

WET PINE SAVANNAS

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WET PINE SAVANNAS THEME

Concept: Wet Pine Savannas occur in seasonally saturated sites in the Coastal Plain and lower Piedmont, where natural frequent fire promoted open woodland or savanna vegetation structure dominated or codominated by *Pinus palustris* or, less often, *Pinus serotina*, along with a dense herbaceous layer.

Distinguishing Features: Wet Pine Savannas in natural condition are distinguished by a dense herbaceous layer dominated by characteristic species of grass-like growth form, including *Aristida stricta*, *Sporobolus pinetorum*, *Ctenium aromaticum*, *Muhlenbergia expansa*, *Calamovilfa brevipilis*, *Rhynchospora* spp., *Andropogon cretaceus*, *Pleea tenuifolia*, and *Sporobolus teretifolius*. The canopy is usually dominated by *Pinus palustris* but may be dominated by *Pinus serotina* or may be largely absent. With long absence of fire, wetland shrubs may become dense, so that it may become difficult to distinguish savannas from Pond Pine Woodland. However, with the exception of *Rhynchospora* and *Andropogon*, the presence of even small numbers of the above species indicates that a site was an open Wet Pine Savanna, as does the presence of remaining *Pinus palustris*.

Within this theme, communities are distinguished by environmental gradients of moisture and soil texture, as well as by biogeography. Wet Pine Flatwoods, with limited species richness, occur on the marginally wet coarse sandy soils, while the various Pine Savanna communities, most with high species richness, are either clearly wetter or occur on loamy soils. Some communities have distinctive subtypes confined to the Sandhills or to various parts of the Coastal Plain. A couple are differentiated by dominance by species of limited geographic range: *Pleea tenuifolia* and *Kalmia (Leiophyllum) buxifolia*.

Sites: Wet Pine Savanna communities once were naturally extensive in flatter parts of the Coastal Plain. Remnants occur on relict dunes and sand sheets, on ridges embedded in peatlands, and on flat upland terraces. In the Sandhills, they occur in small wet swales and in sloping seeps. The rare Piedmont examples occur on wet upland flats.

Soils: Wet Pine Savannas can occur on a wide variety of wet Ultisols and on wet Spodosols such as the Leon series.

Hydrology: Wet Pine Savannas are seasonally saturated to near the ground surface but rarely hold standing water. In most, saturation comes from a seasonal high water table. A few, especially in the Sandhills, are saturated by groundwater discharge induced by clay layers in the substrate.

Vegetation: Wet Pine Savannas characteristically have an open to very open canopy, most characteristically of *Pinus palustris* but sometimes of *Pinus serotina*. The herb layer is dense. The dominant species may be *Aristida stricta* or any of several other characteristic graminoids: *Sporobolus pinetorum*, *Ctenium aromaticum*, *Muhlenbergia tenuifolia*, *Sporobolus teretifolius*, *Pleea tenuifolia*, or several *Rhynchospora* species. These may be patchy within a savanna, or one may dominate across the entire community. In many Wet Pine Savanna communities, the herb layer in examples that are in good condition has very high species richness, with many associated graminoids and forbs, including multiple insectivorous species, several orchids, numerous

composites, but few or no legumes. Species richness values at fine scales (10 meters and less) are some of the highest recorded in the world (Walker and Peet 1983). A few of the sandy communities have low species richness even when in the best condition.

Wet Pine Savannas generally have no more than sparse midstory trees, except where regenerating pines are growing up in canopy gaps. When frequently burned, shrubs are sparse or patchy, but examples with a history of fire suppression may have extensive cover of shrubs or the trailing *Vaccinium crassifolium*.

Dynamics: See the extensive discussion of dynamics for the Dry Longleaf Pine Communities theme. Most of the processes and patterns are common to Wet Pine Savannas as well, including the crucial role of frequent fire, the population structure and behavior of *Pinus palustris*, the conservative life histories of much of the flora, and the difficulty of restoration. Indeed, a significant portion of the research cited there was done in wet savannas.

Wet Pine Savannas may differ from Dry Longleaf Pine Communities in several ways that may increase complexity. Production of biomass is faster than in the drier sandhills, though it probably is not greater than in Mesic Pine Savannas. In wet and in dry communities, soil texture is an important driver of differences in communities (Palmquist et al. in prep, Taggart 1990). Since production is more limited by nutrients (Christensen 1977, Walker and Peet 1983) and less by water, nutrient holding capacity is probably more important than water holding capacity as a cause for the differences in communities between sandy and loamy soils. However, soil saturation may limit productivity in wetter years. Sandy soils may possibly become dry in seasons when the water table is low.

More than in drier systems, the variety in dominants in the herb layer may potentially affect fire dynamics. It also raises questions about the interactions among dominants. Patchiness in the herb layer may be readily observed, some clearly related to microsite differences but some perhaps having other causes. At least a few of the characteristic dominants (*Rhynchospora* and *Andropogon*) appear to be less conservative than most herbs of longleaf pine communities, and this suggests a possibility of shifting patterns over time or of a role for more severe disturbance. As detailed by Palmquist et al. (2015), the interaction of soil environment with fire regime and changes in fire regime may be quite complex and may play out differently at different spatial scales. The higher productivity of loamy soils may allow for faster changes, and though the dominant herbs are quite stable, changes in fine-scale species richness can happen quickly.

Additionally, *Pinus palustris* may interact with other potential canopy tree species, usually *Pinus serotina*. Though this species is present in some of the apparently least altered wet savannas, it is unclear if this is a natural state or is the result of past fire suppression. *Pinus serotina* is usually present in adjacent communities. It is well adapted to surviving fire as mature trees but is less well suited to reproducing with frequent fire. Pond pine regeneration would depend on a longer fire-free interval than the 2-3 years thought to prevail under more natural conditions, but such intervals may have occurred frequently enough to allow it to coexist in some sites. In addition, more than in drier systems, some relatively unaltered Wet Pine Savannas have little or no tree cover, a situation that may be related to fire intensity with the dense herb layer, to intense fires in adjacent Pond Pine Woodlands, or to difficulty of pine regeneration because of wetness.

Wet Pine Savannas may contain minor amounts of hardwoods shared with pocosins, particularly *Persea palustris* and *Magnolia virginiana*. Tall shrubs such as *Cyrilla racemiflora* and *Vaccinium fuscatum*, even *Ilex myrtifolia*, may also occur. These species likely existed in small patches and wetter microsites, but with long suppression of fire they have often proliferated. A great variety of shrubs also tends to proliferate in the absence of fire, including most of those found in Peatland Pocosins as well as most of those in Dry Longleaf Pine Communities. *Arundinaria tecta* may also occur and become dense or widespread. While a sandhill community altered by lack of fire remains dominated by scrub oaks, Wet Pine Savannas may become so dominated by shrubs and *Pinus serotina* that they are difficult to distinguish from Pond Pine Woodland.

Comments: See the comments for Dry Longleaf Pine Communities, many of which apply here as well.

The terms “savanna” and “flatwoods” have had been widely used in ecological literature in two different ways, applying to both pine and hardwood-dominated communities. At times, they refer simply to vegetation structure, with savannas being grassy and flatwoods being shrubby. In other usages, particularly in the Southeastern U.S., they refer to moisture regimes, with savannas being wetter and flatwoods somewhat drier. Savannas have also often been assumed to have high species richness, flatwoods low. In the 3rd approximation, the terms were used to indicate moisture regimes, with Mesic Pine Flatwoods and Wet Pine Flatwoods drier than Pine Savanna, which was always wet. Because this usage caused confusion, leading some users to expect that the flatwoods communities should naturally be shrubby, the usage in names has been shifted in the 4th Approximation. The species-rich mesic longleaf pine communities that are not naturally more shrubby have been renamed to use the term “savanna.” “Flatwoods” is now reserved for marginally wet sandy communities previously known as Wet Pine Flatwoods, which are low in species richness. Whether Wet Pine Flatwoods are naturally more shrubby under optimal fire regimes is unclear, though it was suggested by Glitzenstein et al. (2003).

As in the Dry Longleaf Pine Communities, most of the subtypes in this theme were recognized as variants in the 3rd Approximation, after being recognized in natural heritage surveys of longleaf pine communities. Most were confirmed by early analysis of CVS data. Recent thorough analysis of CVS plot data (Palmquist et al. in prep), supplemented by data ranging from Virginia to Florida, confirmed the identity of these units. Most of the descriptions here are based on that analysis but are supplemented by other observations.

References:

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KEY TO WET PINE SAVANNAS

1. Community in the Piedmont. **Wet Piedmont Longleaf Pine Forest**
1. Community not in the Piedmont
 2. Community north of the natural range of *Aristida stricta* dominance (a short distance north of the Neuse River)..... **Northern Wet Pine Savanna**
 2. Community within the natural range of *Aristida stricta* (whether the species is present or not)
 3. Community saturated by seepage, occurring on a gentle to steep slope where a clay layer underlying sand induces ground water seepage; primarily in the Sandhills region but potentially elsewhere where similar conditions occur.
 4. Community with high species richness, sharing many species with Wet Loamy Pine Savanna, such as *Ctenium aromaticum*, *Chaptalia tomentosa*, *Coreopsis linifolia*, *Erigeron vernus*, *Xyris ambigua*, *Bigelovia nudata*, *Viola primulifolia*, *Aletris farinosa*, *Eryngium integrifolium*, *Triantha racemosa*, and many others; well-developed examples known only in Fort Bragg **Sandhill Seep (Savanna Subtype)**
 4. Community with moderate to low species richness, sharing only a few species with Wet Loamy Pine Savanna; the above species scarce or generally absent. **Sandhill Seep (Typic Subtype)**
 3. Community saturated by a seasonal high water table, occurring on flat terraces or in gentle swales; primarily in the outer Coastal Plain but potentially in the middle Coastal Plain and Sandhills.
 5. Community on sand soil, with little fine material; soil generally mapped as a Spodosol. Vegetation largely or completely lacking the suite of species typical of loamy soils, such as *Coreopsis lancifolia*, *Marshallia graminifolia*, *Scleria minor*, *Rhexia lutea*, *Polygala ramosa*, *Aletris farinosa*, *Eupatorium rotundifolium*, *Bigelovia nudata*, *Chaptalia tomentosa*, *Cirsium virginianum*, *Helianthus heterophyllus*, *Helianthus angustifolius*, *Lysimachia loomisii*, *Eryngium integrifolium*, and *Eryngium integrifolium*. While *Rhynchospora plumosa*, *fascicularis*, and *ciliaris* may be present in wetter communities, most other *Rhynchospora* are absent or scarce.
 6. Community marginally wet; herb layer low in species richness even when frequently burned and in good condition; herb species limited to the most widespread species of wet longleaf pine communities such as *Aristida stricta*, *Pteridium pseudocaudatum*, *Pyxidantha barbulate*, *Carphephorus* spp., and species shared with non-wetland communities; herbs of wetter sites, if present at all, limited to wet microsites or ecotones.
 7. Community containing *Kalmia (Leiophyllum) buxifolia* along with more widespread shrubs; geographically limited community occurring Brunswick County and as small disjunct examples in eastern Carteret County and Cumberland County **Wet Pine Flatwoods (Sand Myrtle Subtype)**
 7. Community lacking *Kalmia buxifolia*; shrub layer consisting solely of widespread shrubs such as *Ilex glabra*, *Gaylussacia* spp., etc.; geographically widespread community, throughout the southern half of the Coastal Plain
 8. Community occurring in a distinct basin in drier sandy terrain; trees sparse or absent; vegetation consisting of few species, primarily *Hypericum tenuifolium* and *Aristida stricta*. **Wet Pine Flatwoods (Depression Subtype)**
 8. Community not occurring in a distinct basin, or if so, with more diverse herbaceous and shrub vegetation and generally with pines if not recently disturbed. **Wet Pine Flatwoods (Typic Subtype)**
 6. Community wetter; herb layer fairly diverse if frequently burned, containing species of wetter sites, such as *Sporobolus pinetorum*, *Ctenium aromaticum*, *Muhlenbergia expansa*, *Andropogon glaucopsis*, *Osmundastrum cinnamomeum*, *Pilea tenuifolia*, and carnivorous plants, along with more widespread species of wet longleaf pine communities.

9. Herb layer dominated or codominated by *Pleea tenuifolia* over most of the community.
 **Wet Sandy Pine Savanna (Rush Featherling Subtype)**
9. Herb layer not dominated or codominated by *Pleea tenuifolia*, though the species may be present in smaller amounts; general dominated by *Aristida stricta* or *Sporobolus pinetorum* when frequently burned..... **Wet Sandy Pine Savanna (Typic Subtype)**
5. Community on loamy soil, with finer material present in addition to sand; soil generally mapped as an Ultisol. Vegetation containing many species of a suite typical of loamy soil, such as *Coreopsis lancifolia*, *Marshallia graminifolia*, *Scleria minor*, *Rhexia lutea*, *Polygala ramosa*, *Aletris farinosa*, *Eupatorium rotundifolium*, *Bigelovia nudata*, *Chaptalia tomentosa*, *Cirsium virginianum*, *Helianthus heterophyllus*, *Helianthus angustifolius*, *Lysimachia loomisii*, *Eryngium integrifolium*, and *Eryngium integrifolium*. A wide suite of *Rhynchospora plumosa* may be present. Widespread wet savanna species such as *Aristida stricta*, *Sporobolus pinetorum*, *Rhexia alifanus*, *Xyris caroliniana*, *Osmundastrum cinnamomeum*, and *Dionaea muscipula* may be in either set of communities.
10. Community containing, in addition to the above species, an additional suite of species of very wet sites, such as *Rhynchospora latifolia*, *Sporobolus teretifolius*, *Eryngium yuccifolium*, *Stenanthium (Zigadenus) densum*, *Carex lutea*, *Thalictrum cooleyi*, *Scleria bellii*, *Coreopsis aristulata*, and *Allium* sp., 1; dominant herbs usually *Ctenium aromaticum*, *Muhlenbergia expansa*, *Sporobolus pinetorum*, *Sporobolus teretifolius*, or *Rhynchospora* spp.; *Aristida stricta* never dominant and often absent; very rare community known in small portions of Pender, Brunswick, and Columbus County. **Very Wet Loamy Pine Savanna**
10. Community, if in good condition, containing a diverse herb layer, but lacking the specialized suite of species of wetter sites; herb layer dominated by *Aristida stricta*, *Sporobolus pinetorum*, *Ctenium aromaticum*, *Muhlenbergia expansa*, or *Andropogon* spp.; less rare community throughout the southern half of the Coastal Plain, possibly in the Sandhills (but consider Sandhill Seep (Savanna Subtype) if the community is sloped and has seepage. .. **Wet Loamy Pine Savanna**

WET PIEDMONT LONGLEAF PINE FOREST

Concept: Wet Piedmont Longleaf Pine Forests are wetland woodlands or forests of the eastern Piedmont (primarily the Uwharries and areas adjacent to the Sandhills) in which *Pinus palustris* naturally dominates or codominates. They may be seepage-fed or have perched water tables. *Pinus palustris* may be scarce in examples where past logging and fire suppression have removed it and allowed other pines and hardwoods to expand. *Pinus serotina* may also be abundant.

Distinguishing Features: Wet Piedmont Longleaf Pine Forests are distinguished from all other Wet Pine Savannas by their occurrence in the Piedmont, on Piedmont geological substrates, and in all but one case, by the apparently natural absence of *Aristida stricta*. Northern Wet Pine Savannas also lack *Aristida stricta*, but they can contain a number of Coastal Plain species absent in the Piedmont. However, because all examples of both communities have been heavily altered by past fire suppression, herbs are often too few to define the differences.

Wet Piedmont Longleaf Pine Forests are distinguished from Dry Piedmont Longleaf Pine Forests by having a substantial component of wetland herbs and shrubs, such as *Rhynchospora* spp., *Calamagrostis coarctata* (*cinnoides*), *Cinna arundinacea*, *Erianthus* spp., and *Osmundastrum cinnamomeum*. However, the boundary between wet and dry can be subtle, perhaps because of the effects of fire suppression; many upland woody and herbaceous species are found mixed with wetland species.

Wet Piedmont Longleaf Pine Forests can co-occur with Hillside Seepage Bogs or Piedmont Boggy Streamheads, with a similarly subtle boundary. *Pinus palustris* may occur in any community but is scarce in the boggy communities. Hillside Seepage Bogs and Piedmont Boggy Streamheads are both distinctly wetter. While the most water-tolerant species, such as *Osmundastrum cinnamomeum*, *Osmunda spectabilis*, *Sarracenia* spp., *Drosera* spp., *Sphagnum* spp., *Sophronanthe pilosa*, *Alnus serrulata*, and *Viburnum nudum* may occur in Wet Piedmont Longleaf Pine Forest, they are a minor component; they generally occur with much greater cover in Hillside Seepage Bog and Piedmont Boggy Streamhead. Other species of wetter sites, such as *Lycopus virginicus*, are common in Piedmont Boggy Streamheads but are unlikely in Wet Piedmont Longleaf Pine Forest.

Synonyms: *Pinus palustris* - *Pinus taeda* - *Pinus serotina* / *Chasmanthium laxum* - *Panicum virgatum* Piedmont Woodland (CEGL003663).

Ecological Systems: Southeastern Interior Longleaf Pine Woodland (CES202.319).

Sites: Wet Piedmont Longleaf Pine Forests occur on flat or gently sloping upland areas. One example is in a Triassic basin; the others are in or near the Uwharrie Mountains but in flatter terrain, primarily on metasedimentary rocks.

Soils: Wet Piedmont Longleaf Pine Forests are often small areas that are inclusions in soil map units. Soils mapped for occurrences include Biscoe (Aeric Epiaquult), Badin (Typic Hapludult), Herndon (Typic Kanhapludult), Lignum (Aquic Hapludult), Worsham (Typic Endoaquult), Mayodan (Typic Hapludult), and Claycreek (Oxaquic Hapludalf).

Hydrology: Sites are seasonally saturated but have little or no surface water. Wetness in some sites appears to come from seepage, in other sites from a perched water table produced by an impermeable soil.

Vegetation: All remaining examples of Wet Piedmont Longleaf Pine Forest were heavily altered by logging and long fire suppression, and the best examples have been recently thinned and otherwise treated for restoration. The natural structure of Wet Piedmont Longleaf Pine presumably is an open woodland or savanna with *Pinus palustris* dominant or codominant with *Pinus taeda* or possibly *Pinus echinata*. Remaining examples have, or recently had, a significant hardwood component, primarily *Acer rubrum*, *Liquidambar styraciflua*, and *Liriodendron tulipifera*, but also including upland species such as *Quercus marilandica*, *Quercus stellata*, *Quercus alba*, *Carya glabra*, and probably understory species such as *Oxydendrum arboreum*, *Nyssa sylvatica*, and *Sassafras albidum*, which often remain as dense sprouts if they are no longleaf in the canopy. These presumably would have been absent or sparse in more frequently burned natural conditions. The shrub layer also often is dense but once would have been more open. Species that are frequent in CVS plot data or site descriptions include *Gaylussacia frondosa*, *Vaccinium formosum*, *Vaccinium fuscatum*, *Aronia arbutifolia*, *Amelanchier obovalis*, and *Amelanchier canadensis*. A number of other wetland and upland shrubs occur occasionally, including *Gaylussacia dumosa*, *Vaccinium tenellum*, *Vaccinium pallidum*, *Lyonia mariana*, *Rhododendron viscosum*, *Eubotrys racemosa*, *Viburnum nudum*, and *Alnus serrulata*. *Toxicodendron radicans*, *Gelsemium sempervirens*, *Smilax rotundifolia*, *Smilax glauca*, *Smilax laurifolia*, and *Muscadinia rotundifolia* are fairly frequent and, in current conditions, can dominate patches. The herb layer presently is moderate to sparse, but presumably was once dense, more dominated by grasses, and more continuous. Most frequently dominant in patches are *Pteridium pseudocaudatum*, *Vaccinium crassifolium*, *Chasmanthium laxum*, *Danthonia sericea*, and *Andropogon glomeratus*. Other constant or frequent species in CVS plot data or site descriptions include *Schizachyrium scoparium*, *Panicum virgatum*, *Osmundastrum cinnamomeum*, *Eupatorium pilosum*, *Eupatorium rotundifolia*, *Rhexia* spp., *Rhynchospora* (include *debilis*, *glomerata*, *recognita*, *gracilentata*, *chalarocephala*, and *ciliaris*), *Lobelia nuttallii*, *Erianthus* spp., *Polygala lutea*, *Juncus dichotomus*, *Juncus coriaceus*, *Scleria nitida* or *triglomerata*, *Symphyotrichum pilosum*, *Uvularia puberula*, *Sophranthe pilosa*, *Hieracium gronovii*, *Calamovilfa brevipilis*, *Eryngium yuccifolium*, *Sericocarpus linifolius*, and *Aletris farinosa*. A number of other species are less frequent at present but are indicative of the conditions or of Coastal Plain affinities and may once have been more frequent, including *Calamagrostis coarctata*, *Cinna arundinacea*, *Danthonia epilis*, *Helianthus angustifolius*, *Helianthus atrorubens*, *Xyris caroliniana*, *Viola primulifolia*, *Lespedeza hirta*, *Lespedeza capitata*, *Lespedeza angustifolia*, *Eupatorium leucolepis*, *Scleria ciliata*, *Scleria elliottii*, *Polygala cruciata*, *Polygala curtisii*, *Lycopodiella alopecuroides*, *Iris verna*, *Aristida virgata*, *Oxypolis rigidior*, *Osmunda spectabilis*, *Pycnanthemum flexuosum*, and *Eleocharis* sp. *Aristida stricta* is reported to be present in a single example, the most altered one but the one closest to the Sandhills.

Range and Abundance: Ranked G1. Five occurrences are known. Most are in the Uwharrie Mountains area, but the largest is in the Wadesboro Triassic basin in Cabarrus County. The NVC association is also questionably attributed to South Carolina.

Associations and Patterns: Wet Piedmont Longleaf Pine Forest is a large patch community. One large example is over 600 acres, but all other examples are around 20 acres. It is unlikely that any large examples ever existed. Where natural boundaries exist, Wet Piedmont Longleaf Pine Forests are associated with Dry Piedmont Longleaf Pine Forests. Some also may grade into Piedmont Boggy Streamhead or Piedmont Headwater Stream Forest.

Variation: Two variants are recognized, based on the setting. Floristic differences are not well known.

1. Seepage Variant occurs in sloping terrain and appears to have seepage or concentration of upland runoff as a significant source of water. The examples in the Uwharrie Mountains area appear to be this variant.

2. Flat Variant occurs in flatter upland terrain where a perched or seasonal high water table appears to be the cause of wetness. The example in Anson County is the variant.

Dynamics: As with other longleaf pine communities, Wet Piedmont Longleaf Pine Forest depends on frequent fire to maintain its ecological character. Without fire, shrubs quickly proliferate, and hardwood trees gradually establish a dense canopy that eliminates the characteristic herbs. However, natural fire may have been somewhat less frequent than in the Coastal Plain, and this, along with the substrate, may be responsible for the different flora and different character of this community.

Because the hydrology is dependent on local seepage and perched water tables, Wet Piedmont Longleaf Pine Forests are particularly subject to changes in weather from year to year. During dry periods, they can become very dry.

Comments: Wet Piedmont Longleaf Pine Forests are one of the less well-known natural communities. All known examples are recovering from long suppression of fire. Prescribed burning and selective thinning are now reversing its effect, but communities are altered enough that it is difficult to observe details of their natural character. Other than site descriptions in Natural Heritage Program files and a handful of CVS plots, a single published paper described examples (Culpepper et al. 2017). The vegetation description is based on plots from two sites and thorough species lists for two different sites. The heterogeneity of examples, with drier and wetter microsites, and the unclear boundaries with adjacent communities, add further difficulties to describing the vegetation.

Hillside Seepage Bogs are often associated with Dry Piedmont Longleaf Pine Forest. It is possible that *Pinus palustris* once occurred in them, potentially blurring the distinction between them and Wet Piedmont Longleaf Pine Forest. However, Hillside Seepage Bogs contain a more specialized wetland flora that indicates that they are wetter.

Rare species:

Vascular plants: *Fothergilla major*, *Iris prismatica*, and *Trillium pusillum* var. *pusillum*.

Vertebrate animals: *Picoides borealis*.

References:

Culpepper, J., J.D. Bricken, S.D. Hunt, R.J. Barlow, J.S. Kush, D.K. Lauer. 2017. Restoration of a fire-climax species with a rare longleaf pine forest in the Piedmont of North Carolina. *Natural Areas Journal* 37:563-569.

WET PINE FLATWOODS (TYPIC SUBTYPE)

Concept: Wet Pine Flatwoods are longleaf pine communities of seasonally wet, coarse sandy Spodosols, less wet than the Wet Sandy Pine Savanna type, and typically low in species richness. This type may possibly have more shrub cover than the various Pine Savanna communities under natural conditions, but still is naturally more dominated by grasses than by shrubs. The Typic Subtype covers the common examples of the Coastal Plain in which *Kalmia (Leiophyllum) buxifolia* is not a major component. Instead, *Gaylussacia frondosa*, *Ilex glabra*, *Hypericum tenuifolium*, *Arundinaria tecta*, *Rhododendron atlanticum*, or other wetland shrubs are present with low to high cover. *Aristida stricta* dominates a dense but low-diversity herb layer, sometimes with codominant *Pteridium aquilinum* or *Vaccinium crassifolium*.

Distinguishing Features: Wet Pine Flatwoods are distinguished from Xeric Sandhill Scrub and Pine/Scrub Oak Sandhill by a characteristic lack of scrub oaks and lack of obligate upland herbs (however, scrub oaks may “stray” into them, especially in long periods without fire). Wet Pine Flatwoods are distinguished from both Wet Sandy Pine Savannas and Wet Loamy Pine Savannas by the absence of plant species typical of richer or wetter sites, such as *Sporobolus pinetorum*, *Ctenium aromaticum*, *Muhlenbergia expansa*, *Andropogon glaucopsis*, *Osmundastrum cinnamomeum* and carnivorous plants. They are distinguished from Mesic Pine Savanna by coarse sandy soil and by a low-diversity herbaceous flora that largely lacks legumes and has some wetland species. While Wet Pine Flatwoods are often regarded as having more shrub cover than wetter or more fertile savannas, the amount of shrubs cannot be used to distinguish them as defined here. Both mesic and wetter savannas can become dominated by the shrubs characteristic of Wet Pine Flatwoods in the absence of fire, and if herb diversity is lost, they can be difficult to distinguish. Similarly, the abundance of *Aristida stricta* cannot be used to distinguish among these community types, as it may dominate in most. Wet Pine Flatwoods are distinguished more by the absence of species characteristic of other communities than by the presence of any distinctive plants.

The Typic Subtype is distinguished from the Sand Myrtle Subtype by the absence or scarcity of *Kalmia buxifolia*. It is distinguished from the Depression Subtype by a richer herb and shrub layer, characteristic greater density of *Pinus palustris*, and by occurring on sandy flats, swales, or in larger basins.

Synonyms: Synonyms: Wet Pine Flatwoods (Wet Spodosol Variant); *Pinus palustris* / *Ilex glabra* / *Aristida stricta* Woodland (CEGL003648). Wet Sandy Pine Savanna of earlier 4th approximation guide drafts.

Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Sites: Wet Pine Flatwoods (Typic Subtype) occurs on upland flats or terraces, on low rises or shallow depressions in relict dune fields or relict beach ridge systems, and on lower parts of Carolina bay rims. It occurs in areas with seasonal high water tables.

Soils: Soils are sandy Spodosols. The coarse sandy soils are low in nutrient holding capacity. The majority of examples are mapped as the Leon series (Aeric Alaquod), a unit that can support several different communities. Some are mapped as Lynn Haven (Typic Alaquod). A number of

other series are sometimes mapped, but the community probably represents inclusions with them. However, examples mapped as Ultisols or Alfisols may suggest that the community is an overgrown Mesic Pine Flatwoods or Wet Loamy Pine Savanna.

Hydrology: Soils are saturated at or near the surface during wet seasons; the coarse sand has little water holding capacity, but it is unclear if drought stress is significant when water tables drop in drier seasons. Hydrology is palustrine, but these sites may not be recognized as wetlands because the sandy soils do not show many of the redoximorphic features used to recognize wetland soils.

Vegetation: Vegetation structure is similar to most longleaf pine communities, with an open woodland to savanna canopy dominated by *Pinus palustris*, a dense grassy herb layer, and a shrub layer that varies with fire history. There is some indication that these marginally wet sandy soils retain more shrub cover naturally under conditions of frequent fire than do those of finer textured soils (Glitzenstein 2003). There generally is little midstory and few canopy hardwoods except in cases of severe alteration by fire exclusion. The canopy sometimes is codominated by *Pinus serotina*. It is not certain if this is natural or is an effect of past logging and altered fire regime; it also could result from mass effects in small patches surrounded by pocosins.

The shrub layer may potentially include a large number of species. Frequent abundant species in CVS data (Palmquist et al. in prep) are *Ilex glabra*, *Vaccinium tenellum*, and *Gaylussacia dumosa*. *Gaylussacia frondosa* is frequent and often dominant in site observations. Less frequent in plots but sometimes observed to be locally dominant are *Rhododendron atlanticum*, *Hypericum tenuifolium*, *Kalmia carolina*, and in more altered places, *Lyonia lucida* or *Ilex coriacea*. Often present in smaller numbers are *Aronia arbutifolia*, *Lyonia mariana*, *Morella pumila*, *Persea palustris*, *Magnolia virginiana*, and *Arundinaria tecta*. The herb layer is strongly dominated by *Aristida stricta* or is codominated by *Vaccinium crassifolium* or *Pteridium pseudocaudatum*. Other frequent herbs in plot data as well as other observations include *Schizachyrium scoparium*, *Andropogon virginicus* var. *virginicus*, *Pityopsis graminifolia*, *Liatris* sp., *Scleria ciliata*, *Carphephorus bellidifolius*, and *Ionactis linariifolia*. Wetter examples may share a few additional species with wetter pine savannas, including *Xyris caroliniana*, *Rhexia alifanus*, *Polygala lutea*, and *Lachnocaulon anceps*. The wetter ecotone on the edge of peatland communities may have some additional wet savanna species, including *Lysimachia asperulifolia*, *Anchistea virginica*, *Dionaea muscipula*, and *Drosera* spp.

Range and Abundance: Ranked G3. This type is the most common remaining longleaf pine community type of the outer Coastal Plain in the state, but it is rare globally. It occurs only in North Carolina and northern South Carolina.

Associations and Patterns: Wet Pine Flatwoods usually occur on sandy landscapes in mosaics with Xeric Sandhill Scrub and Pond Pine Woodland, sometimes also with Pine/Scrub Oak Sandhill (Coastal Fringe Subtype or Mixed Oak Subtype) or Wet Sandy Pine Savanna. In these mosaics, a few inches difference in elevation relative to the water table can separate the different communities. In the range of the Sand Myrtle Subtype, that community may also occur in mosaics with the Typic Subtype. Where Wet Pine Flatwoods borders a Pond Pine Woodland or other pocosin community, a wet ecotone may harbor species characteristic of Wet Sandy Pine Savanna in a narrow band.

Variation: Examples are variable and often heterogeneous within patches. The shrub species that are present, and dominant, are particularly variable. The herb layer is less variable, though examples vary substantially in amount of *Vaccinium crassifolium* and *Pteridium latiusculum*. These variations probably reflect fire history more than site differences. Analysis of CVS plot data (Palmquist et al. in prep.) identified three distinct groups within the Typic Subtype. These may warrant recognition as variants.

Dynamics: Dynamics are similar to most longleaf pine communities. Glitzenstein et al. (2003) suggest, based on fire experiments in South Carolina and Georgia, that communities of wet Spodosols, such as our Wet Pine Flatwoods, may retain substantial shrub cover even with very frequent fire. It is not clear how widely this principle applies, and whether it applies to the original natural examples as well as to examples that had experienced periods of longer fire exclusion. The lower herb diversity or lower grass productivity may possibly allow more shrubs to persist. Conversely, however, the low fertility makes these communities slower than most longleaf pine communities to become overgrown by shrubs and lose their grass cover in the absence of fire. Their species richness, lower to begin with, is altered less by exclusion of fire.

Comments: Wet Pine Flatwoods represents the marginally wet portion of the moisture gradient on coarse sandy soils. The moisture gradient on these soils appears to be compressed when compared with that of loamy soils. While loamy or clayey soils sometimes have a distinctive mesic savanna community that develops between the oak-rich sandhill communities and the wet savannas, there is no apparent mesic segment of the moisture gradient on coarse sandy soils. Wet Pine Flatwoods often grade directly into Xeric Sandhill Scrub or Pine/Scrub Oak Sandhill; scrub oaks and wetland shrubs can intermix in ecotonal areas and become more intermixed with long fire exclusion. The lack of moisture-holding capacity in the sand, which leads to dry conditions whenever the water table is not high, presumably is the reason, but the low fertility of these soils may also be involved. The seasonal high water table is presumably the reason for exclusion of scrub oaks and the preponderance of facultative wetland shrubs and trees in Wet Pine Flatwoods when fire is suppressed for long periods. However, Wet Pine Flatwoods are often not considered jurisdictional wetlands because their low-diversity vegetation is dominated by facultative plants of widespread moisture tolerance and lacks obligate wetland species. Their coarse sandy soils also lack the material to develop most of the redoximorphic features used to recognize hydric soils.

Naming conventions for this community type have been problematic. In earlier drafts of the 4th Approximation, I named this community as a kind of Pine Savanna, but there is a confusing array of Pine Savanna names even without it, so I have returned to the 3rd Approximation name of Wet Pine Flatwoods.

These communities are closely related to the suite of communities that are called Pine Savannas, sharing frequent fire and dominance by longleaf pine and wiregrass. However, while most wet longleaf pine communities are known for their high fine-scale plant species richness, Wet Pine Flatwoods tend to have low species richness. In some other usages, the term “flatwoods” implies more shrub cover than “savanna,” whether natural or artificial. However, all of the wet longleaf pine communities become shrubby if they are not burned frequently, so shrub abundance is a poor basis for naming communities. Indeed, shrub cover can be very transient, changing drastically over

the course of a 3-year burn rotation.

Rare species:

Vascular plants: *Asclepias pedicellata*. Pocosin ecotones only: *Dionaea muscipula*, *Lysimachia asperulifolia*

Vertebrate animals: *Ophisaurus mimicus*, *Peucaea aestivalis*, *Picoides borealis*, *Pituophis melanoleucus lemanoleucus*

References:

Glitzenstein, J.S., D.R. Streng, and D.D. Wade. 2003. Fire frequency effects on longleaf pine (*Pinus palustris* P. Miller) vegetation in South Carolina and Northeast Florida, USA. *Natural Areas Journal* 23: 22-37.

Palmquist, K.A., R.K. Peet, S.C. Carr. M.T. Lee, M.P. Schafale, A.S. Weakley, and T.R. Wentworth. In prep. Longleaf pine (*Pinus palustris*) vegetation of the Atlantic and East Gulf Coast Coastal Plain, USA: Vegetation classification, biogeography, and soil properties. [Title being determined.]

WET PINE FLATWOODS (SAND MYRTLE SUBTYPE)

Concept: Wet Pine Flatwoods are longleaf pine communities of seasonally wet, coarse sandy Spodosols, less wet than the Wet Sandy Pine Savanna type, and typically low in species richness. This type may possibly have more shrub cover than the various Pine Savanna communities under natural conditions, but still is naturally more dominated by grasses than by shrubs. The Sand Myrtle Subtype covers the rare longleaf pine communities of wet sandy soils in the outer Coastal Plain where *Kalmia (Leiophyllum) buxifolia* is a dominant or codominant shrub.

Distinguishing Features: Wet Pine Flatwoods are distinguished from Xeric Sandhill Scrub and Pine/Scrub Oak Sandhill by a characteristic lack of scrub oaks and lack of obligate upland herbs (however, scrub oaks may “stray” into them, especially during long periods without fire). Wet Pine Flatwoods are distinguished from both Wet Sandy Pine Savannas and Wet Loamy Pine Savannas by the absence of plant species typical of richer or wetter sites, such as *Sporobolus pinetorum*, *Ctenium aromaticum*, *Muhlenbergia expansa*, *Andropogon glaucopsis*, *Osmundastrum cinnamomeum* and carnivorous plants. They are distinguished from Mesic Pine Savannas by coarse sandy soil and by a low-diversity herbaceous flora that largely lacks legumes and has some wetland species.

The Sand Myrtle Subtype is readily distinguished from all other longleaf pine communities by the presence of significant numbers of *Kalmia buxifolia*. All of the shrub species of Wet Pine Flatwoods (Typic Subtype) may also be present. *Kalmia buxifolia* may occasionally spread into drier sandhill communities within its range; these may be distinguished by a significant component of shrub oaks and an absence of other wetland species.

Synonyms: Wet Pine Flatwoods (*Leiophyllum* Variant); *Pinus palustris* / *Leiophyllum buxifolium* / *Aristida stricta* Woodland (CEGL003649). Wet Sandy Pine Savanna of earlier 4th approximation guide drafts.

Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Sites: The Sand Myrtle Subtype occurs on upland flats or terraces, on low rises or shallow depressions in relict dune fields or relict beach ridge systems, and on lower parts of Carolina bay rims, within the Coastal Plain range of *Kalmia buxifolia*.

Soils: Soils are sandy Spodosols. The coarse sandy soils are low in nutrient holding capacity. The majority of examples are mapped as the Leon series (Aeric Alaquod), a unit that can support several different communities.

Hydrology: Soils are saturated at or near the surface during wet seasons; the coarse sand has little water holding capacity, but it is unclear if drought stress is significant when water tables drop in drier seasons. Hydrology is palustrine, but these sites may not be recognized as wetlands because the sandy soils do not show many of the redoximorphic features used to recognize wetland soils.

Vegetation: Vegetation structure is similar to most longleaf pine communities, with an open woodland to savanna canopy dominated by *Pinus palustris*, a dense grassy herb layer, and a shrub

layer that varies with fire history. There generally is little midstory and few canopy hardwoods. *Pinus serotina* often is present in the canopy as a minority species. The shrub layer is fairly diverse, whether cover is high or low, and this probably is natural. The most abundant shrub layer species in CVS plot data (Palmquist et al. in prep) are *Kalmia buxifolia*, *Gaylussacia dumosa*, and *Ilex glabra*. Other constant or frequent shrubs include *Gaylussacia frondosa*, *Hypericum tenuifolium*, *Persea palustris*, *Vaccinium tenellum*, *Magnolia virginiana*, *Ilex coriacea*, *Aronia arbutifolia*, and *Arundinaria tecta*. *Vaccinium crassifolium* sometimes dominates large patches of ground cover. The herb layer is strongly dominated by *Aristida stricta*, when the community is in good condition, but *Pteridium pseudocaudatum* or *Vaccinium crassifolium* may reduce its density. Other frequent herbs in plot data include *Schizachyrium scoparium*, *Iris verna*, *Pyxidantha barbulata*, *Pityopsis graminifolia*, *Carphephorus bellidifolius*, *Carphephorus tomentosus*, and *Trilisa paniculata*. In wetter microsites and ecotones, species of Wet Sandy Pine Savanna may be present, including, frequently, *Xyris caroliniana*, *Rhynchospora plumosa*, *Andropogon glaucopsis*, and *Lachnocaulon anceps*.

Range and Abundance: The equivalent association is ranked G2? but this community likely is appropriately G1. It is endemic to North Carolina, where it is limited primarily to Brunswick County, with small disjunct occurrences in Carteret and Hoke counties. Its distribution follows the Coastal Plain range of *Kalmia buxifolia*.

Associations and Patterns: The Sand Myrtle Subtype occurs in mosaics with the Typic Subtype, as well as with Wet Sandy Pine Savanna (Rush Featherling Subtype), Xeric Sandhill Scrub (Coastal Fringe Subtype), Pine/Scrub Oak Sandhill (Coastal Fringe Subtype), and Pond Pine Woodland.

Variation: Examples vary with the transition to adjacent communities. Drier portions may have some *Quercus geminata* and other species of the Coastal Fringe Subtype of Pine/Scrub Oak Sandhill. No variants are recognized. The two disjunct examples may be somewhat different.

Dynamics: Dynamics apparently are similar to other longleaf pine communities. Like the Typic Subtype, it may support more shrubs than most longleaf pine communities under a natural regime of frequent fire (Glitzenstein et al. 2003). There may be subtle differences in the fire regime, compared to the Typic Subtype. The primary range of this subtype, southeastern Brunswick County, is known to be particularly difficult to conduct prescribed burns in safely, because of the volatility of fuels and unpredictability of winds. Its location at a sharp angle on the coast subjects it to sea breeze influence from two directions.

Comments: *Kalmia buxifolia* as a species has an unusual distribution and range of ecology. It occurs in Heath Balds and high elevation rock outcrop communities in the mountains, outcrops on a few lower Piedmont monadnocks, and in this rare community subtype of the Coastal Plain.

Rare species:

Vascular plants: *Asclepias pedicellata*. Pocosin ecotones only: *Dionaea muscipula* and *Lysimachia asperulifolia*.

Vertebrate animals: *Ophisaurus mimicus*, *Peucaea aestivalis*, *Picoides borealis*, and *Pituophis melanoleucus lemanoleucus*.

Invertebrate animals: *Cyclophora* sp. 1 (*culicaria* of authors).

References:

Glitzenstein, J.S., D.R. Streng, and D.D. Wade. 2003. Fire frequency effects on longleaf pine (*Pinus palustris* P. Miller) vegetation in South Carolina and Northeast Florida, USA. *Natural Areas Journal* 23:22-37.

Palmquist, K.A., R.K. Peet, S.C. Carr. M.T. Lee, M.P. Schafale, A.S. Weakley, and T.R. Wentworth. In prep. Longleaf pine (*Pinus palustris*) vegetation of the Atlantic and East Gulf Coast Coastal Plain, USA: Vegetation classification, biogeography, and soil properties. [Title being determined.]

WET PINE FLATWOODS (DEPRESSION SUBTYPE)

Concept: Wet Pine Flatwoods are longleaf pine communities of seasonally wet, coarse sandy Spodosols, less wet than the Sandy Pine Savanna type, and typically low in species richness. The Depression Subtype covers small, marginally wet, sandy limesink depressions and swales in dry sandhills, where *Aristida stricta* and *Hypericum tenuifolium* dominate. Trees are virtually or completely absent in the few known examples, but *Pinus palustris* might potentially be present.

Distinguishing Features: Wet Pine Flatwoods are distinguished from Xeric Sandhill Scrub and Pine/Scrub Oak Sandhill by a characteristic lack of scrub oaks and lack of obligate upland herbs (however, scrub oaks may “stray” into them, especially with long periods without fire). Wet Pine Flatwoods are distinguished from both Sandy Pine Savannas and Wet Loamy Pine Savannas by the absence of plant species typical of richer or wetter sites, such as *Sporobolus pinetorum*, *Ctenium aromaticum*, *Muhlenbergia expansa*, *Andropogon glaucopsis*, *Osmundastrum cinnamomeum* and carnivorous plants. They are distinguished from Mesic Pine Savanna by coarse sandy soil and by a low-diversity herbaceous flora that largely lacks legumes and has some wetland species.

The Depression Subtype is distinguished from other Wet Pine Flatwoods subtypes by occurrence in small, closed basins, in combination with a depauperate flora and dominance of *Hypericum tenuifolium*. Local areas in the Typic Subtype may be dominated by these species, but generally trees and other shrubs will be present. This community is distinguished from Vernal Pools and other small depression communities by the dominance of *Aristida stricta* rather than *Andropogon* spp., *Panicum virgatum*, or species of wetter affinities, though *Andropogon* in particular may be abundant.

Synonyms: *Hypericum reductum* / *Aristida stricta* Dwarf-shrubland (CEGL003954).
Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Sites: The Depression Subtype occurs in small but distinct depressions or deep swales in relict sand dune areas. The depressions may be either dune swales or limesink depressions.

Soils: Soils are inclusions that are probably similar to Leon (Aeric Alaquod) or other Spodosols, but would generally be mapped as Kureb, Mandarin, or some other deep sandy Entisol.

Hydrology: Hydrology is not well known, but presumably is an important factor in the distinctive character of this community. The few examples that have been examined showed no evidence of surface flooding, even at times of high water table and flooding of nearby areas. But the exclusion of scrub oaks and most or all pines presumably is related to wetness and to a water regime different from the wetter Sandy Pine Savanna. The absence of the more diverse Vernal Pool flora might be due to inadequate surface flooding, or possibly to other factors such as low fertility.

Vegetation: Vegetation consists of an open shrub layer dominated by *Hypericum tenuifolium*, alone or in combination with *Lyonia mariana* or *Gaylussacia dumosa*. The herb layer is sparse to moderately dense. *Aristida stricta* or *Rhynchospora* sp. are dominant or codominant. *Andropogon*

sp. may be abundant. *Vaccinium crassifolium* and a few other species may be present, but this community is extremely low in species richness. *Pinus palustris* has been observed only as a few small individuals in known examples.

Range and Abundance: Ranked G1G2Q. This community is poorly known and perhaps overlooked, but its specialized habitat appears extremely rare. It is likely to be ultimately ranked as G1. In North Carolina, it is presently known at just two sites, in Pender County and possibly New Hanover County. It may possibly also occur in northern South Carolina, though it has not been reported there and has not been attributed to it in the NVC.

Associations and Patterns: The Depression Subtype is a small patch community that is surrounded by Sand Barren or Xeric Sandhill Scrub (Coastal Fringe Subtype in all known examples). Other small depression communities, including Vernal Pool, Small Depression Drawdown Meadow, and Small Depression Pond, may occur nearby, as may Wet Pine Flatwoods (Typic Subtype) or other longleaf pine communities.

Variation: Variation is not known.

Dynamics: Dynamics are virtually unknown. Examples presumably are subject to the same fire regime as the surrounding landscape, which, if Sand Barren, may be less frequent than in most longleaf pine communities. The depression topography and sparser grass likely leads to lower fire intensity than in most longleaf pine communities.

The cause of the depauperate nature of these communities is not clear. Occasional standing water may eliminate some species, but *Aristida stricta* is not tolerant of prolonged flooding and would be absent if standing water of significant duration occurred. The coarse sandy soil may develop dry conditions when water tables are low, sufficient to exclude most wetland species typical of other Wet Pine Flatwoods. It is unclear if site conditions exclude *Pinus palustris* or if its absence in the few known examples is due to past land use or to chance. If pines could occur at the density they have in Sand Barrens, the probability of having one in one of the small depressions would be low.

Comments: This community is one of the more problematic in the 4th Approximation, and it is uncertain if it truly warrants recognition as a subtype. It is one of the least known communities. No plot data exist. Exceptionally small patches of many communities are often floristically depauperate and not well developed. However, it appears as a distinctive entity where it occurs, the scrub oaks and most other species dropping out as you enter the depression. It was first recognized as a community by Alan Weakley, who added it to the NVC based on observations at 421 Sand Ridge, a site that has had limited scientific access in recent years. A second example has been found in a similar relict sand dune setting, in patches comparable to other small depression communities, and indicating a repeating pattern. It needs to be sought in other, similar sites, where it might not have been reported.

This community appears conceptually intermediate between Wet Pine Flatwoods and Vernal Pool, but I have chosen to give emphasis to the presence of *Aristida stricta* as a link to Wet Pine Flatwoods, despite the possible exclusion of pine.

Rare species: None known.

References:

WET SANDY PINE SAVANNA (TYPIC SUBTYPE)

Concept: Wet Sandy Pine Savannas are pine/wiregrass savannas of wet sandy soils, wetter than Wet Pine Flatwoods. They are typically high in species richness but with flora consisting mostly of the more widespread savanna species. The Typic Subtype covers the examples in most parts of the Coastal Plain, where herb layers are dominated by grasses, usually *Aristida stricta*, and in which *Pleea tenuifolia* is not dominant or codominant (though it is occasionally present).

Distinguishing Features: Wet Sandy Pine Savannas are distinguished from Wet Pine Flatwoods by a more diverse herb layer that includes species indicative of greater wetness. Species in Wet Sandy Pine Savanna but scarce or absent in Wet Pine Flatwoods include *Andropogon glomeratus*, *Andropogon cretaceus* (*glaucopsis*), *Osmundastrum cinnamomeum*, *Anchistea virginica*, *Sarracenia flava*, *Dionaea muscipula*, *Calamovilfa brevipilis*, *Sporobolus pinetorum*, and *Ctenium aromaticum*. All plant species of Wet Pine Flatwoods may also occur in Wet Sandy Pine Savanna. Though Wet Pine Flatwoods may naturally have more shrub cover under frequent fire, the amount of shrubs is usually artificially high in both communities and is not a good distinguishing feature. Wet Sandy Pine Savanna and Wet Pine Flatwoods can be hard to distinguish in fire-suppressed examples where indicator herbs have become sparse and may be impossible if no herbs remain, but the presence of even small numbers of the above indicators, if not merely confined to ecotones or wet microsites, indicates this wetter community.

Wet Sandy Pine Savannas are distinguished from Wet Loamy Pine Savanna and Very Wet Loamy Pine Savanna by the soil texture and fertility and by corresponding differences in vegetation. They are typically dominated by *Aristida stricta*, with *Sporobolus pinetorum*, *Ctenium aromaticum*, and *Muhlenbergia capillaris* only rarely dominant and often scarce or absent. The flora of Wet Sandy Pine Savannas is largely a subset of that of Wet Loamy Pine Savanna, so they are best distinguished by the absence of species indicative of loamy soils. Species frequent in Wet Loamy Pine Savannas and not typically found in Wet Sandy Pine Savannas include *Coreopsis lancifolia*, *Marshallia graminifolia*, *Scleria minor*, *Rhexia lutea*, *Polygala ramosa*, *Aletris farinosa*, *Eupatorium rotundifolium*, *Bigelovia nudata*, *Chaptalia tomentosa*, *Cirsium virginianum*, *Helianthus heterophyllus*, *Helianthus angustifolius*, *Lysimachia loomisii*, *Eryngium integrifolium*, *Eryngium integrifolium*, and several *Rhynchospora* species (*baldwinii*, *chapmanii*, *galeana*). Characteristic herbs such as *Andropogon* sp., *Osmundastrum cinnamomeum*, *Trilisa* spp., *Rhexia alifanus*, *Polygala lutea*, *Dionaea muscipula*, *Xyris caroliniana*, *Stenanthium* (*Zigadenus*) *densum*, *Sarracenia* spp., and *Drosera* spp. are generally present in both.

The Typic Subtype is distinguished from the Rush Featherling Subtype by not having *Pleea tenuifolia* dominant, though the species sometimes is present.

Synonyms: Pine Savanna (Wet Spodosol Variant); *Pinus palustris* - *Pinus serotina* / *Ctenium aromaticum* - *Muhlenbergia expansa* - *Carphephorus odoratissimus* Woodland (CEGL003658). [The NVC name likely will be changed soon, to reflect data indicating that some of these nominal species are not characteristic of this community.] Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Sites: Wet Sandy Pine Savannas occur on upland flats or terraces, on low rises or shallow depression in relict dune fields or relict beach ridge systems, and on lower parts of Carolina bay

rims. They occur in areas with prolonged seasonal high water tables, which are wetter than sites of Wet Pine Flatwoods.

Soils: Soils are sandy Spodosols. The coarse sandy soils lack fine material and are low in nutrient holding capacity. The majority of examples are mapped as the Leon series (Aeric Alaquod), a few as Woodington, Foreston, or other sandy Ultisols. Wet Sandy Pine Savanna and Wet Pine Flatwoods are generally mapped as the same soils, and they often cooccur.

Hydrology: Wet Sandy Pine Savannas are saturated at or near the surface during wet seasons, but virtually never have surface flooding. These sites are generally downhill and wetter than those of Wet Pine Flatwoods. Hydrology is palustrine, but these sites may not be recognized as wetlands because the sandy soils do not show many of the redoximorphic features used to recognize hydric soils.

Vegetation: Vegetation structure is similar to most longleaf pine communities, with an open woodland to savanna canopy dominated by *Pinus palustris*, a dense grassy herb layer, and a shrub layer that varies with fire history. The canopy sometimes is codominated by *Pinus serotina*, though it is not certain if this is natural or is an effect of past logging and altered fire regime.

The dense herb layer is dominated by *Aristida stricta*. *Vaccinium crassifolium* can have high cover, especially when fire has been too infrequent. Other wet savanna grasses, especially *Calamovilfa brevipilis*, *Sporobolus pinetorum*, and *Ctenium aromaticum*, are sometimes present but rarely dominate over substantial patches. The herb layer has moderate to high species richness in examples in good condition. Data in Palmquist et al. (in prep.) show an average of 55 vascular plant species per 1/10 hectare, compared to 83 for Wet Loamy Pine Savanna. Other herbs with high constancy and sometimes high cover include several *Andropogon* species (*cretaceus*, *glomeratus*, *virginicus*), *Osmundastrum cinnamomeum*, and *Pteridium pseudocaudatum*. Smaller herbs with high constancy in plot data include *Polygala lutea*, *Rhexia alifanus*, *Trilisa paniculata*, and *Iris verna*. Other frequent herbs include several *Rhynchospora* (*plumosa*, *fascicularis*, *ciliaris*), several *Dichantherium* (*ensifolium*, *dichotomum*, *webberianum*), *Pityopsis graminifolia*, *Cleistesiopsis divaricatus*, *Rhexia petiolata*, *Trilisa odoratissima*, *Dichantherium ensifolium*, *Carphephorus tomentosus*, *Eupatorium pilosum*, *Eurybia paludosa*, *Dionaea muscipula*, *Sarracenia flava*, *Drosera capillaris*, *Eurybia paludosa*, *Pyxidantha barbulate*, *Rhexia lutea*, *Stenanthium densum*, *Polygala brevifolia*, *Xyris ambiguus*, *Carphephorus bellidifolius*, *Liatris* sp., *Lachnocaulon anceps*, *Solidago pulchra*, *Lobelia nuttallii*, *Amphicarpum amphicarpon*, *Gentiana autumnalis*, and *Seymeria cassioides*. Less frequent but notable species include *Carex striata*, *Pilea tenuifolia*, *Lysimachia asperulifolia*, *Sabatia difformis*, *Agalinis setacea*, *Rhynchospora pallida*, and *Balduina uniflora*.

Though shrubs are a limited component in savannas that have had frequent fire, a diversity of species may be present. Highly constant species include *Magnolia virginiana*, *Persea palustris*, *Ilex glabra*, *Gaylussacia frondosa*, *Gaylussacia dumosa*, *Morella pumila*, *Vaccinium tenellum*, and *Aronia arbutifolia*. Other frequent shrubs include *Ilex coriacea*, *Hypericum tenuifolium*, *Lyonia mariana*, *Lyonia ligustrina*, *Lyonia lucida*, *Morella carolinensis*, *Arundinaria tecta*, *Rhododendron atlanticum*, *Vaccinium formosum*, *Vaccinium fuscatum*, *Clethra alnifolia*, *Hypericum crux-andreae*, and *Kalmia caroliniana*. *Smilax laurifolia* is also frequent.

Range and Abundance: The equivalent NVC association is ranked G3, but G2 likely is more appropriate given the high threat and dependence on continued commitment to burning. In North Carolina, this community occurs largely in the outer Coastal Plain from Carteret County southward, with a few examples locally in the Sandhills and on inner Coastal Plain relict sand dunes. About 25 occurrences are known. A few examples may occur in northern South Carolina. It has been questionably attributed to Georgia in the NVC but should be restricted to the range of *Aristida stricta*.

Associations and Patterns: Wet Sandy Pine Savannas usually occur on sandy landscapes in mosaics with Wet Pine Flatwoods and Pond Pine Woodland. Where they are together, Wet Pine Flatwoods are at distinctly higher elevation. In these mosaics, a few inches difference in elevation relative to the water table can separate the different communities. Where Wet Pine Flatwoods borders a Pond Pine Woodland or other pocosin community, a wet ecotone may harbor species characteristic of Sandy Pine Savanna in a narrow band. However, in other places, it appears a broad zone of Wet Sandy Pine Savanna occurred in this position but has become lost beneath the spreading shrubs of the Pond Pine Woodland.

Variation: Examples are variable and often heterogeneous within patches. Given the diversity of herbs, there can be much variation in local species composition in response to microsite differences. No variants are recognized.

Dynamics: Dynamics are similar to those generally described in the Dry Longleaf Pine Communities and Wet Pine Savannas theme descriptions, especially the crucial role of fire, the patchy tree canopy structure, the conservativeness of many of the dominant plants, and the slowness to recover after mechanical damage or fire suppression.

Frequent fire is particularly important for preventing shrub invasion in these wetter savannas, which are invaded faster than Wet Pine Flatwoods or sandhill communities. In many Pond Pine Woodland patches, including those bordered by Sandy Pine Savanna or Wet Pine Flatwoods, small numbers of *Pinus palustris*, patches of uncharacteristic shrubs (*Gaylussacia frondosa*, *Kalmia carolina*, *Rhododendron atlanticum*), or remnant individuals of savanna grasses suggest that a savanna once extended farther. Large extents of savanna may have been lost by this encroachment of Pond Pine Woodland with past fire exclusion, even in conservation lands that are now managed with frequent fire. The absence of the shallow organic layer characteristic of Pond Pine Woodlands soils suggests this situation. Cecil Frost (personal communication) believes that it is possible for such organic layers to accumulate within historic time, suggesting that Sandy Pine Savannas may once have extended even further. Given the conservatism of most savanna herbs, and their absence in long term seed banks, it is unclear if restoration of such areas could be accomplished even with very frequent fire or chemical or mechanical removal of shrubs.

Glitzenstein et al. (2003) suggest, based on fire experiments in South Carolina and Georgia, that communities of wet Spodosols, such as our Wet Pine Flatwoods, may retain substantial shrub cover even with very frequent fire, while wetter savannas are shrubby only with less frequent fire. It is unclear how this principle, if it can be generalized to North Carolina at all, would apply to these wetter Spodosol sites.

Comments: Wet Sandy Pine Savannas were not distinguished from Loamy Pine Savannas in the 3rd Approximation, and the distinction was not generally recognized before that time, amid the high species richness and large pool of shared species. However, appreciation of the importance of soil texture as a major influence in general has been borne out by extensive observations, study of rare species, and quantitative analysis (Palmquist, et al. in prep.). Nevertheless, distinction among the different longleaf pine savannas can be subtle and may be impossible in areas altered by absence of fire.

It has been a dilemma what to call this community, and several different names have been used in earlier drafts of the 4th Approximation. Earlier names referred to Spodosols, but this was dropped in favor of the more familiar term “sandy” because the texture rather than a spodic horizon per se is the likely crucial characteristic. Nevertheless, many of the loamy soils that it is contrasted with are sandy loams, and it really is the absence of fine material in the soil that presumably is most important. The late change to Wet Sandy Pine Savanna was done to address a concern that the lack of “wet” in the name implied that it is drier than Wet Pine Flatwoods when it is actually wetter. It is unclear how the wetness of Wet Sandy Pine Savanna sites compares to that of Wet Loamy Pine Savanna or Very Wet Loamy Pine Savanna sites. All have seasonal water tables near the surface, all may differ in the duration of the high water table, but how much moisture remains when the water table drops may be more important.

Rare species:

Vascular plants: *Asclepias pedicellata*, *Dionaea muscipula*, *Lechea torreyi* var. *congesta*, *Lophiola aurea*, *Lysimachia asperulifolia*, and *Polygala hookeri*.

Nonvascular plants: *Sphagnum fitzgeraldii*.

Vertebrate animals: *Ophisaurus mimicus*, *Peucea aestivalis*, *Picoides borealis*, and *Pituophis melanoleucus lemanoleucus*.

Invertebrate animals: *Atrytone arogos* and *Hemipachnobia subporphorea*.

References:

Glitzenstein, J.S., D.R. Streng, and D.D. Wade. 2003. Fire frequency effects on longleaf pine (*Pinus palustris* P. Miller) vegetation in South Carolina and Northeast Florida, USA. *Natural Areas Journal* 23:22-37.

Palmquist, K.A., R.K. Peet, S.C. Carr, M.T. Lee, M.P. Schafale, A.S. Weakley, and T.R. Wentworth. In prep. Longleaf pine (*Pinus palustris*) vegetation of the Atlantic and East Gulf Coast Coastal Plain, USA: Vegetation classification, biogeography, and soil properties. [Title being determined.]

WET SANDY PINE SAVANNA (RUSH FEATHERLING SUBTYPE)

Concept: Wet Sandy Pine Savannas are pine/wiregrass savannas of wet sandy soils, wetter than Wet Pine Flatwoods. The Rush Featherling Subtype encompasses the rare communities of the southern outer Coastal Plain where *Pleea tenuifolia* is dominant or codominant in the herb layer. Examples are known only from Brunswick and Pender counties. The *Pleea* plants form tall hummocks which give the ground greater relief than in other savannas and exclude other plants from where they occur. The strong dominance of *Pleea* often leads to lower species richness in this subtype compared to other wet savannas.

Distinguishing Features: Wet Sandy Pine Savannas are distinguished from Wet Pine Flatwoods by a more diverse herb layer that includes species indicative of greater wetness. The Rush Featherling Subtype is distinguished from all other communities by the dominance of *Pleea tenuifolia* in the herb layer. The species may be present in other Pine Savanna communities but is not dominant or codominant.

Synonyms: Pine Savanna (Pleea Flat Variant); *Pinus palustris* - *Pinus serotina* / *Pleea tenuifolia* - *Aristida stricta* Woodland (CEGL003661).

Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Sites: The Rush Featherling Subtype occurs in sites similar to the Typic Subtype, on upland flats or terraces, on low rises in relict beach ridge systems, and on lower parts of Carolina bay rims. It occurs in areas with prolonged seasonal high water tables. Where it occurs with Wet Pine Flatwoods, it is at a distinctly lower elevation. In the few places where it occurs near the Typic Subtype of Wet Sandy Pine Savanna, it appears to be slightly lower.

Soils: Soils are sandy Spodosols, almost always mapped as Leon (Aeric Alaquod). The coarse sandy soils are low in nutrient holding capacity.

Hydrology: Soils are saturated at or near the surface during wet seasons, though virtually never with surface flooding. These sites are generally visibly downhill and wetter than those of Wet Pine Flatwoods, and, though less obvious, appear to be wetter than the Typic Subtype of Sandy Pine Savanna. Hydrology is palustrine, but these sites may not be recognized as wetlands because the sandy soils do not show many of the redoximorphic features used to recognize hydric soils.

Vegetation: Vegetation structure is similar to most longleaf pine communities, with an open woodland to savanna canopy dominated by *Pinus palustris*, a dense grassy herb layer, and a shrub layer that varies with fire history. *Pinus serotina* sometimes is abundant in the canopy, though it is not certain if this is natural or is an effect of past logging and altered fire regime.

The dense herb layer is dominated or codominated by *Pleea tenuifolia*, with *Aristida stricta* or *Sporobolus pinetorum* sometimes codominant. *Vaccinium crassifolium* may be extensive. Frequent herbs in CVS plot data (Palmquist et al. in prep.) include *Xyris caroliniana*, *Xyris ambigua*, *Polygala lutea*, *Rhexia alifanus*, *Andropogon glaucopsis*, *Pityopsis graminifolia*, *Rhynchospora plumose*, *Dichantheium webberianum*, *Dionaea muscipula*, *Iris verna*, *Trilisa*

paniculate, *Eurybia paludosa*, *Stenanthium densum*, *Zigadenus glaberrimus*, *Lachnanthes caroliniana*, *Fimbristylis puberula*, and *Cleistesiospis divaricata/oricamporum*. Relatively frequent are *Sarracenia flava*, *Drosera capillaris*, *Solidago pulchra*, and *Dichantheium tenue*. Shrubs have low cover in examples with frequent fire and may be dense in less frequently burned examples. The most abundant species are *Ilex glabra* and *Gaylussacia dumosa*. Other frequent species include *Vaccinium tenellum*, *Hypericum tenuifolium*, *Morella pumila*, *Morella caroliniana*, *Kalmia buxifolia*, *Ilex coriacea*, *Aronia arbutifolia*, *Lyonia mariana*, *Vaccinium formosum*, and *Lyonia lucida*.

Range and Abundance: Ranked G1. This community is found only in Brunswick and Pender counties, with most of its acreage within a few miles of the towns of Boiling Spring Lakes and Southport. It is not known to occur outside of North Carolina.

Associations and Patterns: The Rush Featherling Subtype occurs as small to large patches, associated with the Typic Subtype, Wet Pine Flatwoods (Typic and Sand Myrtle Subtype), and Pond Pine Woodland. Xeric Sandhill Scrub and Coastal Plain depression communities may be present nearby.

Variation: Examples vary in the amount of *Pleea tenuifolia*. No variants are recognized.

Dynamics: Dynamics are probably similar to most longleaf pine communities but are not specifically known. *Pleea tenuifolia* apparently burns readily enough, though it is not as flammable as *Aristida stricta*. The dense hummocks created by *Pleea* may exclude other plants more effectively than *Aristida*, and these communities tend to be lower in species richness. The cause of *Pleea* codominance in these sites is not clear. The species is present in other savannas, both sandy and loamy, in places where this subtype does not occur. Where it cooccurs with other savanna communities, this subtype appears to be wetter, but where it does not occur, other savanna communities grade directly into Pond Pine Woodland.

As in the Typic Subtype, plants of Pond Pine Woodland appear to invade these communities in the long absence of fire, and a substantial acreage of degraded area may exist adjacent to existing patches.

Comments: The Rush Featherling Subtype appears very distinctive in the field, where the dense hummocks of *Pleea* make walking difficult. However, it proved difficult to distinguish in analysis of CVS data, with other vegetation clustering with the few good examples despite an absence of the distinguishing species. There were also a couple of CVS plots dominated by *Pleea* outside of known examples, and other reports of *Pleea* dominating a mowed power line right-of-way not associated with a savanna. These areas may represent a greater extent of the community than has been recognized, but a few investigated by the author were found to be patches too small to regard as separate communities.

Rare species:

Vascular plants: *Agalinis linifolia*, *Andropogon mohrii*, *Dionaea muscipula*, *Lysimachia asperulifolia*, and *Platanthera integra*.

Vertebrate animals: *Picoides borealis*.

References:

Palmquist, K.A., R.K. Peet, S.C. Carr, M.T. Lee, M.P. Schafale, A.S. Weakley, and T.R. Wentworth. In prep. Longleaf pine (*Pinus palustris*) vegetation of the Atlantic and East Gulf Coast Coastal Plain, USA: Vegetation classification, biogeography, and soil properties. [Title being determined.]

WET LOAMY PINE SAVANNA

Concept: Wet Loamy Pine Savannas are longleaf pine or pond pine savannas that are wet but less wet than the Very Wet Loamy Pine Savanna type, on soils other than coarse sands (sandy loam, loam, or soils with a clayey B horizon). These communities are typically very high in fine-scale species richness, sharing all of the species of Sandy Pine Savanna and having a large additional suite of herbaceous species. *Ctenium aromaticum*, *Sporobolus pinetorum*, *Muhlenbergia expansa*, or *Rhynchospora* spp. typically dominate or codominate with *Aristida stricta*.

Distinguishing Features: Wet Loamy Pine Savannas are distinguished from Wet Sandy Pine Savannas by a suite of herbaceous species that occur primarily on the finer textured soils, including *Coreopsis lancifolia*, *Marshallia graminifolia*, *Scleria minor*, *Rhexia lutea*, *Polygala ramosa*, *Aletris farinosa*, *Eupatorium rotundifolium*, *Bigelovia nudata*, *Chaptalia tomentosa*, *Cirsium virginianum*, *Helianthus heterophyllus*, *Helianthus angustifolius*, *Lysimachia loomisii*, *Eryngium integrifolium*, *Eryngium integrifolium*, and several *Rhynchospora* species (*baldwinii*, *chapmanii*, *galeana*). Characteristic herbs such as *Andropogon* sp., *Osmundastrum cinnamomeum*, *Trilisa* spp., *Rhexia alifanus*, *Polygala lutea*, *Dionaea muscipula*, *Xyris caroliniana*, *Stenanthium (Zigadenus) densum*, *Sarracenia* spp., and *Drosera* spp. are generally present in both, but may be less prominent in loamy savannas.

Wet Loamy Pine Savannas are distinguished from Very Wet Loamy Pine Savannas by the lack or scarcity of a suite of herbaceous species of wetter or richer sites. These include *Rhynchospora latifolia*, *Sporobolus teretifolius*, *Eryngium yuccifolium*, *Stenanthium (Zigadenus) densum*, *Carex lutea*, *Thalictrum cooleyi*, *Scleria bellii*, *Coreopsis aristulata*, and *Allium* sp. 1. Additional species are likely to be present in Very Wet Loamy Pine Savanna and unlikely to be present in other savannas, including *Triantha racemosa*, *Asclepias longifolia*, *Eriocaulon decangulare*, *Rhynchospora oligantha*, and *Ilex myrtifolia*.

Wet Loamy Pine Savannas are distinguished from Mesic Pine Savannas by an abundant suite of wetland herbaceous plants and an almost complete lack of leguminous herbs. *Desmodium lineatum*, *Desmodium tenuifolium*, *Stylosanthes biflora*, *Tephrosia hispidula*, *Amorpha herbacea*, and *Amorpha georgiana* are legumes known in Wet Loamy Pine Savanna in small numbers, but most other species in that family are found only in Mesic Pine Savanna and drier communities, including *Tephrosia virginiana*, *Baptisia cinerea*, *Baptisia tinctoria*, *Galactia* spp., *Lespedeza capitata*, *Lespedeza hirta*, *Pediomelum canescens*, and *Phaseolus sinuatus*.

Synonyms: Pine Savanna (Wet Ultisol Variant); *Pinus palustris* - *Pinus serotina* / *Ctenium aromaticum* - *Muhlenbergia expansa* - *Rhynchospora latifolia* Woodland (CEGL003660); *Pinus palustris* - *Pinus serotina* / *Sporobolus pinetorum* - (*Aristida stricta*) - *Eryngium integrifolium* Woodland (CEGL004501).

Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Sites: Wet Loamy Pine Savannas occur in the outer Coastal Plain on upland flats or terraces, in shallow swales, and on low ridges amid, all where the substrate contains some silt or clay

component and is not pure coarse sand. In the Sandhills Region, they occur in shallow swales with loamy soil.

Soils: Soils in this community are wet Ultisols of a diversity of series. Most frequently mapped are Foreston (Aquic Paleudult), Rains (Typic Paleaquult), Onslow (Spodic Paleudult), and Leon (Aeric Alaquod), though it is unclear if the Leon soils are correctly mapped. Other series mapped at moderate frequency include Woodington (Typic Paleaquult), Lynchburg (Aeric Paleaquult), and Johns (Aquic Hapludult).

Hydrology: Wet Loamy Pine Savannas are saturated at or near the surface during wet seasons, but virtually never have surface flooding.

Vegetation: Vegetation structure is similar to most longleaf pine communities, with an open woodland to savanna canopy dominated by *Pinus palustris*, a dense grassy herb layer, and a shrub layer that varies with fire history. The canopy sometimes is codominated by *Pinus serotina*, though it is not certain if this is natural or is an effect of past logging and altered fire regime.

The herb layer may be dominated by *Aristida stricta*, *Ctenium aromaticum*, *Sporobolus pinetorum*, *Muhlenbergia expansa*, or *Andropogon cretaceus*, varying among different savannas and in patches within sites. *Vaccinium crassifolium* or *Pteridium pseudocaudatum* may also dominate patches, especially where fire has not been frequent. Though less constant, *Calamovilfa brevipilis*, *Osmundastrum cinnamomeum*, *Anchistea virginica*, *Centella erecta*, and *Pilea tenuifolia* may also dominate patches. The herb layer tends to be very diverse. CVS plot data (Palmquist et al. in prep.) show an average species richness of 83 vascular plant species per 1/10 hectare, the majority of it herbs. Additional herbs that are highly constant in CVS data and in whole-site species lists by Richard LeBlond include *Rhexia alifanus*, *Rhexia lutea*, *Rhexia petiolata*, *Polygala lutea*, *Xyris caroliniana*, *Aletris farinosa*, *Coreopsis linifolia*, *Dichantheium ensifolium*, *Rhynchospora plumosa*, *Carphephorus tomentosus*, *Pityopsis graminifolia*, *Cleistesiosopsis divaricata*, and *Drosera capillaris*. Other frequent herbs include several *Eupatorium* (*pilosum*, *rotundifolium*, *leucolepis*), *Helianthus heterophyllus*, *Helianthus angustifolius*, *Iris verna*, several *Rhynchospora* (*baldwinii*, *chapmanii*, *ciliaris*, *galeana*), *Andropogon glomeratus*, *Lobelia nuttallii*, *Sisyrinchium capillare*, *Erigeron vernus*, *Xyris ambigua*, *Dionaea muscipula*, *Sarracenia flava*, *Sarracenia purpurea*, *Calopogon pallidus*, *Calopogon barbatus*, *Calopogon tuberosus*, *Viola primulifolia*, *Symphyotrichum dumosum*, *Eurybia paludosa*, *Dichantheium strigosum*, *Trilisa paniculata*, *Gymnopogon brevifolius*, *Chaptalia tomentosa*, *Marshallia graminifolia*, *Eryngium integrifolium*, *Scleria minor*, *Scleria ciliata*, *Desmodium tenuifolium*, *Tephrosia hispidula*, *Lycopodiella alopecuroides*, *Lycopodiella appressa*, *Cirsium virginianum*, *Triantha racemosa*, *Stenanthium densum*, *Zigadenus glaberrimus*, *Sabatia difformis*, *Polygala hookeri*, *Sericocarpus linifolius*, *Nabalus autumnalis*, *Ludwigia virgata*, *Desmodium lineatum*, and a number of others.

Though shrubs are a limited component in savannas that have had frequent fire, a diversity of species may be present. Highly constant species include *Ilex glabra*, *Gaylussacia frondosa*, *Aronia arbutifolia*, *Vaccinium tenellum*, *Morella caroliniana*, *Magnolia virginiana*, *Hypericum crux-andreae*, and *Arundinaria tecta*. Other frequent shrubs include *Gaylussacia dumosa*, *Morella pumila*, *Vaccinium formosum*, *Vaccinium fuscatum*, *Persea palustris*, *Lyonia ligustrina*, *Lyonia*

lucida, *Rhododendron atlanticum*, *Ilex coriacea*, and what may be an undescribed species of *Hypericum* resembling *brachyphyllum*. *Smilax laurifolia* and *Smilax glauca* are also frequent.

Range and Abundance: The equivalent NVC associate is ranked G1, but G2 is probably more appropriate. There are more than 40 occurrences known in North Carolina, but very few are in good condition. The high threat and dependence on a commitment to ongoing burning gives them higher risk than number of occurrences would suggest. Examples are scattered through the southern half of the outer Coastal Plain, with a few small occurrences in the Sandhills and fewer still remaining in the middle Coastal Plain.

Associations and Patterns: Wet Loamy Pine Savannas are best regarded as small patch communities, though large patches may have existed in the past. They sometimes occur in fine-scale mosaics with Mesic Pine Savanna in nearly flat areas, occupying the slightly lower area. Less often, they may occur with Pine/Scrub Oak Sandhill (Mesic Transition or Blackjack Subtype) or, more rarely still, Very Wet Loamy Pine Savanna. Many examples, probably most in the past, are bordered by Pond Pine Woodland in wetter swales. There may be a broad ecotonal zone in the transition, where conditions are obviously wetter. Also frequent is a broad zone that is sometimes revealed by a particularly effective fire, where sparse savanna herbs are present amid dense pocosin shrubs. This suggests that the savanna may once have been more extensive and that it was overrun by shrubs spreading from the adjacent Pond Pine Woodland.

Variation: No variants are recognized. Examples vary with the transition to adjacent communities. Floristic differences between the outer Coastal Plain and Sandhills examples should be sought.

Dynamics: Dynamics are similar to those generally described in the Dry Longleaf Pine Communities and Wet Pine Savannas theme descriptions, especially the crucial role of fire, the patchy tree canopy structure, the conservativeness of many of the dominant plants, and the slowness to recover after mechanical damage or fire suppression.

Wet Loamy Pine Savannas are well known for their extremely high species richness at fine scales. Walker and Peet (1983) reported record-setting values of up to 42 species per 0.25 square meter, more than 50 per square meter, and 63-84 per 625 square meters in an annually burned example. Annual fire is generally believed to be more frequent than the natural regime, though some authors such as Frost (2000) believed rates nearly this high to be possible in this community. Fire at this frequency, if sustained in the long term, would prevent regeneration of even many of the characteristic species, including *Pinus palustris*, and is believed to be particularly detrimental to characteristic insect species. Palmquist et al. (2014) demonstrated that, despite the conservatism of the vegetation in general, the high species richness could disappear quickly, at least at the finer scales, through some combination of drought and with even slightly reduced fire frequency. More generally, Palmquist et al. (2015) demonstrated the complexity of the interplay among site wetness, soil texture, fire frequency, and scale of measurement in changes in species richness over time. The higher productivity of the wet communities with loamy soil leads to more rapid changes in vegetation over time, even though most of the individuals are long-lived.

Comments: Two associations in the NVC appeared to be equivalent to Wet Loamy Pine Savanna: *Pinus palustris* - *Pinus serotina* / *Ctenium aromaticum* - *Muhlenbergia expansa* - *Rhynchospora*

latifolia Woodland (CEGL003660) and *Pinus palustris* - *Pinus serotina* / *Sporobolus pinetorum* - (*Aristida stricta*) - *Eryngium integrifolium* Woodland (CEGL004501). The analysis of CVS data by Palmquist et al. (in prep) indicates that only one of these associations is needed. Both associations as currently named and described in the NVC are problematic, the first because *Rhynchospora latifolia*, used in the name, is not frequent in Wet Loamy Pine Savanna, but only in Very Wet Loamy Pine Savanna. The second has been defined to extend into the “wiregrass gap” in South Carolina, presumably because *Aristida stricta* sometimes is replaced by other grasses. However, there is no reason to believe that the overall floral assemblage of this community ranges farther southward than the other longleaf pine communities that occur in North Carolina.

Rare species:

Vascular plants: *Agalinis virgata*, *Amorpha confusa*, *Amorpha georgiana*, *Andropogon mohrii*, *Asclepias pedicellata*, *Dionaea muscipula*, *Helenium pinnatifidum*, *Helianthus floridanus*, *Lysimachia asperulifolia*, *Macbridea caroliniana*, *Muhlenbergia torreyana*, *Parnassia caroliniana*, *Paspalum dissectum*, *Pinguicula pumila*, *Platanthera integra*, *Platanthera nivea*, *Polygala hookeri*, *Solidago verna*, *Spiranthes longilabris*, and *Sporobolus teretifolius*.

Vertebrate animals: *Crotalus adamanteus*, *Peucaea aestivalis*, and *Picoides borealis*.

Invertebrate animals: *Euphyes bimaculate*, *Exyra semicrocea*, *Gabara* sp. 1, and *Metarranthis lateritiaria*.

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VERY WET LOAMY PINE SAVANNA

Concept: Very Wet Loamy Pine Savannas are very rare longleaf pine or pond pine savannas of the wettest loamy or silty soils, often with local inclusions high in calcium and pH. They are typically very high in species richness. They share most plant species of the Wet Loamy Pine Savanna but have some reduced in importance, and they also have a distinctive suite of additional species. *Pinus serotina* and *Ctenium aromaticum*, *Sporobolus teretifolius*, *Muhlenbergia expansa*, *Rhynchospora* spp., or *Carex striata* typically dominate. *Aristida stricta* is generally absent or scarce, and *Pinus palustris* is often scarce or appears to have difficulty regenerating after logging.

Distinguishing Features: Very Wet Loamy Pine Savannas are distinguished from all other pine savannas and flatwoods by a suite of herbs that includes *Rhynchospora latifolia*, *Sporobolus teretifolius*, *Eryngium yuccifolium*, *Stenanthium (Zigadenus) densum*, *Carex lutea*, *Thalictrum cooleyi*, *Scleria bellii*, *Coreopsis aristulata*, and *Allium* sp. 1. Additional species are likely to be present in Very Wet Loamy Pine Savanna and unlikely to be present in other savannas, including *Triantha racemosa*, *Asclepias longifolia*, *Eriocaulon decangulare*, *Rhynchospora oligantha*, and *Ilex myrtifolia*. A few species frequent in other savannas are scarce in Very Wet Loamy Pine Savannas, including *Aristida stricta*, *Vaccinium crassifolium*, *Pteridium pseudocaudatum*, *Iris verna*, *Gymnopogon brevifolius*, and the occasional species of drier sites such as *Pityopsis graminifolia* and *Symphytotrichum walteri*. A widely used hint of the presence of Very Wet Loamy Pine Savanna is the co-occurrence of *Liriodendron tulipifera* and *Taxodium ascendens* in or near the savanna.

Synonyms: *Pinus palustris* - *Pinus serotina* / *Magnolia virginiana* / *Sporobolus teretifolius* - *Carex striata* Woodland (CEGL004500). Pine Savanna (Very Wet Clay Variant) (3rd Approximation).

Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Sites: Very Wet Loamy Pine Savannas occur in the outer Coastal Plain on upland flats or terraces where limestone is near the surface (though outcrops are rare).

Soils: Most soils are mapped as Woodington (Typic Paleaquult) or Grifton (Typic Endoaqualf). Very Wet Loamy Pine Savannas appear to be associated with distinctive soils, generally with limestone near the surface. Nevertheless, soils have, at most, only small inclusions that are high in calcium and have a higher pH (5.5 to 7.2); the majority of their soil is similar to other pine savannas (pH 3.8-4.1). This community was called the Very Wet Clay Variant of Pine Savanna in the 3rd approximation, but soil samples in CVS plots consisted mostly of silt. Clay content was never higher than 10 percent and was not generally higher than in other loamy savannas.

Hydrology: Wet Loamy Pine Savannas are saturated at or near the surface during wet seasons, but virtually never have surface flooding. They are wetter than Wet Loamy Pine Savannas, presumably with the water table staying near the surface for longer periods.

Vegetation: Vegetation is an open to very open savanna, sometimes nearly treeless, that may be dominated by either *Pinus palustris* or *Pinus serotina*, with the latter more likely to be present.

While it is not clear if either the sparseness of trees or the scarcity of *Pinus palustris* is fully natural, both are more likely in this community than in other Wet Pine Savannas.

The herb layer is dense and very diverse. CVS data (Palmquist et al. in prep.) show an average of 85 vascular plant species per 1/10 hectare. *Ctenium aromaticum* and *Muhlenbergia expansa* are both highly constant and may be dominant in substantial patches. Also frequent and sometimes dominant are *Sporobolus pinetorum* and *Sporobolus teretifolius*. *Aristida stricta* is fairly frequent but not extensive. Though not appearing dominant in CVS data, *Rhynchospora* spp., *Andropogon cretaceus*, or *Andropogon glomeratus* may also dominate large patches. Though not usually with as high cover, *Rhynchospora latifolia* sometimes dominates the aspect. Other herbs that are highly constant in CVS data include *Rhexia alifanus*, *Rhexia lutea*, *Sarracenia flava*, *Sarracenia purpurea*, *Xyris caroliniana*, *Rhynchospora plumosa*, *Coreopsis linifolia*, *Dichanthelium ensifolium*, *Eurybia paludosa*, *Bigelowia nudata*, *Drosera capillaris*, *Zigadenus glaberrimus*, *Lycopodiella alopecuroides*, *Symphyotrichum dumosum*, *Eupatorium leucolepis*, *Sisyrinchium capillare*, *Helianthus heterophyllus*, *Lobelia nuttallii*, *Erigeron vernus*, and *Aletris farinosa*. Other herbs that are frequent include several additional *Rhynchospora* species (*chapmanii*, *oligantha*, *ciliaris*, *baldwinii*), *Polygala lutea*, *Rhexia petiolata*, *Dionaea muscipula*, *Stenanthium densum*, *Xyris ambigua*, *Xyris baldwinii*, *Triantha racemosa*, *Viola primulifolia*, *Asclepias longifolia*, *Chaptalia tomentosa*, *Eriocaulon decangulare*, *Lachnocaulon anceps*, *Marshallia graminifolia*, *Calopogon pallidus*, *Calopogon tuberosus*, *Trilisa paniculata*, *Carphephorus tomentosus*, *Helianthus angustifolius*, *Lachnanthes caroliniana*, *Polygala brevifolia*, *Fimbristylis puberula*, *Carex striata*, *Cleistosiopsis divaricata*, *Solidago virgata*, *Pseudolycopodiella caroliniana*, *Lycopodiella appressa*, *Eryngium integrifolium*, *Eryngium yuccifolium* var. *synchaetum*, *Polygala ramosa*, *Polygala hookeri*, *Osmundastrum cinnamomeum*, *Oxypolis ternata*, *Anchistea virginica*, *Seymeria cassioides*, *Scleria minor*, *Scleria ciliata*, *Scleria pauciflora*, *Pycnanthemum flexuosum*, *Iris tridentata*, *Parnassia caroliniana*, *Sarracenia minor*, *Centella erecta*, *Osmunda spectabilis*, *Ludwigia virgata*, *Arnoglossum ovatum*, *Lysimachia loomisii*, *Panicum virgatum*, *Dichanthelium acuminatum*, *Dichanthelium longiligulatum*, *Amphicarpum amphicarpon*, *Sabatia difformis*, *Eupatorium pilosum*, and *Eupatorium rotundifolium*. Less frequent but notable species also include *Thalictrum cooleyi*, *Carex lutea*, *Scleria bellii*, *Coreopsis aristulata*, and an unnamed *Allium* species, all of which appear to be endemic to this community or nearly so. Analysis of whole-site species lists by Richard LeBlond largely agrees with the CVS data, but includes a few additional species at fairly high frequency: *Agalinis aphylla*, *Aletris aurea*, *Andropogon mohrii*, *Anthenantia rufa*, *Aristida palustris*, *Bartonia virginica*, *Carex glaucescens*, *Cirsium virginianum*, *Coelorachis rugosa*, *Dichanthelium roanokense*, *Dichanthelium scabriusculum*, *Eupatorium mohrii*, *Euthamia caroliniana*, *Lobelia canbyi*, *Lobelia glandulosa*, *Oxypolis filiformis*, *Paspalum praecox*, *Pinguicula caerulea*, *Pluchea rosea*, *Polygala cruciata*, *Proserpinaca pectinata*, *Scleria muhlenbergii*, *Solidago gracillima*, *Dichanthelium scoparium*, *Fuirena breviseta*, *Hyptis alata*, *Juncus biflorus*, and *Solidago pulchra*.

In addition to the overall high species richness, the diversity within some large genera is also remarkable. In addition to the five species of *Rhynchospora* already named, Richard LeBlond reports *Rhynchospora caduca*, *careyana*, *cephalantha* var. *cephalantha*, *chalarocephala*, *colorata*, *corniculata*, *debilis*, *distans*, *decurrens*, *divergens*, *elliottii*, *fascicularis*, *filifolia*, *galeana*, *glomerata* var. *glomerata*, *gracilentata*, *inexpansa*, *inundata*, *macrostachya*, *microcephala*, *mixta*, *nitens*, *pallida*, *pinetorum*, *pusilla*, *rariflora*, *thornei*, and *torreyana*, with 16-27 species present in

the several Pender County sites. He reports a similar high diversity in the genus *Dichantheium*, with 13-23 taxa in several of the same sites.

While shrubs and small trees are a minor component in frequently burned examples, a great diversity of them may be present. The highly constant species are *Ilex glabra*, *Morella caroliniana*, *Acer rubrum* (presumably var. *trilobum*), *Magnolia virginiana*, *Aronia arbutifolia*, and *Cyrilla racemiflora*. *Cyrilla* often becomes tall and dense where burning has been inadequate. Other frequent shrubs include *Gaylussacia dumosa*, *Persea palustris*, *Vaccinium formosum*, *Vaccinium fuscatum*, *Morella pumila*, *Morella cerifera*, *Gaylussacia frondosa*, *Lyonia lucida*, *Nyssa sylvatica*, *Nyssa biflora*, *Diospyros virginiana*, *Clethra alnifolia*, *Arundinaria tecta*, *Hypericum crus-andreae*, *Ilex coriacea*, *Liquidambar styraciflua*, *Ilex myrtifolia*, *Rhus copallinum*, and what may be an undescribed species of *Hypericum* resembling *brachyphyllum*. *Smilax laurifolia*, *Smilax glauca*, and *Toxicodendron radicans* are frequent. *Vaccinium crassifolium* may be present but is less likely to dominate patches than in other wet longleaf pine communities.

Range and Abundance: Ranked G1. About ten examples are known in North Carolina, most in two small clusters, in northeastern Pender County and around the Waccamaw River in Brunswick and Columbus County. This community is nearly endemic to North Carolina, but a single example was recently recognized in South Carolina.

Associations and Patterns: Very Wet Loamy Pine Savannas are best regarded as small patch communities, though some examples may be more than 20 acres in size. Natural associations are not well known. Some are bordered by small stream drainages, a couple by Pond Pine Woodland, but most lack natural boundaries.

Variation: The two geographic clusters of this community have enough floristic differences to recognize as variants:

Maple Hill Variant occurs in Pender County.

Old Dock Variant occurs in Columbus and Brunswick County.

The South Carolina occurrence may represent a third variant.

Dynamics: Dynamics are generally similar to those described in the Dry Longleaf Pine Communities and Wet Pine Savannas theme descriptions, especially the crucial role of fire, the patchy tree canopy structure, the conservativeness of many of the dominant plants, and the slowness to recover after mechanical damage or fire suppression. The patterns of species richness at fine scales have not been studied as intensively as they have for Wet Loamy Pine Savannas, but likely are similar. Frequent fire appears crucial for maintaining species richness, as the high productivity of the dominant herbs as well as shrubs can quickly suppress smaller species.

The cause of the sparseness of trees in so many sites is not well known. It may not be natural, but it likely reflects something other than the past logging that is universal in pine savannas. It appears possible that wetness has made it more difficult for longleaf pine to regenerate after logging. This community may be at the margin of tolerance for longleaf pine, with reproduction possible only under rare circumstances, while its natural fire frequency is beyond the tolerance of other tree species. One planting of longleaf pine in a Very Wet Loamy Pine Savanna site known to the author, though planted on artificially raised mounds, ended with complete mortality after a hurricane led

to a prolonged wet period. It possible that competition from the dense herb layer and the high fire intensity it generates are detrimental even to longleaf pine seedlings, but it is not clear that these effects are greater than in some other pine savannas.

Comments: The distinctiveness of the Very Wet Loamy Pine Savanna community type has taken time to be fully appreciated. It has a remarkable collection of endemic species, but most have been recognized only in the last few decades. The most distinctive dominant species, *Sporobolus teretifolius*, remained confounded with *Sporobolus pinetorum* until the 1990s. Most of the sites for this community became known to the scientific and land conservation community only in the 1980s or later. Though specific published literature is scarce, they have been well surveyed by many botanists, and site reports and floristic analysis by Richard LeBlond and CVS data give a good picture of the community.

In addition to the NVC association named in synonymy above, a second association appears to be equivalent to this community: *Pinus palustris* - *Pinus serotina* / *Sporobolus pinetorum* - *Ctenium aromaticum* - *Eriocaulon decangulare* var. *decangulare* Woodland (CEGL004502).

Rare species:

Vascular plants: *Agrostis altissima*, *Allium* sp.1, *Andropogon mohrii*, *Aristida simpliciflora*, *Arnoglossum ovatum*, *Carex lutea*, *Dionaea muscipula*, *Helenium pinnatifidum*, *Linum floridanum* var. *chrysocarpum*, *Ludwigia linifolia*, *Macbridea caroliniana*, *Parnassia caroliniana*, *Plantago sparsiflora*, *Platanthera integra*, *Polygala hookeri*, *Rhynchospora decurrens*, *Rhynchospora divergens*, *Rhynchospora pinetorum*, *Rhynchospora thornei*, *Sarracenia minor*, *Scleria baldwinii*, *Scleria bellii*, *Scleria verticillata*, *Spiranthes longilabris*, *Sporobolus teretifolius*, and *Thalictrum cooleyi*.

Vertebrate animals: *Peucaea aestivalis* and *Picoides borealis*.

Invertebrate animals: *Acrionicta sinescripta*, *Calephelis virginensis*, *Exyra semicrocea*, *Melanoplus nubilus*, *Nematocampa baggetteria*, *Papaipema appasionata*, and *Stethophyma celatum*.

References:

Palmquist, K.A., R.K. Peet, S.C. Carr, M.T. Lee, M.P. Schafale, A.S. Weakley, and T.R. Wentworth. In prep. Longleaf pine (*Pinus palustris*) vegetation of the Atlantic and East Gulf Coast Coastal Plain, USA: Vegetation classification, biogeography, and soil properties. [Title being determined.]

NORTHERN WET PINE SAVANNA

Concept: The Northern Wet Pine Savanna community type encompasses all wet longleaf pine communities north of the range of wiregrass. It covers a broader range of site conditions than the other communities of the Wet Pine Savannas because the small number of sites and heavy alteration makes determination of their natural condition nearly impossible. It probably covers equivalents to Wet Pine Flatwoods, Wet Sandy Pine Savanna, and Wet Loamy Pine Savanna.

Distinguishing Features: Northern Wet Pine Savannas are distinguished from all other Pine Savanna types by occurrence north of the natural range of *Aristida stricta*, a short distance north of the Neuse River.

Synonyms: *Pinus palustris* - (*Pinus serotina*) / *Ilex glabra* - *Gaylussacia frondosa* - (*Kalmia carolina*) Woodland (CEGL003647). Wet Pine Flatwoods (Northern Variant).

Ecological Systems Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Sites: Northern Wet Pine Savannas occur on flat upland terraces and low ridges surrounded by swamps or marshes.

Soils: Northern Wet Pine Savannas could potentially have occurred on a wide range of wetland Ultisols and, less commonly, Spodosols. Pure sandy soils are much less extensive in the northern part of the Coastal Plain. Soils mapped in remnant examples include Exum (Aquic Paleudult), Grantham (Typic Paleaquult), Seabrook (Aquic Udipsamment), Younges (Typic Endoaqualf), and Boling (Aquic Hapludalf).

Hydrology: Sites are seasonally saturated by a high water table.

Vegetation: Remaining Northern Wet Pine Savannas, reflecting a long history of fire suppression, have canopies containing *Pinus palustris* and usually at least some *Pinus serotina*. *Acer rubrum*, *Liquidambar styraciflua*, *Quercus nigra*, and other oaks may also be present in the canopy and are common in the understory or shrub layer in sites that are now being burned. *Persea palustris*, *Magnolia virginiana*, *Diospyros virginiana*, and *Nyssa sylvatica* are also frequent in the understory or shrub layer. Limited CVS data (Palmquist et al. in prep) and site descriptions show a great diversity of shrub species common to the remnants. *Gaylussacia frondosa*, *Ilex glabra*, *Clethra alnifolia*, and *Arundinaria tecta* dominate patches. Other constant or frequent shrubs include *Morella cerifera*, *Aronia arbutifolia*, *Rhododendron atlanticum*, *Rhododendron viscosum*, *Vaccinium fuscatum*, *Vaccinium formosum*, *Vaccinium tenellum*, *Gaylussacia dumosa*, *Morella caroliniana*, *Ilex coriacea*, *Lyonia lucida*, *Rhus copallinum*, and *Symplocos tinctoria*. *Smilax glauca*, *Smilax rotundifolia*, *Smilax laurifolia*, and *Muscadinia rotundifolia* are frequent, and *Gelsemium sempervirens* may also be present. Shrub layers are generally dense at present, and the NVC association is named based on shrubs, but this community was probably no more shrubby than other longleaf pine savannas in natural condition. The herb layer in natural condition was probably dominated by *Schizachyrium scoparium* or various species of *Andropogon*, but no examples are now grass-dominated. *Pteridium pseudocaudatum* is the predominant herb in many examples. Frequent species in CVS plots for the handful of sites that have been sampled include

Osmundastrum cinnamomeum, *Andropogon cretaceus*, *Andropogon glaucopsis*, *Osmunda spectabilis*, *Aristida virgata*, *Solidago virgata*, *Eupatorium rotundifolia*, and *Eupatorium album*. Additional species reported in a thesis by Murray (1995) on the one site with substantial remaining herb diversity (combining wet and dry environments) indicate relationships to other longleaf pine communities and hint at differences: *Aletris farinosa*, *Dichanthelium strigosum* var. *leucoblepharis*, *Eupatorium pilosum*, *Eutrochium purpureum*, *Iris verna*, *Lobelia nuttallii*, *Muhlenbergia capillaris*, *Panicum virgatum*, *Polygala mariana*, *Rhynchospora inexpansa*, *Rhynchospora debilis*, *Scleria triglomerata*, *Solidago odora*, *Tephrosia virginiana*, *Asclepias longifolia*, *Eurybia paludosa*, *Baptisia cinerea*, *Baptisia tinctoria*, *Bartonia virginica*, *Carphephorus tomentosus*, *Danthonia sericea*, *Desmodium tenuifolium*, *Desmodium strictum*, *Gentiana autumnalis*, *Helianthus angustifolius*, *Lechea racemulosa*, *Lespedeza* sp., *Liatris graminifolia*, *Platanthera* sp., *Polygala lutea*, *Pycnanthemum* sp., *Rhexia mariana* var. *purpurea*, *Rhynchospora harveyi*, *Tephrosia spicata*, and *Sabatia* sp. It is not known if some Northern Wet Pine Savannas had species richness values comparable to those farther south, but likely they did not. Many of the characteristic species reach their northern range limit in southern North Carolina and do not appear to have naturally occurred in the range of this community.

Range and Abundance: Ranked G2 but probably warranting G1. No high-quality examples are known to remain. About five examples remain in North Carolina. This community is also known in southern Virginia. Historical records cited by Murray (1995) demonstrate that longleaf pine was widespread even in the inner Coastal Plain in Halifax County, but it is unclear if it dominated the landscape to the extent that it did farther south. The northern Coastal Plain at present supports more extensive oak-hickory forests than the southern part in North Carolina.

Associations and Patterns: Northern Wet Pine Savannas now occur as small patch communities. They probably once occurred in large patches. Natural associations are not known. Most examples are now isolated, but a few are associated with tidal marshes.

Variation: The few remaining examples show substantial variation. This community spans a broad range of wetness and soil texture, probably equivalent to at least four community types.

Dynamics: The dynamics described for the Wet Pine Savannas and Dry Longleaf Pine Communities themes probably apply fairly well to Northern Wet Pine Savannas in their natural condition. The dominance of *Pinus palustris* implies frequent fire, but the absence of the extremely flammable *Aristida stricta* along with a somewhat different climate may have led to somewhat lower fire frequency and intensity. The grasses most likely to have dominated are less conservative than *Aristida stricta*, and this may also have changed community dynamics in some way.

Comments:

Rare species:

Vertebrate animals: *Picoides borealis*.

References:

Murray, A.N. 1995. Description and restoration of a relict longleaf pine flatwood in Halifax County, North Carolina. M.S. Thesis, North Carolina State University, Raleigh.

Palmquist, K.A., R.K. Peet, S.C. Carr, M.T. Lee, M.P. Schafale, A.S. Weakley, and T.R. Wentworth. In prep. Longleaf pine (*Pinus palustris*) vegetation of the Atlantic and East Gulf Coast Coastal Plain, USA: Vegetation classification, biogeography, and soil properties. [Title being determined.]

SANDHILL SEEP (TYPIC SUBTYPE)

Concept: Sandhill Seeps are sloping, seepage-fed herbaceous or shrub-herb wetlands that share flora with the Wet Pine Savannas theme. They form in interbedded sand and clay, where a clay layer forces shallow groundwater to the surface. They are primarily in the Sandhills region but may occur in similar settings of interbedded sand and clay elsewhere in the Coastal Plain. They are generally small patches on mid to lower slopes; they may occur as isolated seeps or as broad to narrow ecotonal communities between Pine/Scrub Oak Sandhill and Streamhead Pocosin communities. The amount of shrub biomass varies with fire history, but the natural state includes abundant herbs. The Typic Subtype encompasses the more widespread examples that lack the distinctive flora of the Savanna Subtype that is shared with Wet Loamy Pine Savannas.

Distinguishing Features: Sandhill Seeps are distinguished from Streamhead Pocosins by occurring on mineral soils with a slope and by having a significant persistent component of herbs. Many frequently burned examples have a shrub-dominated central portion but have substantial areas of herb or mixed dominance. However, the natural boundary may be difficult to discern if long absence of fire has allowed shrubs to invade more of the seep. In general, any persisting conservative savanna herbs, even sparse, are an indication that that location was once an herb-dominated seep. Streamhead Pocosins may have opportunistic herbs immediately after a hot fire but the persistent herb component is limited to a few wetland fern and sedge species.

The Typic Subtype is distinguished from the Savanna Subtype by having smaller numbers of species shared with Wet Loamy Pine Savannas of the outer Coastal Plain, lacking much of the diverse herbaceous flora of the Savanna Subtype. Species frequent in the Savanna Subtype and scarce or absent in the Typic Subtype include *Ctenium aromaticum*, *Chaptalia tomentosa*, *Coreopsis linifolia*, *Erigeron vernus*, *Xyris ambigua*, *Bigelowia nudata*, *Eupatorium leucolepis*, *Vilva primulifolia*, *Aletris farinosa*, *Eryngium integrifolium*, *Triantha racemosa*, *Stenanthium densum*, *Gymnopogon brevifolia*, *Marshallia graminifolia*, *Nabalus autumnalis*, *Scleria ciliaris*, *Centella erecta*, *Ludwigia virgata*, *Solidago speciosa*, *Solidago virgata*, *Ludwigia hirtella*, *Polygala cruciata*, and *Xyris curtisii/diformis*. Few species are more confined to the Typic Subtype, but *Sarracenia rubra*, *Scleria nitida*, *Pteridium pseudocaudatum*, *Rhododendron atlanticum*, *Fothergilla gardenii*, *Amelanchier obovalis*, *Arundinaria tecta*, and *Quercus marilandica* appear to be.

Synonyms: *Gaylussacia frondosa* - *Clethra alnifolia* - *Arundinaria gigantea* ssp. *tecta* / *Aristida stricta* - *Pteridium aquilinum* var. *pseudocaudatum* Herbaceous Vegetation (CEGL004468). *Clethra alnifolia* - *Toxicodendron vernix* / *Aristida stricta* - *Osmunda cinnamomea* - *Sarracenia* spp. Shrub Herbaceous Vegetation (CEGL004467).

Ecological Systems Atlantic Coastal Plain Sandhill Seep (CES203.253).

Sites: Sandhill Seeps occur on gentle to steep slopes on substrates where clay underlies permeable sands and where a clay layer intersects the ground surface. All or most are on side slopes in the dissected Sandhills region. Rare examples may occur elsewhere in the Coastal Plain on upland slopes along stream valleys or on relict coastal scarps. Some seeps are isolated on mid slopes, with the seepage water sinking beneath sand below them, while others are on the edges of streamhead drainages that are themselves kept saturated by seepage. Some seeps are associated with a slope

break, a local steepening of the slope presumably caused by the greater coherence of the clay layer. Some seeps occur in a distinctive amphitheater-shaped indentation in the slope, likely created by sapping by the groundwater discharge. Because some clay layers are extensive while others are not, seeps may occur in bands or in multiple patches along a given drainage, while others are isolated. Even where clay layers are continuous, patterns of slope erosion or of downslope movement of sand may make seeps discontinuous.

Soils: Sandhill Seep soils consist of sand underlain by shallow clay or by dense clay at the surface. Plinthite may be common. The thickness of the sand above the clay often varies across a given seep, creating gradients in wetness and soil texture and leading to zonation in the vegetation. Seeps are inclusions in other soil map units. Most are mapped as Blaney (Arenic Hapludult), Vacluse (Fragic Kanhapludult), or Gilead (Aquic Hapludult); fewer as Johnston (Cumulic Humaquept) or Fuquay (Plinthic Kandiudult); and rarely as various other series.

Hydrology: Sandhill Seeps are seasonally to semipermanently saturated at or near the surface. Rainwater readily percolates downward through the coarse sand uphill, but the impermeable clay layers stop downward movement and cause lateral flow that emerges as seepage where the clay layer approaches the surface. The most vigorous seeps may have their discharge collecting into a flowing rivulet in the center. In mid slope seeps, there is often a sand layer below the clay, and water flowing downhill from the seep may sink deeply enough into the sand that the rooting zone again is dry enough to support sandhill communities downhill from the seep.

Vegetation: Sandhill Seep vegetation is unusually heterogeneous and is often visibly zoned in response to variation in wetness and soil conditions or in response to gradients of wetness and soil conditions or of fire penetration. While seeps with little recent fire may be covered with shrubs throughout, even frequently burned seeps often have a central zone with tall woody vegetation that resembles Streamhead Pocosin. *Lyonia lucida*, *Ilex coriacea*, *Ilex glabra*, or *Cyrilla racemiflora* typically dominate this zone, while *Toxicodendron vernix*, *Morella caroliniana*, *Aronia arbutifolia*, *Vaccinium fuscatum*, sometimes even *Eubotrys racemosa* or *Alnus serrulata* may be present. There may be an open canopy containing *Pinus serotina*, *Liriodendron tulipifera*, *Acer rubrum*, *Persea palustris*, or *Magnolia virginiana*. *Smilax laurifolia* may form dense tangles. These species may be present in other zones of the seep but generally at low density, though, if fire has only recently penetrated the seep, they may exist as dense beds of sprouts. Outer zones that are shrubby are more likely to be dominated by *Clethra alnifolia*, *Gaylussacia frondosa*, *Ilex glabra*, or *Arundinaria tecta*, and may contain *Fothergilla gardenii*, *Amelanchier obovalis*, *Rhus copallinum*, *Lyonia mariana*, *Vaccinium tenellum*, *Gaylussacia dumosa*, *Nyssa sylvatica*, *Sassafras albidum*, and even a few stems of *Quercus marilandica* or *Pinus palustris*. Outer zones may include some *Aristida stricta* and often abundant *Pteridium pseudocaudatum*. The herb layer in the intermediate and interior zones often includes patches dominated by *Osmundastrum cinnamomeum*, and may have patches dominated by *Andropogon glomeratus*, *Andropogon virginicus*, or *Dichantheium ensifolium*. Beds of *Sphagnum* spp. may be present. Otherwise, the herbaceous vegetation tends to be fairly diverse, heterogeneous within and among sites, and lacks strong dominants. The only highly constant species in CVS plot data (Palmquist et al. in prep) are *Eupatorium rotundifolium* and *Xyris caroliniana*. Other frequent species include *Eupatorium pilosum*, *Eupatorium leucolepis*, *Xyris caroliniana*, *Xyris platylepis*, *Polygala lutea*, *Rhexia petiolata*, *Lobelia nuttallii*, *Sarracenia purpurea*, *Sarracenia flava*, *Sarracenia rubra*,

Lachnocaulon anceps, *Pycnanthemum flexuosum*, *Dichantherium strigosum*, *Dichantherium dichotomum*, *Ctenium aromaticum*, *Hexastylis sorriei*, *Solidago salicina*, and *Symphyotrichum dumosum*. In the wetter interior herbaceous areas, *Eriocaulon decangulare*, *Anchistea virginica*, *Lorinseria areolata*, or *Osmunda spectabilis* may be abundant. Other species that are characteristic, though less frequent in plot data, include *Sporobolus pinetorum*, *Calamovilfa brevipilis*, *Oxypolis ternata*, *Drosera capillaris*, *Drosera rotundifolia*, *Lilium pyrophilum*, *Lobelia "batsonii"*, and in rare examples, *Cladium mariscoides*.

Range and Abundance: Ranked G3. Almost all examples are in the Sandhills region, with the majority of examples known within Fort Bragg. Rare examples attributed to this community occur in the middle or outer Coastal Plain. This community is also present in the Sandhills in South Carolina.

Associations and Patterns: Sandhill Seeps are small patch communities. They sometimes occur in complexes with multiple small patches, but never amount to a large collective acreage. Sandhill Seeps are usually bordered by Pine/Scrub Oak Sandhill (Blackjack Subtype), at least on the uphill side and often laterally and even downhill as well. Many grade downhill to Streamhead Pocosin or, probably more naturally than at present, Streamhead Canebrake. Of particular note are unusual examples that are bordered below by Coastal Plain Semipermanent Impoundments.

Variation: Sandhill Seeps encompass an extremely wide range in wetness and composition, among examples but also, because of their geologic setting, within individual seeps. See the comments below for discussion of the two former subtypes. Because of the changes caused by the universal alteration in fire regimes, it is difficult to sort out patterns in the variation. It is likely that several subtypes should be recognized, but the basis for doing so is unsettled and needs substantial additional work. Before beginning development of the 4th Approximation, several variants of Sandhill Seep were developed during survey work at Fort Bragg. Though definition of them is difficult, they are retained as variants, as a starting point for future work.

1. Typic Variant best fits the description here, often encompassing strong zonation and ranging from marginally wet to moderately wet within individual examples.

2. Bog Variant encompasses lower slope and slope base examples or zones that are extremely wet and bog-like, often with more organic soil, and with vegetation that is a subset of the most saturation-tolerant herbs. This variant often is associated with Coastal Plain Semipermanent Impoundments and, though it is above the level of the impounded water, may be dependent on the effect of the impoundment on the ground water gradient. Where the impoundment is abandoned and has developed into a mire, plants of the Sandhill Seeps often extend out into the pond bed and mix with species of the mire. This is recognized as the Bog Variant of Coastal Plain Semipermanent Impoundment (Sandhills Mire Subtype).

3. Twig-rush variant is an extremely rare community occurring over a nearly flat-lying surficial clay bed and dominated by *Cladium mariscoides*.

Dynamics: As with other Wet Pine Savannas, Sandhill Seeps are extremely dependent on frequent fire to maintain their characteristic herb diversity. Without fire, shrubs quickly expand to cover the

entire seep and herbaceous plants can be largely eliminated. However, fire dynamics are more complex than in the flat savannas or even in rolling sandhills. While the outer zones likely burn every time the adjacent sandhills burn, slope breaks, rivulets, and wetter zones may limit fire spread or reduce its intensity. The Streamhead Pocosins that often lie a short distance downhill limit fire spread with some wind directions. Even if ignited, portions may be able to burn only during drier seasons. Even places with frequently prescribed fire, sufficient to maintain sandhill communities in excellent condition, may have Sandhill Seeps deteriorating because of too little burning.

Many seeps show evidence of variable fire penetration, with tall, unburned shrub zones in the middle, zones of dense shrub sprouts that are recently burned but may have once been unburned for many years, and more frequently burned outer zones. This pattern likely is largely a result of past fire suppression, but something similar probably occurred under natural conditions. Even in portions of Fort Bragg that have burned more frequently than under natural conditions sometimes have such unburned centers. Therefore, these communities may have shown more temporal variation than other savannas, with shrubs expanding and contracting over time.

More than most longleaf pine communities, Sandhill Seeps may be subject to variation in weather from year to year. The sources of ground water are local, shallow, and have limited residence time in the ground. Dry conditions may interact with the fire regime, allowing fire to penetrate farther into the seep but also allowing upland species to spread into the edge of the seep.

The seeping groundwater is low in nutrients, but it may carry enough nutrients leached from the ash and vegetation in the sandhills above to make Sandhill Seeps more fertile than adjacent communities.

Comments: Sandhill Seeps have been covered by two NVC associations: *Gaylussacia frondosa* - *Clethra alnifolia* - *Arundinaria gigantea* ssp. *tecta* / *Aristida stricta* - *Pteridium aquilinum* var. *pseudocaudatum* Herbaceous Vegetation (CEGL004468) and *Clethra alnifolia* - *Toxicodendron vernix* / *Aristida stricta* - *Osmunda cinnamomea* - *Sarracenia* spp. Shrub Herbaceous Vegetation (CEGL004467). In earlier drafts of the 4th Approximation, they were divided into a Wet and a Very Wet Subtype. Both subdivisions proved impractical. The NVC associations were not clearly distinguished as more and less wet, making them especially difficult to apply and contradicting the subtypes they were synonymized to. It was generally impossible to tell which subtypes were present from older site descriptions, and almost all sites that were visited proved to have both subtypes present as zones. Analysis of CVS data failed to find two sets of plots corresponding to them. Sandhill Seeps are particularly hard to study with CVS plot methodology. Their small size often is comparable to that of a single CVS module, sometimes resulting in portions of plot containing upland vegetation. With the strong zonation, small changes in placement of the plot can lead to drastically different data. Variation in past and current fire regimes further complicates the picture. Nevertheless, Sandhills Seeps in the current broad classification are one of the most heterogeneous communities in the 4th Approximation. Further subdivision is clearly warranted if an appropriate way of organizing the variation can be clarified.

A third NVC association, described as a sandhill-pocosin ecotone community, is also similar and perhaps equivalent to Sandhill Seeps: (*Pinus palustris*, *Pinus serotina*) / *Ctenium aromaticum* -

Muhlenbergia expansa - *Calamovilfa brevipilis* Woodland (CEGL003659). It was included in some early drafts of the 4th Approximation but has been dropped. While the nominal species and other species described for this association sometimes occur in narrow ecotones, a few meters wide, on the border of Streamhead Pocosins and Pine/Scrub Oak Sandhill, all of them also occur in more extensive Sandhill Seeps. It is often extremely difficult to distinguish between Sandhill Seeps and ecotones. If several fires are able to penetrate into the pocosin vegetation, wetland herbs often become apparent in a broader area. It thus appears that some ecotones are just narrow remnants of once-broader seeps. Others may have always been narrow. However, ecotones are particularly subject to modification by fire suppression, as fire plow lines often disturb them and as shrubs easily spread into them from the adjacent pocosins. It would be possible to name many ecotone communities, as most upland and wetland longleaf pine communities can occur adjacent to a pocosin and have small numbers of distinctive savanna species at the interface.

Rare species:

Vascular plants: *Astragalus michauxii*, *Balduina atropurpurea*, *Carex exilis*, *Cladium mariscoides*, *Danthonia epilis*, *Dichanthelium cryptanthum*, *Dionaea muscipula*, *Eriocaulon texense*, *Eupatorium resinsum*, *Helianthus floridanus*, *Lilium pyrophilum*, *Lindera subcoriacea*, *Lysimachia asperulifolia*, *Parnassia caroliniana*, *Rhynchospora macro*, *Rhynchospora oligantha*, *Schwalbea americana*, *Solidago gracillima*, *Solidago verna*, *Xyris chapmanii*, and *Xyris scabrifolia*.

Vertebrate animals: *Picoides borealis*.

Invertebrate animals: *Hesperia meskei*.

References:

Palmquist, K.A., R.K. Peet, S.C. Carr, M.T. Lee, M.P. Schafale, A.S. Weakley, and T.R. Wentworth. In prep. Longleaf pine (*Pinus palustris*) vegetation of the Atlantic and East Gulf Coast Coastal Plain, USA: Vegetation classification, biogeography, and soil properties. [Title being determined.]

SANDHILL SEEP (SAVANNA SUBTYPE)

Concept: Sandhill Seeps are sloping, seepage-fed herbaceous or shrub-herb wetlands that share flora with the Wet Pine Savannas theme. They form in interbedded sand and clay, where a clay layer forces shallow groundwater to the surface. They are primarily in the Sandhills region but may occur in similar settings of interbedded sand and clay elsewhere in the Coastal Plain. The Savanna Subtype covers examples that, when frequently burned, resemble Wet Loamy Pine Savannas in their flora. Patches with this kind of vegetation exist in the frequently burned central portions of Fort Bragg. Narrow bands of related vegetation exist on the ecotones between sandhill communities and Streamhead Pocosins in other areas with fairly frequent burning.

Distinguishing Features: Sandhill Seeps are distinguished from Streamhead Pocosins by occurring on mineral soils with a slope and by having a significant persistent component of herbs. However, the natural boundary may be difficult to discern if long absence of fire has allowed shrubs to spread into the seep. In general, any persisting conservative savanna herbs, even sparse, are an indication that a location was once an herb-dominated seep, though more widespread or less conservative species such as *Osmundastrum cinnamomeum* or *Rhynchospora* spp. may not be reliable indicators.

The Savanna Subtype is distinguished from the Typic Subtype by a large number of herbaceous species, most of them shared with Wet Loamy Pine Savannas. Species frequent in the Savanna Subtype and scarce or absent in the Typic Subtype include *Ctenium aromaticum*, *Chaptalia tomentosa*, *Coreopsis linifolia*, *Erigeron vernus*, *Xyris ambigua*, *Bigelovia nudata*, *Eupatorium leucolepis*, *Viola primulifolia*, *Aletris farinosa*, *Eryngium integrifolium*, *Triantha racemosa*, *Stenanthium densum*, *Gymnopogon brevifolius*, *Marshallia graminifolia*, *Nabalus autumnalis*, *Scleria ciliaris*, *Centella erecta*, *Ludwigia virgata*, *Solidago speciosa*, *Solidago virgata*, *Ludwigia hirtella*, *Polygala cruciata*, and *Xyris curtisii/diformis*. Few species are more confined to the Typic Subtype, but *Sarracenia rubra*, *Scleria nitida*, *Pteridium pseudocaudatum*, *Rhododendron atlanticum*, *Fothergilla gardenii*, *Amelanchier obovalis*, *Arundinaria tecta*, and *Quercus marilandica* appear to be.

The Savanna Subtype floristically resembles Wet Loamy Pine Savanna but may generally be distinguished by its location in the Sandhills region, occurring on at least gentle slopes, and having soil saturation resulting from seepage rather than from a high water table. Though floristically similar, there are significant floristic differences between the two communities. Some of the species frequent in the Savanna Subtype but not in Wet Loamy Pine Savanna include *Viburnum nudum*, *Toxicodendron vernix*, *Pycnanthemum flexuosum*, *Scleria pauciflora*, *Liatris spicata*, *Juncus acuminatus*, *Juncus trigonocarpus*, *Schwalbea americana*, *Angelica venenosa*, and *Lycopus virginicus*. Some of the species frequent in Wet Loamy Pine Savanna and absent or much less frequent in this community include *Dionaea muscipula*, *Pilea tenuifolia*, *Sporobolus pinetorum*, *Sisyrinchium capillare*, *Vaccinium crassifolium*, *Desmodium tenuifolium*, *Eurybia paludosa*, *Cleistesiosis divaricatus*, *Carphephorus tomentosus*, *Cirsium virginianum*, *Lysimachia loomisii*, *Trilisa odoratissima*, *Trilisa paniculata*, and *Tephrosia hispidula*.

Synonyms: (*Pinus palustris*, *Pinus serotina*) / *Ctenium aromaticum* - *Muhlenbergia expansa* - *Calamovilfa brevipilis* Woodland (CEGL003659).

Ecological Systems Atlantic Coastal Plain Sandhill Seep (CES203.253).

Sites: Sandhill Seeps occur on gentle to steep slopes on substrates where clay underlies permeable sands and where a clay layer intersects the ground surface. All or most are on side slopes in the dissected Sandhills region. The Savanna Subtype appears to occur on less wet seeps with gentler slopes.

Soils: Sandhill Seep soils consist of sand underlain by shallow clay or by dense clay at the surface. Plinthite may be common. Details of soils for the Savanna Subtype in particular are poorly known. Examples may be expected to be mapped as the common Ultisols of the Sandhills: as Blaney (Arenic Hapludult), Vaucuse (Fragic Kanhapludult), Gilead (Aquic Hapludult), Fuquay (Plinthic Kandiudult), or Byars (Umbric Paleaquult).

Hydrology: Sandhill Seeps are seasonally to semipermanently saturated at or near the surface. Rainwater readily percolates downward through the coarse sand uphill, but the impermeable clay layer stops downward movement and cause lateral flow which emerges as seepage where the clay layer approaches the surface.

Vegetation: Vegetation in the Savanna Subtype, where frequently burned, may have an open canopy of either *Pinus palustris* or *Pinus serotina*. A diverse herb layer may be dominated by *Aristida stricta* or may have patches dominated by *Ctenium aromaticum* or *Sporobolus pinetorum*, potentially also by *Calamovilfa brevipilis* or *Rhynchospora* sp. In CVS plots (Palmquist, et al. in prep.), *Eupatorium rotundifolium*, *Andropogon* sp., *Dichanthelium* spp., *Scleria pauciflora*, and *Chaptalia tomentosa* sometimes have high cover. Other highly constant species include *Lachnocaulon anceps*, *Rhexia alifanus*, *Symphyotrichum dumosum*, *Coreopsis linifolia*, *Drosera capillaris*, *Erigeron vernus*, *Eupatorium pilosum*, *Eupatorium leucolepis*, *Xyris ambigua*, *Xyris caroliniana*, *Osmundastrum cinnamomeum*, *Bigelovia nudata*, *Pycnanthemum flexuosum*, and *Viola primulifolia*. Additional frequent herb layer species include *Aletris farinosa*, *Calopogon tuberosus*, *Eryngium integrifolium*, *Helianthus angustifolius*, *Lespedeza capitata*, *Pogonia ophioglossoides*, *Polygala lutea*, *Solidago odora*, *Symphyotrichum walteri*, *Sarracenia flava*, *Pteridium pseudocaudatum*, *Hypoxis wrightii*, *Lycopodiella alopecuroides*, *Muhlenbergia expansa*, *Rhexia petiolata*, *Stylosanthes biflora*, *Iris verna*, *Stenanthium densum*, *Calopogon pallidus*, *Dichanthelium strigosum*, *Eupatorium mohrii/recurvans*, *Gymnopogon brevifolius*, *Ionactis linariifolia*, *Liatris spicata*, *Lespedeza virginica*, *Lycopodiella alopecuroides*, *Lycopus virginicus*, *Marshallia graminifolia*, *Nabalus autumnalis*, *Potentilla canadensis*, *Sisyrinchium capillare*, *Vaccinium crassifolium*, *Juncus acuminatus*, *Juncus trigonocarpus*, *Oxypolis ternata*, *Scleria ciliata*, *Zigadenus glaberrimus*, *Panicum virgatum*, *Aletris aurea*, *Centella erecta*, *Coreopsis verticillata*, *Desmodium tenuifolium*, *Eriocaulon decangulare*, *Ludwigia virgata*, *Orbexilum pedunculatum/psoralioides*, *Pinguicula caerulea*, *Pityopsis graminifolia*, *Rhexia lutea*, *Sarracenia purpurea*, *Schwalbea americana*, *Scleria minor*, *Sericocarpus linifolius*, *Solidago salicina*, *Solidago speciosa*, *Solidago virgata*, *Sophranthe pilosa*, and several species of *Rhynchospora* (*chapmanii*, *marliniana/plumosa*, *grayi*, *rariflora*).

Shrub cover and density vary with fire history. The highly constant species in plots are *Ilex glabra*, *Morella carolinensis*, and *Viburnum nudum*. Other frequent species include *Clethra alnifolia*, *Aronia arbutifolia*, *Arundinaria tecta*, *Gaylussacia frondosa*, *Gaylussacia dumosa*, *Lyonia*

ligustrina, *Vaccinium tenellum*, *Rhus copallinum*, *Toxicodendron vernix*, *Vaccinium formosum*, and *Alnus serrulata*,

Range and Abundance: Ranked G2, but see comments below about questions regarding the concept of the NVC association. The only place where broad areas with the vegetation described here are known is the central portion of Fort Bragg. This would suggest a rank of G1. Narrow ecotones with small subsets of this flora are widespread in Fort Bragg and limited in other conservation lands. If they are interpreted as the same community, most examples are very small or heavily degraded by shrub encroachment. The NVC association is also attributed to South Carolina. No plots or specific occurrences are known there, and it likely exists only as very small or degraded examples.

Associations and Patterns: The Savanna Subtype is a small patch community, at least as well-developed examples exist at present. Examples generally would be bordered by Pine/Scrub Oak Sandhill (Blackjack Subtype) uphill, and Streamhead Pocosin downhill.

Variation: Little is known of the range of variation.

Dynamics: Uncertainties in the interpretation of this community lead to different conclusions about probable dynamics. This community appears to be even more dependent on frequent fire than most wet longleaf pine communities. Well-developed examples are known only in places that are burned nearly annually, a frequency believed to be more than the likely natural fire regime.

Comments: The concept and description of this community remain somewhat uncertain. It is accepted provisionally for the 4th Approximation. The NVC association was initially defined as the “sandhill-pocosin” ecotone, a zone between Pine/Scrub Oak Sandhill and Streamhead Pocosin in which multiple species of pine savannas are found. It is notable because a large number of plant species can exist in it that are not present in either adjacent community, and for some, it appears to be their only habitat in the Sandhills region. It is generally only a few meters wide. It was not accepted in earlier drafts of the 4th Approximation because it is problematic as a unit for tracking of occurrences. However, in the very frequently burned parts of central Fort Bragg, many of them in rarely accessible artillery range buffer zones, savanna-like vegetation occurs in broader expanses, running down gentle slopes to adjoin Streamhead Pocosin that are much narrower than those elsewhere. A unique opportunity to sample vegetation plots in some of these areas led to the data that were used to describe this community. Analysis of CVS data (Palmquist, et al. in prep.) found them to be distinct from both Sandhill Seeps and Wet Loamy Pine Savannas, as described above, and recommended revising the concept of the NVC association to emphasize these areas rather than narrow ecotones. This approach has been adopted for the 4th Approximation.

As thus defined, the Savanna Subtype could be interpreted as either a version of Sandhill Seep or a version of Wet Loamy Pine Savanna. The decision to treat it as a Sandhill Seep is uncertain. It appears to share the setting of the Typic Subtype of Sandhill Seep. Its flora, based on existing plots, appears more similar to Wet Loamy Pine Savanna. However, it is unclear how much its distinctive character is a result of site differences and how much it is a result of fire history. The few species that are more abundant in plots from the Typic Subtype are mostly shrubs that generally increase with fire suppression. Most examples occur outside of Fort Bragg, where even

lands that are now burned at something approximating a natural fire frequency underwent many years with no fire. Fort Bragg was established not long after effective fire suppression came to the Sandhills region; it has been subject to frequent fire for most of the time since. It thus has a continuity with the frequently burned past that remains nowhere else. On the other hand, the near annual burning there is probably unnaturally frequent. It may have altered this community in various ways. The geology of Fort Bragg also differs in some ways from the rest of the Sandhills, so it is possible there are site differences as well. The community described here is thus an extremely rare, highly diverse community known from only a small area and distinct due to an unknown combination of subtle site differences, historical continuity of fire regimes, and an extreme present fire regime.

It remains somewhat a question for investigation or interpretation whether the ecotones a few meters wide that support some of the same species represent the same community. It is possible that they are the last remnants of savannas that once were much wider and more comparable to those in Fort Bragg. However, it is also possible that they are naturally small and depauperate, and that the Savanna Subtype can fully develop only on unusual terrain such as gentler slopes.

It also remains a question how distinct the Typic Subtype of Sandhill Seep is from the Savanna Subtype in long term character. Most remaining examples of the Typic Subtype show evidence of substantial alteration by fire suppression, suggesting they may have lost some of their herbaceous flora.

Rare species:

Vascular plants: *Astragalus michauxii*, *Balduina atropurpurea*, *Carex exilis*, *Cladium mariscoides*, *Danthonia epilis*, *Dichanthelium cryptanthum*, *Dionaea muscipula*, *Eriocaulon texense*, *Eupatorium resinosum*, *Helianthus floridanus*, *Lilium pyrophilum*, *Lindera subcoriacea*, *Lysimachia asperulifolia*, *Parnassia caroliniana*, *Rhynchospora macro*, *Rhynchospora oligantha*, *Schwalbea americana*, *Solidago gracillima*, *Solidago verna*, *Xyris chapmanii*, *Xyris scabrifolia*,

Vertebrate animals: *Picoides borealis*

Invertebrate animals: *Hesperia meskei*

References:

Palmquist, K.A., R.K. Peet, S.C. Carr, M.T. Lee, M.P. Schafale, A.S. Weakley, and T.R. Wentworth. In prep. Longleaf pine (*Pinus palustris*) vegetation of the Atlantic and East Gulf Coast Coastal Plain, USA: Vegetation classification, biogeography, and soil properties. [Title being determined.]