PIEDMONT AND MOUNTAIN UPLAND POOLS AND DEPRESSIONS

Contents

PIEDMONT AND MOUNTAIN UPLAND POOLS AND DEPRESSIONS THEME

Concept: Piedmont and Mountain Upland Pools and Depressions are isolated wetlands of small basins in upland settings. They are filled by rainwater and local runoff from a limited area, and they hold standing water part but generally not all of the year. They may be forests or open woodland or shrub/herb vegetation. Most are in the central and eastern Piedmont, but one rare subtype is in the Blue Ridge.

Distinguishing Features: Piedmont and Mountain Upland Pools and Depressions are distinguished from all other communities by their occurrence in upland settings in the Piedmont or Mountains, outside of floodplains and generally not associated with streams, with wetness resulting from naturally ponded water rather than seepage or overbank flooding. When not flooded, they may be distinguished by dominance of wetland vegetation, in strong contrast to that of the surrounding uplands.

Within the theme, Upland Pool communities are distinguished by being wet enough to not support a closed tree canopy, while Upland Depression Swamp Forests have a full forest canopy when not disturbed.

Sites: Piedmont and Mountain Upland Pools and Depressions communities occur in both gently sloped basins in unusually flat upland topography associated with mafic or clay-rich rocks and in steeper ridgetop depressions in more rugged terrain. Infiltration of water may be prevented by either a dense clay hardpan or by bedrock. They are most often associated with mafic rocks such as gabbro and diabase, but they may occur on felsic rocks, clay-rich sedimentary or meta-sedimentary rocks, or, rarely, on flat-lying quartzite beds.

Soils: These communities have soils where internal drainage is restricted, either by bedrock or by a dense clay hardpan. Many, but not all, have shrink-swell clays such as montmorillonite, which prevent infiltration. Soils are very acidic and low in base cations, but those on mafic rocks are somewhat higher in both. Iredell soil (Vertic Hapludalf) is the predominant soil mapped.

Hydrology: Piedmont and Mountain Upland Pools and Depressions are seasonally flooded by water that may range from a few inches to several feet deep. Water comes from rainfall and from a small local watershed. An impermeable substrate, either a clay hardpan or potentially bedrock, prevents infiltration. Water loss is primarily through evaporation. Some basins have a visible overflow channel while others do not, but all must have a place where water overflows the basin in periods of extreme wetness. Standing water typically extends into the growing season but is gone by summer in most examples. In some years standing water may be absent, may persist through more of the season, or may return later in the season after heavy rains. Because of the impermeable substrate and limited rooting depth, conditions for plants may be dry when water has evaporated and soil has dried.

Vegetation: Vegetation in Piedmont and Mountain Upland Pools and Depressions may be either a forest with a full tree canopy, or somewhat more open vegetation that includes trees confined to the edges and shrubs or herb dominating in the middle. In most examples, *Quercus phellos* is the dominant or most abundant tree. Some communities have codominant or dominant *Quercus lyrata*,

or more rarely, *Quercus michauxii, Quercus bicolor*, or in the mountains, *Nyssa sylvatica*. In the more open Upland Pools, shrubs are abundant at least on the edges. *Cephalanthus occidentalis, Vaccinium fuscatum, Vaccinium formosum, Eubotrys racemosa*, and in the mountains*, Leucothoe fontanesiana* are often dominant. In many examples, tangles of vines, especially *Smilax rotundifolia* or *Smilax walteri,* are extensive. Herbs are species tolerant of prolonged flooding or able to respond to drawdown. *Carex joorii* dominates in many examples, both forested and open. In more open Upland Pools, *Scirpus cyperinus, Dulichium arundinaceum*, or other species may dominate. *Sphagnum* spp. and *Climacium americanum* are often present. Examples are often notable for containing species more typical of the Coastal Plain than of the Piedmont or Blue Ridge.

Dynamics: As in most seasonally flooded wetlands, variation in water presence and depth, both with seasons and among years with different rainfall, is important. When flooded, these depressions support an ephemeral fauna of invertebrates, which presumably consume the leaf litter. All of the communities in this theme may be important breeding sites for frogs and salamanders, both common and rare species, attracting them from a large surrounding area. This makes them important to the fauna and ecosystem dynamics of the landscape, despite their small size. It also makes their fauna dependent on the presence and condition of upland habitat in the landscape. Seymour (2011) noted that the pronounced seasonal variation in vegetation in depressional wetlands in other places, also true of North Carolina's Coastal Plain depressions, is muted in Upland Depression Swamp Forests. The predominant plants are long-lived perennials that persist through seasons and years, though some species may temporarily appear or greatly expand in dry years.

The basins that support Piedmont and Mountain Upland Pools and Depressions communities appear to be stable long-term features but their origin is unclear. LeGrand (1952) noted that no mechanism of surface erosion seems capable of creating them and suggested that they originate by solution of the underlying rock. He noted that mafic rocks have much more soluble mineral matter than felsic. This mechanism would need further explanation for why the depressions occur in small areas on the mafic rocks, though underlying fractures that promote ground water movement might be sufficient explanation. Reed et al. (1963) offered a similar explanation for the pools in quartzite on the rim of Linville Gorge, calculating that, given the range of silica content found in the water, the volume of the pools could have been removed in tens of thousands, if not thousands, of years. Though the basins appear to be long-lasting, given the high rainfall of the region, it would seem likely that basins would overflow enough to lead to eventual erosion of channels that would permanently drain them. However, the flatness of the landscape where many occur may slow this process.

Comments:

References:

LeGrand, H.E. 1952. Solution Depressions in Diorite in North Carolina: American Journal of Science 250:566-583.

Reed, J.C., Jr., B. Bryant, and J.T. Hack. 1963. Origin of some intermittent ponds on quartzite ridges in western North Carolina. Geological Society of America Bulletin 74:1183-1188.

Seymour, S.D. 2011. Vegetation of non-alluvial wetlands of the Southeastern Piedmont. M.S Thesis, University of North Carolina, Chapel Hill.

KEY TO PIEDMONT AND MOUNTAIN UPLAND POOLS AND DEPRESSIONS

1. Community with a well-developed forest canopy when not recently disturbed, with trees rooted throughout the community; *Quercus phellos, Quercus lyrata*, or rare, *Quercus michauxii* or *Quercus bicolor dominant;* in the eastern or central Piedmont ……..**Upland Depression Swamp Forest**

1. Community without a well-developed forest canopy, with trees largely confined to the shallower edges; trees various; in either Piedmont or Mountains.

2. Community in the Mountain Region.....**Upland Pool (Mountain Subtype)**

2. Community in the Piedmont Region.

3. Community with strong zonation, with deep water in the center; edge zone dominated by *Nyssa biflora* substantial Coastal Plain flora, such as *Smilax walteri*, present; known only in Uwharrie National Forest**..... Upland Pool (Pleasant Grove Subtype)**

3. Community with moderate or weak zonation; water shallower in the center, though deep enough to limit tree establishment; *Nyssa biflora* absent; other Coastal Plain flora present or not.

4. Community with substantial Coastal Plain flora, including abundant *Smilax walteri, Dulichium arundinaceum*, *Rhynchospora* spp., and *Eleocharis* spp.; known only in Uwharrie National Forest.... .....**Upland Pool (Roberdo Subtype)**

4. Community without substantial Coastal Plain flora, though a few species may be present; *Smilax walteri* absent, though *Smilax rotundifolia* or other species may be abundant; *Quercus phellos* generally dominant on the edge; anywhere in the eastern or central Piedmont. .... **Upland Pool (Typic Piedmont Subtype)**

UPLAND DEPRESSION SWAMP FOREST

Concept: Upland Depression Swamp Forests are forested isolated wetlands in shallow depressions or perched on upland ridges and flats with impeded soil drainage. Water stands for part of the year, but wetness is not great enough to prevent a closed tree canopy from developing. They occur on unusually flat areas with hardpan soils derived from mafic rocks or slates, or in small topographic basins on ridgetops on volcanic rock. The forests are usually dominated by *Quercus phellos*, sometimes codominant with or replaced by *Quercus lyrata, Quercus bicolor, Quercus michauxii*, or *Liquidambar styraciflua*. Successional examples may be dominated by *Acer rubrum* or *Liquidambar styraciflua*.

Distinguishing Features: Upland Depression Swamp Forests are distinguished from Upland Pools by having a closed canopy all the way across the basin when not recently disturbed, and therefore lacking shade-intolerant shrubs and herbs. Upland Pools may have trees on the edge but lack them in the center and have a less diverse flora because of the long hydroperiod.

Upland Depression Swamp Forests are distinguished from floodplain forests of various kinds by their isolated upland location and lack of channel flow or overbank flooding, which is indicated by the lack of most characteristic bottomland trees, the usual predominance of *Quercus phellos*, and the usual presence of *Sphagnum lescurii* and *Climacium americanum*. While some Upland Depression Swamp Forests have an outlet channel, the outlet is usually too small to form a floodplain. However, a few ambiguous and transitional examples occur, where Upland Depression Swamp Forests give way gradually to Piedmont Headwater Stream Forest (Hardpan Subtype) communities. Both of these communities may be dominated by *Quercus phellos* and share other flora, but the Piedmont Headwater Stream Forest should have additional species of alluvial conditions and should show a channel or substantial evidence of flow.

Upland Depression Swamp Forests may closely resemble Mixed Moisture Hardpan Forests. They are distinguished by strong predominance of wetland oaks, with virtually no individuals of upland oaks such as *Quercus stellata* or *Quercus alba* present. When water is not present, Upland Depression Swamp Forest basins can be difficult to distinguish from surrounding uplands. Communities may be recognizable only by the canopy of wetland oaks.

Synonyms: *Quercus phellos / Carex (albolutescens, intumescens, joorii) / Climacium americanum* Forest (CEGL007403).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Sites: Upland Depression Swamp Forests occur in both unusually flat upland topography associated with mafic or clay-rich rocks and in ridgetop depressions in more rugged terrain such as the Uwharrie Mountains. On ridge tops, basins usually have visibly sloping sides, but on upland flats the basins may be so subtle as to be invisible without water present.

Soils: Upland Depression Swamp Forests usually have soils with limited internal drainage and often with shrink-swell clays such as montmorillonite. The predominant soil series mapped is Iredell (Vertic Hapludalf), but the swamps likely represent inclusions of a wetter soil. Some examples are mapped as other soils of mafic rocks such as Orange (Albaquic Hapludalt); a few are

associated with clay-rich soils of sedimentary or metasedimentary rocks, particularly Misenheimer (Aquic Dystrudept) or Leaksville (Typic Albaqualf). Examples on ridge tops tend to not be distinguished from the surrounding uplands, but they presumably represent inclusions. Examples vary with substrate in soil chemistry. All examples are highly acidic, but those on mafic rock have higher pH and higher abundance of base cations. Wetter examples are more acidic and lower in nutrients than drier on all substrates.

Hydrology: Upland Depression Swamp Forests are seasonally flooded by water that may range from a few inches to two or three feet deep. Water comes from rainfall and from a small local watershed. An impermeable substrate, either a clay hardpan or potentially bedrock, prevents infiltration. Water loss is primarily through evaporation. Some basins have a visible overflow channel while others do not, but all must have a place where water overflows the basin in periods of extreme wetness. Standing water typically extends into the growing season but is gone by summer, but in some years standing water may be absent, may persist through more of the season, or may return after heavy rains. Because of the impermeable substrate and limited rooting depth, conditions for plants may be dry when water has evaporated and soil has dried.

Vegetation: Upland Depression Swamp Forests have a full forest canopy but limited understory, with trees rooted throughout the basin unless recently disturbed. The vegetation has been well described in a comprehensive plot study by Seymour (2011) and in numerous site reports. *Quercus phellos* is constantly present and most often strongly dominant, though it may be codominant or occasionally have only minor abundance. *Quercus lyrata* is codominant or dominant in some wetter examples, and *Quercus bicolor* and *Quercus michauxii* are prominent in a very few examples. *Liquidambar styraciflua* is highly constant in the canopy or understory but dominates only in disturbed examples. Other trees often occurring in small numbers include *Acer rubrum, Fraxinus americana*, and *Nyssa sylvatica*. Upland species such as *Quercus stellata, Quercus alba, Ulmus alata, Juniperus virginiana, Pinus* spp., or others may be present in small numbers, especially in drier examples or on the edges. Shrubs may be sparse, fairly dense throughout, or concentrated in a zone around the edge. *Vaccinium fuscatum* and *Vaccinium formosum* are most often dominant, *Ilex verticillata* may be frequent, and *Cephalanthus occidentalis* may be present in wetter examples. Vines tend to be abundant, often dominating the shrub layer in patches around the edge. *Smilax rotundifolia* is almost universally present, and *Muscadinia rotundifolia, Smilax bona-nox*, *Thyrsanthella difformis*, *Toxicodendron radicans*, *Campsis radicans*, and *Parthenocissus quinquefolia* are frequent and sometimes very abundant. Herbs are usually patchy; they may range from locally dense to sparse or nearly absent. They are often zoned, with a dense ring around the edge or where vines are not abundant. *Carex* species are most often dominant. *Carex joorii* dominates in the wetter examples, while *Carex albolutescens, lupulina, complanata, louisianica, typhina, flaccosperma, glaucodea, pigra*, and others may be present and sometimes abundant in other examples. Other herbs that may be abundant include *Scirpus cyperinus, Chasmanthium laxum,* and *Leersia virginica*. *Climacium americanum* and *Sphagnum lescurii* are frequent but usually with limited abundance. *Danthonia spicata, Coleataenia anceps, Scutellaria integrifolia, Asplenium platyneuron*, and *Cinna arundinacea* may be fairly frequent. Seymour (2011) also noted moderate frequency of weedy species such as *Erechtites hieracifolia* and *Andropogon* spp., perhaps in canopy gaps but perhaps reflecting opportunistic establishment in dry years.

Range and Abundance: Ranked G2G3 but more appropriately G3 if not G4. Nearly 80 examples are scattered across the eastern and central Piedmont, with a concentration in the extensive mafic rocks around Charlotte and a cluster of ridgetop examples in the Uwharrie area. This community also occurs in South Carolina and Georgia, and the association is attributed to Maryland, Virginia, and Alabama.

Associations and Patterns: Upland Depression Swamp Forests are generally small patch communities. Most examples are only one or a handful of acreage in size. However, a few large examples exceed 20 acres. They may be associated with other forests of unusual soils, such as Xeric Hardpan Forest, Mixed Moisture Hardpan Forest, or Piedmont Headwater Stream Forest (Hardpan Subtype), rarely with Upland Pool, but most examples are surrounded by Dry Basic Oak–Hickory Forest or Dry Oak–Hickory Forest.

Variation: Seymour (2011) identified four different groups of Upland Depression Swamp communities, divided first by wetness and then by rock substrate. Some of these may be further subdivided by markedly different canopy dominants. The following may be recognized as variants:

Wet Mafic Variant occurs in the wettest sites over mafic rocks. *Quercus lyrata* is frequent in this variant and is often codominant. Shrubs tend to be scarce, though vines may dominate the shrub layer.

Wet Felsic Variant occurs in the wettest sites over other kinds of rocks, including felsic igneous and metamorphic rocks and acidic sedimentary rocks. It less often has *Quercus lyrata* codominating. *Acer rubrum* and *Nyssa biflora* are fairly constant understory species. A shrub layer dominated by *Vaccinium* spp. often is dense throughout. *Sphagnum* is more likely to be present.

Dry Mafic Variant occurs in drier, less deeply flooded sites over mafic rocks. It is dominated by *Quercus phellos* but may have abundant *Ulmus alata* and *Fraxinus americana*, and there may be small numbers of other upland trees common in basic oak forests, such as *Juniperus virginiana* and saplings of *Celtis* sp. and *Gleditsia tricanthos*. Vines are still prominent, including more *Smilax bona-nox* and *Campsis radicans*. Herbs are more diverse and include species such as *Scutellaria integra* and *Asplenium platyneuron*, as well as widespread species such as *Danthonia spicata*.

Swamp Chestnut Oak Variant is a very rare variant of drier mafic rock sites that has *Quercus michauxii* codominant or dominant. It shares many other species with the Dry Mafic Variant.

Swamp White Oak is a very rare variant of calcium-rich sedimentary rocks that has *Quercus bicolor* dominant.

Dry Felsic Variant occurs in drier, less deeply flooded sites over felsic or other acidic rocks. It is strongly dominated by *Quercus phellos*, but often has some *Acer rubrum, Liquidambar styraciflua*, *Ulmus alata*, or occasional upland species such as *Pinus* spp. Shrubs tend to be few, but vines, including *Smilax glauca* and *Muscadinia rotundifolia*, as well as *Smilax rotundifolia*, are abundant.

While Seymour (2011) named four of these variants as associations, they are treated as variants here because they seem less distinct than most subtypes. Further study may find more distinctions. Because her analysis was based on plots, it also is unclear if they represent distinct kinds of basins or, to some degree, zones within basins. It is interesting that her analysis did not distinguish *Quercus lyrata*-dominated examples from wetter *Quercus phellos*-dominated examples, though *Quercus lyrata* is distinctly associated with wetter sites. She noted that flora was highly variable among occurrences of these isolated small patch communities, and suggested that, as in some other small patch wetlands, founder effects or other random fluctuations may be important.

Dynamics: Dynamics of Upland Depression Swamp Forests are similar to those described for the Piedmont and Mountain Upland Pools and Depressions in general, including seasonal and year-to-year variation in water levels, the ephemeral invertebrate and amphibian communities, and the questions of origin and longevity of the basins.

Tree dynamics of Upland Depression Swamp Forests are similar to those of most North Carolina forests, with trees regenerating primarily in small gaps. This community is more susceptible to windthrow than upland forests, because of the shallow rooting of the trees, likely increasing the size of gaps somewhat. Given the small size of many patches, it is possible for much of the canopy in a patch to be lost at one time.

Upland Depression Swamp Forests are not very susceptible to fire. They may burn when dry, but movement and consumption of leaf litter may leave discontinuous fuel, and the matting of litter after flooding reduces its flammability.

Comments: Upland Depression Swamp Forest is well characterized by the work of Seymour (2011). It was recognized in several earlier descriptive studies, including Wells (1974) and Ohman (1980).

Liquidambar styraciflua - Acer rubrum / Carex spp. - *Sphagnum* spp. Forest (CEGL007388) is an association of depressional wetlands attributed to several states and regions, including North Carolina and the Piedmont. It was initially assigned to one North Carolina Piedmont location that investigation proved to be a successional Upland Depression Swamp Forest that had been clearcut. However, in other states it appears to be intended to represent rare natural communities such as a distinctive swamp in Cades Cove in the Great Smoky Mountains. This mix of stable natural vegetation and ruderal vegetation is problematic. This association is not recognized in North Carolina, and *Liquidambar*-dominated vegetation in Piedmont upland depressions is better regarded as altered examples of *Quercus phellos / Carex (albolutescens, intumescens, joorii) / Climacium americanum* Forest.

Rare species:
Vertebrate animals: *Hemidactylium scutatum*.

References:
Ohmann, J.L. 1980. Unique communities and rare plant species in Duke Forest: An applied methodology for their location and protective management. M.F. Thesis, Duke Univ.

Seymour, S.D. 2011. Vegetation of non-alluvial wetlands of the Southeastern Piedmont. M.S Thesis, University of North Carolina, Chapel Hill.

Wells, E.F. 1974. A vascular flora of the Uwharrie Wildlife Management Area. Castanea 39:39-57.

UPLAND POOL (TYPIC PIEDMONT SUBTYPE)

Concept: Upland Pools are rare, isolated wetlands in upland settings, with water deep enough to prevent the formation of a forest canopy across the basin. Water stands well into the growing season, though it often dries by the end of summer. Examples may occur on unusually flat areas with hardpan soils derived from mafic rocks or slates, or in small topographic basins on ridgetops on various kinds of rock. The Typic Piedmont Subtype covers most of the rare Piedmont examples, which lack the distinctive Coastal Plain flora and other distinctive features of the Pleasant Grove and Roberdo subtypes.

Distinguishing Features: Upland Pools are distinguished from Upland Depression Swamp Forests by the lack of a full tree canopy. Some trees may be present, scattered in the pool or forming an edge zone within the wetland. The pool may also be partly shaded by trees from adjacent forests but should have sufficient light to allow shade-intolerant plants to survive even in the absence of recent disturbance.

The Typic Piedmont Subtype is distinguished from the Pleasant Grove and Roberdo subtypes by the absence of the characteristic Coastal Plain species that distinguish them — *Nyssa biflora, Cyrilla racemiflora*, and *Smilax walteri*. It is distinguished from the Mountain Subtype by the absence of the characteristic Blue Ridge components of the flora, as well as occurrence in the eastern or central Piedmont.

Synonyms: *Cephalanthus occidentalis - (Leucothoe racemosa) / Carex joorii* Shrubland (CEGL004075). *Carex joorii* Pools (Seymour 2011).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Sites: Upland Pools occur in deeper depressions than Upland Depression Swamp Forests. Water may stand for much, sometimes all, of the growing season in the center. Examples occur in both ridgetop saddles and on upland flats, and they may be associated with either mafic or felsic rock.

Soils: Upland Pools have soils with limited internal drainage, created either by a hardpan of shrink-swell clay or by bedrock. They are small enough that they generally are not distinguished in soil mapping; they represent inclusions of wetland soil in upland map units. Seymour (2011) found soils to be highly acidic and low in nutrients regardless of the geologic substrate.

Hydrology: Upland Pools are seasonally to semipermanently flooded, holding water through much of the growing season in many years. Water comes from rainfall and from a small local watershed. An impermeable substrate, either a clay hardpan or potentially bedrock, prevents infiltration. Water loss is primarily through evaporation. Some basins have a visible overflow channel while others do not, but all must have a place where water overflows the basin in periods of extreme wetness. The center is wet enough that it may not dry completely in wetter years.

Vegetation: Upland Pool (Typic Piedmont Subtype) communities have partial tree cover, coming primarily from *Quercus phellos* and *Liquidambar styraciflua* rooted on the shallower edges. Some *Acer rubrum* may also be present. A few trees may be present in the interior, often on stumps or higher microsites. Shrubs are also primarily confined to edges. *Cephalanthus occidentalis* is

usually present in either the edges or the interior and is an indicator of the wetness of the community. *Vaccinium fuscatum* and sometimes *Eubotrys racemosa* may be abundant on the edges. *Smilax rotundifolia* may be abundant at the edge. The herb layer is usually dominated by *Carex joorii*, which may have substantial cover. A little *Sphagnum* and *Climacium americanum* may be present. There are few or no other herbs in the interior, but *Carex gigantea* and *Isoetes melanopoda* have been found in plots and *Cyperus pseudovegetus* was noted in one pond when water was low.

Range and Abundance: Ranked G1. This community is known only in North Carolina, though the NVC association is questionably attributed to South Carolina. It could potentially occur in other nearby Piedmont states.

Associations and Patterns: Upland Pools are small patch communities, usually less than one acre in size. They are surrounded by upland communities of various kinds, including Xeric Hardpan Forest, Dry Basic Oak–Hickory Forest, and Piedmont Monadnock Forest.

Variation: Variation is limited because of the small size and limited species pool in this community. No variation is recognizable related to the substrate or topographic setting.

Dynamics: Dynamics of Upland Pools are similar to those described for the Piedmont and Mountain Upland Pools and Depressions theme in general, including seasonal and year-to-year variation in water levels, the ephemeral invertebrate and amphibian communities, and the questions of origin and longevity of the basins.

Upland Pools are not susceptible to fire and likely would not burn when the surrounding forests burned, though their edges might be affected to some degree.

Comments: Seymour (2011) noted that, while *Carex joorii* usually strongly dominated the herb layer, the absence of other species was more characteristic than the presence of *Carex joorii*. This was the most species-poor of the communities she analyzed. She found it to be the most distinct group among the groups of Upland Depression Swamp plots; however, plots representing the Pleasant Grove Subtype and Roberdo Subtype were removed from analysis as outliers.

Rare species:
Vertebrate animals: *Ambystoma talpoideum* and *Hemidactylium scutatum.*

References:
Seymour, S.D. 2011. Vegetation of non-alluvial wetlands of the Southeastern Piedmont. M.S Thesis, University of North Carolina, Chapel Hill.

UPLAND POOL (PLEASANT GROVE SUBTYPE)

Concept: Upland Pools are rare, isolated wetlands in upland settings, with water deep enough to prevent the formation of a forest canopy across the basin. Water stands well into the growing season. The Pleasant Grove Subtype a distinctive example with strong concentric zonation, a *Nyssa biflora*-dominated edge zone, and a number of plants of Coastal Plain affinities. This subtype is currently known only from Pleasant Grove Bog in Uwharrie National Forest, but discovery of additional examples in the eastern Piedmont is possible.

Distinguishing Features: Upland Pools are distinguished from Upland Depression Swamp Forests by the lack of a full tree canopy. The Pleasant Grove Subtype is distinguished by the presence of substantial concentric zonation, with *Nyssa biflora* dominating the edge, and by overall vegetation of deciduous wetland species more typical of the Coastal Plain. Though many species are shared with the Coastal Plain, the abundance of *Cephalanthus occidentalis* distinguishes it from Small Depression Pond and Small Depression Drawdown Meadow communities.

Synonyms: *Nyssa biflora / Cephalanthus occidentalis - Leucothoe racemosa* Forest (CEGL004550).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Sites: The Pleasant Grove Subtype occurs in a fairly deep basin in a ridgetop saddle in rolling terrain on felsic metavolcanic rock.

Soils: The soil in the one known example is mapped as Biscoe-Secrest (Aeric Epiaquult), but clearly represents a wetter inclusion.

Hydrology: The pool appears to be flooded in the center during most years, with the edges drying progressively through the growing season. Water comes from rainfall and from a small local watershed. An impermeable substrate presumably prevents infiltration. Water loss is primarily through evaporation.

Vegetation: The Pleasant Grove Subtype has vegetation that is strongly zoned. The center remains flooded most of the time and generally appears as open water. Where it draws down, *Scirpus cyperinus* or *Juncus repens* may dominate, and scattered *Cephalanthus occidentalis* are present. A denser vine tangle zone is dominated by *Smilax walteri*. The edge is dominated by *Nyssa biflora*, with a substantial shrub layer of *Eubotrys racemosa* and *Cephalanthus occidentalis*. *Acer rubrum* is also abundant and some *Liquidambar styraciflua* is present. Other shrubs present include *Viburnum nudum, Vaccinium fuscatum, Alnus serrulata*, *Ilex verticillata*, and *Itea virginica*. There is a little *Smilax laurifolia* and *Toxicodendron radicans*. The CVS plot also includes some *Carex crinita*, but no other herbs have been noted.

Range and Abundance: Ranked G1. This community is endemic to North Carolina and is known from a single example in Uwharrie National Forest.

Associations and Patterns: The Pleasant Grove Subtype is a small patch community. The known example is around 0.5 acre. It is associated with Dry Piedmont Longleaf Pine Forest, with Wet Piedmont Longleaf Pine Forest and Piedmont Boggy Streamhead nearby.

Variation: Only a single example is known.

Dynamics: Dynamics of the Pleasant Grove Subtype are presumed to be similar to those described for the Piedmont and Mountain Upland Pools and Depressions theme in general, including seasonal and year-to-year variation in water levels, the ephemeral invertebrate and amphibian communities, and the questions of origin and longevity of the basin. Fire in the frequently burned surrounding longleaf pine communities may affect the edges of the community but would not spread within it.

Comments: Seymour (2011) found this community to be a statistical outlier in her analysis of Piedmont depressions, because there was only a single plot. This community is unique in its combination of Piedmont and Coastal Plain characteristics. Though it shares some species with the Roberdo Subtype, its overall composition is different because of the relatively steep-sided basin and strong zonation. The setting is different from other Upland Pools but the depression appears to be of natural origin.

Rare species:
Vertebrate animals: *Ambystoma talpoideum*.

References:
Seymour, S.D. 2011. Vegetation of non-alluvial wetlands of the Southeastern Piedmont. M.S Thesis, University of North Carolina, Chapel Hill.

UPLAND POOL (ROBERDO SUBTYPE)

Concept: Upland Pools are rare, isolated wetlands in upland settings, with water deep enough to prevent the formation of a forest canopy across the basin. Water stands well into the growing season. The Roberdo Subtype covers the distinctive example with a more "pocosin-like" character, with a substantial component of evergreen Coastal Plain shrubs and greenbriers.

Distinguishing Features: Upland Pools are distinguished from Upland Depression Swamp Forests by the lack of a full tree canopy. The Roberdo Subtype is distinguished by having weak zonation, with extensive areas of shrub and vine cover as well as open herbaceous areas. The Pleasant Grove Subtype, in contrast, has deeper water, strong zonation, and an edge dominated by *Nyssa biflora*.

Synonyms: *Leucothoe racemosa - Vaccinium fuscatum - Smilax walteri* Shrubland (CEGL004533).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Sites: The Roberdo Subtype occurs in a shallow, gently sloped basin in a ridgetop saddle in rolling terrain on felsic metavolcanic rock.

Soils: The soil in the one known example is mapped as Biscoe-Secrest (Aeric Epiaquult), but clearly represents a wetter inclusion.

Hydrology: The Roberdo Subtype pool is flooded well into the growing season and holds standing water in the center throughout some years. Water comes from rainfall and from a small local watershed. An impermeable substrate presumably prevents infiltration. Water loss is primarily through evaporation.

Vegetation: The Roberdo Subtype shows weak zonation, with a more open, wetter center and a broad, densely vegetated edge. Some drawdown areas are dominated by *Dulichium arundinaceum* or *Scirpus cyperinus*. Other herbs in the open center include *Utricularia gibba, Eleocharis* sp., *Carex crinita, Carex glaucescens, Rhynchospora* sp., and *Scleria* sp. *Sphagnum* species are present in patches. In the broad shallower area, *Smilax walteri* dominates in extensive shrub layer tangles. The dominant shrubs are *Eubotrys racemosa*, *Vaccinium formosum,* and *Vaccinium fuscatum*, with some *Viburnum nudum* and *Cephalanthus occidentalis*. Scattered *Acer rubrum* and small *Liquidambar styraciflua* are present. In the outer edge, large *Pinus taeda* and a few *Pinus palustris* occur. In the past, there may have been more *Pinus palustris*.

Range and Abundance: Ranked G1? This community is endemic to North Carolina and is known from only a single example in Uwharrie National Forest.

Associations and Patterns: The Roberdo Subtype is a small patch community. The known example is about one acre. It is surrounded by Dry Piedmont Longleaf Pine Forest and is associated with Piedmont Boggy Streamhead.

Variation: Only a single example is known.

Dynamics: Dynamics of the Roberdo Subtype are presumed to be similar to those described for the Piedmont and Mountain Upland Pools and Depressions theme in general, including seasonal and year-to-year variation in water levels, the ephemeral invertebrate and amphibian communities, and the questions of origin and longevity of the basin. Because of the gentle slope and the broad edge zone where water draws down, fire may be able to spread into part of this community and be a significant influence, though it must rarely or never reach the center.

Comments: Seymour (2011) found this community to be a statistical outlier in her analysis of Piedmont depressions. There was only a single plot, though a second CVS plot has since been added in the same site. This community is unique in its combination of Piedmont and Coastal Plain characteristics. Though it shares some species with the Pleasant Grove Subtype, its overall composition is different because of the gentle slope, weak zonation, and perhaps greater influence of fire. The setting is different from other Upland Pools, but the depression appears to be of natural origin.

Rare species:
Vertebrate animals: *Ambystoma talpoideum*.

References:
Seymour, S.D. 2011. Vegetation of non-alluvial wetlands of the Southeastern Piedmont. M.S Thesis, University of North Carolina, Chapel Hill.

UPLAND POOL (MOUNTAIN SUBTYPE)

Concept: Upland Pools are rare, isolated wetlands in upland settings, with water deep enough to prevent the formation of a forest canopy across the basin. Water stands well into the growing season. The Mountain Subtype covers the rare examples in the Blue Ridge region.

Distinguishing Features: Upland Pools are distinguished from Upland Depression Swamp Forests by the lack of a full tree canopy. The Mountain Subtype has some plants more typical of lowlands, such as *Dulichium arundinaceum*, but lacks *Cephalanthus occidentalis* and does not have as well-developed a Coastal Plain flora as Piedmont examples have.

Synonyms: *Scirpus cyperinus* - *Dulichium arundinaceum* / *Sphagnum* spp. Herbaceous Vegetation (CEGL004134).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Sites: The Mountain Subtype occurs in natural depressions on flat ridgetop areas. The two known good examples occur on flat-lying quartzite.

Soils: The soil within the basins of the known examples consists of accumulated muck and fragments of quartzite.

Hydrology: The Mountain Subtype is flooded well into the growing season but probably usually lacks standing water by the end of summer.

Vegetation: The Mountain Subtype includes an open center without trees but with substantial herbaceous vegetation. Dominant herbs in patches include *Scirpus cyperinus, Dulichium arundinaceum, Persicaria hydropiperoides, Osmunda spectabilis*, and *Sphagnum lescurii*. Other herbs include *Bartonia verna, Juncus effusus,* and *Juncus canadensis*. A substantial woody edge zone is present. In one example it is dominated by *Liquidambar styraciflua, Acer rubrum,* and *Nyssa sylvatica*; in the other *Quercus montana* and *Quercus coccinea* are the most abundant. *Leucothoe fontanesiana, Kalmia latifolia*, and *Galax urceolata* are found in the edge zones.

Range and Abundance: Ranked G1Q but probably truly G1. In North Carolina, well-developed examples are known only on the rim of Linville Gorge, but a nearby site called Pond Mountain needs investigation. Another site called Pond Mountain, in Ashe County, has ridgetop depressions that may have been natural ponds but are now heavily altered.

The synonymized association is attributed to Georgia and potentially to Tennessee.

Associations and Patterns: The Mountain Subtype is a small patch community, well less than one acre in the known examples. It is surrounded by upland communities such as Pine–Oak/Heath and Chestnut Oak Forest.

Variation: If additional examples exist, they may be substantially different.

Dynamics: Dynamics of Upland Pools are similar to those described for the Piedmont and Mountain Upland Pools and Depressions theme in general, including seasonal and year-to-year variation in water levels, the ephemeral invertebrate and amphibian communities, and the questions of origin and longevity of the basins. Reed et al. (1963) suggested these pools were created by solution of the quartzite, calculating that, given the range of silica content found in the water the volume of the pools could have been removed in tens of thousands, if not thousands, of years.

Comments: This community was recognized by Newell (1997) and Newell and Peet (1998) in their study of Linville Gorge vegetation. The Mountain Subtype is unlikely any other community in the Mountain Region and is notable for the lowland species present at relatively high elevation in it.

Rare species:
Vertebrate animals: *Ambystoma talpoideum*.

References:
Newell, C.L. 1997. Local and regional variation in the vegetation of the southern Appalachian Mountains. Ph.D. dissertation. Curriculum in Ecology, University of North Carolina at Chapel Hill. 1,008 pp.

Newell, C.L. and R.K. Peet. 1998. Vegetation of Linville Gorge Wilderness, North Carolina. Castanea 63:275-322.

Reed, J.C., Jr., B. Bryant, and J.T. Hack. 1963. Origin of some intermittent ponds on quartzite ridges in western North Carolina. Geological Society of America Bulletin 74:1183-1188.