COASTAL PLAIN NONALLUVIAL WETLAND FORESTS

Contents

COASTAL PLAIN NONALLUVIAL WETLAND FORESTS THEME

Concept: Coastal Plain Nonalluvial Wetland Forests are communities of flat, poorly drained interfluvial areas that naturally have infrequent fire and do not have the characteristics vegetation of Wet Pine Savannas or Peatland Pocosins. They are forests dominated by *Taxodium, Nyssa, Liquidambar, Chamaecyparis*, wetlands species of *Quercus*, *Pinus taeda,* or *Liriodendron*, have little or no *Pinus serotina*, and completely lack *Pinus palustris*. They may occur on either mineral or organic soils. They are kept wet by rainfall, sheet flow, and seasonal high water tables, are not in closed basins, and never have flooding from rivers, streams, or estuaries.

Distinguishing Features: Coastal Plain Nonalluvial Wetland Forests are distinguished by natural dominance of wetland deciduous hardwoods, *Taxodium,* or *Chamaecyparis* in areas remote from estuaries, streams, and rivers, and not in closed basins.

Within the theme, Nonriverine Swamp Forests are distinguished by dominance by *Nyssa biflora* and *Taxodium distichum*, sometimes codominant with *Pinus taeda*, *Liquidambar styraciflua, Liriodendron tulipifera*, or other species. Nonriverine Wet Hardwood Forests are distinguished by the presence of wetland *Quercus* species, usually *Quercus laurifolia, michauxii*, or *pagoda*. Peatland Atlantic White Cedar Forest is dominated by *Chamaecyparis thyoides*. The unique Wet Marl Forest is distinguished by a diverse mix of calciphilic wetland species in all strata, from *Carya myristiciformis* in the canopy to *Swida (Cornus) asperifolia* in the shrub layer, and *Carex basiantha* in the herb layer.

Synonyms: Wet flat.

Sites: Nonriverine Swamp Forests occur on flat, poorly drained upland areas that are not associated with streams, generally in the outer Coastal Plain. They occur on geologically young surfaces in the areas where stream drainages have not yet developed and topographic relief is practically nonexistent. They tend to be midway between stream systems, beyond the headwaters of local tributaries. They may make up the center of such areas, or they may occupy the periphery of large domed peatlands. These surfaces may be fine-textured relict sea bottom or lagoon bottom sediments between ancient shorelines. They may be bounded by scarps. They may also occur in peat-filled drowned river valleys near estuaries. There they are on slightly domed areas, surrounded by tidally influenced swamps but beyond significant tidal influence.

Soils: Soils of Coastal Plain Nonalluvial Wetland Forests may be deep or shallow organic soils or wet fine-textured mineral soils. The wetter Nonriverine Swamp Forests are often on …., while less wet Nonriverine Wet Hardwood Forests tend to be on wet Ultisols such as Umbraquults or Ochraquults or wet Alfisols such as Umbraqualfs or Endoaqualfs. The very rare Wet Marl Forest is on a calcareous wet Alfisol.

Hydrology: Coastal Plain Nonalluvial Wetland Forest sites are kept wet by rainfall and sheetflow. The water is not confined in a closed basin but drainage is limited by lack of relief and distance to stream channels. The wetter sites have some surface water during wet seasons, while the driest may be saturated near the surface but rarely flooded. The hydrology is not as

extremely ombrotrophic as in Peatland Pocosins, but the water is oligotrophic because the flow is limited and is from other oligotrophic areas.

Vegetation: Coastal Plain Nonalluvial Wetland Forest communities all have well-developed forest canopies where not recently disturbed. The canopy is dominated by varying combinations of *Taxodium, Nyssa, Liquidambar, Chamaecyparis*, *Pinus taeda, Acer rubrum*, wetland species of *Quercus*, and occasionally *Liriodendron*. While the canopy composition often resembles that of various Coastal Plain Floodplain communities and even some mesic upland forests, the lower strata tend to share species with Peatland Pocosins and other more oligotrophic wetlands. *Persea palustris* and *Magnolia virginiana* are often the most abundant understory, though *Carpinus caroliniana* or *Ilex opaca* may also be abundant. *Ilex glabra, Lyonia lucida, Cyrilla racemiflora, Leucothoe axillaris, Clethra alnifolia,* or *Smilax laurifolia* may be dense, but *Vaccinium fuscatum, Vaccinium formosum, Eubotrys racemosa*, and *Itea virginica* may also occur. *Anchistea virginica, Lorinseria areolata*, and *Sphagnum* spp. are usually the dominant herbs, though *Saururus cernuus* and various other wetland species may be present.

Dynamics: Most Coastal Plain Nonalluvial Wetland Forests have stand dynamics typical of most forest communities in North Carolina. Their natural state is as predominantly old-growth forests, with a wide variety of tree ages in a stand, and with tree regeneration occurring over periods of years in small to medium size canopy gaps. Their location near the coast, combined with the shallow rooting of some dominant trees in wet sites, makes them more susceptible to wind throw than many hardwood forests. One member of this theme, Peatland Atlantic White Cedar Forest, has a distinctly different form of population dynamics. In it, natural regeneration is by catastrophic disturbance and stands are naturally even-aged.

Coastal Plain Nonalluvial Wetland Forests vary in the influence of fire, but they have limited flammability at most times and have less frequent natural fire than Peatland Pocosins. Peatland Atlantic White Cedar Forests depend on fire to promote regeneration of the canopy, but their dominant tree species has very little tolerance of fire. Natural fires must be infrequent enough that canopies can mature between them. Other communities probably are affected by fire even less frequently and don't tend to be catastrophically disturbed by it.

It is unclear to what extent boundaries between this theme and more flammable themes such as Peatland Pocosins are determined by fire history and to what extent fire history is driven by the flammability of the vegetation. There is a belief that Nonriverine Swamp Forest, Bay Forest, Peatland Atlantic White Cedar Forest, Pond Pine Woodland, and Peatland Canebrake differ primarily in their fire regime rather than their physical sites, and that they might naturally form a shifting mosaic upon the landscape. In this view, communities could readily turn into each other in response to fire history. It is well documented that Peatland Atlantic White Cedar Forests were once much more extensive, and lack of fire as well as logging appears to have contributed to many coming to resemble Nonriverine Swamp Forests. Frost (2000) believed that many Nonalluvial Wetland Forest areas once burned much more frequently and would have supported Peatland Canebrake. However, the long-lived dominant species in most communities and the limited ability of species such as *Arundinaria tecta* to move into new sites suggests patches of different communities may not shift very readily. Aspects of the landscape and ability of fire to spread may have led to community patterns that were stable in the long term, or that perhaps

expanded and contracted at their boundaries in response to the influence of climatic cycles on fire frequency rather than shifting randomly.

Coastal Plain Nonalluvial Wetland Forests are among the communities most threated by accelerating rise in sea level. While a few are as much as 50 feet above sea level, many examples are only a couple feet in elevation, immediately inland of tidal communities or even surrounded by them. Many of their characteristic species are extremely sensitive to salt, even at oligohaline levels. As estuarine waters penetrate farther inland, zones of Coastal Plain Nonalluvial Wetland Forests turn into Freshwater Tidal Wetlands over the space of a few years. In most places, the community is Nonriverine Swamp Forest, and this transition occurs with the canopy of *Nyssa* and *Taxodium* remaining as a relict stand while the lower strata die out and are replaced by *Morella cerifera* and the various herbs Tidal Swamp.

Comments: The name for this theme and those for many of the individual communities are somewhat unsatisfactory, but no better names have been found. Names such as Nonriverine Wet Hardwood Forest and Nonriverine Swamp Forest are based on what the ecological setting is not, rather than what it is. There seems to be no well-known specific name for the extensive wet flats and sheet flow hydrology that support them. At the same time, the names appear broader than the concepts they denote. Other Coastal Plain wetlands are also not alluvial or riverine, including Peatland Pocosins, Wet Pine Savannas, and Coastal Plain Depression Communities. The resemblance of the canopies of particular communities to those of floodplain forests has often led these communities to be called by the same names. Nevertheless, Coastal Plain Nonalluvial Wetland Forests are a distinctive group of communities and ecosystems, with its own hydrology and nutrient dynamics and with combinations of plants that are different from all other communities. Though well-developed and extensive in North Carolina, especially in the northeastern Coastal Plain, they are much less notable in nearby states.

References:

Frost, C.C., III. 2000. Studies in landscape fire ecology and presettlement vegetation of the southeastern United States. PhD. Dissertation, University of North Carolina, Chapel Hill.

KEY TO COASTAL PLAIN NONALLUVIAL WETLAND FORESTS

1. Forest dominated by *Chamaecyparis thyoides*, at least weakly (more than 50% of the canopy cover or basal area, unless recently disturbed).....**Peatland Atlantic White Cedar Forest**

1. Forest not dominated by *Chamaecyparis thyoides*, though the species may be present.

2. Very rare forest community occurring on shallow limestone substrate with calcareous soil. Forest containing calciphilic species, including *Carya myristiciformis, Swida (Cornus) asperifolia*, and *Tilia americana* var. *caroliniana*, along with other species of richer soils not found in other communities of the theme, such as *Carya cordiformis, Acer negundo,* and *Cercis canadensis*. Presently known only at Rocky Point Marl Forest..... **Wet Marl Forest**

2. Forest not containing the above species, not associated with shallow limestone.

3. Forest dominated or codominated by *Quercus* species, or forest dominated by *Liquidambar styraciflua* and containing *Quercus* species.

4. Forest dominated by *Quercus laurifolia* and *Nyssa biflora*. Less water-tolerant *Quercus* species absent or present only as a minor component in drier microsites..... .....**Nonriverine Wet Hardwood Forest (Oak–Gum Slough Subtype)**

4. Forest dominated by *Quercus michauxii, Quercus pagoda,* or other oaks of less wet sites, along with *Quercus laurifolia* and *Liquidambar styraciflua*. *Nyssa biflora* absent or scarce..... ..... **Nonriverine Wet Hardwood Forest (Oak Flat Subtype)**

3. Forest not containing *Quercus* species beyond single individuals in uncharacteristic microsites.

5. Forest containing *Liquidambar styraciflua* or *Liriodendron tulipifera*, in combination with *Nyssa biflora* or other species of wetter sites. *Liquidambar or Liriodendron* may be dominant, codominant, or present in smaller numbers.

6. Forest containing *Liriodendron tulipifera* as a significant component, or forest containing appreciable *Asimina triloba*. *Liquidambar* may be present or absent, and the forest will generally be dominated by *Nyssa biflora* and contain at least some *Taxodium distichum.* .... **Nonriverine Swamp Forest (Poplar–Pawpaw Subtype)**

6. Forest not containing *Liriodendron* or *Asimina*; dominated by combinations of *Nyssa biflora, Liquidambar styraciflua*, and other wetland species. ....**Nonriverine Swamp Forest (Sweetgum Subtype)**

5. Forest not containing *Liquidambar* or *Liriodendron*.

7. Forest containing *Pinus taeda, Pinus serotina,* or *Chamaecyparis thyoides* along with the usually dominant *Nyssa biflora* and *Acer rubrum* and minority of *Taxodium distichum*. ....**Nonriverine Swamp Forest (Mixed Subtype)**

7. Forest consisting largely of *Nyssa biflora, Nyssa aquatica*, *Acer* rubrum, and *Taxodium distichum*, without *Pinus* or *Chamaecyparis.*..... .....**Nonriverine Swamp Forest (Cypress–Gum Subtype)**

NONRIVERINE WET HARDWOOD FOREST (OAK FLAT SUBTYPE)

Concept: Nonriverine Wet Hardwood Forests are wetland forests of nonalluvial mineral soil flats not underlain by limestone, dominated by wetland oaks along with other hardwoods. The Oak Flat Subtype covers the less wet examples, containing *Quercus michauxii, Quercus pagoda*, *Liquidambar styraciflua*, and often *Quercus laurifolia*, but lacking *Nyssa biflora* and other species of wetter communities.

Distinguishing Features: Nonriverine Wet Hardwood Forests are distinguished by the dominance or substantial presence of bottomland oaks (*Quercus laurifolia, Quercus michauxii, Quercus pagoda*) in sites remote from rivers and not subject to overland flooding. The canopy composition may resemble Brownwater Bottomland Hardwoods but the dominance of the shrub layer by *Leucothoe axillaris* or *Clethra alnifolia* distinguishes the community. Nonriverine Wet Hardwood Forests are distinguished from the wetter Nonriverine Swamp Forests by the presence of *Quercus*. *Liquidambar* is usually present in Nonriverine Wet Hardwood Forest but is absent from most Nonriverine Swamp Forest (except the Sweetgum Subtype). *Taxodium* is absent from Nonriverine Wet Hardwood Forests. Disturbed examples of either may become strongly dominated by *Pinus taeda*, *Acer rubrum*, or *Liquidambar styraciflua*, and may be distinguishable only by the water tolerance of their lower strata or by remnant oak saplings or seedlings.

The Oak Flat Subtype is distinguished from the Oak—Gum Slough Subtype by a canopy containing *Quercus michauxii, Quercus pagoda*, or a mixture of oaks rather than being dominated by *Quercus laurifolia* and *Nyssa biflora*. The Oak Flat Subtype is the least wet of Coastal Plain Nonalluvial Wetland Forests. Where it grades into Mesic Mixed Hardwood Forest, which may share *Quercus michauxii* or other oaks, it may be distinguished by the absence of *Fagus grandifolia* and *Quercus alba*.

Synonyms: *Quercus michauxii - Quercus pagoda / Clethra alnifolia - Leucothoe axillaris* Forest (CEGL007449).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Sites: Nonriverine Wet Hardwood Forests occur on flat, poorly drained upland areas that are not associated with streams. They tend to be midway between stream systems, beyond the headwaters of local tributaries.

Soils: Nonriverine Wet Hardwood Forests have loamy or clay-rich soils with well-developed horizons. They may be mapped as a wide variety of Ultisols and Alfisols. Most common map units are Roanoke (Typic Ochraquult) and Cape Fear (Typic Umbraquult). Other units include Argent (Typic Endoaqualf), Brookman (Typic Umbraqualf), Pantego (Umbric Paleaquult), Portsmouth (Typic Umbraqualf), Tomotley (Typic Ochraqult), and Leaf (Typic Albaqualf). The soil often has a hummock and hollow structure, with several inches or more of local relief.

Hydrology: As with other nonalluvial wetlands, Nonriverine Wet Hardwood Forests are wetted by rainfall, season high water table, and by sheet flow from adjacent flats. The water table likely is perched, but this is not well known. Surface water a few inches deep may be present in wet

seasons, and water may persist into the growing season in local lower areas. The Oak Flat Subtype is the least wet of Coastal Plain Nonalluvial Wetland Forests.

Vegetation: Rheinhardt and Rheinhardt (2000) and Morris (2004) present quantitative data on the woody vegetation in most examples of the Oak Flat Subtype known at the time. The canopy is generally dominated by varying combinations of *Liquidambar styraciflua* and *Acer rubrum* along with *Quercus michauxii, Quercus laurifolia,* or *Quercus pagoda*. *Acer rubrum* may be abundant, even dominant, in more disturbed canopies, while oaks were probably more abundant before logging in the last century. Occasional examples observed since that study have had other species abundant, which may include *Quercus shumardii, Carya ovata, Quercus nigra, Quercus phellos, Fraxinus pennsylvanica,* or *Ulmus americana*. Trees of wetter sites, such as *Nyssa biflora* or *Taxodium distsichum* are absent or confined to wetter microsites. The understory is usually well-developed and has one or two species strongly dominant. These are most frequently *Persea palustris, Ilex opaca, Carpinus caroliniana*, and *Acer rubrum*. *Magnolia virginiana* and the various canopy species are also typical in the understory. The shrub layer may be open or dense. No species has high constancy, but *Vaccinium formosum, Vaccinium fuscatum, Ilex glabra*, *Leucothoe axillaris*, *Clethra alnifolia*, or *Asimina triloba* may dominate. Other less dominant shrubs found in quantitative studies and site reports include *Symplocos tinctoria, Arundinaria tecta, Ilex coriacea, Gaylussacia frondosa,* and *Sabal minor*. Vines are usually present and may be diverse and abundant. Species noted in site reports include *Muscadinia rotundifolia, Toxicodendron radicans, Smilax rotundifolia, Smilax walteri, Smilax laurifolia, Campsis radicans, Berchemia scandens, Gelsemium sempervirens*, and several others. The herb layer is similarly variable. In site reports, the most constant species is *Lorinseria areolata*. Also frequent are *Carex* spp., *Osmundastrum cinnamomeum, Osmunda spectabilis, Anchistea virginica, Athyrium asplenioides*, *Mitchella repens*, and *Chasmanthium laxum*. Other species include *Arisaema triphyllum, Parathelypteris noveboracensis, Hexastylis arifolia, Tipularia discolor*, and, local in wetter patches, *Saururus cernuus*. *Climacium americanum* is fairly frequent, but *Sphagnum* spp. is only occasional. Exotic plants, especially *Lonicera japonica* and *Microstegium vimineum*, are sometimes present, but tend to be extensive only in drier microsites.

Range and Abundance: Ranked G2. The Oak Flat Subtype is found almost exclusively in the outer part of the Embayed Region, in the northern part of the Coastal Plain. The greater relief of the Coastal Plain farther south does not seem suitable for it. A few examples occur in adjacent Virginia but this community is nearly endemic to North Carolina.

The Oak Flat Subtype is one of the most threatened communities in North Carolina in terms of the proportion that has been lost and the ease with which it can be lost. If Pinchot and Ashe's (1987) concept of oak flats was similar, his estimate of some 640,000 acres implies loss of catastrophic proportions, given that less than 6000 acres now remain. This community occurs on soils that are more fertile than most Coastal Plain soils and which are easily drained. Most of its acreage was likely converted to farmland early in colonial history. Additional area now is in pine plantation. Within the author's experience, a larger portion of the remnants found by the Natural Heritage Program has later been lost than for any other community.

Associations and Patterns: The Oak Flat Subtype is a large patch community. Most examples now are tens of acres. Occurrences of several thousand acres were present as recently as the 1980s,

but only one such example remains. The Oak Flat Subtype often is associated with patches of the Oak—Gum Slough Subtype, which occur in lower areas that may be incipient stream drainages. The Oak Flat Subtype may grade to Mesic Mixed Hardwood Forest (Coastal Plain Subtype) Upland Flat Variant. The two may occur as patches adjacent to each other, or they may occasionally be interspersed in a mosaic. The Oak Flat may also be associated with Nonriverine Swamp Forest. However, most examples of it are now isolated amid heavily altered vegetation.

Variation: Rheinhardt and Rheinhardt (2000) and Morris (2004) noted that examples did not seem to vary with soil texture. There is substantial variation in associated vegetation, though the small number of remaining examples makes it difficult to find patterns. Two variants are tentatively recognized for trial, based on floristic variation that suggests different soil fertility. A broad range of soil fertility is also suggested by the occurrences of several Alfisol soil map units as well as Ultisols.

1. Oligotrophic Variant represents apparently less fertile examples, where species such as *Persea palustris, Magnolia virginiana, Leucothoe axillaris, Clethra alnifolia, Ilex glabra, Ilex coriacea,* and *Anchistea virginica* tend to occur and the species of the Eutrophic Variant are absent or scarcer.

2. Eutrophic Variant represents apparently more fertile examples, where *Carpinus caroliniana, Quercus shumardii, Carya ovata, Asimina triloba, Chasmanthium laxum,* and *Onoclea sensibilis* are present and the species listed for the Oligotrophic Variant are absent or scarce.

Dynamics: Dynamics of the Oak Flat Subtype are similar to the theme in general. Hurricanes in the last several decades have caused substantial wind throw in older forests, resulting in many small to medium size canopy gaps but not wholesale stand destruction. While the oak litter would potentially burn in dry years, fire is unlikely to be intense or to have much influence in these communities. Upland oak forests are now generally believed to depend on fire for oak regeneration. However, this is less clear for the wetland oaks. Oak saplings and understory size trees are more often present in the understory of Nonriverine Wet Hardwood Forests than of other oak communities.

The Oak Flat Subtype is one of the most threatened communities in North Carolina partly because of its response to use. Even in examples that are not deliberately converted to other vegetation, repeated logging has increased the portion of *Liquidambar* and *Acer*, so that few of even the best remaining examples are actually dominated by oaks. While all examples were logged in the past, remnants that are clearcut at present regenerate as successional vegetation with virtually no oaks.

Comments: Nonriverine Wet Hardwood Forests apparently were recognized by Pinchot and Ashe (1897), under the name of oak flats. They were generally not otherwise a focus for early ecological work. Rheinhardt and Rheinhardt (2000), Andrews (2003), and Morris (2004) represent a period of greater interest more recently.

Quercus pagoda - Quercus michauxii - Quercus alba / Arundinaria gigantea ssp. *tecta - Sabal minor / Chasmanthium laxum* Forest (CEGL007849) may be an analogous community of South Carolina and Georgia.

Rare species:
Vascular plants: *Trillium pusillum* var. *virginianum*.

References:
Andrews, R.L. 2003. Comparison of bucket-wheel spoil and phosphogypsum/clay blend as substrates for nonriverine wet hardwood forest restoration. M.S. thesis, North Carolina State University.

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Pinchot, G., and W.W. Ashe. 1897. Timber trees and forests of North Carolina. N.C. Geological Survey Bulletin 6.

Rheinhardt, M.C., and R.D. Rheinhardt. 2000. Canopy and woody subcanopy composition of wet hardwood flats in eastern North Carolina and southeastern Virginia. Bulletin of the Torrey Botanical Society 127: 33-43.

NONRIVERINE WET HARDWOOD FOREST (OAK–GUM SLOUGH SUBTYPE)

Concept: Nonriverine Wet Hardwood Forests are wetland forests of nonalluvial mineral soil flats not underlain by limestone, dominated by wetland oaks along with other hardwoods. The Oak–Gum Slough Subtype covers the wetter examples, usually in swales or incipient drainage systems, dominated by *Quercus laurifolia*, often with abundant *Nyssa biflora*. This subtype is transitional to Nonriverine Swamp Forest or Coastal Plain Small Stream Swamp.

Distinguishing Features: Nonriverine Wet Hardwood Forests are distinguished by the dominance or substantial presence of bottomland oaks in sites remote from rivers and not subject to overland flooding. The Oak-Gum Slough Subtype is distinguished by the dominance of *Quercus laurifolia* and *Nyssa biflora*, usually with only minor amounts of *Quercus michauxii* or *Quercus pagoda*. It is distinguished from Coastal Plain Small Stream Swamp, which could potentially be dominated by the same trees, by not occurring in a well-developed floodplain nor along a creek channel and not being subject to overbank flooding. It may, however, go through a gradual transition to a floodplain community as one moves away from the center of the wet flat.

Synonyms: *Quercus laurifolia - Nyssa biflora / Clethra alnifolia - Leucothoe axillaris* Forest (CEGL007447).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Sites: Nonriverine Swamp Forests occur on flat, poorly drained upland areas that are not associated with streams. They tend to be midway between stream systems, beyond the headwaters of local tributaries. The Oak–Gum Slough Subtype often occurs in elongate, slightly lower areas where more water collects than in the adjacent nonriverine wetlands. These may or may not drain from one end or feed into a gradually more developed stream channel and floodplain that carries water away from the nonriverine flat.

Soils: Nonriverine Wet Hardwood Forests have loamy or clay-rich soils with well-developed horizons. The Oak–Gum Slough Subtype generally is not distinguished from the Oak Flat Subtype in soil mapping. They may be mapped as a wide variety of Ultisols and Alfisols. Most common map units are Roanoke (Typic Ochraquult) and Cape Fear (Typic Umbraquult). Other units include Argent (Typic Endoaqualf), Brookman (Typic Umbraqualf), Pantego (Umbric Paleaquult), Portsmouth (Typic Umbraqualf), Tomotley (Typic Ochraqult), and Leaf (Typic Albaqualf). The soil often has a hummock and hollow structure, with several inches or more of local relief.

Hydrology: As with other nonalluvial wetlands, Nonriverine Wet Hardwood Forests are wetted by rainfall, seasonal high water table, and by sheet flow from adjacent flats. Surface water several inches deep may be present in wet seasons, and water may persist into the growing season in much of the community. The Oak–Gum Slough Subtype is wetter than the Oak Flat Subtype, often collecting water from it but is less wet than Nonriverine Swamp Forests.

Vegetation: The Oak–Gum Slough Subtype is a forest dominated by *Quercus laurifolia* and *Nyssa biflora*. *Acer rubrum* may be abundant. Other trees, present in smaller numbers, may include *Liquidambar styraciflua, Quercus nigra, Quercus phellos, Quercus michauxii,* and occasionally

Fraxinus pennsylvanica, Populus heterophylla, or *Taxodium distichum*. The understory often consists of *Acer rubrum* or *Carpinus caroliniana*; it may include *Magnolia virginiana* or other species. The shrub layer generally is low in density. Species in known examples include *Vaccinium formosum, Arundinaria tecta*, and *Cyrilla racemiflora*. *Smilax rotundifolia* or other vines may be present. Herbs are sparse to moderate, with no species having very high constancy. Species noted in site reports include *Saururus cernuus, Carex* spp., *Lorinseria areolata, Osmunda spectabilis, Persicaria* sp., *Limnobium spongia*, and *Sphagnum* sp.

Range and Abundance: Ranked G2G3. The Oak–Gum Slough is often not recognizable in earlier site reports, where it may be overlooked or lumped with the Oak Flat Subtype. Fewer examples are documented in North Carolina, but additional ones are likely to be discovered. Their greater wetness may have led some to be left where adjacent communities were destroyed. Most are in the Embayed Region in the northern Coastal Plain. The synonymized NVC association is defined as more wide-ranging than that of the Oak Flat Subtype, extending from Virginia to Georgia.

Associations and Patterns: The Oak–Gum Slough Subtype appears to be a small patch community, though this is not certain. Most of the few examples are tens of acres or less. They tend to occur with the Oak Flat Subtype but tend to be much less extensive.

Variation: Little is known of the variation in this subtype. This subtype appears to be narrowly defined, with little variation, but this may be because few examples have been described.

Dynamics: Little is specifically known about the dynamics of this subtype. It presumably is similar to the Oak Flat Subtype, but it may receive slightly more nutrient input from local collection of water. Because of the greater wetness, *Liquidambar* is less likely to take over after logging, though *Acer rubrum* may still dominate successional stands.

Comments: *Quercus phellos - Nyssa biflora / Panicum hemitomon - Carex* spp. - *Woodwardia virginica* Forest (CEGL004104) is an association defined in South Carolina. It have an unclear relationship to the Oak–Gum Slough community, but it appears to be more like a pond. It may be more closely related to Coastal Plain Depression Swamp.

Rare species: No rare species are known to be associated with this community.

References:

WET MARL FOREST

Concept: Wet Marl Forest is a perched wetland forest of nonalluvial flats shallowly underlain by limestone. It is dominated by calciphilic and rich-site wetland hardwood forest species, particularly *Carya myristiciformis*. The only example known to remain is at Rocky Point Marl Forest.

Distinguishing Features: Wet Marl Forests may be distinguished from Nonriverine Wet Hardwood Forests by the limestone-derived, calcareous soils and the strong presence of calciphilic plant species such as *Carya myristiciformis, Tilia americana var. caroliniana*, and *Cornus asperifolia*, along with an abundance of other species of rich sites such as *Carya cordiformis, Quercus shumardii, Acer floridanum, Acer negundo, Cercis canadensis*, and *Sabal minor*. Wet Marl Forests are distinguished from Coastal Plain Marl Outcrop and Basic Mesic Forest by their occurrence on poorly drained flats and by the abundance of wetland species.

Synonyms: *Carya cordiformis - Quercus pagoda - Quercus shumardii - Carya myristiciformis / Sabal minor - Cornus asperifolia* Forest (CEGL007316).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Sites: Wet Marl Forest occurs on poorly drained upland flats remote from streams. Limestone (locally called "marl") is near the surface. Small limestone outcrops or float may be present, but the site is not very rocky.

Soils: The only known example of Wet Marl Forest is mapped as Meggett soil (Typic Albaqualf). The soil is relatively high in pH, base saturation, and calcium levels compared to most Coastal Plain soils.

Hydrology: Wet Marl Forest appears to be a perched wetland, wetted by rainfall and sheet flow and kept wet by limited infiltration and runoff in the flat topography. The soil surface has distinct hummock and hollow topography, with fine-scale variation in the depth and duration of standing water.

Vegetation: Wet Marl Forest is a diverse forest with a mix of species including many requiring higher pH, higher base saturation soil conditions. Abundant in the canopy and constant in CVS plots are *Carya myristiciformis, Liquidambar styraciflua, Quercus michauxii, Quercus laurifolia, Quercus shumardii, Carya ovata, Fraxinus americana*, and *Liriodendron tulipifera*. Moderately frequent additional species include *Fraxinus pennsylvanica, Carya cordiformis, Ulmus americana*, *Ulmus rubra,* and *Quercus pagoda*. The understory is dominated by *Carpinus caroliniana, Asimina triloba, Acer floridanum*, and *Acer rubrum*. Additional constant or frequent species include *Ilex opaca, Acer negundo, Cornus florida, Persea palustris*, *Tilia americana* var. *caroliniana, Morus rubra*, *Magnolia virginiana*, and *Crataegus macrosperma*. The shrub layer is moderate to dense. Over much of the community, *Sabal minor* is dominant. *Swida (Cornus) asperifolia* is also highly constant and often codominant. Other constant to frequent shrubs are *Aesculus pavia, Viburnum prunifolium, Euonymus americanus, Sambucus canadensis*, *Callicarpa americana*, and the exotic *Ligustrum sinense*. Woody vines are extremely diverse. Highly constant species in plots are *Berchemia scandens, Muscadinia rotundifolia, Toxicodendron radicans,*

Parthenocissus quinquefolia, Smilax bona-nox, Smilax rotundifolia, Campsis radicans, Nekemias arborea, Vitis cinerea var. *baileyana, Hydrangea (Decumaria) barbara*, *Lonicera sempervirens*, and the exotic *Lonicera japonica*. Herbs are similarly diverse where *Sabal* is not too dense. *Carex basiantha* is constant and sometimes dominant. *Podophyllum peltatum, Arisaema triphyllum, Dichanthelium commutatum, Endodeca serpentaria, Sanicula canadensis, Mitchella repens, Solidago caesia, Polystichum acrostichoides, Sanicula odorata, Carex corrugate, Mikania scandens*, and *Saururus cernuus* are also highly constant in plots. Other frequent species include *Athyrium asplenioides, Boehmeria cylindrica, Cryptotaenia canadensis, Galium uniflorum, Glyceria striata, Juncus coriaceus, Solidago rugosa, Onoclea sensibilis, Ruellia strepens, Viola sororia, Asplenium platyneuron, Carex gholsonii, Chasmanthium laxum, Dichanthelium boscii, Festuca subverticillata, Galium circaezans, Geum canadense, Geum virginianum, Hexastylis arifolia, Hydrocotyle umbellata, Oplismenus setarius, Packer glabella, Persicaria setacea, Persicaria virginiana, Poa autumnalis, Sabatia calycina*, and *Passiflora lutea*.

Range and Abundance: Ranked G1. This community is only definitively known from a single site. There is some possibility that similar communities exist in South Carolina or Georgia, where limestone occurs near the surface in wet flats. It is unclear if the calcareous communities in those states should be considered the same community.

Associations and Patterns: Wet Marl Forest is a small patch community, though it once occurred as a large patch community. The natural surroundings of the one known example have been lost. It may have graded to a non-calcareous Nonriverine Swamp Forest or to better drained upland forests.

Variation: The single example know is highly diverse and heterogeneous on a fine scale, suggesting a broad range of wetness, but a number of CVS plots in it have a large number of highly constant species. The range of apparent wetness probably results from the microtopography, but it is possible plants are displaying different moisture tolerances because of the calcareous conditions.

Dynamics: Dynamics of this community are poorly known. They probably are similar to Nonriverine Wet Hardwood Forest, occurring as old-growth forest with tree regeneration occurring in small to medium size gaps. Fire likely is of limited importance.

Comments:

Rare species:
Vascular plants: *Asclepias purpurascens, Carex basiantha, Carex cherokeensis, Carya myristiciformis, Lythrum lanceolatum, Oplismenus setarius, Ponthieva racemosa, Ruellia strepens, Scirpus lineatus, Swida asperifolia*.
Vertebrate animals: *Crotalus adamanteus, Neotoma floridana floridana*.
Invertebrate animals: *Catocala myristica, Melanoplus nossi*.

References:

NONRIVERINE SWAMP FOREST (CYPRESS–GUM SUBTYPE)

Concept: Nonriverine Swamp Forests are the wettest Coastal Plain Nonalluvial Wetland Forests. They are saturated to shallowly flooded wetlands not associated with rivers or basins, with canopies dominated or codominated by combinations of *Nyssa, Taxodium,* and *Acer rubrum*. The Cypress–Gum Subtype covers the wettest examples, with canopies of *Taxodium distichum, Nyssa biflora*, *Nyssa aquatica,* and *Fraxinus* spp. and few or no trees other than *Acer rubrum* present. Ground water input as well as poor drainage may be responsible for the wetness of this subtype, and minerals in ground water may give it some of its distinctive character. This subtype is more like riverine swamps in flora and vegetation structure than are the other subtypes.

Distinguishing Features: Nonriverine Swamp Forests are distinguished from Cypress–Gum Swamps and Tidal Swamps by occurring on wet flats away from the influence of rivers. They are distinguished from Coastal Plain Depression Swamps by not occurring in distinct closed basins. A few may be in very shallow basins, generally too subtle to be obvious.

The Cypress–Gum Subtype is distinguished from other Nonriverine Swamp Forests by strong dominance by *Taxodium distichum* or *Nyssa* spp. In known examples this is associated with composition more similar to river swamps and a smaller component of pocosin shrubs than in other subtypes.

Synonyms: *Taxodium distichum - Nyssa biflora / Berchemia scandens - Toxicodendron radicans / Woodwardia areolata* Forest (CEGL004429).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Sites: Nonriverine Swamp Forests occur on flat, poorly drained upland areas that are not associated with streams. They occur on geologically young surfaces in the areas where stream drainages have not yet developed and topographic relief is practically nonexistent. Some of the Cypress–Gum Subtype occur near scarps that represent ancient shorelines, with the swamp on what would have been the floor of the ocean or sound.

Soils: Most examples of the Cypress–Gum Subtype occur on organic soils such as Pungo or Dare (Typic Haplosaprist) or Ponzer, Belhaven, or Croatan (Terric Haplosaprist). A few occur on wet mineral soils such as Pantego (Umbric Paleaquult), Tomotley (Typic Ochraquult), or Leaf (Typic Albaquult. As in many other nonriverine wetlands, the soil surface often has a hummock and hollow structure, with several inches or more of local relief.

Hydrology: Nonriverine Swamp Forests are seasonally flooded, with shallow standing water over much or all of the area well into the growing season. They are wet primarily because of poor drainage in the flat terrain with no streams. Water comes primarily from rainfall or sheetflow, but some examples occur near scarps and may receive some groundwater.

Vegetation: The Cypress–Gum Subtype is usually dominated by *Nyssa biflora*, sometimes with codominant *Acer rubrum* var. *trilobum* and with varying amounts of *Taxodium distichum*. It is likely that *Acer* is increased and *Taxodium* decreased in proportion to the impact of past logging.

A few examples have *Nyssa aquatica* present, rarely abundant. Other tree species may be present in small numbers, including *Populus heterophylla, Fraxinus profunda, Quercus laurifolia, Ulmus americana*, and *Liquidambar styraciflua*. The understory may be dominated by *Ilex opaca, Persea palustris*, or *Acer rubrum* in different places. *Magnolia virginiana* is also frequent. The shrub layer is generally open. No species has high constancy, but species with moderate frequency in site reports and the limited CVS plots include *Clethra alnifolia, Vaccinium fuscatum, Vaccinium formosum, Itea virginica, Eubotrys racemose, Lyonia lucida, Cyrilla racemiflora*, and *Arundinaria tecta*. Less frequent species may include *Morella caroliniana, Viburnum nudum, Viburnum dentatum, Ilex laevigata*, and *Symplocos tinctoria*. Woody vines are usually abundant and diverse. *Muscadinia rotundifolia, Smilax rotundifolia*, and *Toxicodendron radicans* are the most frequent, but *Smilax laurifolia, Parthenocissus quinquefolia, Hydrangea (Decumaria) barbara, Bignonia capreolata, Berchemia scandens*, *Campsis radicans*, and *Gelsemium sempervirens* also occur. The herb layer may be sparse or fairly dense. The only species with fairly high frequency are *Lorinseria areolate* and *Carex* collectively. Other herbs that occur in some examples include *Anchistea virginica, Saururus cernuus, Dulichium arundinaceum, Omunda spectabilis, Mitchella repens, Osmundastrum cinnamomeum, Persicaria* sp., *Thelypteris palustris, Impatiens capensis, Athyrium asplenioides, Hypericum walteri, Iris virginica, Dryopteris celsa*, and *Sphagnum* sp.

Range and Abundance: Ranked G2G3 but probably G2. In North Carolina, fewer than ten examples are known, all in the outer parts of the Coastal Plain. Most are in the Embayed Region in the northern part of the state. This community is also known from adjacent Virginia but is nearly endemic to North Carolina.

Associations and Patterns: The Cypress–Gum Subtype is a large patch community. It may grade to Nonriverine Wet Hardwood Forest, Peatland Atlantic White Cedar Forest, Pond Pine Woodland, or rarely to Tidal Swamp. It may be bordered by upland communities where a scarp occurs adjacent to it or where upland ridges protrude from the peat.

Variation: Known examples of the Cypress–Gum Subtype are quite variable, but the patterns remain to be sorted out. The appears to be a gradient of apparent nutrient richness and species composition, from those more like river swamps to more pocosin-like examples. This is reflected by the presence of *Nyssa aquatica, Fraxinus profunda, Itea virginica*, and *Viburnum* spp. in some, *Gordonia lasianthus, Lyonia lucida, Anchistea virginica*, and *Sphagnum* sp. in some. The variation in the amount of *Taxodium* and *Acer* in the canopy probably reflects influence of past logging, but the natural range of variation in these species is not well known.

Dynamics: Dynamics of the Cypress–Gum Subtype are similar to those of most Coastal Plain Nonalluvial Wetland Forests in general. However, the resistance of *Taxodium* and *Nyssa* to windthrow presumably lead to fewer and smaller gaps and longer-lived trees. As in other swamps, *Taxodium* may have failed to regenerate well after logging and may be reduced in the long term in many if not all examples.

The environmental factors that lead to the formation of the Cypress–Gum Subtype rather than other subtypes are not well known. They seem to be more fertile than the Mixed Subtype and presumably are more wet than the Poplar–Pawpaw Subtype or Sweetgum Subtype. Some examples

occur where groundwater input is possible, and this may increase fertility, but not all appear to have this influence.

There is some question of the relationship of Nonriverine Swamp Forest, both the Cypress–Gum Subtype and the Mixed Subtype, with other communities of peatlands. Heavily logged examples come to be dominated by *Nyssa biflora* and *Acer rubrum*, while logged Peatland Atlantic White Cedar Forests generally become dominated by the same species. The earlier vegetation in these areas can be difficult to tell. It is sometimes suggested that the past occurrences of these communities was related to fire frequency. Frost (2000) believed that Nonriverine Swamp Forests occurred naturally where fire was very infrequent, and that many areas that now appear to be this community were once frequently Peatland Canebrakes or Peatland Atlantic White Cedar Forests. This may be true in some areas, though the longevity of trees and the spread of *Taxodium* makes this seem unlikely in the most mature examples. It seems more possible in younger examples of more successional composition.

Comments: The Cypress–Gum Subtype has had limited study. The Great Dismal Swamp attracted some study around the time of the establishment of the National Wildlife Refuge (e.g., Kirk 1979; Carter and Gammon 1976). The Virginia Natural Heritage Program has collected a number of plots in the Great Dismal Swamp near the state line, but only a couple of CVS plots in North Carolina appear to represent this community.

Rare species: No rare species are known to be associated with this subtype.

References:

Carter, V. and P. Gammon. 1976. Great Dismal Swamp vegetative cover map. U.S. Geological Survey Open File Map 76-615.

Frost, C.C., III. 2000. Studies in landscape fire ecology and presettlement vegetation of the southeastern United States. PhD. Dissertation, University of North Carolina, Chapel Hill.

Kirk, P.W., Jr. 1979. (ed.): The Great Dismal Swamp. Old Dominion University Research Foundation, Inc.

NONRIVERINE SWAMP FOREST (MIXED SUBTYPE)

Concept: Nonriverine Swamp Forests are the wettest Coastal Plain Nonalluvial Wetland Forests. They are saturated to shallowly flooded wetlands not associated with rivers or basins, with canopies dominated or codominated by combinations of *Nyssa, Taxodium,* and *Acer rubrum*. The Mixed Subtype covers examples on moderate-to-deep organic soils, dominated by a mixture of hardwoods and conifers that includes *Pinus taeda, Chamaecyparis thyoides*, or *Pinus serotina*, as well as the typical dominants.

Distinguishing Features: Nonriverine Swamp Forests are distinguished from Cypress-Gum Swamps and Tidal Swamps by occurring on wet flats away from the influence of rivers. They are distinguished from Coastal Plain Depression Swamps by not occurring in distinct closed basins. A few may be in very shallow basins, generally too subtle to be obvious.

The Mixed Subtype is distinguished from other subtypes by having *Pinus taeda* or *Chamaecyparis thyoides* as substantial components, in addition to *Nyssa, Taxodium*, and *Acer*. This subtype often resembles Pond Pine Woodland and Peatland Atlantic White Cedar Forest in the lower strata, differing mainly in the canopy. Peatland Atlantic White Cedar Forests that have been logged and have not regenerated well may be indistinguishable from similarly logged examples of the Mixed Subtype.

Synonyms: *Pinus taeda - Chamaecyparis thyoides - Acer rubrum - Nyssa biflora / Lyonia lucida - Clethra alnifolia* Forest (CEGL007558).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Sites: Nonriverine Swamp Forests occur on flat, poorly drained upland areas that are not associated with streams. The Mixed Subtype occurs primarily on extensive flat peatlands or on small, elevated patches in peat-filled drowned river valleys. The elevated patches are generally oval in shape and stand above the tidal influence that surrounds them. They may be domed peatlands in miniature. A few examples are in Carolina bays or other inland peat-filled swales. Most examples are only a few feet above sea level.

Soils: The Mixed Subtype occurs primarily on organic soils, most often mapped as Dorovan or Pungo (Typic Haplosaprist) but sometimes as Ponzer, Belhaven, or Scuppernong (Terric Haplosaprists). A minority are mapped as mucky or wet mineral soils such as Roper (Histic Humaquept), Hyde (Typic Umbraquult), or several others. Several authors have suggested that the peat supporting Nonriverine Swamp Forests has a higher mineral content and may have received occasional input from nearby estuarine waters in the past.

Hydrology: As with other Nonriverine Swamp Forests, the Mixed Subtype is nearly permanently saturated and may be shallowly flooded seasonally by rainfall and local sheet flow. Sites are wet primarily because of poor drainage in the flat terrain with no streams. Most lie near sea level but they are beyond the influence of tidal waters, if only by a few inches of elevation and a few feet of distance.

Vegetation: The Mixed Subtype is universally dominated or codominated by *Nyssa biflora* and *Acer rubrum* with a significant minority or codominance of *Pinus taeda, Chamaecyparis thyoides, Taxodium distichum*, or, less often, *Pinus serotina*. *Magnolia virginiana* sometimes is in the canopy. The understory usually is dominated by *Persea palustris* or *Acer rubrum*, and it may include *Magnolia virginiana* or various of the canopy species. The shrub layer is fairly dense. In site reports, *Lyonia lucida* is the most constant and most often dominant species, closely followed by *Ilex glabra*. Moderately frequent species include *Vaccinium formosum, Ilex coriacea, Clethra alnifolia*, and *Morella caroliniensis*. Other shrub species sometimes include *Viburnum nudum, Leucothoe axillaris, Cyrilla racemiflora, Arundinaria tecta*, and *Morella cerifera*, and several other species occur occasionally. *Smilax laurifolia* occurs with high constancy, and *Smilax walteri, Gelsemium sempervirens*, and *Toxicodendron radicans* occur occasionally. Herbs generally have limited cover. *Lorinseria areolata*, *Anchistea virginica*, *Saururus cernuus*, and *Sphagnum* sp. are the only species with even moderate constancy.

Range and Abundance: Ranked G2G3 but probably G3. This is the most extensive and numerous subtype in North Carolina, with more than 35 examples, a couple over 15,000 acres. The Mixed Subtype occurs in adjacent Virginia but is nearly endemic to North Carolina.

Associations and Patterns: The Mixed Subtype may be thought of as a large patch community or as a matrix community that forms a common part of a couple of very specific kinds of landscapes in the outer Coastal Plain. It often grades to Tidal Swamp in drowned river valleys and on the edges of large peatlands near estuaries. In large peatlands and in the few Carolina bays where it occurs, it is often associated with Peatland Atlantic White Cedar Forest, Pond Pine Woodland, or Bay Forest. It may also be associated with Nonriverine Wet Hardwood Forest on the edges of peatlands.

Variation: Examples are quite variable in the relative proportions of canopy species. Much of the visible variation may be caused by different effects of logging history, as *Chamaecyparis, Taxodium*, and *Pinus taeda* are all highly valued species that have unpredictable ability to regenerate after logging.

Dynamics: Dynamics of the Mixed Subtype are not well known but may be intermediate between those of the Cypress–Gum Subtype and of Peatland Atlantic White Cedar Forest. The forests likely existed naturally as uneven-aged stands with tree regeneration primarily in small to medium size gaps. However, gaps created by hurricanes and gaps or understory/shrub layer control by fires may have been important. The canopies of the Mixed Subtype contain a mix of species that normally demonstrate very different stand dynamics, with short-lived, catastrophically regenerated *Chamaecyparis thyoides* on one extreme and long-lived, rarely regenerated *Taxodium distichum* on the other. The very shade-tolerant *Acer rubrum* and shade-intolerant *Pinus taeda* present a slightly different axis of contrast. The present species mix probably is partly a result of logging history and of fire exclusion. *Taxodium* and *Chamaecyparis* often fail to regenerate after logging, and they likely were more abundant in past stands. *Acer rubrum* and, by default, *Nyssa biflora*, often increase with logging and fire exclusion and likely were less abundant in the past. An alternative view advanced by Cecil Frost and others for some occurrences is that they were once Peatland Atlantic White Cedar Forests and that the current composition is a result of succession in the absence of regenerating fire with or without logging. This may be reasonable for relatively

young examples that are predominantly *Acer* and *Nyssa*, but it seems less likely where *Taxodium* is present and likely was once more abundant.

The Mixed Subtype, by virtue of having most of its occurrences and acreage near sea level, is the Coastal Plain Nonalluvial Wetland Forest community most threatened by rising sea level. The dynamic of gradual conversion to Tidal Swamp, described for the theme, most often plays out in it, leaving perhaps thousands of acres in transition. In many places, around the shorelines of drowned rivers and other estuaries, this process is one that has been occurring for many centuries and may be regarded as natural. However, the process is accelerated and exacerbated in an avoidable way by the existence of sea level ditches, which bring oligohaline tidal waters well inland of where they would penetrate overland.

Much of this subtype occurs on deep organic soils that appear similar to those of pocosins. What causes the difference in community is not entirely clear. Intermittent mineral input by wind tides and differences in fire regime have both been suggested. This subtype often occurs with embedded patches of Peatland Atlantic White Cedar Forest, sometimes also Bay Forest and Pond Pine Woodland. It is possible that these communities exist as a long-term shifting mosaic with current condition determined by fire history. However, the longevity of the trees and the limited conditions suitable for seedling establishment of some suggest that any shifting is infrequent or slow.

Comments: Heavily logged examples may regenerate as the successional *Acer rubrum* var. *trilobum* - *(Nyssa biflora) / Clethra alnifolia - (Persea palustris)* Forest (CEGL007445) or as a secondary bay forest (*Magnolia virginiana - Persea palustris / Lyonia lucida* Forest (CEGL007049)).

Study of the Mixed Subtype has been surprising limited, given its extent and its importance on conservation lands. CVS plots are either scarce or are not appropriately classified. Published literature is near nonexistent. However, numerous descriptions exist in Natural Heritage Program site reports and other unpublished material.

Rare species:
Vascular Plants: *Carex canescens* ssp. *disjuncta* and *Peltandra sagittifolia.*
Vertebrate animals: *Canis rufus, Dendroica virens waynei, Haliaeetus leucocephalus,* and *Picoides borealis.*
Invertebrate animals: *Hypagyrtis brendae, Iridopsis cypressaria, Metarranthis lateritaria,* and *Orgyia detrita*.

References:

NONRIVERINE SWAMP FOREST (POPLAR–PAWPAW SUBTYPE)

Concept: Nonriverine Swamp Forests are the wettest Coastal Plain Nonalluvial Wetland Forests. They are saturated to shallowly flooded wetlands not associated with rivers or basins, with canopies dominated or codominated by combinations of *Nyssa, Taxodium,* and *Acer rubrum*. The Poplar–Pawpaw Subtype covers examples on shallow organic or mucky mineral soil, with vegetation that contains substantial amounts of *Liriodendron tulipifera* in the canopy and/or *Asimina triloba* in the understory. These species are generally not dominant, but their presence indicates a somewhat richer and less wet site.

Distinguishing Features: Nonriverine Swamp Forests are distinguished from Cypress-Gum Swamps and Tidal Swamps by occurring on wet flats away from the influence of rivers. They are distinguished from Coastal Plain Depression Swamps by not occurring in distinct closed basins. The Poplar–Pawpaw Subtype is distinguished from all other subtypes by having *Liriodendron tulipifera* and *Asimina triloba* as significant components of their strata.

Synonyms: *Nyssa biflora - Acer rubrum var. trilobum - Liriodendron tulipifera / Magnolia virginiana - Asimina triloba / Clethra alnifolia* Forest (CEGL004428).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Sites: The Poplar–Pawpaw Subtype occurs on large poorly drained upland flats, with or without organic deposits,

Soils: No consistent pattern can be found in the soils of the Poplar–Pawpaw Subtype. The four known examples are mapped with six different soil series, with Belhaven (Terric Haplosaprist) the only one found in more than one example. Other mapped soils include true organic soils (Dorovan – Typic Haplosaprist), organic-rich mineral soils (Pettigrew – Histic Humaquept, Murville – Typic Haplaquod), and less organic-rich mineral soils (Portsmouth and Cape Fear – Typic Umbraquults). Soils are usually strongly hummocky.

Hydrology: As with other Nonriverine Swamp Forests, the Mixed Subtype is nearly permanently saturated and may be shallowly flooded seasonally by rainfall and local sheet flow. Sites are wet primarily because of poor drainage in the flat terrain with no streams.

Vegetation: The Poplar–Pawpaw Subtype is dominated by a mix of trees with *Liriodendron tulipifera, Nyssa biflora,* and *Acer rubrum* constantly present. *Liquidambar styraciflua, Magnolia virginiana, Chamaecyparis thyoides, Taxodium distichum*, and other species occur in small numbers with low constancy. The understory is dominated by a varying mixture of *Asimina triloba, Persea palustris*, and sometimes *Ilex opaca*. The shrub layer is moderate to dense. *Clethra alnifolia* is more often dominant, but *Arundinaria tecta* may dominate. Other shrub species include *Eubotrys racemosa, Itea virginica*, and *Rhododendron* spp. Vines are sometimes prominent, including *Parthenocissus quinquefolia, Muscadinia rotundifolia, Toxicodendron radicans, Gelsemium sempervirens, Bignonia capreolata, Hydrangea (Decumaria) barbara, Berchemia scandens,* and several species of *Smilax*. Herbs are generally sparse, with no species having high constancy. *Lorinseria areolata, Boehmeria cylindrica, Osmunda spectabilis, Dryopteris*

carthusiana, Dryopteris ludoviciana, and *Asplenium platyneuron* are among the species noted in one or two sites. *Pleopeltis michauxiana* is prominent as an epiphyte in one site.

Range and Abundance: Ranked G2 but probably G1. The association is known definitively only in North Carolina but is questionably attributed to Virginia. It is extremely rare in North Carolina, with only four examples known.

Associations and Patterns: The Poplar–Pawpaw Subtype is a large patch community, occurring in areas over 1000 acres. Most of the few examples are partly or fully isolated amid altered vegetation, making it difficult to tell their natural associations. They are sometimes associated with other subtypes of Nonriverine Swamp Forest, including the Sweetgum Subtype and Cypress–Gum Subtype, and may once have been associated with Nonriverine Wet Hardwoods.

Variation: Little is known about the natural variation within this subtype.

Dynamics: Little is known about the natural dynamics of this subtype. The abundance of *Liriodendron tulipifera*, a species that is shade-intolerant and less resistant to uprooting than *Nyssa* or *Taxodium*, may suggest a greater role for wind disturbance than in the other subtypes. Fire is unlikely to be an important influence. Most examples are at slightly higher elevation than some of the other subtypes, so rising sea level is unlikely to be a short-term concern.

Comments: The Poplar–Pawpaw Subtype is the least well studied and most poorly understood of the Nonriverine Swamp Forests. Only a single CVS plot appears to represent it, and there are only a few thorough site descriptions.

A question has been raised as to whether the distinctive vegetation of this subtype is of natural origin or if it may be an artifact of artificial drainage and logging history. Arguments for this view include that known sites are bordered or surrounded by large ditches or drained agricultural land, that the community contains species typically associated with different moisture levels, and that older trees often appear to be standing on "stilt roots," suggesting organic substrate has subsided or oxidized beneath them. However, examples of other Nonriverine Swamp Forests with similar altered hydrology and logging history remain recognizable as other subtypes or develop successional vegetation that does not resemble the Poplar–Pawpaw Subtype. While *Liriodendron tulipifera* is generally associated with mesic sites and *Nyssa biflora* with very wet sites, *Liriodendron* can tolerate saturated soil; the two sometimes occur together in other communities, including Sandhill Streamhead Swamp and Coastal Plain Small Stream Swamp. The "stilt root" phenomenon can result not only from subsidence of organic substrate beneath established trees, but also by establishment of tree seedlings on fallen logs which subsequently decay. The author has observed that sites with older trees on "stilt roots" also contain older trees rooted at the current ground surface level. Thus, while much remains unknown about the Poplar–Pawpaw Subtype, it appears appropriate to accept it as a natural community, probably developed on richer soils than those typical of the other subtypes.

Rare species:
Vertebrate animals: *Dendroica virens waynei.*

References:

NONRIVERINE SWAMP FOREST (SWEETGUM SUBTYPE)

Concept: Nonriverine Swamp Forests are nonalluvial wetlands of poorly drained flats, dominated or codominated by combinations of *Nyssa, Taxodium,* and *Acer rubrum*. The Sweetgum Subtype encompasses examples on mineral soil, with *Liquidambar styraciflua* codominant or in significant amounts, and lacking the distinctive characteristics of the Poplar–Pawpaw Subtype.

Distinguishing Features: Nonriverine Swamp Forests are distinguished from Cypress–Gum Swamps and Tidal Swamps by occurring on wet flats away from the influence of rivers. They are distinguished from Coastal Plain Depression Swamps by not occurring in distinct closed basins.

The Sweetgum Subtype is distinguished from other subtypes by the presence of *Liquidambar styraciflua* in either the canopy or understory, reflecting lower organic content in the soil. *Liquidambar* serves as an indicator; it may not dominate but is generally abundant. Nonriverine Wet Hardwood Forests may also contain abundant *Liquidambar*, but also contain oaks in more than minor numbers and have little or no *Nyssa biflora*.

Synonyms: *Nyssa biflora - Liquidambar styraciflua - Acer rubrum var. trilobum / Clethra alnifolia* Forest (CEGL004679).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Sites: The Sweetgum Subtype occurs on poorly drained flats, remote from streams.

Soils: The Sweetgum Subtype is believed to be associated with fine-textured mineral soils, in contrast to the organic or organic-rich soils of the other common subtypes of Nonriverine Swamp Forest. Series such as Cape Fear and Hyde (Typic Umbraquults) and Leaf (Typic Albaquult) are characteristic. However, this character is not always apparent in soil mapping. A number of examples are mapped as Belhaven (Terric Haplosaprist) or Dorovan (Typic Haplosaprist). The community may be on inclusions within these map units.

Hydrology: As with other Nonriverine Swamp Forests, the Sweetgum Subtype is nearly permanently saturated and may be shallowly flooded seasonally by rainfall and local sheet flow. Sites are wet primarily because of poor drainage in the flat terrain with no streams.

Vegetation: The Sweetgum Subtype is generally dominated by *Nyssa biflora*, *Acer rubrum,* and *Liquidambar styraciflua*, with all species occurring with near 100% constancy in both CVS plots and site descriptions. *Taxodium distichum, Pinus taeda*, or *Pinus serotina* may occur in small numbers and with low to moderate frequency. Occasional *Quercus laurifolia* and *Quercus nigra* may occur. The understory is usually dominated by *Persea palustris*, along with *Acer rubrum*, and *Ilex opaca* or *Magnolia virginiana* are fairly frequent. The shrub layer generally is dense, with *Clethra alnifolia, Lyonia lucida, Ilex glabra*, or *Arundinaria tecta* dominant. Other shrubs that occur with at least moderate frequency include *Vaccinium formosum, Vaccinium fuscatum,* and *Eubotrys racemosa. Cyrilla racemiflora, Viburnum nudum, Morella caroliniensis, Aronia arbutifolia Aronia arbutifolia*, and *Symplocos tinctoria* may occasionally be present. Several species of vines are frequent, including *Parthenocissus quinquefolia, Toxicodendron radicans,*

Smilax laurifolia, Smilax laurifolia, Smilax rotundifolia, Smilax walteri, Smilax glauca, Berchemia scandens, Gelsemium sempervirens, and *Hydrangea (Decumaria) barbara*. Herbs are low in density, and no species occur with high frequency. *Lorinseria areolata* is the most frequent species in both plot data and site descriptions. Other species include *Anchistea virginica, Onoclea sensibilis, Saururus cernuus, Osmundastrum cinnamomeum, Osmunda spectabilis, Hypericum walteri*, *Lobelia inflata*, and several species of *Carex*.

Range and Abundance: Ranked G2? This subtype occurs primarily in the northeastern Coastal Plain in the state, but a few examples are farther inland. The association appears to be endemic to North Carolina, though it might be found in adjacent Virginia. It is quite rare; fewer than 15 occurrences are known in North Carolina, though some are large. It is unclear how extensive it was before widespread land clearing.

Associations and Patterns: The Sweetgum Subtype is a large patch community, with patches up to 1000 acres or more but apparently not a regular part of any typical landscape mosaic. Patches are often associated with other subtypes of Nonriverine Swamp Forest, especially the Mixed Subtype. It might also be naturally associated with Nonriverine Wet Hardwood Forest.

Variation: Examples vary in canopy composition, but no pattern of variation has been recognized.

Dynamics: Dynamics for the Sweetgum Subtype are probably similar to those for the Coastal Plain Nonalluvial Wetland Forests theme as a whole.

Comments:
The *Liquidambar* is probably increased in all examples as a result of past logging but serves as an indicator of mineral soil. The 3rd Approximation previously recognized a Sweetgum variant of Nonriverine Wet Hardwood Forest. This has been dropped, but some examples have been reinterpreted as this wetter community.

Pinus taeda - Acer rubrum - Liquidambar styraciflua / Arundinaria gigantea ssp. *tecta* Forest (CEGL004649) is apparently a successional community that may be an altered version of this but may also be an altered version of other community types.

Rare species:
Vascular plants: *Lindera subcoriacea.*
Vertebrate animals: *Canis rufus* and *Dendroica virens waynei.*

References:

PEATLAND ATLANTIC WHITE CEDAR FOREST

Concept: Peatland Atlantic White Cedar Forests are wetland forests dominated by *Chamaecyparis thyoides* that occur on organic soils on poorly drained upland flats, in Carolina bays, or in other settings not flooded by rivers and not associated with seepage. Tree and shrub species of Nonriverine Swamp Forests, many also shared with pocosins, may be present and are sometimes abundant.

Distinguishing Features: Peatland Atlantic White Cedar Forests are distinguished from Streamhead Atlantic White Cedar Forests by occurrence on flats or in shallow depressions fed by sheet flow and rainwater, in contrast to seepage-fed drainages in sandhill terrain. There is normally a difference in associated plants, with *Liriodendron tulipifera* in particular usually present only in streamheads. *Chamaecyparis* is present in a few other communities, such as Blackwater Bottomland Hardwoods (Evergreen Subtype), but does not dominate.

Synonyms: *Chamaecyparis thyoides / Persea palustris / Lyonia lucida - Ilex coriacea* Forest (CEGL006146).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Sites: Peatland Atlantic White Cedar Forests occur in several settings. The most extensive are on large peatlands on poorly drained upland flats in the outer Coastal Plain, distant from streams. A number of smaller stands are on elevated patches in peat-filled drowned river valleys. The elevated patches are generally oval in shape and stand above the tidal influence that surrounds them. They may be domed peatlands in miniature. Some small stands also occur in Carolina bays in the Bladen Lakes area. A few small stands occur on Coastal Plain river terraces in areas that appear to no longer flood.

Soils: Peatland Atlantic White Cedar Forests occur on a variety of shallow or deep organic soil and mucky mineral soils. Most peatland examples are mapped as Pungo (Typic Haplosaprist), some as Croatan (Terric Haplosaprist), Belhaven (Terric Haplosaprist), Roper (Histic Humaquept), Torhunta (Typic Humaquept), or Hyde (Typic Umbraquult). Those in drowned river valleys are usually mapped as Dorovan (Typic Haplosaprist). Carolina bay occurrences are usually mapped as Pamlico (Terric Haplosaprist), Lynn Haven (Typic Alaquod), or Torhunta. River terrace examples may be mapped as Murville (Umbric Endoaquod), Rutlege (Typic Humaquept), Johnston (Cumulic Humaquept), or other series. Regardless of mapped series, soils in Peatland Atlantic White Cedar Forests often are very distinctive, consisting of multiple layers of fallen logs draped with leaf litter and duff, with much void space beneath them. Because the cedar wood is very decay-resistant, this structure can persist beneath mature stands.

Hydrology: Peatland Atlantic White Cedar Forests are nearly permanently saturated and may be shallowly flooded seasonally by rainfall and local sheet flow. Sites are wet primarily because of poor drainage in the flat terrain with no streams. Most lie near sea level but they are beyond the influence of tidal waters, if only by a few inches of elevation and a few feet of distance.

Vegetation: Peatland Atlantic White Cedar Forests in natural condition have at least marginal dominance of the canopy by *Chamaecyparis thyoides*. Many stands, apparently more in the past, are nearly pure, with few other trees present. Some remnant stands, including some affected by blowdown or that regenerated poorly after past logging, may have a lower proportion and lower cover, and some stands may be naturally more mixed. *Acer rubrum* and *Nyssa biflora* are canopy associates with high constancy, which sometimes are codominant. *Pinus taeda, Pinus serotina*, and *Gordonia lasianthus* have fairly high frequency in CVS plot data and may also be abundant. The understory is usually dominated by *Persea palustris*, and *Magnolia virginiana* and *Acer rubrum* occur with high constancy. *Nyssa biflora* is frequent and *Ilex opaca* is occasional. The shrub layer is usually dense. *Lyonia lucida, Clethra alnifolia*, and *Ilex coriacea* have high constancy and sometimes dominate. *Ilex glabra* and *Cyrilla racemiflora* also are frequent and sometimes dominate. Other shrubs may include *Vaccinium formosum, Itea virginica, Eubotrys racemosa, Leucothoe axillaris*, *Morella cerifera*, and *Ilex laevigata*. Though not well represented in plots, *Vaccinium fuscatum, Morella caroliniensis*, and *Viburnum nudum* also occur occasionally in site descriptions. Among vines, *Smilax laurifolia* is present with high constancy and sometimes high abundance. Other vines fairly frequent in plot data include *Toxicodendron radicans, Parthenocissus quinquefolia, Gelsemium sempervirens*, and *Muscadinia rotundifolia*. Herbs are minor in this community. *Sphagnum* spp. is frequent and sometimes abundant, while *Anchistea virginica, Lorinseria areolata, Osmundastrum cinnamomeum*, and *Osmunda spectabilis* are also frequent. Other species occasionally present include *Dryopteris celsa*, *Peltandra virginica,* and *Peltandra sagittifolia*. Unpublished transect data in white cedar forests by Lee Otte around 1982 show similar composition and structure.

Range and Abundance: Ranked G2. The high global imperilment is partly due to high threat as well as to rarity. Approximately 40 occurrences are known in North Carolina. Many are much smaller than they were even several decades ago, and vast areas were lost in the 1800s and early 1900s. Atlantic white cedar lumber is valuable, and the forests are sought after for logging. Because of their distinct dynamics and dependence on fire for natural regeneration, most logged areas do not regenerate in the species. Where steps are taken to regenerate the species, they involve intensive site preparation or broadcast herbicide use, leaving little natural character to the resulting vegetation. Natural occurrences also may fail to regenerate naturally after blowdowns or may gradually succeed to hardwood dominance.

The association is attributed to Virginia and Maryland, and questionably to South Carolina, but North Carolina appears to have the bulk of it, both at present and in the past.

Associations and Patterns: Peatland Atlantic White Cedar Forests are large patch communities, with patches of tens to hundreds of acres and a few clusters of thousands of acres. While occurrences in drowned river valleys, in Carolina bays, and on river terraces are naturally bounded and would have always been large patch communities, historical records suggest those in large peatlands were once matrix communities covering thousands of acres.

The different variants defined below have different natural associations. Because of this, Peatland Atlantic White Cedar Forests may be naturally associated with a wide variety of different natural communities, including Nonriverine Swamp Forest, Pond Pine Woodland, Bay Forest, Tidal Swamp, Blackwater Bottomland Hardwoods, Wet Pine Flatwoods, or other upland communities.

Variation: Two patterns of variation may be tentatively recognized among Peatland Atlantic White Cedar Forests, and both can be used as a basis for defining variants. Though not well studied, the different environmental settings seem likely to have different dynamics and potentially differences in fauna and flora. In addition, as suggested in earlier drafts of the 4th Approximation, at least among examples in large peatlands, variation may be recognized among associated tree and shrub species.

1. Peatland Swamp Variant occurs on large peatlands. Associated species are primarily those of Nonriverine Swamp Forest: *Nyssa biflora, Acer rubrum, Taxodium distichum*, and *Pinus taeda*. This variant once covered much larger areas of the landscape in places such as the Dare County mainland and the Great Dismal Swamp.
2. Peatland Pocosin Variant occurs on large peatlands but has associated species more typical of Pond Pine Woodland, primarily *Pinus serotina* and *Gordonia lasianthus*. It is unclear how extensive it was in the large peatlands. It may have occurred primarily in the transition to more extensive pocosins.
3. Tidal River Variant occurs on small, elevated patches in peat-filled drowned river valleys. It is normally surrounded by Tidal Swamp and presumably had little exposure to fire.
4. Carolina Bay Variant occurs in Carolina bays and other similar shallow depressions, farther inland. It may interact with a mosaic of peatland communities similarly to the Peatland Variant but exists in closer association with frequently burned uplands.
5. River Terrace Variant occurs on high terraces of rivers such as the Lumber River, Juniper Creek, and Northeast Cape Fear. Soils are less organic, patches are surrounded by upland or floodplain communities, and though they are believed not to have significant flooding, they may flood in the most extreme events.

Dynamics: Peatland Atlantic White Cedar Forests are believed to have tree dynamics unique among North Carolina forests. The high value of white cedar lumber, widespread logging, and variable regeneration led to early elucidation of these characteristics in forestry studies and publications such as Korstian (1924), Korstian and Brush (1931), Buell and Cain (1943), and Wells (1942). Later ecologists have elaborated on some aspects but report a similar picture (Kologiski 1977; Christensen 1981; Christensen 1988; Frost 1989; Moore and Carter 1987; Laderman 1989). *Chamaecyparis thyoides* is recognized as an extreme example of an early successional species, requiring high light levels and limited competition to establish, having prolific seed output capable of remaining viable in the soil, and readily regenerating in dense, often monospecific, even-aged stands after severe disturbance under the right conditions. The species is relatively short-lived, and stands are particularly susceptible to severe disturbance; the emphasis has been on catastrophic fire, but recent observations show that they are also very sensitive to wind throw in hurricanes. The right conditions for regeneration include removal of the dense shrubs that usually occur in these communities, as well as competing understory trees. Thus, stands regenerate best with a fire that kills the canopy, removes competing trees and shrubs, but with limited consumption of the surface organic matter where the seed bank resides. Unlike many early successional trees, *Chamaecyparis* seeds do not seem to disperse widely, so regeneration is dependent on the seed bank. Burning during drought, which consumes the seed bank and can lower the organic ground surface, favors regeneration by *Pinus serotina*. Logging without control of the shrubs often leads to failure of regeneration and capture of sites by associated hardwoods or to shrubby vegetation

without appreciable canopy. Frequent burning might lead to dominance of pocosin shrubs or *Arundinaria tecta*. Absence of any fire before senescence of the *Chamaecyparis* would lead to dominance by understory hardwoods, whether *Acer rubrum* and *Nyssa biflora* or *Gordonia lasianthus*, *Magnolia virginiana*, and *Persea palustris*. Likewise, a fire that kills a stand of *Pinus serotina*, *Nyssa biflora*, *Acer rubrum*, or other trees and reduces shrub cover may lead to establishment of a new stand of *Chamaecyparis* in places where some seed bank or seed source remains.

Because there are multiple possible outcomes following natural disturbances as well as logging of Peatland Atlantic White Cedar Forest, there is widespread belief that several communities could naturally have existed as a shifting mosaic in large peatlands. Pond Pine Woodland, Nonriverine Swamp Forest, Bay Forest, perhaps Peatland Canebrake, along with Peatland Atlantic White Cedar Forest might develop in a given patch, and any might follow, depending on the occurrence or absence of particular kinds of fires. However, given the longevity and resilience of the dominant species and the limited dispersal of *Chamaecyparis*, *Arundinaria*, and perhaps *Taxodium*, it is unclear how frequently communities would have shifted. Certainly, there is little evidence for new communities appearing in different places at present, beyond the replacement of white cedar by successional hardwoods. It may be more plausible that each community existed in areas where the chronic disturbance regime was best suited for it and that shifts were limited to expansion and contraction along the edges, perhaps in response to climatic cycles.

Despite the apparently exacting conditions required for establishment of *Chamaecyparis* stands, historical records and tallies of lumber harvested indicate that they were numerous and extensive in some large peatlands such as the Dare County peninsula and the Great Dismal Swamp. Current conditions, including exclusion of controllable wildfires, continued occurrence of uncontrollable wildfires during droughts, and limited prescribed burning in peatlands, along with continued widespread logging, have led to drastic declines in the abundance and extent of Peatland Atlantic White Cedar Forest.

Many aspects of this picture can be readily observed in remaining occurrences and in recently logged areas. However, some of these patterns may not be universal. Fire-scarred individuals may occasionally be seen, suggesting intolerance of fire is not absolute. Competing hardwoods sprout readily after most fires and are unlikely to be removed. The deep piles of logs in the soil of many forests may result from windthrow rather than from fire; in any case, they indicate that *Chamaecyparis* can at times regenerate in conditions other than bare ground. The existence of *Chamaecyparis* in mixed forest communities, including Nonriverine Swamp Forest (Mixed Subtype) and Blackwater Bottomland Hardwoods (Evergreen Subtype), indicates that there is an alternative strategy with which this species can also succeed. They can include trees of the same apparent age as other canopy trees, and young individuals can be seen in canopy gaps. Some settings where Peatland Atlantic White Cedar Forest occurs, especially those in peat-filled river valleys surrounded by Tidal Swamp, in places unlikely to attract human ignition, appear very unlikely to burn and probably established their dense even-aged stands by some other process. Additional study is needed to clarify how these mechanisms work.

Nevertheless, it remains clear that the largest acreage of Peatland Atlantic White Cedar Forest likely depended on fire, that it has declined greatly in the absence of fire, and that the amount has declined greatly with each round of logging.

Comments: While the equivalent NVC association ranges northward to Maryland, other *Chamaecyparis* communities that share some characteristics occur farther north, with extensive communities once present in New Jersey and some in New England. The species also occurs southward to Florida, but southern occurrences appear more similar to North Carolina's Streamhead Atlantic White Cedar Forest community.

Peatland Atlantic White Cedar Forest is an exception to the general limited study of communities in the Coastal Plain Nonalluvial Wetland Forests theme. The literature cited here is a sampling of that produced in recent years. Additional studies in North Carolina have focused especially on methods for regenerating *Chamaecyparis* after harvest, on the physiology of the species, and other topics. A series of published proceedings of symposia on management, ecology, and restoration of the species attest to the attest to the breadth of recent interest.

While Peatland Atlantic White Cedar Forest, and *Chamaecyparis thyoides* in general, is known to have declined drastically in historical time, there is evidence for changes in its distribution farther in the past. Multiple authors and literature reviewed by Laderman (1989) describe finding of abundant cedar logs buried in peat in areas that are now pocosins or other communities, indicating that these areas once supported forests of this species. Depths and ages of these logs are generally not given, and these observations have led to some belief that the historic loss is even larger than known. However, these buried logs likely are sub-fossil material, at least thousands of years old. Logs of *Taxodium* also are often found buried beneath pocosins, and the abundance of these two species in peat may reflect their decay resistance rather than overwhelming abundance. It is likely that the conversion of these former forests to pocosin was a result of paludification or to effects of ongoing rising sea level in more distant prehistoric times.

The Peatland Atlantic White Cedar Forest community was formerly placed in the Peatland Pocosins theme. It was moved to Coastal Plain Nonalluvial Wetland Forests theme early in development of the 4th Approximation. It shares affinities with both themes and may be associated with both. However, its greatest affinities and most common association now appears to be with Nonriverine Swamp Forest (Mixed Subtype).

Rare species:
Vascular plants: *Lindera subcoriacea.*
Vertebrate animals: *Setaphaga virens waynei.*
Invertebrate animals: *Callophyrs hesseli, Hypagyrtis brendae.* There is an additional suite of several possibly rare Lepidoptera specialized on *Chamaecyparis* on the NHP Watch List.

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