis conopsea* (Aiton) Small-S], and Spanish moss.

Soils

Baldcypress grows best on deep, fine, sandy loam with moderately good drainage, but, because of competition, it is usually found in permanent swamps. The species extends into the coastal region of brackish tidewater but grows poorly there (Harlow and Harrar 1969).

Baldcypress sites are distinguished by frequent, prolonged flooding with water of up to 10 feet (3 m) or more and flow rates of up to 4 miles [6 kilometers (km)] per hour (although occasionally stagnant). The species is found on intermittently flooded and poorly drained phases of Spodosols, Ultisols, Jnceptisols, Alfisols, and Entisols. It occurs in the thermic and hyperthermic soil temperature regimes (Wilhite and Toliver 1990).

Pondcypress occurs on the impoverished and poorly drained phases of Spodosols and Ultisols of the thermic and hyperthermic soil temperature regimes. Soils range from sands to clays to mucks to peats. Pondcypress grows in shallow ponds and poorly drained sites on the Coastal Plain, seldom in the swamps of rivers and streams. Pondcypress grows on soils with a pH of 6.8 or lower, and baldcypress occurs on soils with a pH of 5.5 or higher. Usually pondcypress sites are much less fertile than baldcypress sites and are flat or with slight depressions called domes (Wilhite and Toliver 1990).

Water tupelo grows in low, wet flats or sloughs and in deep swamps. It grows best in the sloughs and swamps of Coastal Plain rivers and in the large swamps of southwestern Louisiana and southeastern Texas. Water may reach a depth of 20 feet (6 m) and may remain as high as 13 feet (4 m) for long periods. Soils that support water tupelo range from mucks and clays to silts and sands and are in the orders Alfisols, Entisols, Histisols, and Inceptisols. Most are moderately to strongly acidic; subsoil often is rather permeable (Johnson 1990).

Swamp tupelo grows on an assortment of wet, bottom-land soils, including organic mucks, heavy clays, and wet sands, mainly on soils of the orders Ultisols, Inceptisols, and Entisols. It thrives under flooded conditions and is seldom found on sites that are not inundated most of the growing season. The species occurs in headwater swamps, strands, ponds, river bottoms, bays, estuaries, and low coves. It does not usually occur in the deep parts of swamps. The water regime is more important than soil type for good growth of swamp tupelo; it grows best on soil that is continuously saturated, with shallow moving water (Outcalt 1990).

Hall and Penfound (1939a) examined the water content of the soil in Indian Village Swamp. At the end of a long hydroperiod, the water content was 197 percent, 505 percent, 343 percent, and 289 percent in the first, second, third, and fourth foot of the soil. The amount of material driven off by combustion (for the same samples) was 22 percent, 44 percent, 39 percent, and 38 percent, respectively. Soil pH values ranged from 6.1 to 6.7.

In the nearby tupelo area at times of flood, the amount of water at the l-foot (0.3-m) level (as based on the dry weight of the soil) was 4.67 times the oven-dry weight of the soil, but this decreased to 1.22 at the 4-foot (1.2-m) level because little organic matter was present (Hall and Penfound 1939b). There was more sand at the 4-foot (1.2-m) level. The loss by combustion was approximately 11 percent at the l- to 3-foot (0.3 to 0.9 m) levels and 9 percent at the 4-foot (1.2-m) level. The soil was strongly acidic (pH 5.1 to 5.3).

Associated Flora and Fauna

The cypress-tupelo community is an important habitat for numerous animals and birds including neotropical migrant birds. Bird censuses were carried out from 1979 to 1989 in the Francis Beidler Forest (a national Audubon sanctuary in Four Holes Swamp, SC). This is a virgin hardwood swamp forest with the largest stand of original growth cypress and water tupelo in the United States (Brunswig and Winton 1978, Porcher 198 1). Species present in the swamp included: northern parula warbler (*Parula americana*), blue-gray gnatcatcher (*Polioptila caerulea*), great crested flycatcher (*Myiarchis crinirus*), tufted titmouse (*Parus bicolor*), red-eyed vireo (*Vireo olivuceous*), yellow-billed cuckoo (*Coccyzus americanus*), prothonotary warbler (*Protonotaria citrea*), cardinal (*Cardinalis cardinalis*), Acadian flycatcher (*Empidonax virescens*), white-breasted nuthatch (*Sitta curolinensis*), hooded warbler (*Wilsonia citrina*), yellow-throated warbler (*Dendroicu dominica*), Carolina chickadee (*Parus carolinensis*), Carolina wren (*Thryothorus ludoviciunus*), white-eyed vireo (*Vireo griseus*), brownbeaded cowbird (*Molothrus ater*), wood thrush (*Hylocichla mustelina*), pine warbler (*Dendroica pinus*), red-bellied woodpecker (*Centurus carolinus*), downy woodpecker (*Picoides pubescens*), wood duck (*Aix sponsa*), chimney swift (*Chaetura pelagica*), ruby-throated hummingbird (*Archilochus colubris*), eastern wood peewee (*Contopus virens*), Swainson's warbler (*Limnothlypis swainsonii*), summer tanager (*Piranga rubra*), barred owl (*Strix varia*), and pileated woodpecker (*Dryocopus pileutus*). Visitors included: the red-shouldered hawk (*Buteo lineatus*), yellow-crowned night heron (*Nycticorax violucea*), white ibis (*Eudocimus albus*), mourning dove (*Zenaida macroura*), blue jay (*Cyanocitta cristata*), common crow (Corvus *brachyrynchos*), and fish crow (Corvus *ossifragus*).

Although the old-growth cypress-tupelo community is an excellent habitat for fungi and mosses, little data are recorded on their occurrence in this community. Epiphytes were abundant in Indian Village Swamp (Hall and Penfound 1939a); bryophytes grew on the lower 40 feet (12.2 m) of tree trunks. A community of *Pallavicinia lyelli*, sometimes with *Odontoschisma* spp., occurred on the edges of the swamp on slight elevations, on knees, and around the bases of trees. *Riccardia latifrons* and *R. pinguis* occurred on decaying logs. *Fontinalis sullivanti* inhabited the submerged bases of baldcypress and gum trees, and above that was a community dominated by *Porella pinnata*. From the part of the trunks that were rarely submerged to about 30 feet (9 m) above the ground, there existed a community of *Leucolejeunea clypeata*, *Leocolejeunea unciloba*, *Radula sullivanti*, and other less numerous species. The upper portion of the trunks and some branches were colonized with a sparse xeric community of *Frullania* spp. In the swamp tupelo swamp studied by Hall and Penfound (1939b), mosses and liverworts were common in the trunks of trees.

Other Important Features

Water quality is important to the old-growth baldcypress-tupelo community, but little data on it are available. Michael Dawson provided water quality data for the Francis Beidler

Forest.[3] Mean turbidity (1978-92) for quarterly samples taken from two sites in the swamp ranged from 12.5 to 23.5 at Canoe Lake and from 13.7 to 22.7 for Goodson Lake; pH ranged from 7.0 to 7.1 and 6.8 to 7.0; dissolved oxygen ranged from 5.0 to 9.5 and 4.3 to 9.1; hardness ranged from 4.6 to 6.0 and 4.4 to 4.7; phosphates ranged from 0.27 to 1 .Ol and 1.56 to 2.03, respectively.

Forest Dynamics and Ecosystem Function

Swamps such as red river cypress-tupelo swamps, with high nutrient input during flooding and alternating periods of decomposition, are among the most productive of ecosystems; however, swamps with little intra- or intersystem nutrient circulation, such as headwater swamps and cypress ponds, can be low in productivity. If permanent water inhibits decomposition and nutrient input via drainage is negligible, as in the Okefenokee system, tree growth will be slow and ultimate tree size will be small. In the Okefenokee system, the net effect of geological processes is to remove nutrients from circulation. The deepest peats in Okefenokee are 6,500 years old, so nutrients have been accumulating for some time (Schlesinger 1978).

Disturbance Regime—Ewel and Mitsch (1978) stated that dominance of cypress in some swamps is maintained partly by occasional fires that damage scarcer species. Schlesinger (1978) noted that numerous charcoal deposits, some at great depth, suggest that fiie played an important role in the Okefenokee Swamp. Large fires occurred during droughts in 1844, 1910, 1932, and 1954-55. Fire scars on the large pondcypress trees suggest that the understory must have been severely burned in 1954-55. Comparison of burned and unburned stands suggests that fire increases the dominance of cypress by reducing the number of species and the relative importance of broadleaf species.

Hurricanes and other major disruptions strongly influence the structure and composition of many forests and also affect succession (Lugo et al. 1983). However, the cypress-tupelo community seems better able to withstand hurricanes and severe storms than other community types. Hurricane Hugo (September 21, 1989) seriously damaged only 19 percent of trees in sloughs of Congaree Swamp, SC, and few trees were uprooted. Hugo reduced canopy diversity by uprooting many species other than baldcypress and water tupelo, especially trees rooted on fallen logs, etc. Storms such as Hurricane Hugo can cause changes in composition for some time after they occur. The heavy fuel loads increase the likelihood of fire, and resprouted trees will be more susceptible to wood-rotting organisms and further mechanical damage (Putz and Sharitz 199 1).

Current Conditions-The current forest community differs from that of presettlement time in several ways. Changes have occurred in the abundance of plants and animals that inhabit the cypress-tupelo community, and introduced plants and animals are causing problems. Although fires occurring in swamps during droughts can be difficult to put out, suppression of fires originating outside of swamps no doubt leads to less burning within. Large predators, such as the black bear and the Florida panther, are scarce everywhere, and thus are less likely to occur now in swamps than they were formerly. Partly due to the absence of large predators, animal herbivore populations are increasing and can influence the vegetative composition of the community. Introduced animals, such as the nutria (*Myocastor* coypu), are impeding baldcypress regeneration as they often destroy seedlings by eating the root collar. Introduced tree species, such as Chinese tallow [*Sapium sebiferum* (L.) Roxb.] and Brazilian pepper (*Schinus terebinthifolia* Raddi), are changing the composition of some cypress-tupelo communities.

On most sites, the cypress-tupelo forest is considered a climax community because extended periods of flooding restrict invasion by shade-tolerant species. Disturbances such as hurricanes and fires also help to restrict entry of other tree species into swamps. However, if flooding is reduced or eliminated the forest type may be replaced by shade-tolerant species.

Representative Old-Growth Stands

Areas where representative old-growth stands may appear include:

- Grassy Lake Natural National Landmark, Hempstead County, AR
- Moro Creek Bottoms Preserve, Cleveland and Calhoun Counties, AR
- Big Cypress Bend, inside or near Fakahatchee Strand State Preserve, FL
- Big Cypress Nature Preserve, Collier County, FL
- Bayou DeView Bald Cypress Stand, Monroe County, AR

[3] Dawson, Michael. 1995. Bird data and water chemistry. 16 p. Unpublished report. On file with: Francis Beidler Forest, 336 Sanctuary Road, Harleyville, SC 29448.

- Corkscrew Swamp Sanctuary, Collier County, FL
- Gum Swamp Research Natural Area, Osceola National Forest, FL
- Heather Island, Marion County, FL
- Jim Creek Cypress Swamp, Tosohatchee State Reserve, FL
- Orange Lake Cypress, Marion County, FL
- Strand West of Cow Bone Island, Seminole Indian Reservation, FL
- Pond Cypress Swamps, Apalachicola National Forest, FL
- 'Fate's Hell Swamp, Franklin County, FL
- Ebenezer Creek Swamp, east of Springfield, GA
- Lewis Island Natural Area, northwest of Darien, GA
- Heron Pond, Johnson County, IL
- Little Black Slough, Johnson County, IL
- Lower Cache River State Natural Area, southern Illinois
- Bayou Sale Swamp, LA
- Big Cypress, Bienville Parish, LA
- Black Bayou Swamp, Tangipahoa Parish, LA
- Coochie Brake, southwest of Winnfield, LA
- Cunningham Brake, southwest of Cypress, LA
- Jim Reed Bayou Swamp/Black Bayou Swamp, Tangipahoa Parish, LA
- White Kitchen Preserve, near Slidell, LA
- Allred Lake Natural Area, Butler County, MO
- Big Oak Tree Natural Area, Big Oak Tree State Park, MO
- Cash Swamp Natural Area, Dunklin County, MO
- Black River Site, NC
- Beidler Sanctuary, Dorchester County, SC
- Congaree. Swamp National Monument, south of Columbia, SC
- Four Holes Swamp, SC
- Guilliard Lake Scenic and Research Natural Area, Berkley County, SC

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An interim definition of old-growth cypress-tupelo forests is presented to assist in management of these communities until comprehensive definitions based on research can be formulated. The basic criteria for identifying old-growth cypress-tupelo *(Taxodium distichum-Nyssa aquatica)* communities in the South are presented.

Keywords: *Nyssa aquatica, N.* ***biflora*****,** old growth, old-growth stands, South, swamps, ***Taxodium ascendens*****,** *T. distichum,* wetlands.