Ground-Cover Vegetation in Wetland Forests of the Lower Suwannee River Floodplain, Florida, and Potential Impacts of Flow Reductions

By Melanie R. Darst, Helen M. Light, and Lori J. Lewis

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District Chief
U.S. Geological Survey
Suite 3015
227 N. Bronough Street
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CONVERSION FACTORS AND UNIT ABBREVIATIONS

Multiply	By	To obtain
centimeter (cm)	0.3937	inch
meter (m)	3.28	foot
kilometer (km)	0.62	mile
river kilometers (rkm)	0.62	river miles
square centimeter (cm^2)	0.155	square inch
square meter (m^2)	10.76	square foot
square kilometer (km^2)	0.3861	square mile
hectare (ha)	2.471	acre
hectare (ha)	0.003861	square mile
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
degree Celsius (°C)	1.8 (+ 32°)	degree Fahrenheit (°F)

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea level Datum of 1929.

In this report, horizontal coordinate information is referenced to the North American Datum of 1927 (NAD27).

AGENCY ABBREVIATIONS

FDEP	Florida Department of Environmental Protection
LSNWR	Lower Suwannee National Wildlife Refuge
SRWMD	Suwannee River Water Management District
USGS	U.S. Geological Survey

LIST OF SCIENTIFIC NAMES USED WITH COMMON NAME EQUIVALENTS

[Plant nomenclature used in this report follows that by Godfrey and Wooten (1979, 1981) unless otherwise indicated. Names of varieties have been omitted in the body of the report]

Scientific name	Common name
Acalypha gracilens A. Gray	three-seeded mercury
Acer rubrum L.	red maple
Acmella oppositifolia (Lam.) R.K. Jansen[1] [= *Spilanthes americana* (Mutis ex L. *f.*) Hieron. var. *repens* A.J. Moore]	spotflower
Acrostichum danaeifolium Langsd. & Fisch.	giant leather fern
Aesculus pavia L.	red buckeye
Agrostis perennans (Walter) Tuckerm.	autumn bentgrass
Alternanthera philoxeroides (Mart.) Griseb.	alligator weed
Amaranthus australis (A. Gray) J.D. Sauer	southern water hemp
Amorpha fruticosa L.	false-indigo
Ampelopsis arborea (L.) Koehne	pepper-vine
Amsonia rigida Shuttlw. ex Small	blue-stars
Apteria aphylla (Nutt.) Barnhart	nodding nixie
Arisaema dracontium (L.) Schott	green dragon
Arisaema triphyllum (L.) Schott	jack-in-the-pulpit
Aristida stricta Michx. *sensu latum*	wiregrass
Aristolochia serpentaria L.	snakeroot
Arundinaria gigantea (Walt.) Muhl.[2]	cane
Asclepias perennis Walter	white swamp milkweed
Asimina parviflora (Michx.) Dunal	small-fruited pawpaw
Aster carolinianus Walter	climbing aster
Aster dumosus L.	rice-button aster
Aster lateriflorus (L.) Britton	calico aster
Aster sp. L.	aster
Axonopus furcatus (FlÜgge) Hitchc.	carpet grass
Baccharis glomeruliflora Pers.	silvering
Baccharis halimifolia L.	groundsel tree
Baptisia alba (L.) R. Vent[2]	white wild indigo
Bartonia paniculata (Michx.) Muhl.	twining screw-stem
Begonia cucullata Willd.	wax begonia
Berchemia scandens (Hill) K. Koch	supple-jack
Betula nigra L.	river birch
Bidens discoidea (Torr. & A. Gray) Britton	small beggarsticks
Bidens laevis (L.) BSP.	bur-marigold
Bignonia capreolata L.	cross-vine
Boehmeria cylindrica (L.) Sw.	bog-hemp
Botrychium dissectum Spreng.	cut-leaved grapefern
Callicarpa americana L.	American beautyberry
Campsis radicans (L.) Seem. ex Bureau	trumpet-creeper
Cardamine hirsuta L.	hairy bitter cress
Cardamine sp. L.	bitter cress
Carex alata Torr.	broadwing sedge
Carex amphibola Steud.	sedge
Carex bromoides Schkuhr in Willd.	bromelike sedge
Carex crus-corvi Shuttlew. ex Kuntze	ravenfoot sedge
Carex decomposita Muhl.	cypressknee sedge
Carex gigantea Rudge	giant sedge
Carex godfreyi Naczi[1]	Godfrey's sedge
Carex joorii L.H. Bailey	cypress swamp sedge
Carex leptalea Wahlenb.	bristly-stalked sedge
Carex louisianica L.H. Bailey	Louisiana sedge
Carex lupulina Mulh. ex Willd.[1]	hop sedge
Carex stipata Mulh. ex Willd.	owlfruit sedge

Scientific name	Common name
Carpinus caroliniana Walter	ironwood
Carya aquatica (Michx. *f.*) Nutt.	water hickory
Carya glabra (Mill.) Sweet	pignut hickory
Carya sp. Nutt.	hickory
Celtis laevigata Nutt.	hackberry
Centella asiatica (L.) Urban	spadeleaf
Cephalanthus occidentalis L.	buttonbush
Ceratophyllum echinatum A. Gray[1]	spiny hornwort
Chasmanthium laxum (L.) Yates	spikegrass
Chasmanthium nitidum (Baldwin ex Elliott) Yates	shiny woodoats
Chasmanthium sessiliflorum (Poir.) Yates	longleaf spikegrass
Chasmanthium sp. Link	spikegrass
Cicuta mexicana J.M. Coult. & Rose	water hemlock
Cladium jamaicense Crantz	sawgrass
Clematis crispa L.	leather flower
Commelina diffusa Burm. *f.*	dayflower
Commelina sp. L.	dayflower
Commelina virginica L.	Virginia dayflower
Conoclinium coelestinum (L.) DC.	blue mistflower
Coreopsis leavenworthii Torr. & A. Gray	tickseed
Cornus foemina Mill.	stiff cornel dogwood
Crataegus aestivalis (Walter) Torr. & A. Gray	may haw
Crataegus flava Aiton	yellow haw
Crataegus marshallii Eggl.	parsley haw
Crataegus viridis L.	green haw
Crinum americanum L.	swamp-lily
Cuscuta obtusiflora Kunth[1] var. *glandulosa* Engelm.	dodder
Cyperus croceus Vahl[1]	Baldwin's flatsedge
Cyperus drummondii Torr. & Hook	flatsedge
Cyperus retrorsus Chapm.	pinebarren flatsedge
Cyperus sp. L.	flatsedge
Cyperus strigosus L.	straw-colored flatsedge
Cyrilla racemiflora L.	titi
Decumaria barbara L.	climbing hydrangea
Desmodium glabellum (Michx.) DC.	beggar's ticks
Desmodium sp. Desv.	beggar's ticks
Dichondra caroliniensis Michx.	ponysfoot
Dioda virginiana L.	buttonweed
Dioscorea floridana Bartlett	wild yam
Dioscorea quaternata (Walter) J.F. Gmel.	fourleaf wild yam
Diospyros virginiana L.	persimmon
Dychoriste humistrata (Michx.) Kuntze	swamp twinflower
Echinochloa walteri (Pursh) A. Heller	coast cockspur
Echinodorus cordifolius (L.) Griseb.	creeping burhead
Eichhornia crassipes (Mart.) Solms	water-hyacinth
Eleocharis baldwinii (Torr.) Chapm.	roadgrass
Eleocharis vivipara Link	viviparous spikerush
Elephantopus nudatus A. Gray	elephant's foot
Elytraria caroliniensis (J.F. Gmel) Pers. var. *caroliniensis*	Carolina scalystem
Eragrostis sp. Wolf	lovegrass
Erechtites hieracifolia (L.) Raf. ex DC.[1]	fireweed
Eriochloa michauxii (Poir.) Hitchc.	cupgrass
Euonymus americanus L.	strawberry bush
Eupatorium compositifolium Walter	boneset
Eustachys petraea (Sw.) Desv.[1]	pineswoods fingergrass
Forestiera acuminata (Michx.) Poir.[1]	swamp-privet
Fraxinus caroliniana Mill.	pop ash

Scientific name	Common name
Fraxinus profunda (Bush) Bush	pumpkin ash
Galactia volubilis (L.) Britton	downy milkpea
Galium tinctorium L.	marsh bedstraw
Gelsemium sempervirens (L.) W.T. Aiton[1]	Carolina jessamine
Gleditsia aquatica Marsh.	water locust
Gratiola floridana Nutt.	hedge-hyssop
Halesia carolina L.	Carolina silverbell
Hedyotis uniflora (L.) Lam.	clustered mille graine
Helenium autumnale (L.)	sneezeweed
Hibiscus coccineus Walter	scarlet rosemallow
Hydrocotyle ranunculoides L. *f.*	floating marsh pennywort
Hydrocotyle verticillata Thunb.	whorled marsh pennywort
Hymenocallis duvalensis Traub[1]	white-sands spiderlily
Hymenocallis rotata (Ker-Gawler) Herb.	springrun spiderlily
Hypericum galioides Lam.	bedstraw St. John's wort
Hypericum hypericoides (L.) Crantz	St. Andrew's cross
Hypericum sp. L.	St. John's wort
Hypolepis repens (L.) C. Presl.[1]	creeping bramble fern
Hypoxis curtissii Rose[1]	yellow stargrass
Hyptis alata (Raf.) Shinners	musky mint
Ilex cassine L.	dahoon
Ilex decidua Walt. var. *curtissii* Fern.	possum-haw
Ilex glabra (L.) A. Gray	gallberry
Ilex opaca Aiton var. *opaca*	American holly
Ilex vomitoria Aiton	yaupon
Ipomoea cordatotriloba Dennst.[1]	tievine
Iris hexagona Walter	prairie iris
Isoetes flaccida Shuttlew. ex A. Braun	quillwort
Itea virginica L.	Virginia willow
Juncus polycephalos Michx.[1]	many-headed rush
Juniperus silicicola (Small) Bailey[1]	southern red cedar
Justicia ovata (Walter) Lindau in Urban var. *lanceolata* (Chapm.) R.W. Long	water willow
Kosteletzkya virginica (L.) Presl. ex A. Gray[1]	seashore marsh-mallow
Leersia virginica Willd.	whitegrass
Lemna valdiviana Phil.	duckweed
Lilaeopsis chinensis (L.) Kuntze	eastern grasswort
Limnobium spongia (Bosc.) Steud.	frog's bit
Liquidambar styraciflua L.	sweetgum
Lobelia cardinalis subsp. *cardinalis*	cardinal flower
Ludwigia palustris (L.) Elliott	marsh seedbox
Ludwigia repens J.R. Forst.	creeping primrose willow
Luziola fluitans (Michx.) Terrell & H. Rob.[1]	southern watergrass
Lycopus rubellus Moench.	water-hoarhound
Lygodium japonicum (Thunb.) Sw.[1]	Japanese climbing fern
Lyonia lucida (Lam.) K. Koch	fetterbush
Lythrum lineare (L.)	wand loosestrife
Macrothelypteris torresiana (Gaudich.) Ching[1]	Mariana maiden fern
Magnolia virginiana L.	sweetbay
Malaxis spicata Sw.	Florida adder's mouth orchid
Matelea gonocarpos (Walter) Shinners[1]	angel-pod milkvine
Melanthera nivea (L.) Small	squarestem
Melothria pendula L.	creeping cucumber
Micranthemum umbrosum (J.F. Gmel.) S.F. Blake	shade mudflower
Micromeria brownei (Sw.) Benth.	Browne's savory
Mikania scandens (L.) Willd.	climbing hempweed

Scientific name	Common name
Mitchella repens (L.)	partridge berry
Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray	miterwort
Morus rubra L.	red mulberry
Myrica cerifera L.	wax-myrtle
Nasturtium microphyllum (Boenn.) Reichnb.	Florida watercress
Nyssa aquatica L.	water tupelo
Nyssa biflora Walter[2]	swamp tupelo
Onoclea sensibilis L.	sensitive fern
Oplismenus hirtellus (L.) P. Beauv.[1]	woodsgrass
Osmunda cinnamomea L.	cinnamon fern
Osmunda regalis L. var. *spectablis* (Willd.) A. Gray	royal fern
Ostrya virginiana (Mill.) K. Koch	eastern hop-hornbeam
Oxalis corniculata L.	yellow lady's wood-sorrel
Panicum anceps Michx.	beaked panicum
Panicum commutatum Schultes[3]	variable witchgrass
Panicum dichotomum L.	cypress witchgrass
Panicum gymnocarpon Elliott	savannah panicum
Panicum hians Elliott	gaping panicum
Panicum laxiflorum Lam.[3]	openflower panicum
Panicum rigidulum Bosc ex Nees[3] var. *pubescens* (Vasey) Lelong	panic grass
Panicum sp. L.	panic grass
Panicum virgatum L.	switchgrass
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper
Paspalum repens Bergius	water paspalum
Paspalum setaceum Michx.	thin paspalum
Peltandra virginica (L.) Schott & Endl.	green arum
Persea borbonia (L.) Spreng.	red bay
Persea palustris (Raf.) Sarg.	swamp bay
Phragmites australis (Cav.) Trin. ex Steud.	common reed
Phyllanthus carolinensis Walter	leaf-flower
Physostegia leptophylla Small	obedient-plant
Pilea pumila (L.) A. Gray	clearweed
Pinus elliottii Engelm. var. *elliottii*	slash pine
Pinus glabra Walt.	spruce pine
Pinus taeda L.	loblolly pine
Planera aquatica Walter ex J.F. Gmel.	planer-tree
Platanthera flava (L.) Lindl.	southern rein orchid
Pluchea camphorata (L.) DC.	camphorweed
Pluchea longifolia Nash	longleaf camphorweed
Pluchea odorata (L.) Cass.	sweetscent
Pluchea sp. Cass.	marsh-fleabane
Polygonum punctatum Elliott	dotted smartweed
Polygonum setaceum Baldw. ex Elliott	bog smartweed
Polygonum sp. L.	smartweed
Pontederia cordata L. var. *cordata*	pickerelweed
Proserpinaca palustris L.	mermaid-weed
Pteridium aquilinum (L.) Kuhn	bracken
Quercus geminata Small	sand live oak
Quercus laurifolia Michx.	swamp laurel oak
Quercus lyrata Walt.	overcup oak
Quercus michauxii Nutt.	swamp-chestnut oak
Quercus minima (Sarg.) Small	dwarf live oak
Quercus nigra L.	water oak
Quercus sp. L.	oak
Quercus virginiana Mill.	live oak
Rhexia mariana L.	meadow beauty
Rhynchospora caduca Elliott	angel-stem beaksedge

Scientific name	Common name
Rhynchospora corniculata (Lam.) A. Gray	short-bristle horned beaksedge
Rhynchospora miliacea (Lam.) A. Gray	millet beaksedge
Rhynchospora mixta Britton ex Small	mingled beaksedge
Rhynchospora sp. Vahl	beak-rush
Rubus betulifolius Small[4]	highbush blackberry
Rubus sp. L.	brambles
Rubus trivialis Michx.	southern dewberry
Ruellia caroliniensis (Walter ex J.F. Gmel) Steud	wild petunia
Rumex verticillatus L.	swamp dock
Sabal minor (Jacq.) Pers	bluestem palm
Sabal palmetto (Walt.) Lodd. ex Schult. & Schult *f.*	cabbage palm
Sabatia calycina (Lam.) A. Heller	marsh-pink
Saccharum baldwinii Spreng[1] [=*Erianthus strictus* Baldw. ex Ell.]	narrow plumegrass
Sacciolepis striata (L.) Nash	American cupscale
Sagittaria graminea Michx.	arrowhead
Sagittaria lancifolia L.	arrowhead
Salix caroliniana Michx.	Carolina willow
Salvinia minima Baker[1]	water spangles
Samolus valerandi L.[1] subsp. *parviflourus* (Raf.) Hultén	water pimpernel
Saururus cernuus L.	lizard's tail
Scleria oligantha Michx.	littlehead nutrush
Scleria triglomerata Michx.	tall nutrush
Sebastiana fruticosa (W. Bartr.) Fern.	sebastian-bush
Senecio glabellus Poir	butterweed
Senna marilandica (L.) Link[1]	wild sensitive plant
Serenoa repens (W. Bartr.) Small	saw palmetto
Sideroxylon reclinata Michx.[1]	buckthorn
Sisyrinchium atlanticum E.P. Bicknell	blue-eyed grass
Sium suave Walter	water parsnip
Smilax auriculata Walter	greenbriar
Smilax bona-nox L.	catbriar
Smilax glauca Walter	sawbriar
Smilax laurifolia L.	bamboo-vine
Smilax pumila Walter	wild sarsaparilla
Smilax tamnoides L.	greenbriar
Solidago chapmanii A. Gray	Chapman's goldenrod
Solidago leavenworthii Torr. & A. Gray	goldenrod
Solidago sempervirens L.C. Rich. var. *mexicana* (L.) Fern.	seaside goldenrod
Spiranthes cernua L.C. Rich.	nodding ladies' tresses
Spiranthes odorata (Nutt.) Lindl.[1]	fragrant ladies' tresses
Spiranthes sp. Rich.	ladies' tresses
Spirodela polyrhiza (L.) Schleid.	common duckmeat
Spirodela punctata (G. Meyer) C.H. Thompson	dotted duckmeat
Taxodium distichum (L.) L.C. Rich.	bald cypress
Teucrium canadense L.	germander
Thelypteris hispidula (Decne.) C.F. Reed[1] var. *versicolor* (R.P. St. John) Lellinger	hairy maiden fern
Thelypteris interrupta (Willd.) K. Iwats.	Willdenow's fern
Thelypteris kunthii (Desv.) C.V. Morton	southern shield fern
Thelypteris palustris Schott	marsh fern
Toxicodendron radicans (L.) Kuntze	poison ivy
Trachelospermum difforme (Walter) A. Gray	climbing dogbane
Tragia urens L.	wavyleaf noseburn
Triadenum walteri (J.F. Gmel.) Gleason	marsh St. John's wort
Tripsacum dactyloides (L.) L.	eastern gammagrass
Ulmus alata Michx.	winged elm

Scientific name	Common name
Ulmus americana L.	American elm
Ulmus crassifolia Nutt.	cedar elm
Utricularia gibba L.	humped bladderwort
Vaccinium arboreum Marshall	sparkleberry
Vaccinium corymbosum L.	highbush blueberry
Vaccinium elliottii Chapm.	mayberry
Vaccinium myrsinites Lam.	shiny dwarf blueberry
Vaccinium stamineum L.	deerberry
Vernonia gigantea (Walter) Trel. ex Branner& Coville subsp. *gigantea*	ironweed
Viburnum obovatum Walter	small-leaf viburnum
Vicia floridana S. Watson	Florida vetch
Viola affinis LeConte	violet
Viola sp. L.	violet
Vitis aestivalis Michx.	summer grape
Vitis cinerea (Engelm. ex Gray) Millardet var. *floridana* Munson[4]	downy winter grape
Vitis rotundifolia Michx.	muscadine grape
Wolffiella gladiata (Hegelm.) Hegelm.	mudmidget
Woodwardia areolata (L.) T. Moore	netted chainfern
Zamia pumila A. DC.	coontie
Zephyranthes atamasca (L.) Herb.[1]	atamasco lily
Zizania aquatica L.	wild rice
Zizaniopsis miliacea (Michx.) Döll. & Asch.	southern wild rice

[1] Wunderlin (1998)
[2] Clewell (1985)
[3] Lelong (1986)
[4] Godfrey (1988)

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Abstract

Ground-cover vegetation was surveyed in wetland forests in the lower Suwannee River floodplain, Florida, in a study conducted by the U.S. Geological Survey in cooperation with the Suwannee River Water Management District from 1996 to 1999. Increased water use in the basin, supplied primarily from ground water, could reduce ground-water discharge to the river and flows in the lower Suwannee River. Many of the 282 ground-cover species found in wetland forests of the floodplain have distributions that are related to flow-dependent hydrologic characteristics of forest types, and their distributions would change if flows were reduced. Overall species diversity in the floodplain might decrease, and the composition of ground-cover vegetation in all forest types might change with flow reductions.

The study area included forests within the 10-year floodplain of the lower Suwannee River from its confluence with the Santa Fe River to the lower limit of forests near the Gulf of Mexico. The floodplain is divided into three reaches (riverine, upper tidal, and lower tidal) due to variations in hydrology, vegetation, and soils with proximity to the coast. The riverine (non-tidal) reach had the greatest number of total species (203) and species unique to that reach (81). *Mitchella repens*, *Toxicodendron radicans*, and *Axonopus furcatus* were the most frequently dominant species in riverine bottomland hardwoods. Free-floating aquatic species, such as *Spirodela punctata* and *Lemna valdiviana*, were the dominant species in the wettest riverine swamps. The upper tidal reach had the lowest number of total species (116), only two species unique to that reach, and the lowest density of ground cover (26 percent). *Panicum commutatum* and *Crinum americanum* were frequent dominant species in upper tidal forests. The lower tidal reach had the highest ground-cover density (43 percent) and the second highest number of total species (183) and number of species unique to that reach (55). *Saururus cernuus* and species of *Carex* were frequently dominant in lower tidal swamps. Lower tidal hammocks, the most elevated lower tidal forests, were dominated by *Osmunda cinnamomea* and *Chasmanthium laxum*.

Flow reductions in the lower Suwannee River could change the flow-dependent hydrologic characteristics of wetland forests. Decreases in inundation and saturation in riverine forests could result in a decrease in the number and extent of semi-permanently inundated ponds. As a result, several species of free-floating, aquatic plants that grow only in riverine floodplain ponds might decrease in abundance or disappear if flows were reduced. Decreases in inundation and saturation could also result in a shift to more upland species in all riverine forests and upper tidal bottomland hardwoods. Upland species and some exotic

species might increase in abundance in the floodplain, invading forests where hydrologic conditions have been altered by flow reductions. Depth and duration of inundation due to river flooding could decrease in all riverine and upper tidal forests, probably resulting in a shift of species to those that are typically found in forests with shallower, shorter-duration floods. Salinity in the lower tidal reach and adjacent areas of the upper tidal reach might increase with flow reductions, and the distribution of species might change due to varying tolerances of salinity among species. Species with low salt-tolerance unique to the lower tidal reach might disappear from the floodplain, and species with high salinity tolerance could increase in abundance, replacing less salt-tolerant species.

INTRODUCTION

In 1972, the State of Florida adopted legislation directing water management districts to establish minimum flows and levels for water bodies in their regions. Minimum flows and levels were defined as the levels at which further withdrawals would be significantly harmful to water resources or ecology in an area (Chapter 373.042, Florida Statutes). A series of studies was undertaken by the U.S. Geological Survey (USGS), in cooperation with the Suwannee River Water Management District (SRWMD), to describe the water resources and ecology of the lower Suwannee River. In one of these studies, Light and others (2002) described the hydrology, vegetation (canopy and subcanopy), and soils of the forested floodplain of the lower Suwannee River and potential impacts of flow reductions. Potential impacts were based on flow-dependent hydrologic characteristics of floodplain forests: durations of inundation and saturation, flood depths, and salinity. Ground-cover vegetation data were collected during the study period and are presented in this report with a discussion of potential impacts of flow reductions on the distribution of ground-cover species.

Ground-cover vegetation composition can change more quickly than canopy or subcanopy composition. Most ground-cover species are perennials that live for many years but their abundance and distribution can change with hydrologic conditions (Perry and Hershner, 1999). There are several hundred ground-cover species in the Suwannee River floodplain, and many have specific tolerances to inundation, soil saturation, flood depths, and salinity. These species can be used as indicators of subtle changes in the hydrology of the floodplain that could occur as a result of flow reductions. Documentation of the composition of ground-cover vegetation during the study period will allow for assessment of changes in the future.

Purpose and Scope

The purpose of this report is to describe ground-cover vegetation in wetland forests in the lower Suwannee River floodplain, Florida, and to describe impacts of potential river-flow reductions on ground-cover vegetation.

The study area is the forested floodplain of the lower Suwannee River from its confluence with the Santa Fe River to the downstream limit of forests near the Gulf of Mexico (fig. 1). Data collection began in August 1996 and continued through October 1999. Data analysis was completed in August 2001.

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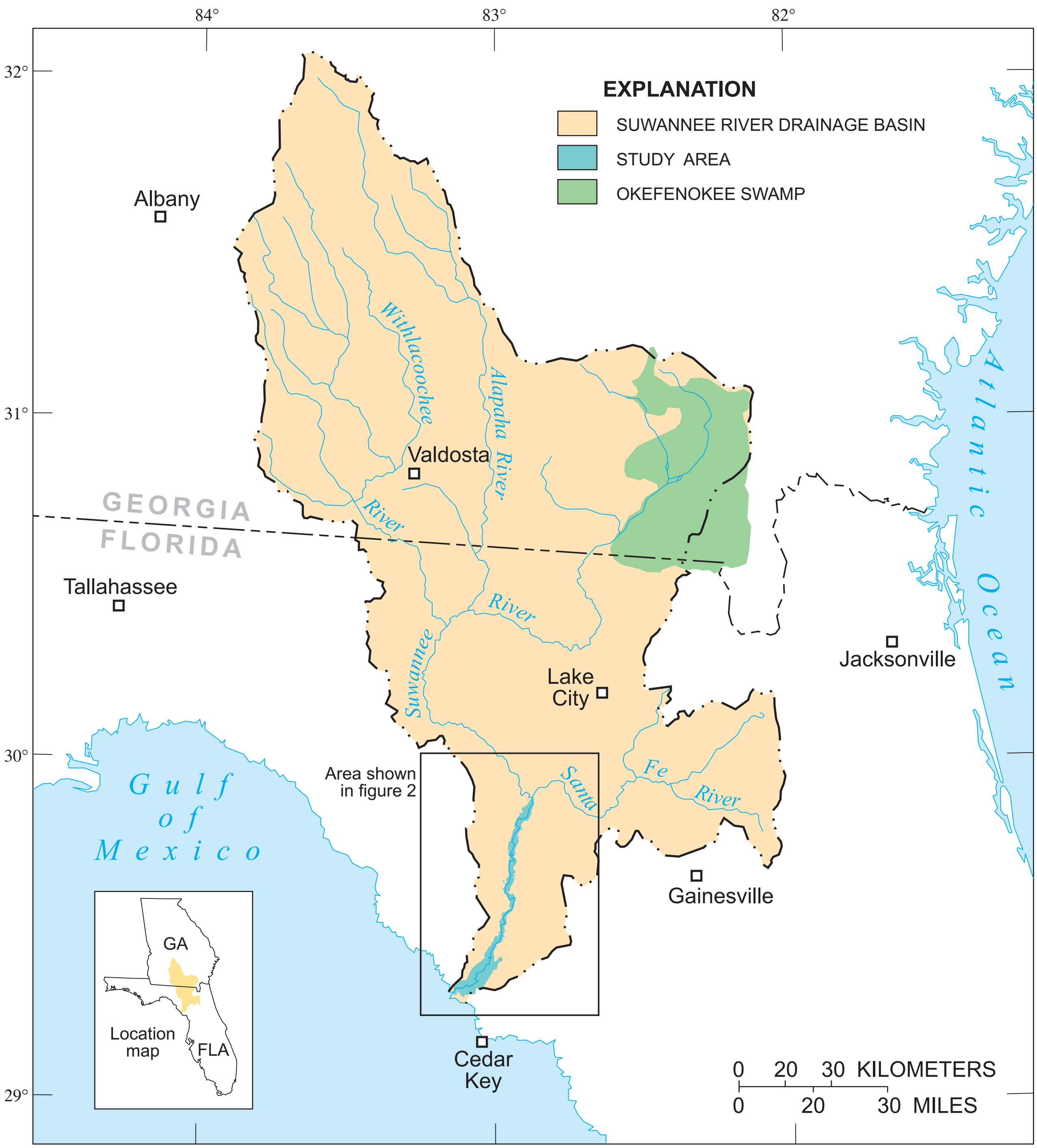

Base from U.S. Geological Survey digital data, 1972
Albers Equal-Area Conic Projection,
Standard parallels 29°30′ and 45°30′, central meridian -83°00′

Figure 1. Drainage basin of the Suwannee River in Florida and Georgia.

Setting

The Suwannee River flows from its headwaters in the Okefenokee Swamp to the Gulf of Mexico (fig. 1). The drainage basin covers approximately 25,770 square kilometers (km^2) of the Gulf Coastal Plain in central southern Georgia and central northern Florida (Berndt and others, 1996). The lower Suwannee River refers to that portion of the river from its confluence with the Santa Fe River to the mouth of the river at the Gulf of Mexico. The lower Suwannee River flows through the Gulf Coastal Lowlands physiographic region (Puri and Vernon, 1964). Stream characteristics in the lower Suwannee River show a combination of blackwater and spring-fed influences, with some alluvial features in the floodplain. Limestone is at or near land surface in the lower Suwannee River basin. Solution features, such as sinkholes, sinkhole lakes, springs, and submerged caves, are common in the basin. Surface-water streams in the nontidal portion of the river are fed predominantly by springs rather than from surface runoff (Crane, 1986). Tidal creeks flow through the floodplain of the tidal portion of the river and increase in number and extent with proximity to the Gulf of Mexico.

The warm, temperate climate of the lower Suwannee River floodplain is characterized by long, humid summers and mild, dry winters. Average annual precipitation (1961-90) at Cross City is 146 centimeters (cm) (Owenby and Ezell, 1992). Average summer air temperature (June, July, and August) is 26.4 degrees Celsius (°C), and average winter air temperature (December, January, and February) is 12.1 °C at Cross City based on the period 1961 to 1990 (Owenby and Ezell, 1992). The growing season (50 percent probability freeze-free period) varies from 259 days at the upstream portion of the study area to 283 days near the mouth of the river (Bradley, 1975). Annual flood peaks occur more often in the growing season than in the dormant season.

During the period of study, the maximum 1-day flows for 1997, 1998, and 1999 had approximate recurrence intervals of 1.7, 25, and 2.5 years, respectively (Light and others, 2002). The highest storm surge in the study period occurred October 7-8, 1996, during Hurricane Josephine. Most of the ground-cover data were collected in 1997 and from June 1998 through February 1999.

The 10-year floodplain of the lower Suwannee River covers approximately 18,600 hectares (ha) that are presently or were historically forested. About 75 percent of this area is wetlands (14,000 ha) and 25 percent is uplands (4,600 ha). The percentage of wetland forests that would be classified as jurisdictional wetlands according to criteria in State and Federal wetland regulations is not known. Most of the wetlands in the floodplain would be classified as palustrine using the classification system developed by the U.S. Fish and Wildlife Service (Cowardin and others, 1979). The lower limit of the study area, near the mouth of the river, is the tree line, an east-west line across the lower tidal floodplain with primarily forests on the upstream side and marshes on the downstream side (fig. 2).

The floodplain is divided into three reaches: riverine (R), upper tidal (UT), and lower tidal (LT) (fig. 2). Table 1 summarizes the hydrologic conditions, soils, and dominant canopy trees in 13 wetland forest types identified by Light and others (2002). Methods of establishing forest types are described in Light and others (2002).

Bottomland hardwoods (Rblh1, Rblh2, Rblh3, and UTblh) are forests on levees, flats, and slopes of floodplains that are flooded continuously for several weeks or longer every 1 to 3 years, and contain plant species adapted to periodic inundation and saturation. Swamps (Rsw1, Rsw2, UTsw1, UTsw2, LTsw1, and LTsw2) are forests in the lowest elevations of the floodplain that are either inundated or saturated most of the time. Swamps contain plant species that have special adaptations for survival in anoxic soils. Mixed forests (UTmix and LTmix) are tidal forest types dominated by a mixture of swamp and bottomland hardwood or hammock species. Hammocks (LTham) refer to hydric hammocks as described by Vince and others (1989). Hydric hammocks are a unique wetland forest type, rare outside Florida, that support a characteristic mixed hardwood forest with evergreen and semi-evergreen trees.

METHODS

Study Sites

Ground-cover vegetation data were collected at three types of study sites. Transects and verification sites were used for intensive collection of data on ground-cover density, dominant species, and species occurrence. Observation sites were used to obtain additional ground-cover species occurrence data.

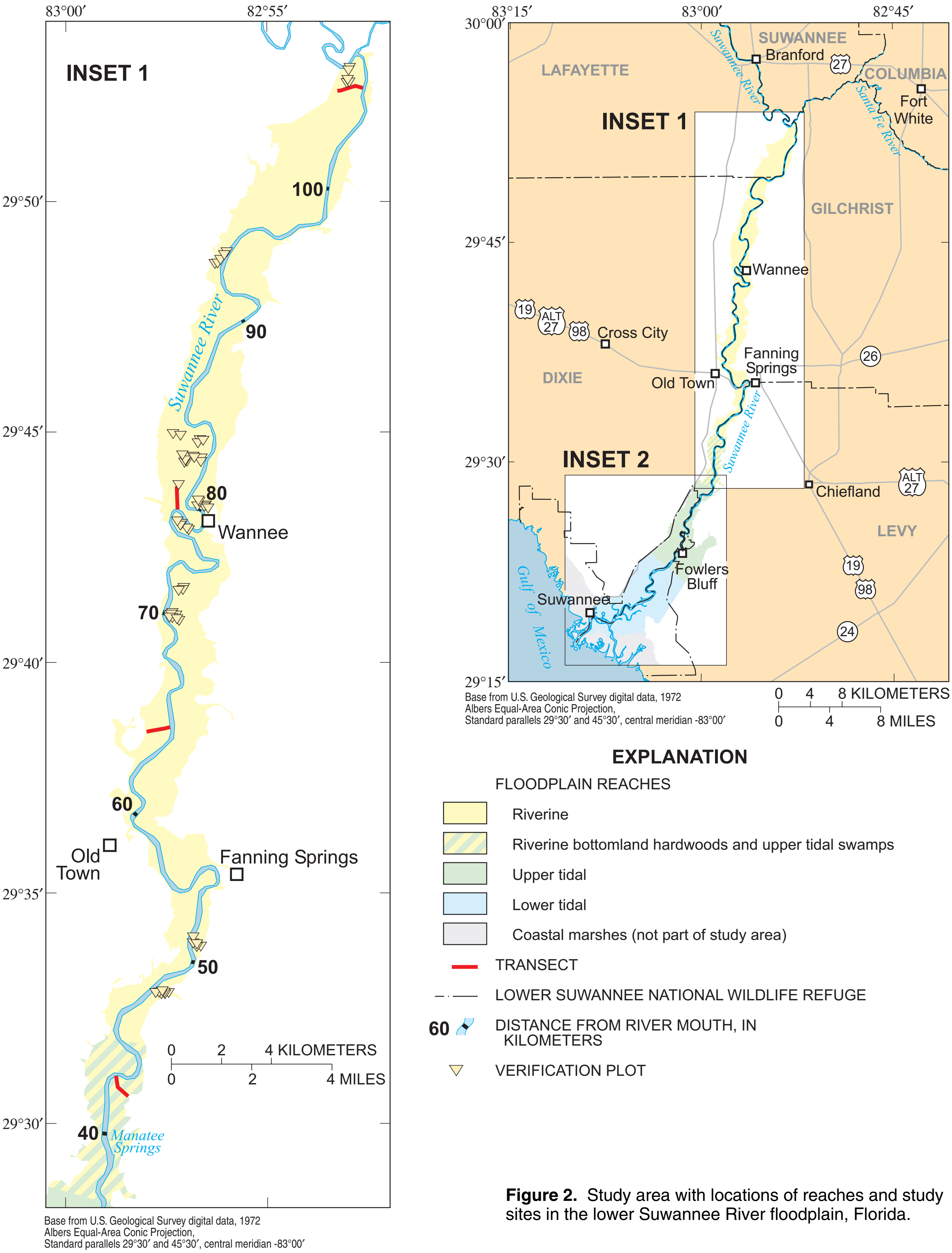

Figure 2. Study area with locations of reaches and study sites in the lower Suwannee River floodplain, Florida.

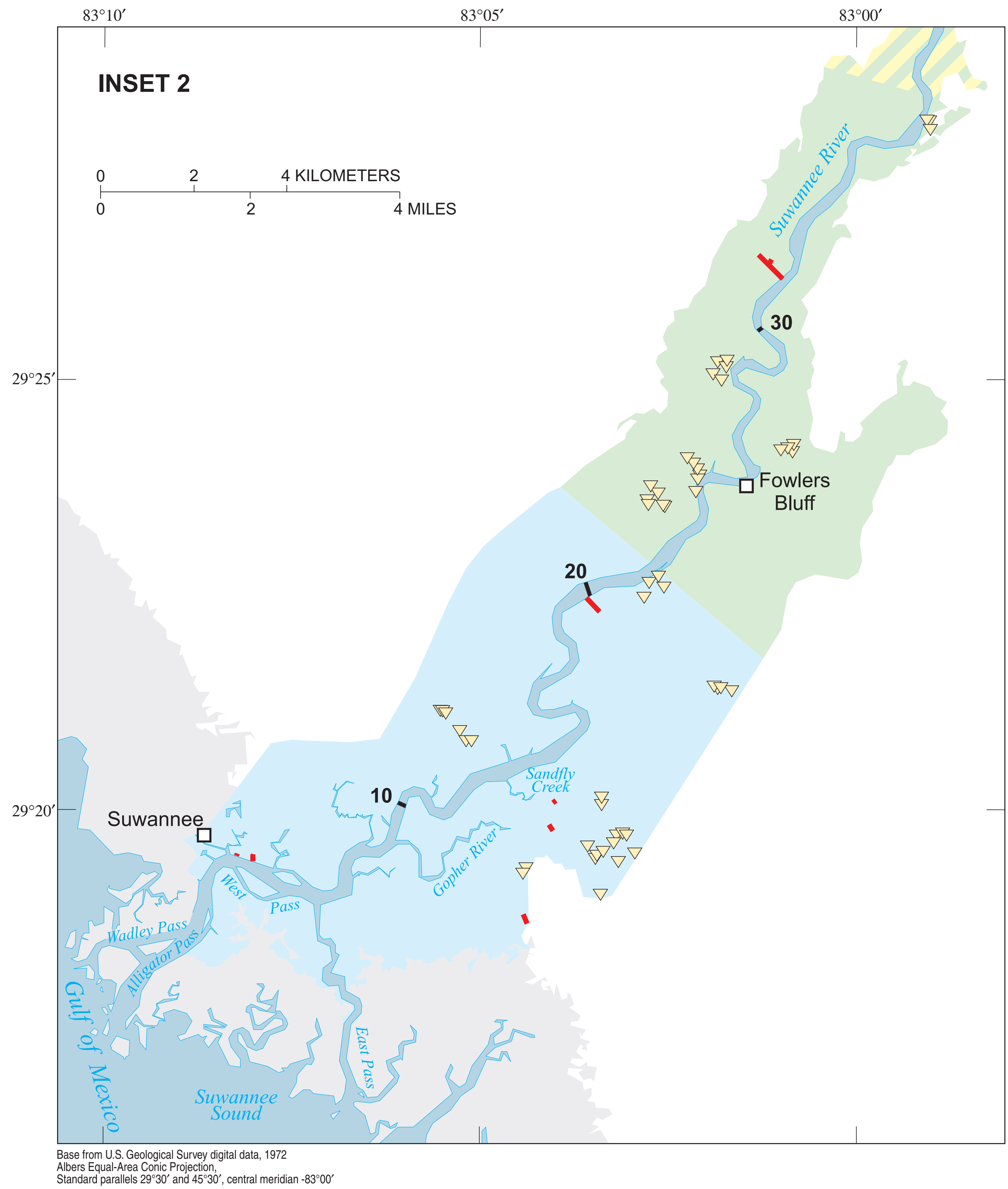

Figure 2. Study area with locations of reaches and study sites in the lower Suwannee River floodplain, Florida. (Continued)

Table 1. Summary of hydrologic conditions, soil textures, and dominant canopy species of wetland forest types in the 10-year floodplain of the lower Suwannee River, Florida

[Rblh, riverine bottomland hardwood forests; Rsw, riverine swamp; UTblh, upper tidal bottomland hardwood forests; UTmix, upper tidal mixed; UTsw, upper tidal swamp; LTham, lower tidal hammock; LTmix, lower tidal mixed; LTsw, lower tidal swamp]

Forest type	Typical hydrologic conditions	Primary soil texture in root zone	Dominant canopy species
Rblh3 **Rblh2**	Flooded average of every 3 years, sometimes for durations of 1 to 2 months or more; soils dry quickly after floods recede	Sand	*Quercus virginiana* *Liquidambar styraciflua* *Quercus laurifolia*
Rblh1	Flooded average of 2 months every year; soils remain saturated another month	Sand, loam, clay	*Quercus laurifolia* *Taxodium distichum* *Quercus lyrata* *Betula nigra* *Liquidambar styraciflua*
Rsw2 **Rsw1**	Flooded 4 to 7 months every year; soils remain saturated another 5 months	Clay, muck	*Taxodium distichum* *Planera aquatica*
UTblh	Flooded 1 to 2 months every 2 years; soils dry quickly after floods recede	Sand	*Quercus laurifolia* *Sabal palmetto*
UTmix	Flooded 2 to 3 months every year; soils dry quickly in some areas and remain continuously saturated in others	Loam, muck, sand	*Taxodium distichum* *Fraxinus profunda* *Quercus laurifolia*
UTsw2 **UTsw1**	Flooded monthly by high tides or high river flows; most soils continuously saturated	Muck	*Nyssa aquatica* *Taxodium distichum* *Fraxinus profunda*
LTham	Flooded every 1-2 years by either storm surge or high river flows; high water table; surface soils on higher elevations dry quickly and soils are continuously saturated in low areas	Muck, sand	*Sabal palmetto* *Pinus taeda*
LTmix	Flooded daily or several times a month by high tides, except in isolated areas; soils continuously saturated except for hummock tops, which have conditions similar to hammocks.	Muck	*Fraxinus profunda* *Nyssa biflora* *Magnolia virginiana*
LTsw2 **LTsw1**		Muck	*Nyssa biflora* *Fraxinus profunda* *Taxodium distichum*

Transects

Twelve belt transects, ranging from 53 to 1,009 meters (m) long, were established in the lower Suwannee River floodplain by Light and others (2002) and are shown in fig. 2. Table 2 lists the primary sites for collection of ground-cover data. Estimates of ground-cover density, identification of dominant species, collection of plant specimens, and lists of species present were made on each transect. The width of the transects varied from 5 to 13 m for collection of canopy and subcanopy data reported in Light and others (2002), but a width of approximately 10 m was used for collecting ground-cover data. Forest types were frequently differentiated in zones parallel to the river; therefore, most transects were located perpendicular to the river to adequately sample vegetation growing near the center and in transitional areas near the edges of each forest type zone. Two transects were located in homogeneous forests for the purpose of sampling that specific forest type (LTmix and LTham). Location, length, and compass bearings of transects were predetermined from aerial photographs and then located on the ground. Transects were originally marked about every 30 m with numbered wooden stakes, and horizontal distances were measured using meter tapes (fig. 3). The transects are now permanently marked and their locations have been described in detail by Lewis and others (2002). Each transect was visited several times during the study period.

Verification Plots

Verification plots ranging from 20 to 26 m in diameter were established by Light and others (2002) to verify forest types mapped using aerial photographs. A total of 102 of these plots were used to obtain additional data on ground-cover density, dominant species, and species occurrence (table 2). A minimum sampling area of 314 square meters (m^2) for

Table 2. Location, sampling area, and number of sample points for study sites in the lower Suwannee River floodplain, Florida

[River kilometers (rkm) indicate stream distances starting with rkm 0 at the mouth of the river at latitude 29 17' 19.2 and longitude 83 9' 51.8. m^2, square meters]

Reach	Number of transects and verification plots	Location in rkm	Area sampled, in m^2	Number of sample points
Riverine	3.4 transects[1]	42.5 - 104.3	21,281	217
	52 verification plots	47.9 - 106.7	24,250	52
Upper Tidal	2.6 transects[1]	31.2 - 42.5	13,981	144
	21 verification plots	23.0 - 36.5	9,293	21
Lower Tidal	6 transects	4.8 - 19.8	10,625	110
	29 verification plots	11.7 - 21.4	11,383	29
		Subtotal for transects	45,887	471
		Subtotal for verification plots	44,926	102
		Total	**90,813**	**573**

[1]One transect near Manatee Springs at rkm 42.5 (fig. 2) has 40 percent bottomland hardwoods that are considered part of the riverine reach, and 60 percent swamps that are part of the upper tidal reach.

swamp forests and 531 m^2 for bottomland hardwood forests was used for verification plots. The boundaries of verification plots were marked with survey flags. Most verification plots were visited only once. Plots with recent tree falls, roadbeds, or other obvious alterations were not used.

Observation Sites

Some additional observations of plant species and collections of specimens were made at about 150 sites located throughout the floodplain. Locations of observation sites are not shown on figure 2. Observation sites were visited during reconnaissance at the beginning of the study and later during forest map verification.

Data Collection

Species Occurrence and Distribution

A list of plant species present was made at all transects and verification plots. For transects, the area examined was approximately 5-m wide on either side of the transect line. At verification plots, the entire plot was examined for species occurrence. The total area sampled for species occurrence was 90,813 m^2 (tables 2 and 3).

When sampling along transects, it was not always possible to know where the exact boundary between two forest types was located. All species growing in transitional areas where the exact forest type was unknown were called "marginal species." Marginal species were assumed to be present in both forest types where they occurred, because mapped areas included transitional areas between forest types. Ground cover was listed for verification plots by mapped forest type regardless of actual canopy composition. More information on map verification is given in Light and others (2002).

Density of Cover and Dominant Species

Sample points were usually established every 10 m on transects starting 5 m from the transect beginning (tables 2 and 3). Additional sample points were added on transects to sample narrow levees. Sample points at verification plots were located at the center of the plot. At each sample point, the observer visually estimated the overall density of ground-cover vegetation, in percent cover, in an approximate 2-m-radius circle. Ground-cover vegetation included all live vegetation less than 3 m in height; it did not include tree bases, logs, cypress knees, leaf litter, or epiphytes. At each sample point, the observer also listed the most prominent ground-cover species that contributed to 50 percent or more of the overall density of cover in the 2-m-radius circle. These species were considered the dominant species at that sample point. If dominance was evenly divided among many species, no species was named. The average number of species named per sample point was 1.7.

Data Analysis

Plant Identification

Approximately 1,700 plant collections were made using standard field and herbarium techniques. Voucher specimens for

Figure 3. Meter tape laid between stakes in lower tidal mixed forest in the lower Suwannee River floodplain, Florida.

unusual species and new county records are to be placed in the Florida State University Herbarium (FSU). More than 100 new county records for species were found that could be added to the Atlas of Florida Vascular Plants (Wunderlin and Hansen, 2000). Keys used for identification include Godfrey and Wooten (1979, 1981), Clewell (1985), Wunderlin (1998), Lelong (1984) and Godfrey (1988). Many species were identified in the field without taking specimens; and for some plants, no species determination could be made.

Species Presence, Richness, Frequency Of Occurrence, and Distribution

All species, including marginal species, were listed for each forest type. Ground-cover species richness was determined for each forest type. Genera with unidentified species, such as *Polygonum sp.*, were considered separate species only when no species of that genus was identified in that reach or forest type. Frequency of occurrence in a forest type was determined for each species by dividing the number of sites at which the species was present in the forest type by the total number of sites where the forest type was sampled (table 3). Each transect was considered one site although the sampling area at transects was usually larger than the area at verification plots. Verification plots were considered separate sites because they were located in separate polygons on the forest map. Geographic Information Systems files of the forest map can be obtained from the USGS (Tallahassee, Florida) or the SRWMD. Observation sites were grouped as one site for each forest type because there was no consistency in area examined and no attempt to list all species present.

Density of Cover and Frequency of Dominance

Density of cover was determined by averaging the amount of estimated ground cover for all sample points in a forest type.

Frequency of dominance was determined by dividing the number of points at which a species was dominant by the total number of points sampled (table 3). Frequency of dominance percentages are absolute and do not total 100 percent. Species importance cannot be

Table 3. Sampling statistics for characteristics of ground-cover vegetation by forest type in the lower Suwannee River floodplain, Florida

[Sample points were used for determination of ground-cover density and dominant species. Sites include transects, verification plots, and observation sites. Multiple observation sites were grouped and considered one site for each forest type]

Forest type	Area[1], in hectares	Number of sample points	Number of sites sampled	Total area sampled, in square meters[2]
Rblh3	1,070	30	15	8,155
Rblh2	961	57	18	11,659
Rblh1	1,273	78	17	12,569
Rsw2	1,244	68	11	8,515
Rsw1	491	36	7	4,633
UTblh	797	12	7	3,828
UTmix	403	15	6	3,744
UTsw2	1,146	62	9	7,167
UTsw1	946	76	6	8,535
LTham	1,789	21	7	4,694
LTmix	1,080	34	10	5,799
LTsw2	1,389	36	11	5,228
LTsw1	1,404	48	11	6,287
Total	**13,993**	**573**	**135**	**90,813**

[1]Light and others, 2002.

[2]Includes sampling areas at transects and verification plots, but not at observation sites.

calculated from percentages of cover using this sampling method (which was chosen for expedience in the field). The frequency of dominance for ground-cover species that were present in specific microhabitats in a forest type is related to the approximate proportion of the forest type area that is that microhabitat. For example, *Mitchella repens,* growing around elevated tree bases in swamps, may have a frequency of dominance that more accurately reflects the relative cover of elevated tree bases in swamps than the percentage of actual coverage of *Mitchella repens* in the forest type.

Impacts of Flow Reductions

The flow-dependent hydrologic characteristics of lower Suwannee floodplain forest types described in Light and others (2002) are: duration of inundation and saturation, flood depth, and salinity. Individual measurements of these characteristics were not made for every site where a ground-cover species was found. Instead, median hydrologic statistics for forest types were used to describe the distribution of ground-cover species with regard to inundation and saturation. Similarly, flood depths determined from median depths in forest types in a 2-year, 14-day, threshold flood were used to describe distributions with regard to flood depth. This statistic is calculated using the highest flow that is equaled or exceeded for 14 consecutive days in a 2-year period. Flood depths in a 5-year, 14-day threshold flood also were calculated by Light and others (2002) and are included in a table of hydrologic characteristics, for additional information on flood depths in forest types not flooded during the 2-year, 14-day threshold flood. Observations of storm surges and salinity data obtained during the study period were used to describe potential changes that might occur in the distribution and abundance of ground-cover species in the lower tidal reach if salinity increases due to flow reductions.

SPECIES OCCURRENCE AND DISTRIBUTION

There were 282 species identified in wetland floodplain forests (table 4). Nearly half of these species (136) were limited in distribution to either the riverine or lower tidal reach. Only two species were found exclusively in the upper tidal reach. One-fourth of the species (74) were found in all three reaches. A list of all ground-cover species found in wetland forests and the number of sites of each forest type where they were present is found in Appendix I.

Table 4. Species presence by reach in wetland forests in the lower Suwannee River floodplain, Florida

[Genera with unidentified species were considered separate species only when no species of that genus was identified in that reach or group of reaches]

Reach	Number of Species					
	Found only in indicated reach	Found only in two reaches			Found in all three reaches	Total
		R/UT	UT/LT	R/LT		
Riverine (R)	81	18		30	74	203
Upper tidal (UT)	2	18	22		74	116
Lower tidal (LT)	55		22	30	74	183
Total	**138**	18	22	30	**74**	**282**

Conditions preceding sampling have some bearing on the distribution of species documented in this report. Lists of species present were compiled starting in the fall of 1996, a year with a much lower than average river flood (Light and others, 2002). Hurricane Josephine occurred on October 7-8, 1996, producing a storm surge that covered the lower tidal reach. The late winter flood in 1997, which was slightly below typical flood levels (1.7-year recurrence interval), preceded the most intense period of data collection from late April to November 1997. Sampling was discontinued during the 25-year flood in March 1998, and then resumed in May 1998, and continued until November 1999.

Species Richness

The riverine reach has more species (203) than either the upper or lower tidal reach (table 4) and the highest number (81) of species unique to that reach. Aquatic species, such as *Utricularia gibba* (fig. 4) and *Ceratophyllum echinataum,* grow in semi-permanent, floodplain ponds that are found only in the riverine reach (fig. 4). There were also many species unique to the riverine reach that grow on river banks and in high bottomland hardwood forests with sandy soils such as *Zephyranthes atamasca*, *Aster lateriflorus*, *Coreopsis leavenworthii*, *Halesia carolina*, and *Asimina parviflora*.

The upper tidal reach had the lowest number of ground-cover species (116) of the three reaches and only two species unique to that reach, both of which were infrequently found. A similar pattern of species richness was observed in a survey of species on the Apalachicola River (Gholson, 1986). In that study, species richness was highest in the non-tidal reach of the Apalachicola River, second highest in surveys nearest to the Gulf of Mexico, and lowest between those two reaches.

Figure 4. Semi-permanent pond in the riverine reach of the lower Suwannee River floodplain, Florida. Free-floating aquatic plants such as *Lemna valdiviana, Spirodela punctata, Utricularia gibba*, and *Wolffiella gladiata* were the dominant ground-cover species in ponds that are usually isolated from the river.

The lower tidal reach of the Suwannee River has 183 species, with 55 species unique to that reach. Ground-cover species unique to the lower tidal reach include species that are obligate brackish-marsh or salt-marsh species (*Lilaeopsis chinensis*, *Lythrum lineare*, *Isoetes flaccida,* and others), species that are tropical in distribution and sparsely distributed along the northern gulf coast of Florida such as *Acrostichum danaeifolium* and *Hypolepis repens*, and species that grow in wetlands but are intolerant of deep or prolonged flooding (*Aster carolinianus*, *Juniperus silicicola*, *Magnolia virginiana*, and others). Lower tidal forests rarely experience continuous flooding that lasts more than a few days.

Riverine bottomland hardwood forests have the highest species richness (117 to 129 species) of all wetland forest types (fig. 5). Rsw1 forests have the lowest species richness (52), deepest flooding, and longest durations of continuous inundation of all forest types (table 1). Upper tidal forests are uniformly lower in species richness than all other forest types except Rsw1.

Although UTmix and UTblh had the lowest amount of area sampled, two types of data analyses indicated that the low numbers of species reported in upper tidal forests were not a result of low sampling area. A regression of area sampled against number of species per forest type was performed for all forest types. No significance ($r^2 = 0.29$) was found for that analysis. Species-area curves (fig. 6) also indicated that the area sampled was adequate for the majority of species, although all curves indicate that more sampling would increase the number of species found.

Species of Special Interest

Species that are threatened, commercially exploited, rare, or exotic are listed in table 5. The most widely occurring listed species is *Osmunda regalis*, a commercially exploited fern that is found in all but the driest riverine forests. Of the six exotic species found, *Alternanthera philoxeroides*, *Eichhornia crassipes*, and *Lygodium japonicum* were seen most frequently. *Alternanthera philoxeroides* was found in all reaches and in six forest types. *Lygodium japonicum* was present only in Rsw2 and Rblh1 forests. *Eichhornia crassipes* was seen in upper tidal and riverine swamps and UTmix forests. It also is present in the lower tidal reach according to Clewell and others (1999), who reported that plants of *Eichhornia crassipes* "originate upstream and occur as transients in the intertidal zone."

Four species that are endemic (or nearly so) to Florida and found in the floodplain are: *Coreopsis leavenworthii*, *Nasturtium microphyllum*, *Solidago chapmanii*, and *Zamia pumila*. None of these were found frequently in floodplain forests.

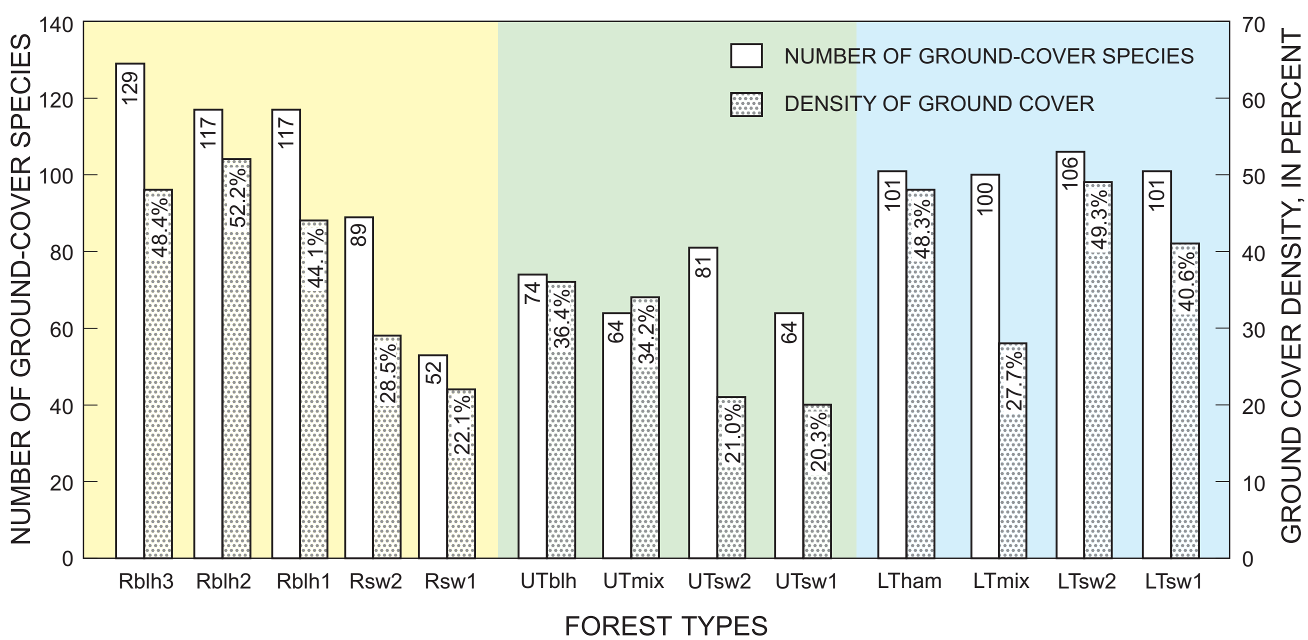

Figure 5. Number of species and density of ground cover in wetland forest types of the lower Suwannee River floodplain, Florida.

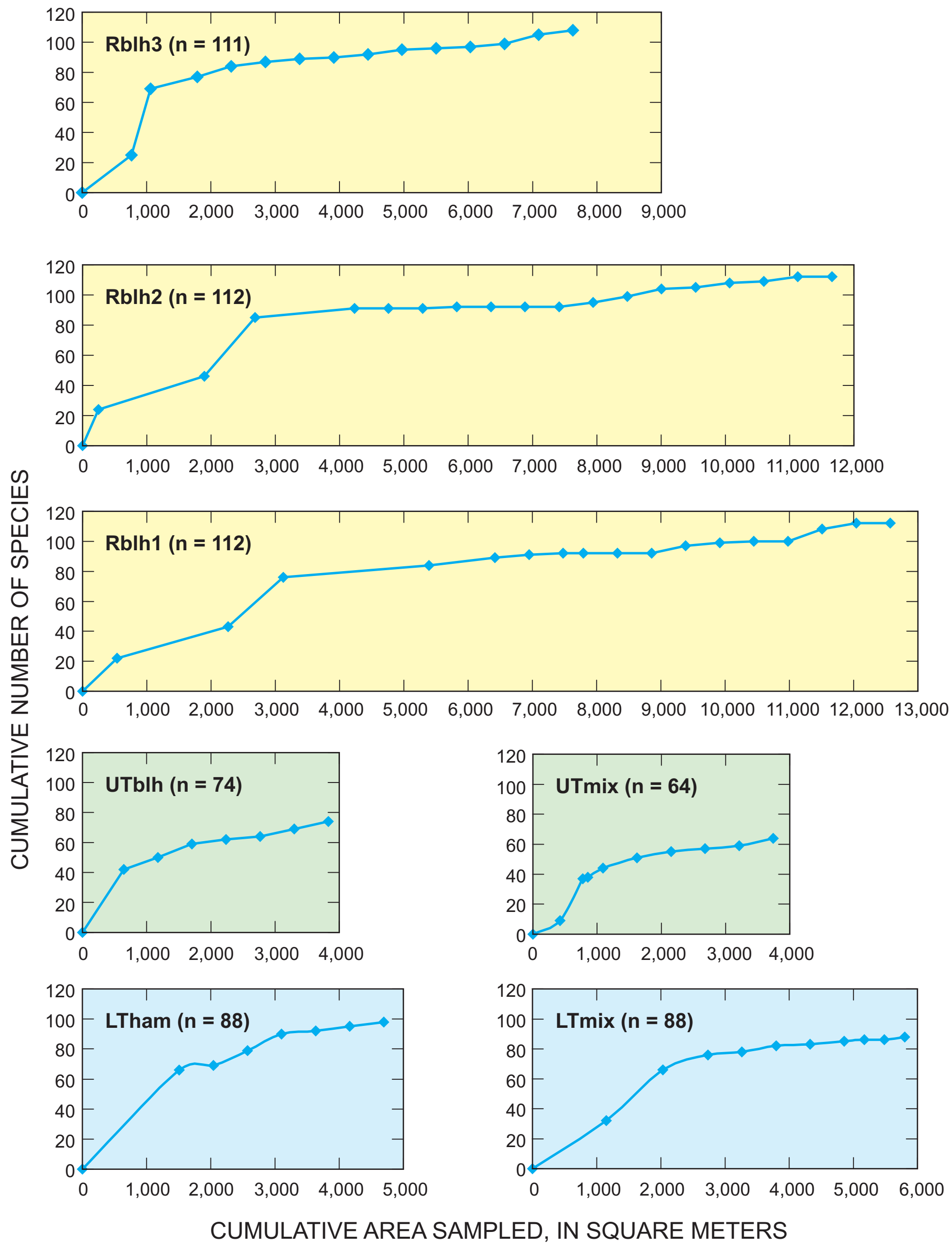

Figure 6. Cumulative number of species sampled with increased total sampling area in selected forest types in the lower Suwannee River floodplain, Florida. Species seen at observation sites are not included. n is the total number of species.

Table 5. Distribution of threatened, commercially exploited, rare, or exotic ground-cover species present in wetland forests in the lower Suwannee River floodplain, Florida

[Species are present in forest types marked with X. Threatened or commercially exploited species are described in Florida Department of Agriculture and Consumer Services (1998); rare species, Ward (1978); exotic species with Category I and II status, Florida Exotic Pest Plant Council (2001). TH, threatened; CE, commercially exploited; R, rare; Cat I, exotic species that are invading and disrupting native plant communities in Florida; Cat II, exotic species that have shown a potential to disrupt native plant communities]

		Forest types												
Native species	**Status**	**Rblh3**	**Rblh2**	**Rblh1**	**Rsw2**	**Rsw1**	**UTblh**	**UTmix**	**UTsw2**	**UTsw1**	**LTham**	**LTmix**	**LTsw2**	**LTsw1**
Lobelia cardinalis	TH				X				X		X	X	X	X
Matelea gonocarpos	TH	X	X	X	X						X	X		
Osmunda cinnamomea	CE						X	X			X	X	X	
Osmunda regalis	CE			X	X	X	X	X	X	X	X	X	X	X
Platanthera flava	CE												X	
Ulmus crassifolia	R		X	X				X						
Zamia pumila	CE	X												
Zephyranthes atamasca	TH	X	X											
Exotic species														
Alternanthera philoxeroides	Cat II			X		X			X	X			X	X
Begonia cucullata	Cat II			X										
Cardamine hirsuta	none			X									X	
Eichhornia crassipes	Cat I				X	X		X	X	X				
Lygodium japonicum	Cat I			X	X									
Macrothelypteris torresiana	none			X										

Frequently Occurring and Characteristic Species

Species present at more than 50 percent of all sites for any forest type are shown in table 6. The riverine reach has the smallest number of most frequently occurring species, which may be due to greater variation between sites than occurs in the tidal reaches. Frequently occurring species can be useful as indicators of community types, but some species (*Toxicodendron radicans*, *Boehmeria cylindrica*, *Mitchella repens,* and others) are common in all reaches and found in many forest types.

Characteristic species are species that can be used in the field to identify an area as belonging to a particular community type (Mueller-Dombois and Ellenberg, 1974). Ideally, a characteristic species would grow only in one reach or forest type and would be sufficiently abundant to be easily noticed and identified in the field. Dominance, distribution, and frequency of occurrence data were used to determine characteristic species for reaches (table 7). No forest type had strongly characteristic ground-cover species. Species characteristic to reaches in the lower Suwannee River floodplain may not typify similar floodplain reaches on other rivers because of differences in hydrologic conditions, climate, and soil types.

Table 6. Most frequently occurring ground-cover species in wetland forests in the lower Suwannee River floodplain, Florida

[Only species that occur at 50 percent or more of the sites in at least one forest type are included in this table. A complete list of species present in wetland forests is in Appendix I. Species are listed in approximate order of increasing tolerance of inundation. Frequencies of occurrence in forest types that equal or exceed 50 percent are shown in **bold type**. Number of sites sampled are shown in parentheses under forest type names.]

A. Riverine reach

	Frequency of occurrence, in percent of sites				
Species	**Rblh3 (15)**	**Rblh2 (18)**	**Rblh1 (17)**	**Rsw2 (11)**	**Rsw1 (7)**
Smilax pumila	**53.3**				
Mitchella repens	**73.3**	**55.6**	11.8		
Smilax bona-nox	33.3	**50.0**	23.5		
Amsonia rigida	26.7	**61.1**	47.1		
Vitis rotundifolia	**53.3**	27.8	5.9	9.1	
Sebastiana fruticosa	**53.3**	38.9	17.6	9.1	
Hypericum galioides	20.0	**55.6**	**70.6**	18.2	
Clematis crispa	33.3	**55.6**	41.2	27.3	
Hypoxis curtissii	46.7	**50.0**	35.3	45.5	
Toxicodendron radicans	**66.7**	**50.0**	41.2	45.5	14.3
Axonopus furcatus	40.0	**77.8**	**76.5**	45.5	14.3
Diodia virginiana	20.0	**50.0**	23.5	18.2	28.6
Panicum rigidulum	13.3	27.8	**52.9**	36.4	28.6
Ampelopsis arborea	33.3	44.4	**52.9**	**54.5**	42.9
Boehmeria cylindrica		33.3	**70.6**	**72.7**	42.9
Lemna valdiviana			5.9	**54.5**	**71.4**

Table 6. Most frequently occurring ground-cover species in wetland forests in the lower Suwannee River floodplain, Florida (Continued)

[Only species that occur at 50 percent or more of the sites in at least one forest type are included in this table. A complete list of species present in wetland forests is in Appendix I. Species are listed in approximate order of increasing tolerance of inundation. Frequencies of occurrence in forest types that equal or exceed 50 percent are shown in **bold type**. Number of sites sampled are shown in parentheses under forest type names]

B. Upper tidal reach

Species	Frequency of occurrence, in percent of sites			
	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)
Vitis rotundifolia	**71.4**	16.7		
Rubus trivialis	**57.1**	16.7		
Osmunda cinnamomea	**57.1**	16.7		
Sabal palmetto	28.6	**50.0**	22.2	
Hypericum galioides	**85.7**	**50.0**	22.2	
Axonopus furcatus	**57.1**	**50.0**	22.2	
Hymenocallis duvalensis	14.3	**50.0**	44.4	
Dychoriste humistrata	**57.1**	**83.3**	**55.6**	
Ampelopsis arborea	**71.4**	**50.0**	22.2	16.7
Thelypteris palustris	**57.1**	**50.0**	22.2	16.7
Mitchella repens	**57.1**	33.3	11.1	33.3
Sabal minor	28.6	**66.7**	22.2	33.3
Conoclinium coelestinum	42.9	**83.3**	33.3	33.3
Rhynchospora miliacea	28.6	**50.0**	44.4	33.3
Justicia ovata	14.3	16.7	**55.6**	33.3
Osmunda regalis	42.9	**66.7**	**55.6**	33.3
Hypoxis curtissii	42.9	**83.3**	**55.6**	33.3
Saururus cernuus	42.9	**50.0**	**66.7**	33.3
Toxicodendron radicans	**85.7**	**50.0**	22.2	**50.0**
Panicum commutatum	**57.1**	33.3	33.3	**50.0**
Centella asiatica	**71.4**	**50.0**	44.4	**50.0**
Boehmeria cylindrica	28.6	**50.0**	44.4	**50.0**
Hydrodotyle verticillata	**57.1**	**83.3**	**77.8**	**50.0**
Asclepias perennis	14.3	**100.0**	**77.8**	**50.0**
Smilax tamnoides	28.6	**66.7**	22.2	**66.7**
Panicum gymnocarpon	28.6	**66.7**	**88.9**	**66.7**
Triadenum walteri	42.9	**100.0**	**55.6**	**83.3**
Crinum americanum	28.6	**83.3**	**66.7**	**83.3**
Eichhornia crassipes		**50.0**	22.2	33.3
Polygonum punctatum		16.7	33.3	**66.7**
Ludwigia repens		16.7	22.2	**83.3**
Decumaria barbara			33.3	**50.0**

C. Lower tidal reach

Species	Frequency of occurrence, in percent of sites			
	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)
Oplismenus hirtellus	**57.1**			
Smilax pumila	**57.1**			
Serenoa repens	**57.1**	10.0		
Thelypteris palustris	**57.1**	**50.0**		
Gelsemium sempervirens	**57.1**			9.1
Sabal minor	14.3	**70.0**	18.2	9.1
Mitchella repens	**71.4**	**50.0**	9.1	18.2
Smilax tamnoides	42.9	**60.0**	27.3	18.2
Hydrodotyle verticillata	42.9	**50.0**	45.5	27.3
Toxicodendron radicans	28.6	**50.0**	**54.5**	27.3
Iris hexagona	42.9	**50.0**	27.3	36.4
Myrica cerifera	**57.1**	**50.0**	27.3	36.4
Boehmeria cylindrica	42.9	**50.0**	**54.5**	36.4
Centella asiatica	**57.1**	**80.0**	**72.7**	36.4
Rhynchospora miliacea	42.9	**90.0**	**90.9**	36.4
Panicum rigidulum	42.9	**60.0**	36.4	45.5
Chasmanthium nitidum	**71.4**	**80.0**	**54.5**	45.5
Asclepias perennis	28.6	**60.0**	45.5	**54.5**
Saururus cernuus	42.9	**70.0**	**63.6**	**54.5**
Sabal palmetto	**71.4**	**60.0**	**63.6**	**81.8**
Itea virginica		**50.0**		27.3
Panicum commutatum		**70.0**	27.3	45.5
Ludwigia repens		40.0	**54.5**	45.5
Cladium jamaicense		20.0	27.3	**54.5**

Table 7. Characteristic ground-cover species for reaches in the lower Suwannee River floodplain, Florida

[Species listed were found at more than 15 percent of all sites in a reach and in at least three forest types in the indicated reach. Species in **bold type** were found in all forest types in indicated reach. Species are listed in order by decreasing frequency of occurrence in indicated reach]

	Riverine	Upper tidal	Lower tidal
Found only in indicated reach	*Senna marilandica* ***Ilex decidua***		*Iris hexagona* *Persea palustris* *Cladium jamaicense* *Aster carolinianus* *Ilex vomitoria* *Vaccinium corymbosum* *Juniperus silicicola*
Found in more than one reach, but occurring at least twice as frequently in indicated reach	*Amsonia rigida* *Saccharum baldwinii* *Sideroxylon reclinata* *Sebastiana fruticosa* *Smilax bona-nox* *Lemna valdiviana* *Elytraria caroliniensis* *Matelea gonocarpos*	***Triadenum walteri*** ***Crinum americanum*** ***Panicum gymnocarpon*** ***Conoclinium coelestinum*** ***Rhynchospora caduca*** *Aster dumosus* ***Crataegus viridis*** ***Rhynchospora mixta*** *Carex lupulina*	***Sabal palmetto*** ***Chasmanthium nitidum*** ***Myrica cerifera*** ***Smilax laurifolia*** *Decumaria barbara* ***Thelypteris kunthii*** *Hymenocallis rotata* *Rumex verticillatus* ***Fraxinus profunda*** ***Hypericum hypericoides*** *Carex gigantea* *Sabatia calycina* ***Lobelia cardinalis*** *Cicuta mexicana*
Found in more than one reach, but most frequently occurring in indicated reach and found on 50 percent or more of sites in reach	***Axonopus furcatus***	***Hydrodotyle verticillata*** ***Asclepias perennis*** ***Hypoxis curtissii*** ***Dyschoriste humistrata*** ***Osmunda regalis*** ***Toxicodendron radicans***	***Rhynchospora miliacea*** ***Centella asiatica*** ***Saururus cernuus***

Only one species, *Ilex decidua*, was found in all forest types of the riverine reach and was unique to that reach. *Crinum americanum*, a characteristic species of the upper tidal reach, was found at more than 66 percent of the sites of UTsw1, UTsw2, and UTmix and at 29 percent of UTblh sites, but was also found at 26 percent of lower tidal reach sites. *Crinum americanum* grows in large colonies that are a prominent visual feature in tidal swamps (fig. 7). The lower tidal reach has many characteristic species, but *Iris hexagona*, *Sabal palmetto*, and *Chasmanthium nitidum* may be the most useful species in the field. *Iris hexagona* (fig. 8) was the most frequently occurring species unique to the lower tidal reach. *Sabal palmetto, Chasmanthium nitidum*, and *Centella asiatica* were the most frequently occurring lower tidal species, but *Centella asiatica* was relatively common in all reaches.

Distribution of Ground-Cover Species Compared to Canopy and Subcanopy Species

The distribution of many woody ground-cover species in this study differs from their distribution in the canopy and subcanopy reported in Light and others (2002). *Acer rubrum* and *Liquidambar styraciflua* were not present in Rsw1 or Rsw2 forests in ground-cover surveys; however, *Acer rubrum* is present in the canopy and subcanopy of Rsw1 and Rsw2 forests, and *Liquidambar styraciflua* is present in the canopy and subcanopy of Rsw2 forests. Mature trees in riverine swamps were probably established during unusually dry periods with several consecutive years of drier than normal weather. Conditions present during the period from 1996 to1999 may not have been dry enough for either *Acer rubrum* or *Liquidambar styraciflua* to successfully produce seedlings in riverine swamps.

Figure 7. Swamp lilies (*Crinum americanum*) cover the ground in an upper tidal swamp in the lower Suwannee River floodplain, Florida. *Crinum americanum*, a characteristic ground-cover species of the upper tidal reach, was a dominant species in UTsw1 forests.

Figure 8. *Iris hexagona* was a characteristic species of the lower tidal reach in the lower Suwannee River floodplain, Florida. It was the most frequently occurring species in lower tidal forests that was unique to that reach.

Nyssa aquatica and *Salix caroliniana* are present in the canopy but are absent in both the subcanopy and ground cover of lower tidal forests. Higher soil salinities resulting from either sea level rise or increased water consumption in recent years may have already eliminated regeneration of *Nyssa aquatica* and *Salix caroliniana* in lower tidal forests based on the absence of seedlings and saplings. Other species that were present in the canopy and subcanopy of lower tidal forests but absent in the ground cover (*Carpinus caroliniana*, *Quercus nigra*, *Celtis laevigata,* and others) may be only temporarily absent due to environmental conditions in recent years that have not been favorable for reproductive success.

DENSITY OF GROUND COVER

Density of ground cover weighted by proportional area of forest types was higher in the lower tidal (42.7 percent) and riverine (40.6 percent) reaches and lower in the upper tidal reach (26.1 percent) (table 8). Seasonality of sampling was examined to determine if differences in the timing of sampling could have affected the resulting densities of cover in forest types. The average density of ground cover was highest in the lower tidal reach, which was sampled more often in the winter than other reaches. It is possible that reported ground-cover density would have been even higher in the lower tidal reach with a greater proportion of summer sampling. The average density of ground cover in the upper tidal reach (26.1 percent), which was sampled in spring, summer, and fall, is well below the average densities for sampling in those seasons throughout the floodplain (32.0, 38.8, and 32.7 percent, respectively).

Table 8. Density of ground cover and seasonal distribution of sampling in wetland forests in the lower Suwannee River floodplain, Florida

[Density of ground cover for reaches was weighted by total area of forest types]

Reach	Number of sample points	Sample points surveyed by season, in percent					Weighted average density of ground cover by reach, in percent
		Spring	Summer	Fall	Winter	Total	
Riverine	269	26.0	65.1	8.9	0.0	100.0	40.6
Upper tidal	165	49.1	38.2	12.7	0.0	100.0	26.1
Lower tidal	139	16.5	29.5	39.6	14.4	100.0	42.7
All reaches	573	30.4	48.7	17.5	3.5	100.0	38.0
Average density of ground cover by season, in percent		32.0	38.8	32.7	20.7		

The density of ground cover by forest type was significantly related ($r^2 = 0.61$, $p < 0.01$) to the number of species found in that forest type (fig. 5). Riverine bottomland hardwood forests have high ground-cover densities (44 to 52 percent) and the highest number of species present (117 to 129). Riverine swamps have low densities (22 to 29 percent); however, cover density in riverine water bodies may have been underestimated because the depth and darkness of the water may have obscured the vegetation in some cases.

Ground-cover density in upper tidal swamps was the lowest of all floodplain swamps (20 to 21 percent). Several factors might account for the sparseness of cover. The basal area of canopy trees per hectare in upper tidal swamps is large (fig. 40, in Light and others, 2002), and the forest floor is deeply shaded. Soils in upper tidal swamps are mucky, and are covered by river floods approximately 0.4 m deep for 14 consecutive days in the average 2-year threshold flood, and by over 1 m of water in the 5-year, 14-day flood (table 1). During periods of continuous flooding, mucky soils provide an unstable substrate for rooted plants. *Crinum americanum*, a characteristic species in upper tidal swamps, has two adaptations that may provide protection against buoyancy in soupy soils: bulbs are deeply set in the substrate (Tobe and others, 1998) and connected by a network of rhizomes (Jan Clark, oral commun., 2001). In comparison, the lower tidal reach, which has higher densities of ground cover, has shorter periods of flooding and, often, a less-shaded forest floor because trees are frequently stunted (Light and others, 2002), and in the riverine reach, swamps contain semi-permanent ponds with dense populations of free-floating aquatic species.

DOMINANT GROUND-COVER SPECIES

The most frequently dominant species in all forest types are listed in table 9. Two frequently dominant species in Rblh3 and Rblh2 forests, *Mitchella repens* and *Toxicodendron radicans*, have a decreasing trend of frequency of dominance with decreasing elevation from Rblh3 forests to Rblh1 forests (table 9A). *Axonopus furcatus* was the most frequently dominant species in three forest types (Rblh2, Rblh1, and Rsw2). The percentage of sample points for *Axonopus furcatus* varied from 35.9 to 14.7 percent, due, in part, to differences in ground-cover density. *Teucrium canadense* was as frequently dominant as *Axonopus furcatus* in Rsw2 forests. *Spirodela punctata*, *Lemna valdiviana*, *Wolffiella gladiata,* and *Utricularia gibba* were the most frequently dominant species in Rsw1 forests. These free-floating aquatic species grow in semi-permanent areas of standing water that are usually isolated from the river (fig. 4).

Panicum commutatum was the most frequently dominant ground-cover species in UTblh, UTmix, and UTsw2 forests (table 9B). The frequency of dominance of *Panicum commutatum* in UTmix forests was the highest of any species in any forest type, indicating that UTmix forests may have a more homogeneous ground cover than other forest types. *Crinum americanum* was the most frequently dominant species in UTsw1 forests (fig. 7). In UTsw2 forests, as in Rsw2 forests, no species was dominant at 20 percent or more of sample points.

Table 9. Most frequently dominant ground-cover species in wetland forests in the lower Suwannee River floodplain, Florida

[The three highest frequencies of dominance for each forest type are in **bold type**. Species listed had one of the three highest frequencies of dominance in at least one forest type. A complete list of all species that were dominant at sample points is given in Appendix II. Number of sample points are shown in parentheses under forest type names. Species are listed in approximate order of increasing tolerance of inundation. Asterisks (*) indicate presence in forest type but not as a dominant species]

A. Riverine reach

Species	Frequency of dominance, in percent of sample points				
	Rblh3 (30)	Rblh2 (57)	Rblh1 (78)	Rsw2 (68)	Rsw1 (36)
Mitchella repens	**43.3**	**21.1**	3.8		
Toxicodendron radicans	**30.0**	**22.8**	10.3	1.5	*
Axonopus furcatus	**16.7**	**26.3**	**35.9**	**14.7**	5.6
Panicum rigidulum	*	10.5	**16.7**	7.4	5.6
Smilax tamnoides	*	5.3	**12.8**	2.9	2.8
Hydrocotyle verticillata		*	1.3	**8.8**	2.8
Teucrium canadense		*	*	**14.7**	*
Utricularia gibba				1.5	**25.0**
Wolffiella gladiata			*	1.5	**25.0**
Lemna valdiviana			*	4.4	**30.6**
Spirodela punctata			*	4.4	**30.6**

B. Upper tidal reach

Species	Frequency of dominance, in percent of sample points			
	UTblh (12)	UTmix (15)	UTsw2 (62)	UTsw1 (76)
Serenoa repens	**16.7**			
Mitchella repens	**16.7**	*	*	*
Smilax tamnoides	**16.7**	*	3.2	3.9
Panicum commutatum	**41.7**	**53.3**	**19.4**	7.9
Centella asiatica	**25.0**	**26.7**	*	**9.2**
Justicia ovata	*	**20.0**	3.2	3.9
Carex lupulina		**20.0**	8.1	*
Crinum americanum	8.3	13.3	**12.9**	**34.2**
Axonopus furcatus	8.3	*	**12.9**	
Panicum rigidulum	*	*	**14.5**	1.3
Polygonum punctatum		*	6.5	**18.4**
Fraxinus caroliniana			*	**9.2**

C. Lower tidal reach

Species	Frequency of dominance, in percent of sample points			
	LTham (21)	LTmix (34)	LTsw2 (36)	LTsw1 (48)
Chasmanthium laxum	**23.8**			
Osmunda cinnamomea	**23.8**	*	*	
Centella asiatica	**19.0**	8.8	8.3	2.1
Chasmanthium nitidum	14.3	**14.7**	**13.9**	8.3
Rhynchospora miliacea	4.8	**17.6**	11.1	8.3
Saururus cernuus	*	**41.2**	**19.4**	**20.8**
Boehmeria cylindrica	*	5.9	**13.9**	4.2
Pilea pumila			**13.9**	2.1
Carex sp.	4.8[1]	11.8[2]	**27.8**[3]	4.2[3]
Panicum rigidulum	4.8	11.8	11.1	**14.6**
Panicum gymnocarpon	*	*	5.6	**16.7**

[1]Includes three species in LTham: *C. amphibola, C. decomposita, and C. godfreyi.*

[2]Includes three species in LTmix: *C. amphibola, C. gigantea, and C. leptalea.*

[3]Includes five species in LTsw1 and LTsw2: *C. alata, C. bromoides, C. gigantea, C. godfreyi*, and *C. lupulina*.

Dominant ground-cover plants in lower tidal hammocks were most often *Osmunda cinnamomea* and *Chasmanthium laxum* (table 9C and fig. 9). LTmix forests were strongly dominated by *Saururus cernuus* (fig. 10). *Saururus cernuus*, which forms colonies by underground rhizomes, was also dominant at about 20 percent of all sampling points in both lower tidal swamps. Plants of the genus *Carex* were the most frequent dominants in LTsw2 forests, but usually could not be identified to species in the field.

Figure 9. Cinnamon fern (*Osmunda cinnamomea*) was a frequently dominant ground-cover species in lower tidal hammocks in the lower Suwannee River floodplain, Florida.

A list of all dominant species named at sample points for each forest type is given in Appendix II. In a comparison of occurrence and dominance of species in the same forest type, there are many cases in which the most frequently occurring species are not among the most frequently dominant species. Frequently occurring species, such as *Asclepias perennis* and *Triadenum walteri*, grow singly or in small groups with little biomass, and are not likely to be named a dominant species at any sample point.

POTENTIAL IMPACTS OF FLOW REDUCTIONS

Hydrology is generally recognized as the most important factor in determining the structure and ecological processes in wetlands (Greeson and others, eds., 1979; Gosselink and others, eds., 1990; Lugo and others, eds., 1990; Carter, 1996). Plant species have varying tolerances to saturated soils. Significant correlations have been reported between frequency of occurrence and elevation in herbaceous floodplain species (Barnes, 1978; Menges and Waller, 1983). In a study of woody plant regeneration in a floodplain swamp in Florida, the distribution patterns of 25 woody species corresponded to duration of inundation by floodwater (Titus, 1990). Changes in elevation and soil-water salinity probably influenced species distributions in a coastal marsh (Earle and Kershaw, 1989). Total submergence of leaves and stems that continues from 10-20 days is fatal to seedlings of many swamp and bottomland hardwood species (Demaree, 1932; Hosner, 1960). Most tree seedlings are stressed by moderate salinities and are killed by salinity

Figure 10. Lizard's tail (*Saururus cernuus*) strongly dominated ground-cover vegetation in lower tidal mixed forests in the lower Suwannee River floodplain, Florida. Colonies of plants are connected by rhizomes that spread through mucky soils.

of 10 parts per thousand (Pezeshki and others, 1987; McKee and Mendelssohn, 1989; Pezeshki and others, 1990; Perry and Williams, 1996; McCarron and others, 1998; Williams and others, 1998).

Water use in the Suwannee River basin in Florida and Georgia is expected to increase over time because of population growth and development in the region. Increased consumption of water, supplied primarily from ground-water sources, could reduce ground-water discharge to the Suwannee River and decrease river flows. Flow reductions would affect flow-dependent hydrologic conditions in the forested floodplain, resulting in changes in the distribution of ground-cover species. Hydrologic characteristics that influence floodplain forest composition are listed in table 10. Hydrologic characteristics that are flow dependent are shown in red type in table 10 and described in detail in Light and others (2002).

Ground-cover species with similar distribution patterns in this study might be similarly affected by flow reductions. The distributions of selected species that appear to be related to flow-dependent hydrologic characteristics are shown in Appendix III. Species listed in tables 11, 12, and 13 and in Appendix III were selected from those species that had the three highest frequencies of dominance in a forest type, occurred on 25 percent or more of the sites of a forest type, or are species of special interest (table 5).

Decreases in Durations of Inundation and Saturation

Decreases in durations of inundation and saturation due to potential flow reductions could have at least two effects: a decrease in the number and extent of semipermanently inundated ponds in the riverine reach and a change to ground-cover vegetation typical of drier forest types in all riverine and UTblh forests. Durations of saturation for forest types were determined by Light and others (2002) from field observations, and are strongly related to soil textures.

Table 10. Hydrologic characteristics of wetland forest types in the lower Suwannee River floodplain, Florida (adapted from Light and others, 2002)

[Flow-dependent characteristics are in red type. Flood depths are median depths in forest types during the highest flows that are equaled or exceeded for 14 consecutive days for the recurrence interval indicated. Very deep flood depths are 2 meters (m) or more; deep, 0.9 to 1.9 m; moderate, 0.3 to 0.8 m; shallow, less than 0.3 m]

Forest type	Hydrologic characteristic				
	Flood depth in 2-year, 14 day threshold flood	Flood depth in 5-year, 14 day threshold flood	Duration and frequency of inundation	Duration of saturation, in months per year	Subject to increased salinity during storm surges?
Rblh3	not flooded	moderate (0.4 m)	1 to 2 months every 3 years	less than 1	no
Rblh2	not flooded	moderate (0.6 m)	1 to 2 months every 3 years	less than 1	
Rblh1	moderate (0.5 m)	deep (1.6 m)	1 to 3 months every year	2 to 8	
Rsw2	deep (1.2 m)	very deep (2.4 m)	2 to 7 months every year	5 to 10	
Rsw1	deep (1.5 m)	very deep (2.6 m)	5 to 9 months every year	12	
UTblh	not flooded	moderate (0.4 m)	1 to 2 months every 2 years	less than 1	In areas closest to lower tidal reach
UTmix	shallow (0.2 m)	deep (0.9 m)	2 to 3 months every year	variable -- 3 to 12	
UTsw2	moderate (0.4 m)	deep (1.1 m)	2 to 3 months every year by river floods and during high tides	12	
UTsw1	moderate (0.4 m)	deep (1.1 m)	2 to 3 months every year by river floods and during high tides	12	
LTham	stage usually tide dependent	stage usually tide dependent	less than 1 month every 1 to 2 years	variable -- from less than 1 to 12	yes
LTmix	stage usually tide dependent	stage usually tide dependent	daily or several times a month (except in isolated areas)	12	
LTsw2	stage usually tide dependent	stage usually tide dependent	daily or several times a month (except in isolated areas)	12	
LTsw1	stage usually tide dependent	stage usually tide dependent	daily or several times a month (except in isolated areas)	12	

Some free-floating, aquatic species (*Spirodela punctata*, *Spirodela polyrhiza*, *Utricularia gibba*, and *Wolffiella gladiata*) were limited in distribution to semi-permanently inundated areas in the riverine reach (table 11). Other aquatic species found in riverine ponds, including *Eichhornia crassipes*, *Lemna valdiviana,* and *Salvinia minima*, also were found in other reaches. Free-floating, aquatic species can be distributed in the floodplain by river flooding, but species have varying tolerances of stranding, dessication, and salinity that may account for differences in reach distribution. If semi-permanent ponds are dry for long periods of time, some free-floating aquatic species will disappear until re-introduced from other sources. A decrease in the number and extent of semi-permanent ponds may lead to the extirpation or decrease in abundance of aquatic species in the riverine reach. Some species, such as *Wolffiella gladiata* and *Spirodela polyrhiza,* are an important food source for ducks, coots, and other waterfowl (Tarver and others, 1978).

Some species that are not free-floating aquatic species (*Ludwigia repens*, *Echinodorus cordifolius*, and others) were found only where soils are saturated for 2 to 12 months of the year. Decreases in saturation in Rblh1, Rsw2, and Rsw1 forests might result in decreased abundance of these species.

Dichondra caroliniensis, *Vaccinium arboreum,* and several other species were present only in Rblh3, Rblh2, or UTblh forests where soils are saturated for 1 month or less during the year. Decreases in saturation due to flow reductions might result in an increased abundance of these species in riverine bottomland hardwoods and UTblh forests and, possibly, in the invasion of wetland forests of the floodplain by upland species that are not currently present.

Decreases in Depth and Duration of Inundation Due to River Flooding

Depth and duration of inundation due to river flooding are strongly correlated characteristics (table 10). The influences of depth and duration of flooding cannot be separated; for example, the absence of some species (that grow in Rsw2 forests) from Rsw1 forests might be

Table 11. Changes in distribution of ground-cover species in wetland forests that might occur if durations of inundation and saturation decreased as a result of flow reductions in the lower Suwannee River, Florida

[Species are selected from those that had one of the three highest frequencies of dominance in a forest type, occurred on 25 percent or more of the sites of a forest type, or are listed as threatened]

Distribution and potential impact of flow reductions	Species
These free-floating aquatic species were present only in semi-permanent ponds in Rblh1, Rsw2, and Rsw1 forests. They might decrease in abundance or disappear if flows were reduced.	*Spirodela punctata* *Spriodela polyrhiza* *Utricularia gibba* *Wolffiella gladiata*
These free-floating aquatic species were present in semi-permanent ponds in riverine forests and in other reaches. They might decrease in abundance in Rblh1, Rsw2, and Rsw1 forests if flows were reduced.	*Eichhornia crassipes* *Lemna valdiviana* *Salvinia minima*
These species were presesnt only in forests where soils are saturated from 2 to 12 months per year. They might decrease in abundance in Rblh1, Rsw2, and Rsw1 forests if flows were reduced.	*Aster dumosus* *Carex louisianica* *Carex lupulina* *Echinodorus cordifolius* *Lobelia cardinalis* *Ludwigia repens* *Planera aquatica* *Proserpinaca palustris* *Rhynchospora corniculata* *Samolus valerandi*
These species were present in the riverine reach (and sometimes in UTblh and LTham forests) in forests that are saturated for less than 1 month per year or are variable with some areas saturated for less than 1 month. They might increase in abundance in Rblh3, Rblh2, and UTblh forests if flows were reduced.	*Dichondra caroliniensis* *Elephantopus nudatus* *Hyptis alata* *Smilax pumila* *Vaccinium arboreum* *Zephyranthes atamasca*

due to either the greater flood depth or the longer duration of inundation in Rsw1 forests. Depth and duration of inundation are greatest in riverine swamps. Five groups of ground-cover species listed in table 12 have distributions that appear to be limited by either maximum flood depths or duration of inundation in forest types. The 2-year, 14-day threshold flood does not cover Rblh3, Rblh2, and UTblh forests. However, Rblh3, Rblh2, and UTblh forests are covered continuously by water during the 5-year, 14-day threshold flood (table 10).

Asclepias perennis, *Carex joorii*, *Clematis crispa,* and many other species were present in Rsw2 and other forest types, but not in Rsw1 forests. If depth or duration of inundation decreased due to flow reductions, these species might become established in Rsw1 forests. *Lygodium japonicum*, an exotic fern that was found in Rblh1 and Rsw2 forests, might become established in Rsw1 forests. *Lygodium japonicum* forms tangled masses that cover and shade other ground-cover species (Langeland and Burks, eds., 1998). The presence of *Lygodium* also increases the risk of crown fires in winter when the fern fronds and stems are dry but present in strands connecting the ground cover to tree limbs.

Acer rubrum, *Liquidambar styraciflua, Mitchella repens*, *Rhynchospora miliacea*, *Sabal minor*, *Saururus cernuus*, *Serenoa repens*, and *Vitis cinerea* are frequently occurring ground-cover species that were present in all reaches but did not grow in riverine swamps. These species might become established in the ground cover of Rsw2 forests if flows were reduced and depth and duration of inundation in riverine swamps decrease.

Crinum americanum, Myrica cerifera, and other species did not grow in Rblh1, Rsw2, or Rsw1 forests, but were present in UTsw2 and UTsw1 forests. Most of the species in this group were found only in tidal reaches, and their distribution may be determined, in part, by soil textures. Some of these tidal species might invade Rblh1 forests with decreased depth and duration of inundation. *Sabal palmetto* and *Gelsemium sempervirens* were present in Rblh3, Rblh2, and in lower tidal forests. The absence of these two species in Rblh1, Rsw2, and Rsw1 forests is probably due to flood depths or duration of inundation, and they might become established in Rblh1 forests if flows were reduced.

Osmunda cinnamomea, *Smilax laurifolia,* and other species were present in UTmix and lower tidal forests, but not in upper tidal swamps, suggesting an intolerance of the depth and duration of river flooding that occurs in UTsw2 and UTsw1 forests. These species might become established in UTsw2 and UTsw1 forests if flows were reduced.

The last group of ground-cover species listed in table 12 was present in the lower tidal reach and Rblh3, Rblh2, and UTblh forests where flooding is typically very shallow, infrequent, or of brief duration. These species might become established in UTmix forests if flows were reduced. This group does not include *Chasmanthium laxum* and other species that were found only in forests with soils saturated less than 3 months because duration of saturation in UTmix forests is not a flow-dependent hydrologic characteristic and probably will not change with flow reductions.

Increases in Salinity

Increases in salinity due to flow reductions would result in a shift to greater abundance of the more saline-tolerant ground-cover species in lower tidal forests and

Table 12. Changes in distribution of ground-cover species in wetland forests that might occur if flood depth and duration of inundation decreased as a result of flow reductions in the lower Suwannee River, Florida

[Species are selected from those that had one of the three highest frequencies of dominance in a forest type, were present on 25 percent or more of the sites of a forest type, or are listed as threatened, rare, or commercially exploited species]

Distribution and potential impact of flow reductions	Species	
These species were present in Rsw2, but not in Rsw1 forests, presumably because flood depth is shallower and duration of flooding is shorter in Rsw2 forests than in Rsw1 forests. These species might become established in Rsw1 forests if flows were reduced.	*Asclepias perennis* *Aster dumosus* *Carex joorii* *Clematis crispa* *Crataegus viridis* *Diospyros virginiana* *Elytraria caroliniensis* *Fraxinus caroliniana* *Hypericum galioides* *Hypoxis curtissii*	*Lobelia cardinalis* *Lygodium japonicum* *Matelea gonocarpos* *Panicum dichotomum* *Panicum gymnocarpon* *Samolus valerandi* *Sebastiana fruticosa* *Senecio glabellus* *Senna marilandica* *Sideroxylon reclinata* *Vitis rotundifolia*
These species were present in Rblh1, but not in Rsw2 or Rsw1 forests, presumably because flood depth is shallower and duration of flooding is shorter in Rblh1 forests than in Rsw2 or Rsw1 forests. These species might become established in Rsw2 forests if flows were reduced.	*Acer rubrum* *Amsonia rigida* *Aristolochia serpentaria* *Berchemia scandens* *Carpinus caroliniana* *Conoclinium coelestinum* *Hymenocallis duvalensis* *Liquidambar styraciflua* *Mitchella repens* *Rhynchospora caduca* *Rhynchospora miliacea*	*Rubus trivialis* *Sabal minor* *Sabatia calycina* *Saccharum baldwinii* *Saururus cernuus* *Scleria triglomerata* *Serenoa repens* *Smilax bona-nox* *Ulmus crassifolia* *Vaccinium elliottii* *Vitis cinerea*
These species were present in UTsw2 and UTsw1, but not in Rblh1, Rsw2, or Rsw1 forests, presumably because flood depth is shallower and duration of flooding is shorter in UTsw2 and UTsw1 forests than in Rblh1, Rsw2, or Rsw1 forests. These species might become established in Rblh1 forests if flows were reduced.	*Carex gigantea* *Cicuta mexicana* *Crinum americanum* *Decumaria barbara* *Gelsemium sempervirens* *Hymenocallis rotata* *Myrica cerifera*	*Rhynchospora mixta* *Rumex verticillatus* *Sabal palmetto* *Sagittaria graminea* *Thelypteris kunthii* *Woodwardia areolata*
These species were present in UTmix, but not in UTsw2, UTsw1, Rblh1, Rsw2, or Rsw1 forests, presumably because flood depth is shallower and duration of flooding is shorter in UTmix forests than in UTsw2, UTsw1, Rblh1, Rsw2, or Rsw1 forests. These species might become established in UTsw2 and UTsw1 if flows were reduced.	*Chasmanthium nitidum* *Hypericum hypericoides* *Osmunda cinnamomea* *Smilax laurifolia*	
These species were present in lower tidal forests (and sometimes in Rblh3, Rblh2, or UTblh forests) where flooding is typically very shallow, infrequent, or of brief duration. These species might become established in UTmix forests if flows were reduced.	*Aster carolinianus* *Cladium jamaicense* *Ilex vomitoria* *Iris hexagona* *Juniperus silicicola*	*Persea palustris* *Platanthera flava* *Solidago sempervirens* *Vaccinium corymbosum* *Viburnum obovatum*

adjacent areas of the upper tidal reach. The extent of salt-tolerance is unknown for most species. Species present in the lower tidal reach are probably at least somewhat tolerant of salinity, but species growing in the part of the lower tidal reach nearest to the Gulf of Mexico are covered by storm surges more frequently than species in upstream areas. Surface soils at sites downstream of Gopher River had higher conductivities than surface soils upstream of Gopher River (fig. 23 in Light and others, 2002). Four groups of species might be variously affected by increased salinity in wetland forests (table 13).

Table 13. Changes in distribution of ground-cover species in wetland forests that might occur if salinity increased as a result of flow reductions in the lower Suwannee River, Florida

[Species are selected from those that had one of the three highest frequencies of dominance in a forest type, occurred on 25 percent or more of the sites of a forest type, or are listed as threatened or commercially exploited species]

Distribution and potential impact of flow reductions	Species
These species were present in upper tidal, but not lower tidal, swamps and are presumed to have no salinity tolerance. They might decrease in abundance in the most downstream part of the upper tidal reach if salinity increased because flows were reduced.	*Amsonia rigida* *Carex joorii* *Crataegus viridis* *Echinodorus cordifolius* *Saccharum baldwinii* *Salix caroliniana*
These species were present only in the lower tidal reach at sites upstream of Gopher River and are presumed to have low salinity tolerance. They might decrease in abundance or disappear if flows were reduced.	*Chasmanthium laxum* *Pteridium aquilinum* *Tragia urens* *Vaccinium corymbosum*
These species were present in other reaches of the floodplain, but occur in the lower tidal reach only at sites upstream of Gopher River and are presumed to have low salinity tolerance. They might decrease in abundance in lower tidal forests if flows were reduced.	*Aristolochia serpentaria* *Aster dumosus* *Axonopus furcatus* *Carex lupulina* *Cephalanthus occidentalis* *Conoclinium coelestinum* *Decumaria barbara* *Dyschoriste humistrata* *Elephantopus nudatus* *Elytraria caroliniensis* *Gelsemium sempervirens* *Gleditsia aquatica* *Hypericum galioides* *Hypericum hypericoides* *Hypoxis curtissii* *Hyptis alata* *Ilex glabra* *Itea virginica* *Lemna valdiviana* *Liquidambar styraciflua* *Lobelia cardinalis* *Matelea gonocarpos* *Osmunda cinnamomea* *Osmunda regalis* *Panicum dichotomum* *Pilea pumila* *Planera aquatica* *Proserpinaca palustris* *Rhynchospora caduca* *Rhynchospora mixta* *Sabal minor* *Sagittaria graminea* *Salvinia minima* *Samolus valerandi* *Sebastiana fruticosa* *Sideroxylon reclinata* *Smilax bona-nox* *Smilax pumila* *Teucrium canadense* *Thelypteris palustris* *Triadenum walteri* *Vaccinium elliottii* *Viola affinis* *Vitis rotundifolia* *Woodwardia areolata*
These species were present in the lower tidal reach at sites downstream of Gopher River that are inundated more frequently by storm surges than sites upstream. Species that were present downstream of Gopher River are presumed to have high salinity tolerance. They might increase in abundance in lower tidal forests if flows were reduced.	*Acer rubrum* *Ampelopsis arborea* *Asclepias perennis* *Aster carolinianus* *Berchemia scandens* *Boehmeria cylindrica* *Carex gigantea* *Centella asiatica* *Chasmanthium nitidum* *Cicuta mexicana* *Cladium jamaicense* *Clematis crispa* *Crinum americanum* *Diodia virginiana* *Diospyros virginiana* *Hydrodotyle verticillata* *Hymenocallis duvalensis* *Hymenocallis rotata* *Ilex vomitoria* *Iris hexagona* *Juniperus silicicola* *Justicia ovata* *Ludwigia repens* *Mitchella repens* *Myrica cerifera* *Oplismenus hirtellus* *Panicum commutatum* *Panicum gymnocarpon* *Panicum rigidulum* *Persea palustris* *Platanthera flava* *Polygonum punctatum* *Rhynchospora corniculata* *Rhynchospora miliacea* *Rubus trivialis* *Rumex verticillatus* *Sabal palmetto* *Sabatia calycina* *Saururus cernuus* *Scleria triglomerata* *Senecio glabellus* *Serenoa repens* *Smilax laurifolia* *Smilax tamnoides* *Solidago sempervirens* *Taxodium distichum* *Thelypteris kunthii* *Toxicodendron radicans* *Ulmus americana* *Viburnum obovatum* *Vitis cinerea*

Amsonia rigida, Carex joorii, Crataegus viridis, Echinodorus cordifolius, Salix caroliniana, and Saccharum baldwinii were found in riverine and upper tidal swamps but were not present in the lower tidal reach. These species may have no tolerance of salinity. These species might decrease in abundance in the most downstream parts of the upper tidal reach if salinity increased due to flow reductions.

Chasmanthium laxum, *Pteridium aquilinum*, *Tragia urens*, and *Vaccinium corymbosum* grew only in the lower tidal reach and were found only at sites upstream of Gopher River. They are presumed to have low salinity tolerance and probably cannot tolerate the deeper flooding that occurs upstream in the upper tidal and riverine reaches. These species might disappear from floodplain wetlands if salinities increase due to flow reduction.

Axonopus furcatus, *Gleditsia aquatica, Liquidambar styraciflua*, *Osmunda cinnamomea*, and many other species were found in other reaches of the floodplain, but were present in the lower tidal reach only at sites upstream of Gopher River. These species are presumed to be less salt-tolerant than species that grow downstream of Gopher River, and these species might become less abundant in lower tidal forests if flows are reduced.

Ground-cover species that grow at study sites downstream of Gopher River include many species that are widely distributed in wetland forests. All of these species might increase in abundance in the lower tidal reach if species with lower salinity tolerances decreased in abundance due to flow reduction. *Ampelopsis arborea*, *Centella asiatica*, *Diodia virginiana*, *Justicia ovata*, *Panicum rigidulum*, *Smilax tamnoides*, and *Toxicodendron radicans* were found in all forest types and downstream of Gopher River in the lower tidal reach. These seven species are not limited in distribution by flow-dependent hydrologic characteristics. Therefore, they might replace more narrowly adapted species that would be adversely affected by flow reductions throughout the floodplain as well as less salt-tolerant species in lower tidal forests, possibly resulting in reduced plant diversity with accompanying reduction in alternative food sources for floodplain wildlife.

Increased salinity in the lower tidal reach due to flow reductions would also result in a loss of lower tidal forests at the tree line (Light and others, 2002). These forests presently are found in the most saline areas tolerated by trees in the floodplain and would convert to brackish marshes.

SUMMARY

Ground-cover vegetation was surveyed in wetland forests in the lower Suwannee River floodplain, Florida, in a study conducted by the U.S. Geological Survey in cooperation with the Suwannee River Water Management District from 1996 to 1999. The study area included forests within the 10-year floodplain of the lower Suwannee River from its confluence with the Santa Fe River to the tree line near the Gulf of Mexico.

The floodplain is divided into three reaches: riverine (R), upper tidal (UT), and lower tidal (LT) and includes 14,000 ha of wetland forests**.** Wetland forest types are fully described in Light and others (2002), and were used in this report for analysis of ground-cover species data. Bottomland hardwoods (Rblh1, Rblh2, Rblh3, and UTblh) are forests on levees, flats, and slopes of floodplains that are flooded continuously for several weeks or longer every 1 to 3 years, and contain plant species adapted to periodic inundation and saturation. Swamps (Rsw1, Rsw2, UTsw1, UTsw2, LTsw1, and LTsw2) are forests in the lowest elevations of the floodplain that are either inundated or saturated most of the time. Swamps contain plant species that have special adaptations for survival in inundated and anoxic soils. Mixed forests (UTmix and LTmix) are tidal forest types dominated by a mixture of swamp and bottomland hardwood or hammock species. Hammocks (LTham) are hydric hammocks, a unique wetland forest type that supports a characteristic mixed hardwood forest with evergreen and semi-evergreen trees.

Species were listed for occurrence at all study sites. Density of ground cover was estimated and dominant species were listed at 573 sample points on transects and at verification sites. Frequency of dominance (the percentage of sample points at which a species was dominant) was used to compare ground-cover species.

Nearly half (136) of the 282 ground-cover species found in the floodplain were limited in distribution to either the riverine or lower tidal reach. One-fourth of the species (74) were found in all three reaches. The riverine reach had more species (203) than either the upper or lower tidal reaches and the highest number (81) of species unique to that reach. The lower tidal reach had 183 species, with 55 species unique to that reach, many of which are probably

intolerant of continuous flooding. Eight species found in wetland forests of the floodplain are considered threatened, commercially exploited, or rare.

Riverine bottomland hardwood forests had the highest species richness of all floodplain wetland forests (117 to 129 species) and Rsw1 forests have the lowest species richness (52). Upper tidal forests are uniformly lower in species richness than all other forest types except Rsw1.

Ilex decidua, a characteristic species of the riverine reach, was found only in the riverine reach and was present in all riverine forest types. *Crinum americanum* is a characteristic species of the upper tidal reach. The lower tidal reach has many characteristic species, but *Iris hexagona, Sabal palmetto,* and *Chasmanthium nitidum* might be the most useful species in the field for identifying lower tidal forest types.

Density of ground cover was highest in the lower tidal (42.7 percent) and riverine (40.6 percent) reaches and lowest in the upper tidal reach (26.1 percent). The density of ground cover by forest type was significantly related to the number of species found in that forest type. Riverine bottomland hardwood forests have the highest ground-cover densities and the highest number of species present. Ground-cover density in upper tidal swamps was the lowest of all floodplain swamps.

Mitchella repens, *Toxicodendron radicans*, and *Axonopus furcatus* were the most frequently dominant species in riverine bottomland hardwood forests. *Axonopus furcatus* and *Teucrium canadense* were the most frequently dominant species in Rsw2 forests. Free-floating aquatic plants (*Spirodela punctata*, *Lemna valdiviana*, *Wolffiella gladiata,* and *Utricularia gibba*) were dominant species in Rsw1 forests. *Panicum commutatum* was a frequently dominant species in UTblh, UTmix, and UTsw2 forests. *Crinum americanum* was the most frequently dominant species in UTsw1 forests. Dominant ground-cover plants in lower tidal hammocks were most often *Osmunda cinnamomea* and *Chasmanthium laxum*. *Saururus cernuus* was frequently dominant in LTmix, LTsw2, and LTsw1 forests. Plants of the genus *Carex* were the most frequently dominant ground-cover vegetation in LTsw2 forests.

Increased withdrawals of water in the Suwannee River basin for human use in Florida and Georgia could reduce ground-water discharge to the Suwannee River and decrease river flows. Flow reductions would affect hydrologic conditions in the forested floodplain, resulting in changes in the distribution of ground-cover species. Ground-cover species that have distributions related to flow-dependent hydrologic characteristics of forest types can be used as indicators of subtle changes in the hydrology of the floodplain.

The hydrologic characteristics of floodplain forests related to river flow are durations of inundation and saturation, depth and duration of inundation, and salinity. Some species were found only in forests that have saturated soils for 2 months of the year or longer. The abundance of these species might decrease in Rsw1, Rsw2, and Rblh1 forests if flows are reduced. A decrease in the duration of inundation will reduce the area of semipermanent ponds in the riverine reach. Some of the species (*Wolffiella gladiata, Utricularia gibba* and others) that grow in these ponds are found nowhere else in the floodplain, and they could disappear or decrease in abundance if flow reductions occur that result in loss of this aquatic habitat (Light and others, 2002).

All riverine and upper tidal forests would be less deeply flooded and have shorter durations of inundation if flow reductions occurred, and ground-cover species that were limited to drier forest types, such as *Liquidambar styraciflua* in Rblh1 and *Sabal palmetto* in Rblh2 forests, could grow in Rsw2 and Rblh1 forests, respectively. Generally drier conditions in some forest types might create conditions more favorable for invasion by some exotic species and by upland species that do not typically grow in wetland forests in the floodplain.

Flow reductions will result in increased salinity in lower tidal forests and adjacent areas of the upper tidal reach. Species with higher salinity tolerances might increase in abundance in forests where salinities increase. Species that are currently found in forests near the Gulf of Mexico may increase in abundance in the lower tidal reach. Increases in salinity could also result in a transition of the most downstream tidal forests to brackish marshes.

Potential flow reductions might result in a decrease in overall species richness. The present composition of ground cover by forest type might change in all forest types. Species such as *Centella asiatica*, *Smilax tamnoides*, and *Toxicodendron radicans*, that have high salt tolerance and are found in all forest types of the floodplain, might increase in abundance in all reaches of the floodplain, replacing species that are adversely affected by flow reductions.

REFERENCES

Barnes, W.J., 1978, The distribution of floodplain herbs as influenced by annual flood elevation: Transactions of Wisconsin Academy of Sciences, Arts and Letters, v. 66, p. 254-266.

Berndt, M.P., Oaksford, E.T., Darst, M.R., and Marella, R.L., 1996, Environmental setting and factors that affect water quality in the Georgia-Florida Coastal Plain study unit: U.S. Geological Survey Water-Resources Investigations Report 95-4268, 45 p.

Bradley, J.T., 1975, Freeze probabilities in Florida: Agricultural Experiment Stations, Institute of Food and Agricultural Sciences, University of Florida: Bulletin 777 (technical), 22 p.

Carter, Virginia, 1996, Wetland hydrology, water quality, and associated functions, *in* Fretwell, J.D., Williams, J.S., and Redman, P.J., compilers, National water summary on wetland resources: U.S. Geological Survey Water-Supply Paper 2425, p. 35-48.

Clewell, A.F., 1985, Guide to the vascular plants of the Florida Panhandle: Tallahassee, Florida State University Press, 605 p.

Clewell, A.F., Beaman, R.S., Coultas, C.L., and Lasley, M.E., 1999, Suwannee River tidal marsh vegetation and its response to external variables and endogenous community processes: Live Oak, Fla., Suwannee River Water Management District, 118 p., plus 15 appendixes, variously paged.

Cowardin, L.M., Carter, Virginia, Golet, F.C., and LaRoe, E.T., 1979, Classification of wetlands and deepwater habitats of the United States: U.S. Fish and Wildlife Service FWS/OBS-79/31, 103 p

Crane, J.J., 1986, An investigation of the geology, hydrogeology, and hydrochemistry of the lower Suwannee River basin: Tallahassee, Florida Geological Survey Report of Investigation 96, 110 p.

Demaree, Delzie, 1932, Submerging experiments with *Taxodium*: Ecology, v. 13, no. 3, p. 258-262.

Earle, J.C., and Kershaw, K.A., 1989, Vegetation patterns in James Bay coastal marshes, III, Salinity and elevation as factors influencing plant zonations: Canadian Journal of Botany, v. 67, p. 2,967-2,974.

Florida Department of Agriculture and Consumer Services, 1998, Rules of the Division of Plant Industry, Chapter 5B-40, Preservation of native flora of Florida: Regulated plant index, Chap. 5B-40.0055, variously paged.

Florida Exotic Pest Plant Council, 2001, Florida Invasive Plant Lists: URL http://www.fleppc.org/01list.htm.

Gholson, Angus, Jr., 1986, Vegetation analysis for the Apalachicola River maintenance dredging disposal site evaluation study: Mobile, Ala., U.S. Army Corps of Engineers, Final Report, COESAM/PDEI/86/004, 205 p.

Godfrey, R.K., 1988, Trees, shrubs, and woody vines of northern Florida and adjacent Georgia and Alabama: Athens, The University of Georgia Press, 734 p.

Godfrey, R.K., and Wooten, J.W., 1979, Aquatic and wetland plants of southeastern United States (Monocotyledons): Athens, The University of Georgia Press, 712 p.

———1981, Aquatic and wetland plants of southeastern United States (Dicotyledons): Athens, The University of Georgia Press, 933 p.

Gosselink, J.G., Lee, L.C., and Muir, T.A., eds., 1990, Ecological processes and cumulative impacts: Chelsea, Mich., Lewis Publishers, 708 p.

Greeson, P.E., Clark, J.R., and Clark, J.E., eds., 1979, Wetland functions and values: The state of our understanding--Proceedings of the national symposium on wetlands, Lake Buena Vista, Florida, November 1978: Minneapolis, American Water Resources Association, Technical Publication Series TPS79-2, 674 p.

Hosner, J.F, 1960, Relative tolerance to complete inundation of fourteen bottomland tree species: Forest Science, v. 6, no. 3, p. 246-251.

Langeland, K.A., and Burks, K.C., eds., 1998, Identification and biology of non-native plants in Florida’s natural areas: Gainesville, University of Florida, IFAS Distribution, 165 p.

Lelong, M.G., 1984, New combinations for *Panicum* subgenus *Panicum* and subgenus *Dichanthelium* (*Poaceae*) of the Southeastern United States: Brittonia, v. 36, no. 3, p. 262-273.

Lewis, L.J., Light, H.M., and Darst, M.R., 2002, Location and description of ecological study sites in floodplain forests of the lower Suwannee River, Florida: U.S. Geological Survey Open-File Report 01-410, 84 p.

Light, H.M., Darst, M.R., Lewis, L.J., and Howell, D.A., 2002, Hydrology, vegetation, and soils of riverine and tidal floodplain forests of the lower Suwannee River, Florida and potential impacts of flow reductions: U.S. Geological Survey Professional Paper 1656-A, (in press).

Lugo, A.E., Brinson, M., and Brown, S., eds., 1990, Ecosystems of the world--Forested Wetlands: Elsevier, v.15, 527 p.

McCarron, J.K., McLeod, K.W., and Conner, W.H., 1998, Flood and salinity stress of wetland woody species, buttonbush (*Cephalanthus occidentalis*) and swamp tupelo (*Nyssa sylvatica* var. *biflora*), Wetlands: v. 18, no. 2, p. 165-175.

McKee, K.L., and Mendelssohn, I.A., 1989, Response of a freshwater marsh plant community to increased salinity and increased water level: Aquatic Botany, v. 34, p. 301-316.

Menges, E.S., and Waller, D.M., 1983, Plant strategies in relation to elevation and light in floodplain herbs: The American Naturalist, v. 122, no. 4, p. 454-473.

Mueller-Dombois, Dieter, and Ellenberg, Heinz, 1974, Aims and methods of vegetation ecology: New York, John Wiley and Sons, 547 p.

Owenby, J.R., and Ezell, D.S., 1992, Monthly station normals of temperature, precipitation, and heating and cooling degree days 1961-90: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, North Carolina: Climatography of the United States No. 81, 26 p.

Perry, J.E., and Hershner, C.H., 1999, Temporal changes in the vegetation pattern in a tidal freshwater marsh: Wetlands, v. 19, no. 1, p. 90-99.

Perry, L., and Williams, K., 1996, Effects of salinity and flooding on seedlings of cabbage palm (*Sabal palmetto*): Springer-Verlag, Oecologia, v. 105, p. 428-434.

Pezeshki, S.R., Delaune, R.D., and Patrick, W.H., Jr. 1990, Flooding and saltwater intrusion: Potential effects on survival and productivity of wetland forests along the U.S. Gulf coast: Elsevier, Forest Ecology and Management: v. 33, no. 34, p. 287-301.

———1987, Response of baldcypress (*Taxodium distichum* L. var. *distichum*) to increases in flooding salinity in Louisiana's Mississippi River deltaic plain, Wetlands, v. 7, no. 1, p. 1-10.

Puri, H.S., and Vernon, R.O., 1964, Summary of the geology of Florida and a guidebook to the classic exposures (revised): Tallahassee, Florida Geological Survey, Special Publication no. 5, 312 p.

Tarver, D.P., Rodgers, J.A., Mahler, J.J., and Lazor, R.L., 1978, Aquatic and wetland plants of Florida: Tallahassee, Florida Department of Natural Resources, Bureau of Aquatic Plant Research Center, Biological Report 85(7.26), 81 p.

Titus, J. H., 1990, Microtopography and woody plant regeneration in a hardwood floodplain swamp in Florida: Bulletin of the Torrey Botanical Club, v. 117, no. 4, p. 429-437.

Tobe, J.D., Burks, K.C., Cantrell, R.W., Garland, M.A., Sweeley, M.E., Hall, D.W., Wallace, P., Anglin, G., Nelson, G., Cooper, J.R., Bickner, D., Gilbert, K., Aymond, N., Greenwood, K., and Raymond, N., 1998, Florida wetland plants: An identification manual: Tallahassee, Florida Department of Environmental Protection, 598 p.

Vince, S.W., Humphrey, S.R., Simons, R.W., 1989, The ecology of hydric hammocks: A community profile: Washington, D.C., U.S. Fish and Wildlife Service, National Wetlands Research Center, Biological Report 85(7.26), 81 p.

Ward, D.B., ed., 1978, Plants: Rare and endangered biota of Florida, v. 5, Pritchard, P.C.H., series editor: Gainesville, University Presses of Florida, 175 p.

Williams, Kimberlyn, Meads, M.V., and Sauerbrey, D.A., 1998, The roles of seedling salt tolerance and resprouting in forest zonation on the west coast of Florida, USA: American Journal of Botany, v. 85, no. 12, p. 1,745-1,752.

Wunderlin, R.P., 1998, Guide to the vascular plants of Florida: Gainesville, University Presses of Florida, 809 p.

Wunderlin, R.P., and Hansen, Bruce, 2000, Atlas of Florida vascular plants: Miami, University of South Florida, Institute for Systematic Botany, URL http://www.plantatlas.usf.edu/ and http://www.usf.edu/~isb/projects/atlas/maps/.

Appendixes

Appendix I. Frequency of occurrence of all ground-cover species found in wetland forests in the lower Suwannee River floodplain, Florida

[Number of sites sampled are shown in parentheses under forest type names.]

Taxonomic groups and species	Number of sites where species were presesnt in each indicated forest type													
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)	Total (135)
Pteridophytes														
Acrostichum danaeifolium												2	1	3
Botrychium dissectum		2				1		1		1	1	2		8
Hypolepis repens										1				1
Isoetes flaccida													1	1
Lygodium japonicum			1	2										3
Macrothelypteris torresiana			1											1
Onoclea sensibilis			2	2									1	5
Osmunda cinnamomea						4	1			2	1	1		9
Osmunda regalis			2	2	2	3	4	5	2	3	3	2	2	30
Pteridium aquilinum										2				2
Salvinia minima			1	3	2								1	7
Thelypteris hispidula			1						1			1	1	4
Thelypteris interrupta										1		1	1	3
Thelypteris kunthii								2		1	3	2	2	10
Thelypteris palustris			2		1	4	3	2	1	4	5			22
Woodwardia areolata						2	1	1	1	2	1		1	9
Gymnosperms														
Juniperus silicicola											4	1	2	7
Pinus elliottii										1				1
Pinus glabra	1													1
Pinus taeda	1													1
Taxodium distichum	1	3	2	2	1	2			2	1	2	2	3	21
Zamia floridana	1													1
Angiosperms														
Monocotyledons														
Agrostis perennans	1	1												2
Apteria aphylla	1													1
Arisaema dracontium	1	1												2
Arisaema triphyllum										1				1
Aristida stricta										1				1
Arundinaria gigantea										1				1
Axonopus furcatus	6	14	13	5	1	4	3	2		3				51
Carex alata												2	1	3
Carex amphibola										1	1			2
Carex bromoides											2	2	1	5
Carex crus-corvi			1	1		1	1	1	1					6
Carex decomposita								1	1	1				3
Carex gigantea									1		2	3	2	8
Carex godfreyi										1		1	1	3
Carex joorii	1	1	8	2		2		1						15
Carex leptalea										1	1	2	1	5
Carex louisianica			1	1	2									4
Carex lupulina			1	1	2		1	2	2		1	1	1	12
Carex stipata				2								1	1	4
Chasmanthium laxum										1				1
Chasmanthium nitidum						1	2			5	8	6	5	27
Chasmanthium sessiliflorum	1									1	1			3
Chasmanthium sp.		1												1
Cladium jamaicense											2	3	6	11
Commelina diffusa					1									1
Commelina sp.		1												1
Commelina virginica			2	2				2				1		7
Crinum americanum						2	5	6	5		4	3	3	28
Cyperus croceus	1	1												2
Cyperus drummondii			1	1										2
Cyperus retrorsus	3	2	1	1										7

Appendix I. Frequency of occurrence of all ground-cover species found in wetland forests in the lower Suwannee River floodplain, Florida (Continued)

[Number of sites sampled are shown in parentheses under forest type names.]

Taxonomic groups and species	Number of sites where species were presesnt in each indicated forest type													
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)	Total (135)
Angiosperms														
Monocotyledons--Continued														
Cyperus sp.													1	1
Cyperus strigosus	1	2	1											4
Dioscorea floridana											1			1
Dioscorea quaternata	1													1
Echinochloa walteri												1		1
Echinodorus cordifolius				4	2			1	2					9
Eichhornia crassipes				1	1		3	2	2					9
Eleocharis baldwinii			1											1
Eleocharis vivipara		2		1	2									5
Eragrostis sp.				1										1
Eriochloa michauxii	2	2												4
Eustachys petraea		1												1
Hymenocallis duvalensis		4	2			1	3	4			3	2	1	20
Hymenocallis rotata							2	1	1		2	3	2	11
Hypoxis curtissii	7	9	6	5		3	5	5	2	3	2	2		49
Iris hexagona										3	5	3	4	15
Juncus polycephalos													2	2
Leersia virginica	1	2	2	1										6
Lemna valdiviana			1	6	5								1	13
Limnobium spongia			1											1
Luziola fluitans		1	1		1									3
Malaxis spicata										1				1
Oplismenus hirtellus	1		1		1					4				7
Panicum anceps	2	4	2			1		1						10
Panicum commutatum	4	7	3	2	1	4	2	3	3		7	3	5	44
Panicum dichotomum	2	5		2						1				10
Panicum gymnocarpon		1		1		2	4	8	4	1	2	5	4	32
Panicum hians	1	1		1										3
Panicum laxiflorum				1										1
Panicum rigidulum	2	5	9	4	2	1	2	2	1	3	6	4	5	46
Panicum sp.	1													1
Panicum virgatum	2			2										4
Paspalum repens			1											1
Paspalum setaceum	2	3												5
Peltandra virginica												1		1
Phragmites australis												2		2
Platanthera flava												1		1
Pontederia cordata							1	1				1		3
Rhynchospora caduca	1	1	1			2	2	2	1	1			1	12
Rhynchospora corniculata					1		1	1	2		4		2	11
Rhynchospora miliacea			1			2	3	4	2	3	9	10	4	38
Rhynchospora mixta						2	1	1	1	2				7
Rhynchospora sp.				1										1
Sabal minor	2	2	1			2	4	2	2	1	7	2	1	26
Sabal palmetto	2	2				2	3	2		5	6	7	9	38
Saccharum baldwinii	6	7	7					1						21
Sacciolepis striata	1	2												3
Sagittaria graminea							2		1			1	2	6
Sagittaria lancifolia											1	2	2	5
Scleria oligantha										1				1
Scleria triglomerata	2		1							2				5
Serenoa repens	5	3	1			3				4	1			17
Sisyrinchium atlanticum	1	1	2	1		1	1	2						9
Smilax auriculata	2	1												3
Smilax bona-nox	5	9	4			2							1	21
Smilax glauca	2	2				1				1				6

Appendix I. Frequency of occurrence of all ground-cover species found in wetland forests in the lower Suwannee River floodplain, Florida (Continued)

[Number of sites sampled are shown in parentheses under forest type names.]

Taxonomic groups and species	Number of sites where species were presesnt in each indicated forest type													
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)	Total (135)
Angiosperms														
Monocotyledons--Continued														
Smilax laurifolia							1			1	3	4	2	11
Smilax pumila	8					2				4				14
Smilax tamnoides	1	7	7	3	1	2	4	2	4	3	6	3	2	45
Spiranthes cernua				2										2
Spiranthes odorata								1	1					2
Spiranthes sp.												1	1	2
Spirodela polyrhiza				3	2									5
Spirodela punctata			2	5	3									10
Tripsacum dactyloides										1				1
Wolffiella gladiata			1	1	1									3
Zephyranthes atamasca	2	2												4
Zizania aquatica											1	1		2
Zizaniopsis miliacea								1	1			1	1	4
Angiosperms														
Dicotyledons														
Acalypha gracilens						1	1							2
Acer rubrum	3	4	6			1				2	1	1	2	20
Acmella oppositifolia	1	1				1	1			1				5
Aesculus pavia	1													1
Alternanthera philoxeroides			1		1			2	1			1	2	8
Amaranthus australis												1	1	2
Amorpha fruticosa	2	1	1			1	1			1	1			8
Ampelopsis arborea	5	8	9	6	3	5	3	2	1	1	3	2	4	52
Amsonia rigida	4	11	8			1	1	1						26
Aristolochia serpentaria	5	8	4			3	2			2				24
Asclepias perennis		2	3	3		1	6	7	3	2	6	5	6	44
Asimina parviflora	2													2
Aster carolinianus											2	5	3	10
Aster dumosus			2	3			2	3	2			1	1	14
Aster lateriflorus	1		1											2
Aster sp.	1	3								2				6
Baccharis glomeruliflora											1			1
Baccharis halimifolia											1			1
Baptisia alba	1	1												2
Bartonia paniculata			1											1
Begonia cucullata			1											1
Berchemia scandens	1	2	3			2	1	2		1	3	1	2	18
Betula nigra	1	1												2
Bidens discoidea					1									1
Bidens laevis												1		1
Bignonia capreolata	1													1
Boehmeria cylindrica		6	12	8	3	2	3	4	3	3	5	6	4	59
Callicarpa americana	1									1				2
Campsis radicans	2	1	2											5
Cardamine hirsuta			1									1		2
Cardamine sp.					1									1
Carpinus caroliniana	4	1	3											8
Carya aquatica			2	1										3
Carya glabra	2													2
Carya sp.	1													1
Celtis laevigata					1									1
Centella asiatica	4	7	3	2	2	5	3	4	3	4	8	8	4	57
Cephalanthus occidentalis		2	2	4	2			1			2		1	14
Ceratophyllum echinatum					1									1
Cicuta mexicana								1	1		4	1	1	8
Clematis crispa	5	10	7	3		2		1	1	3	3	3	3	41

Appendix I. Frequency of occurrence of all ground-cover species found in wetland forests in the lower Suwannee River floodplain, Florida (Continued)

[Number of sites sampled are shown in parentheses under forest type names.]

Taxonomic groups and species	Number of sites where species were presesnt in each indicated forest type													
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)	Total (135)
Angiosperms														
Dicotyledons--Continued														
Conoclinium coelestinum	4	5	4			3	5	3	2			1	1	28
Coreopsis leavenworthii		1	1											2
Cornus foemina				1					1	1	1	1		5
Crataegus aestivalis	1													1
Crataegus flava	2	2												4
Crataegus marshallii	2	2												4
Crataegus viridis		1	3	2		1	1	2	2					12
Cuscuta obtusiflora												1	2	3
Cyrilla racemiflora	2	1	1			1								5
Decumaria barbara								3	3		3	3	4	16
Desmodium glabellum											1			1
Desmodium sp.	1	1	1							1				4
Dichondra caroliniensis	5	5				1								11
Diodia virginiana	3	9	4	2	2	4	2	2	1	2	3	4	2	40
Diospyros virginiana	3	6	2	1		1	1	1			2			17
Dychoriste humistrata	2	7	5	2	2	4	5	5		2	2	2	1	39
Elephantopus nudatus	1	1								2				4
Elytraria caroliniensis	4	3	3	2						1				13
Erechtites hieracifolia	2	1	2											5
Euonymus americanus	1									1	1			3
Eupatorium compositifolium	1	2	2											5
Forestiera acuminata				2										2
Fraxinus caroliniana			2	1				1	1					5
Fraxinus profunda								1	1	1	2	2	2	9
Galactia volubilis		1												1
Galium tinctorium			2	1	1			1	1				1	7
Gelsemium sempervirens	4	1					2	1	1	4			1	14
Gleditsia aquatica	1	2	1	4	2							1		11
Gratiola floridana				1										1
Halesia carolina	1	2	2											5
Hedyotis uniflora	1	1	1											3
Helenium autumnale		1												1
Hibiscus coccineus											1	2	2	5
Hydrocotyle ranunculoides					1									1
Hydrodotyle verticillata		3	7	5	3	4	5	7	3	3	5	5	3	53
Hypericum galioides	3	10	12	2		6	3	2		2	2	2	2	46
Hypericum hypericoides	2	3				1	1			1	2	1	3	14
Hypericum sp.	1									1				2
Hyptis alata						1				2				3
Ilex cassine						1				1	1	1		4
Ilex decidua	2	2	3	2	2									11
Ilex glabra						2				1			1	4
Ilex opaca	2									1				3
Ilex vomitoria										3	3	2	1	9
Ipomoea cordatotriloba	1	2	1	1						1				6
Itea virginica				2	1	1		1	2		5		3	15
Justicia ovata	7	7	7	2	1	1	1	5	2	3	3	3	2	44
Kosteletzkya virginica											1	1		2
Lilaeopsis chinensis												2	1	3
Liquidambar styraciflua	2	3	4							2				11
Lobelia cardinalis				1				2		1	2	1	2	9
Ludwigia palustris				1				1	1			2	1	6
Ludwigia repens			2	2	1		1	2	5		4	6	5	28
Lycopus rubellus	1	1		2		1		2	1		1		1	10
Lyonia lucida												2		2
Lythrum lineare													1	1

Appendix I. Frequency of occurrence of all ground-cover species found in wetland forests in the lower Suwannee River floodplain, Florida (Continued)

[Number of sites sampled are shown in parentheses under forest type names.]

Taxonomic groups and species	Number of sites where species were presesnt in each indicated forest type													
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)	Total (135)
Angiosperms														
Dicotyledons--Continued														
Magnolia virginiana											2			2
Matelea gonocarpos	4	2	2	3						2	1			14
Melanthera nivea	1	2									1			4
Melothria pendula	1	2	1	3										7
Micranthemum umbrosum			1											1
Micromeria brownei	1	1												2
Mikania scandens			1							1	2	1	1	6
Mitchella repens	11	10	2			4	2	1	2	5	5	1	2	45
Mitreola petiolata		1	2	2							1	1		7
Morus rubra	1	1												2
Myrica cerifera						1	1	1	2	4	5	3	4	21
Nasturtium microphyllum												1	1	2
Nyssa aquatica			2	2	1			1	1					7
Nyssa biflora	2		1	1							2		1	7
Ostrya virginiana										1				1
Oxalis corniculata				2										2
Parthenocissus quinquefolia	3										1	1		5
Persea borbonia	2		1											3
Persea palustris										3	3	3	3	12
Phyllanthus carolinensis	1		4		1									6
Physostegia leptophylla	2			2		1	1	1	1	1	1	1	2	13
Pilea pumila												1	1	2
Planera aquatica			1	3	1			2	2		1			10
Pluchea camphorata				1								2		3
Pluchea longifolia	1	1		1		1					1			5
Pluchea odorata		1				1	1	1		1	2	2		9
Pluchea sp.			1										1	2
Polygonum punctatum		2	6	5	2		1	3	4		3	4	2	32
Polygonum setaceum		2		2	1	1					1			7
Polygonum sp.	1													1
Proserpinaca palustris				1	1			1	2		1	4		10
Quercus geminata	1													1
Quercus laurifolia	1	1	3								1	1	1	8
Quercus lyrata		1	2					1						4
Quercus michauxii	1													1
Quercus minima										1				1
Quercus nigra	3													3
Quercus sp.						1								1
Quercus virginiana	2													2
Rhexia mariana			1											1
Rubus betulifolius										1	2			3
Rubus sp.												1		1
Rubus trivialis	3	2	2			4	1			2	1			15
Ruellia caroliniensis	1									1				2
Rumex verticillatus								1			3	2	3	9
Sabatia calycina	1	1	1					1			2	2	3	11
Salix caroliniana		1		1	2				1					5
Samolus valerandi				1				2	1			2	3	9
Saururus cernuus			1			3	3	6	2	3	7	7	6	38
Sebastiana fruticosa	8	7	3	1						1	1			21
Senecio glabellus	1	2	6	5		1	1	4	1		3	2	2	28
Senna marilandica	3	4	6	2										15
Sideroxylon reclinata	3	8	6	3		2	2			2				26
Sium suave									1				1	2
Solidago chapmanii										1				1
Solidago leavenworthii	1	1	1									1		4

Appendix I. Frequency of occurrence of all ground-cover species found in wetland forests in the lower Suwannee River floodplain, Florida (Continued)

[Number of sites sampled are shown in parentheses under forest type names.]

Taxonomic groups and species	Number of sites where species were presesnt in each indicated forest type													
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)	Total (135)
Angiosperms														
Dicotyledons--Continued														
Solidago sempervirens											3	1	1	5
Teucrium canadense		2	3	3	1			1	1	1	1			13
Toxicodendron radicans	10	9	7	5	1	6	3	2	3	2	5	6	3	62
Trachelospermum difforme	1	2				1	1							5
Tragia urens										2				2
Triadenum walteri			3		2	3	6	5	5	3	1	3	3	34
Ulmus alata	1													1
Ulmus americana	1		1	2	1			1		2				8
Ulmus crassifolia		1	1				1							3
Utricularia gibba				1	1									2
Vaccinium arboreum	5	2												7
Vaccinium corymbosum										1	1	2	3	7
Vaccinium elliottii	6	5	2			3						2	1	19
Vaccinium myrsinites										1				1
Vaccinium stamineum	3					1								4
Vernonia gigantea	2	3	1	1				1				1		9
Viburnum obovatum	1	1									3	1		6
Vicia floridana												1	1	2
Viola affinis	2	6								3				11
Viola sp.						1	1				1			3
Vitis aestivalis	1	1	1											3
Vitis cinerea	3	5	4							1	1	2	1	17
Vitis rotundifolia	8	5	1	1		5	1			3				24

Appendix II. Dominant ground-cover species in wetland forests in the lower Suwannee River floodplain, Florida

[Species are listed in approximate order of increasing tolerance of inundation. Frequencies of dominance in **bold type** are equal to or greater than 20 percent of sample points.]

A. Riverine forests

Species	Frequency of dominance, in percent of sample points				
	Rblh3	Rblh2	Rblh1	Rsw2	Rsw1
Baptisia alba	3.3				
Persea borbonia	3.3				
Scleria triglomerata	3.3				
Smilax pumila	3.3				
Vernonia gigantea	3.3				
Vitis cinerea	3.3				
Dichondra caroliniensis	6.7	1.8			
Elytraria caroliniensis	3.3	1.8			
Gelsemium sempervirens	3.3	1.8			
Serenoa repens	13.3	1.8	1.3		
Amsonia rigida	6.7	1.8	1.3		
Mitchella repens	**43.3**	**21.1**	3.8		
Toxicodendron radicans	**30.0**	**22.8**	10.3	1.5	
Vaccinium elliottii	3.3	5.3			
Saccharum baldwinii	6.7	12.3	11.5		
Panicum anceps		3.5			
Clematis crispa		1.8			
Diodia virginiana		1.8			
Matelea gonocarpa		1.8			
Quercus sp.		1.8			
Senna marilandica		1.8			
Smilax sp.		1.8			
Vaccinium arboreum		1.8			
Hypericum galioides	3.3	7.0	1.3		
Sebastiania fruticosa	3.3	7.0	6.4		
Smilax bona-nox		3.5	2.6		
Leersia virginica	3.3	5.3	2.6	2.9	
Panicum commutatum	6.7	7.0	10.3	5.9	
Ampelopsis arborea		3.5	2.6		2.8
Centella asiatica		3.5	1.3	1.5	2.8
Rhynchospora caduca		1.8	2.6		
Justicia ovata	3.3	3.5	9.0	7.4	
Axonopus furcatus	16.7	**26.3**	**35.9**	14.7	5.6
Panicum rigidulum		10.5	16.7	7.4	5.6
Smilax tamnoides		5.3	12.8	2.9	2.8
Acer rubrum		1.8	2.6		
Thelypteris palustris			2.6		
Aster dumosus			1.3		
Sideroxylon reclinata			1.3		
Campsis radicans			1.3		
Carex crus-corvi			1.3		
Carpinus carolinianus			1.3		
Commelina virginica			1.3		
Cyrilla racemiflora			1.3		
Pluchea sp.			1.3		
Senecio glabellus			2.6	1.5	
Hypoxis curtissii			1.3	1.5	
Mitreola petiolata			1.3	1.5	

Appendix II. Dominant ground-cover species in wetland forests in the lower Suwannee River floodplain, Florida (Continued)

[Species are listed in approximate order of increasing tolerance of inundation. Frequencies of dominance in **bold type** are equal to or greater than 20 percent of sample points.]

A. Riverine forests

Species	Frequency of dominance, in percent of sample points				
	Rblh3	Rblh2	Rblh1	Rsw2	Rsw1
Panicum dichotomum				1.5	
Cephalanthus occidentalis				1.5	
Cornus foemina				1.5	
Cyperus retrorsus				1.5	
Fraxinus carolinianus				1.5	
Gleditsia aquatica				1.5	
Spirodela polyrhiza				1.5	
Echinodorus cordifolius				4.4	
Planera aquatica				4.4	
Polygonum punctatum				5.9	
Carex joorii		1.8	2.6	2.9	
Dyschoriste humistrata		1.8		1.5	2.8
Teucrium canadense			5.1	14.7	
Hydrocotyle verticillata			1.3	8.8	2.8
Carex sp.			1.3		2.8
Boehmeria cylindrica			1.3	5.9	2.8
Salvinia minima				1.5	8.3
Osmunda regalis				2.9	11.1
Wolffiella gladiata				1.5	**25.0**
Utricularia gibba				1.5	**25.0**
Lemna valdiviana				4.4	**30.6**
Spirodela punctata				4.4	**30.6**
Carex lupulina					5.6
Eichhornia crassipes					2.8
Ludwigia repens					2.8
Oplismenus hirtellus					2.8
Polygonum setaceum					2.8
Number of sample points	30	57	78	68	36
Total number of species[1]	21	30	33	32	19

[1]Includes genera with unidentified species if no species in the genus is listed in forest type.

B. Upper tidal forests

Species	Frequency of dominance, in percent of sample points			
	UTblh	UTmix	UTsw2	UTsw1
Mitchella repens	16.7			
Serenoa repens	16.7			
Cyrilla racemiflora	8.3			
Hypericum galioides	8.3			
Ilex glabra	8.3			
Smilax sp.	8.3			
Spilanthes americana	8.3			
Woodwardia areolata	8.3			
Taxodium distichum	8.3			1.3
Smilax tamnoides	16.7		3.2	3.9
Panicum commutatum	**41.7**	**53.3**	19.4	7.9
Centella asiatica	**25.0**	**26.7**		
Carex lupulina		**20.0**	8.1	9.2
Justicia ovata		**20.0**	3.2	3.9
Hypoxis curtissii		13.3	1.6	
Dyschoriste humistrata		13.3		
Hymenocallis duvallensis		6.7		
Rubus trivialis		6.7		
Senecio glabellus		6.7		
Thelypteris palustris		6.7		
Vitis rotundifolia		6.7		
Rhynchospora caduca		6.7	1.6	
Hydrocotyle verticillata		13.3	6.5	
Axonopus furcatus	8.3		12.9	
Panicum gymnocarpon	8.3		8.1	2.6
Asclepias perennis			1.6	
Erianthus strictus			1.6	
Quercus lyrata			1.6	
Samolus parviflorus			3.2	
Ludwigia sp.			4.8	
Boehmeria cylindrica			1.6	1.3
Panicum rigidulum			14.5	1.3
Ludwigia palustris			1.6	2.6
Planera aquatica			1.6	5.3
Ludwigia repens			11.3	5.3
Saururus cernuus			4.8	6.6
Crinum americanum	8.3	13.3	12.9	**34.2**
Polygonum punctatum			6.5	18.4
Carex crus-corvi				1.3
Conoclinium coelestinum				1.3
Toxicodendron radicans				2.6
Triadenum walterii				2.6
Aster dumosus				7.9
Fraxinus caroliniana				9.2
Number of sample points	12	15	62	76
Total number of species[1]	14	14	20	20

[1]Includes genera with unidentified species if no species in the genus is listed in forest type.

C. Lower tidal forests

	Frequency of dominance, in percent of sample points			
Species	**LTham**	**LTmix**	**LTsw2**	**LTsw1**
Chasmanthium laxum	**23.8**			
Osmunda cinnamomea	**23.8**			
Serenoa repens	9.5			
Thelypteris palustris	9.5	2.9		
Chasmanthium sessiliflorum	4.8			
Osmunda regalis	4.8			
Panicum dichotomum	4.8			
Pteridium aquilinum	4.8			
Quercus minima	4.8			
Rhynchospora mixta	4.8			
Toxicodendron radicans	4.8			
Vitis rotundifolia	4.8			
Woodwardia areolata	4.8			
Centella asiatica	19.0	8.8	8.3	2.1
Sabal palmetto	4.8	2.9		2.1
Chasmanthium nitidum	14.3	14.7	13.9	8.3
Smilax tamnoides	9.5	11.8	8.3	4.2
Rhynchospora miliacea	4.8	17.6	11.1	8.3
Solidago sempervirens		8.8		
Itea virginica		5.9		
Carex bromoides		2.9		
Iris hexagona		2.9		
Mitreola petiolata		2.9		
Myrica cerifera		2.9		
Polygonum sp.		2.9		
Viburnum obovatum		2.9		
Zizania aquatica		2.9		
Panicum commutatum		5.9	2.8	4.2
Saururus cernuus		**41.2**	19.4	**20.8**
Cicuta mexicana		11.8	2.8	8.3
Crinum americanum		11.8	2.8	8.3
Hymenocallis rotata		8.8	2.8	8.3
Rhynchospora corniculata		8.8		4.2
Thelypteris kunthii		2.9	5.6	2.1
Carex sp.	4.8	11.8	**27.8**	4.2
Boehmeria cylindrica		5.9	13.9	4.2
Pilea pumila			13.9	2.1
Carex gigantea			5.6	
Conoclinium coelestinum			5.6	
Aster carolinianus			2.8	
Hypoxis curtissii			2.8	
Ludwigia sp.			2.8	
Diodia virginiana			2.8	2.1
Triadenum walteri			8.3	6.3
Polygonum punctatum			5.6	4.2
Panicum rigidulum	4.8	11.8	11.1	14.6
Hydrocotyle verticillata	4.8	11.8	11.1	12.5
Ludwigia repens		2.9	5.6	6.3
Panicum gymnocarpon			5.6	16.7
Cuscuta obtusiflora				2.1
Salvinia minima				2.1

C. Lower tidal forests

Species	Frequency of dominance, in percent of sample points			
	LTham	LTmix	LTsw2	LTsw1
Samolus parviflorus				2.1
Senecio glabellus				2.1
Carex stipata				4.2
Sagittaria lanceolata				4.2
Justicia ovata				6.3
Cladium jamaicense				12.5
Number of sample points	21	34	36	48
Total number of species[1]	21	26	23	29

[1]Includes genera with unidentified species if no species in the genus is listed in forest type.

Appendix III. Frequency of occurrence of selected ground-cover species grouped by flow-dependent hydrologic characteristics of wetland forests in the lower Suwannee River floodplain, Florida

[Species are selected from those that had one of the three highest frequencies of dominance in a forest type, occurred on 25 percent or more of the sites of a forest type, or are listed as threatened, rare, or commercially exploited species. Number of sites sampled are shown in parentheses under forest type names.]

A. Durations of inundation and saturation

Group description and species	Number of sites at which species occurred in each indicated forest type												
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)
Free-floating aquatic species found only in riverine reach:													
Spirodela punctata			2	5	3								
Spirodela polyrhiza				3	2								
Utricularia gibba				1	1								
Wolffiella gladiata			1	1	1								
Free-floating aquatic species found in other reaches:													
Eichhornia crassipes				1	1		3	2	2				
Lemna valdiviana			1	6	5								1
Salvinia minima			1	3	2								1
Present only where soils were saturated from 2 to 12 months per year (Rblh1, Rsw2, Rsw1, UTmix, UTsw2, UTsw1, some areas of LTham, LTmix, LTsw2, or LTsw1 forests):													
Aster dumosus			2	3			2	3	2			1	1
Carex louisianica			1	1	2								
Carex lupulina			1	1	2		1	2	2		1	1	1
Echinodorus cordifolius				4	2			1	2				
Lobelia cardinalis				1				2		1	2	1	2
Ludwigia repens			2	2	1		1	2	5		4	6	5
Planera aquatica			1	3	1			2	2		1		
Proserpinaca palustris				1	1			1	2		1	4	
Rhynchospora corniculata					1		1	1	2		4		2
Samolus valerandi				1				2	1			2	3
Present only in forests that were saturated for less than 1 month per year (Rblh3, Rblh2, UTblh, and some areas of LTham forests):													
Dichondra caroliniensis	5	5				1							
Elephantopus nudatus	1	1								2			
Hyptis alata						1				2			
Smilax pumila	8					2				4			
Vaccinium arboreum	5	2											
Zephyranthes atamasca	2	2											

B. Flood depths and durations of inundation due to river flooding

Group description and species	Number of sites at which species occurred in each indicated forest type												
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)
Present in Rsw2 forests but not in Rsw1 forests:													
Asclepias perennis		2	3	3		1	6	7	3	2	6	5	6
Aster dumosus			2	3			2	3	2			1	1
Carex joorii	1	1	8	2		2		1					
Clematis crispa	5	10	7	3		2		1	1	3	3	3	3
Crataegus viridis		1	3	2		1	1	2	2				
Diospyros virginiana	3	6	2	1		1	1	1			2		
Elytraria caroliniensis	4	3	3	2						1			
Fraxinus caroliniana			2	1				1	1				
Hypericum galioides	3	10	12	2		6	3	2		2	2	2	2
Hypoxis curtissii	7	9	6	5		3	5	5	2	3	2	2	
Lobelia cardinalis				1				2		1	2	1	2
Lygodium japonicum			1	2									
Matelea gonocarpos	4	2	2	3						2	1		
Panicum dichotomum	2	5		2						1			
Panicum gymnocarpon		1		1		2	4	8	4	1	2	5	4
Samolus valerandi				1				2	1			2	3
Sebastiana fruticosa	8	7	3	1						1	1		
Senecio glabellus	1	2	6	5		1	1	4	1		3	2	2
Senna marilandica	3	4	6	2									
Sideroxylon reclinata	3	8	6	3		2	2			2			
Vitis rotundifolia	8	5	1	1		5	1			3			

Group description and species	Number of sites at which species occurred in each indicated forest type												
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)
Present in Rblh1 forests but not in Rsw2 or Rsw1 forests:													
Acer rubrum	3	4	6			1				2	1	1	2
Amsonia rigida	4	11	8			1	1	1					
Aristolochia serpentaria	5	8	4			3	2			2			
Berchemia scandens	1	2	3			2	1	2		1	3	1	2
Carpinus caroliniana	4	1	3										
Conoclinium coelestinum	4	5	4			3	5	3	2			1	1
Hymenocallis duvalensis		4	2			1	3	4			3	2	1
Liquidambar styraciflua	2	3	4							2			
Mitchella repens	11	10	2			4	2	1	2	5	5	1	2
Rhynchospora caduca	1	1	1			2	2	2	1	1			1
Rhynchospora miliacea			1			2	3	4	2	3	9	10	4
Rubus trivialis	3	2	2			4	1			2	1		
Sabal minor	2	2	1			2	4	2	2	1	7	2	1
Sabatia calycina	1	1	1					1			2	2	3
Saccharum baldwinii	6	7	7					1					
Saururus cernuus			1			3	3	6	2	3	7	7	6
Scleria triglomerata	2		1							2			
Serenoa repens	5	3	1			3				4	1		
Smilax bona-nox	5	9	4			2							1
Ulmus crassifolia		1	1				1						
Vaccinium elliottii	6	5	2			3						2	1
Vitis cinerea	3	5	4							1	1	2	1
Present in UTsw2 and UTsw1 forests but not in Rblh1, Rsw2, or Rsw1 forests:													
Carex gigantea									1		2	3	2
Cicuta mexicana								1	1		4	1	1
Crinum americanum						2	5	6	5		4	3	3
Decumaria barbara								3	3		3	3	4
Gelsemium sempervirens	4	1					2	1	1	4			1
Hymenocallis rotata							2	1	1		2	3	2
Myrica cerifera						1	1	1	2	4	5	3	4
Rhynchospora mixta						2	1	1	1	2			
Rumex verticillatus								1			3	2	3
Sabal palmetto	2	2				2	3	2		5	6	7	9
Sagittaria graminea							2		1			1	2
Thelypteris kunthii								2		1	3	2	2
Woodwardia areolata						2	1	1	1	2	1		1
Present in UTmix forests but not in UTsw2, UTsw1, Rblh1, Rsw2 or Rsw1 forests:													
Chasmanthium nitidum						1	2			5	8	6	5
Hypericum hypericoides	2	3				1	1			1	2	1	3
Osmunda cinnamomea						4	1			2	1	1	
Smilax laurifolia							1			1	3	4	2
Present in lower tidal forests (and sometimes in Rblh3 and Rblh2 forests) but not in UTmix, UTsw2, UTsw1, Rblh1, Rsw2 or Rsw1 forests:													
Aster carolinianus											2	5	3
Cladium jamaicense											2	3	6
Ilex vomitoria										3	3	2	1
Iris hexagona										3	5	3	4
Juniperus silicicola											4	1	2
Persea palustris										3	3	3	3
Platanthera flava												1	
Solidago sempervirens											3	1	1
Vaccinium corymbosum										1	1	2	3
Viburnum obovatum	1	1									3	1	

C. Salinity in the lower tidal reach and downstream end of upper tidal reach

Group description and species	Number of sites at which species occurred in each indicated forest type												
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)
Present in riverine and upper tidal swamps but not in lower tidal swamps:													
Amsonia rigida	4	11	8			1	1	1					
Carex joorii	1	1	8	2		2		1					
Crataegus viridis		1	3	2		1	1	2	2				
Echinodorus cordifolius				4	2			1	2				
Saccharum baldwinii	6	7	7					1					
Salix caroliniana		1		1	2				1				
Present only in lower tidal forests at sites upstream of Gopher River:													
Chasmanthium laxum										1			
Pteridium aquilinum										2			
Tragia urens										2			
Vaccinium corymbosum										1	1	2	3
Present in lower tidal forests at sites upstream of Gopher River and in other reaches:													
Aristolochia serpentaria	5	8	4			3	2			2			
Aster dumosus			2	3			2	3	2			1	1
Axonopus furcatus	6	14	13	5	1	4	3	2		3			
Carex lupulina			1	1	2		1	2	2		1	1	1
Cephalanthus occidentalis		2	2	4	2			1			2		1
Conoclinium coelestinum	4	5	4			3	5	3	2			1	1
Decumaria barbara								3	3		3	3	4
Dychoriste humistrata	2	7	5	2	2	4	5	5		2	2	2	1
Elephantopus nudatus	1	1								2			
Elytraria caroliniensis	4	3	3	2						1			
Gelsemium sempervirens	4	1					2	1	1	4			1
Gleditsia aquatica	1	2	1	4	2							1	
Hypericum galioides	3	10	12	2		6	3	2		2	2	2	2
Hypericum hypericoides	2	3				1	1			1	2	1	3
Hypoxis curtissii	7	9	6	5		3	5	5	2	3	2	2	
Hyptis alata						1				2			
Ilex glabra						2				1			1
Itea virginica				2	1	1		1	2		5		3
Lemna valdiviana			1	6	5								1
Liquidambar styraciflua	2	3	4							2			
Lobelia cardinalis				1				2		1	2	1	2
Matelea gonocarpos	4	2	2	3						2	1		
Osmunda cinnamomea						4	1			2	1	1	
Osmunda regalis			2	2	2	3	4	5	2	3	3	2	2
Panicum dichotomum	2	5		2						1			
Pilea pumila												1	1
Planera aquatica			1	3	1			2	2		1		
Proserpinaca palustris				1	1			1	2		1	4	
Rhynchospora caduca	1	1	1			2	2	2	1	1			1
Rhynchospora mixta						2	1	1	1	2			
Sabal minor	2	2	1			2	4	2	2	1	7	2	1
Sagittaria graminea							2		1			1	2
Salvinia minima			1	3	2								1
Samolus valerandi				1				2	1			2	3
Sebastiana fruticosa	8	7	3	1						1	1		
Sideroxylon reclinata	3	8	6	3		2	2			2			
Smilax bona-nox	5	9	4			2							1
Smilax pumila	8					2				4			
Teucrium canadense		2	3	3	1			1	1	1	1		
Thelypteris palustris			2		1	4	3	2	1	4	5		
Triadenum walteri			3		2	3	6	5	5	3	1	3	3
Vaccinium elliottii	6	5	2			3						2	1
Viola affinis	2	6								3			
Vitis rotundifolia	8	5	1	1		5	1			3			
Woodwardia areolata						2	1	1	1	2	1		1

Group description and species	Number of sites at which species occurred in each indicated forest type												
	Rblh3 (15)	Rblh2 (18)	Rblh1 (17)	Rsw2 (11)	Rsw1 (7)	UTblh (7)	UTmix (6)	UTsw2 (9)	UTsw1 (6)	LTham (7)	LTmix (10)	LTsw2 (11)	LTsw1 (11)
Occurred in lower tidal forests at sites downstream of Gopher River:													
Acer rubrum	3	4	6			1				2	1	1	2
Ampelopsis arborea	5	8	9	6	3	5	3	2	1	1	3	2	4
Asclepias perennis		2	3	3		1	6	7	3	2	6	5	6
Aster carolinianus											2	5	3
Berchemia scandens	1	2	3			2	1	2		1	3	1	2
Boehmeria cylindrica		6	12	8	3	2	3	4	3	3	5	6	4
Carex gigantea									1		2	3	2
Centella asiatica	4	7	3	2	2	5	3	4	3	4	8	8	4
Chasmanthium nitidum						1	2			5	8	6	5
Cicuta mexicana								1	1		4	1	1
Cladium jamaicense											2	3	6
Clematis crispa	5	10	7	3		2		1	1	3	3	3	3
Crinum americanum						2	5	6	5		4	3	3
Diodia virginiana	3	9	4	2	2	4	2	2	1	2	3	4	2
Diospyros virginiana	3	6	2	1		1	1	1			2		
Hydrodotyle verticillata		3	7	5	3	4	5	7	3	3	5	5	3
Hymenocallis duvalensis		4	2			1	3	4			3	2	1
Hymenocallis rotata							2	1	1		2	3	2
Ilex vomitoria										3	3	2	1
Iris hexagona										3	5	3	4
Juniperus silicicola											4	1	2
Justicia ovata	7	7	7	2	1	1	1	5	2	3	3	3	2
Ludwigia repens			2	2	1		1	2	5		4	6	5
Mitchella repens	11	10	2			4	2	1	2	5	5	1	2
Myrica cerifera						1	1	1	2	4	5	3	4
Oplismenus hirtellus	1		1		1					4			
Panicum commutatum	4	7	3	2	1	4	2	3	3		7	3	5
Panicum gymnocarpon		1		1		2	4	8	4	1	2	5	4
Panicum rigidulum	2	5	9	4	2	1	2	2	1	3	6	4	5
Persea palustris										3	3	3	3
Platanthera flava												1	
Polygonum punctatum		2	6	5	2		1	3	4		3	4	2
Rhynchospora corniculata					1		1	1	2		4		2
Rhynchospora miliacea			1			2	3	4	2	3	9	10	4
Rubus trivialis	3	2	2			4	1			2	1		
Rumex verticillatus								1			3	2	3
Sabal palmetto	2	2				2	3	2		5	6	7	9
Sabatia calycina	1	1	1					1			2	2	3
Saururus cernuus			1			3	3	6	2	3	7	7	6
Scleria triglomerata	2		1							2			
Senecio glabellus	1	2	6	5		1	1	4	1		3	2	2
Serenoa repens	5	3	1			3				4	1		
Smilax laurifolia							1			1	3	4	2
Smilax tamnoides	1	7	7	3	1	2	4	2	4	3	6	3	2
Solidago sempervirens											3	1	1
Taxodium distichum	1	3	2	2	1	2			2	1	2	2	3
Thelypteris kunthii								2		1	3	2	2
Toxicodendron radicans	10	9	7	5	1	6	3	2	3	2	5	6	3
Ulmus americana	1		1	2	1			1		2			
Viburnum obovatum	1	1									3	1	
Vitis cinerea	3	5	4							1	1	2	1