UPLAND SEEPAGES AND SPRAY CLIFFS

Contents

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Concept: Upland Seepages and Spray Cliffs are small patch wetlands that are saturated for long periods by seepage of shallow or deep groundwater or by spray from waterfalls, with limited or no surface flooding or ponding of water, and which lack the characteristic flora and vegetation of Mountain Bogs and Fens, Streamhead Pocosins, Wet Pine Savannas, or other themes. A few may occur in floodplains or along stream courses but have their hydrology more affected by long-term saturation than by flooding.

Distinguishing Features: Upland Seepages are distinguished by their saturated hydrology and by a flora consisting of broadly tolerant wetland species without the concentration of specialized extreme acid-tolerant flora of bogs, the calciphilic flora of Southern Appalachian Fen, and the specialized flora of frequently burned pine savannas. While shrubs typical of pocosins may be present, even outside the Coastal Plain, these seepages lack the dense shrub layer typical of pocosin communities and generally lack *Pinus serotina*. They are also distinguished from minor seepage zones in rock outcrop and upland communities by size. Patches may be only a few meters in size but must be large enough to support a characteristic flora of wetland plants. Spray Cliffs are unique communities distinguished by association with waterfalls and with substantial and long-term spray, though seepage may also be present.

Within this theme, several communities are distinguished from others by a component of bog-related plants, while not having the characteristics of true Mountain Bogs and Fens. This is sometimes a subtle distinction, but more minerotrophic wetland species are always present. Several are distinguished by the influence of flooding as well as seepage and a component of alluvial species. Other communities are distinguished by differences in vegetation related to geomorphic setting and biogeographic region.

Synonyms:

Sites: Seepages occur on gentle to potentially steep upland slopes, along small headwater streams, or on the edges of larger floodplains at the base of an upland slope. There is sometimes an amphitheater-like landform or a change in slope. The groundwater discharge often is associated with a junction between two kinds of substrates, such as an upland slope and an alluvial floodplain, an impermeable layer with a permeable one, or sloping soil with bedrock. They may, however, be associated with fractures in underlying bedrock and show no distinctive landform; some examples are distinguishable only by wetland vegetation in an upland location.

Spray Cliffs occur in association with waterfalls, along streams in areas with high topographic relief and resistant rock. Most of their extent is very steep, though gently sloping or horizonal portions may be present.

Soils: Soils of Upland Seepages and Spray Cliffs may span a broad range, from saturated loams or clays to gravel, though they rarely are very sandy. They show the effect of saturation in gray color and often in high levels of organic matter. They may be deep or may be a shallow sheet of material over bedrock. Most are organic-rich, and a few may be true mucks. Soils in some communities can be very heterogeneous, with deep mucky pockets alternating with rocky areas or

firm clay. Because these communities are all small patches, soils are seldom if ever recognized in soil mapping, and series may not ever be defined for them.

Hydrology: All Upland Seepages and Spray Cliffs are saturated permanently or at least through much of the growing season. The primary source of wetness is groundwater discharge. Ponded water is absent or limited to small microsites. Flooding by streams or rivers is short-term and is a secondary influence on the environment compared to the long-term saturation. The discharged water moves through the community, through the soil, sometimes in a shallow sheet, sometimes in rivulets with limited development of channels. The downstream edge of the community occurs where the water becomes concentrated in a deeper channel, where it sinks back deeper into the ground, or perhaps simply where it spreads out and its influence is reduced.

Vegetation: Vegetation within the Upland Seepages and Spray Cliffs theme ranges widely, though all communities contain abundant predominantly wetland species. The vegetation structure of many of the communities can be hard to characterize. Most have few or no trees rooted within them but, because patches are small, can have substantial canopy cover from trees rooted in adjacent forests. The NVC names some associations as herbaceous vegetation, some as forests, but with the exception of Low Elevation Seep (Piedmont/Mountain Springhead Subtype), tree basal area is low in all. Shrub cover may be moderate or nearly absent. Most communities have a dense herb layer, though in Spray Cliff, Coastal Plain Seepage Bank, and Low Elevation Seep (Bedrock Subtype) the predominant cover may be bryophytes. Species composition is highly variable. A suite of wetland species with broad tolerance for saturated conditions occurs in multiple communities in this theme. It includes *Osmundastrum cinnamomeum, Osmunda spectabilis (regalis), Lorinseria areolata*, *Arisaema triphyllum, Impatiens capensis, Oxypolis rigidior, Houstonia serpyllifolia, Lycopus virginicus*, and, in the mountains, *Chelone glabra* and *Thalictrum clavatum*. *Carex* as a genus is often present and may be represented by a wide range of species. Shrubs of this type include *Alnus serrulata, Viburnum nudum, Vaccinium fuscatum, Eubotrys racemosa*, and *Aronia arbutifolia*. Many of these species are shared with Mountain Bogs and Fens, and some more specialized bog species, such as *Drosera rotundifolia* and several *Carex* species, may occasionally occur. However, bog specialist species in Upland Seepages and Spray Cliffs are mostly confined to one or two community types, are generally not abundant in them, and have limited diversity in any given site. Some species shared with floodplain wetlands, such as *Saururus cernuus* and *Lindera benzoin*, are also frequent. If trees are rooted in the community, they tend to be widespread wetland-tolerant species such as *Acer rubrum, Liquidambar styraciflua*, and *Liriodendron tulipifera*.

Dynamics: Upland Seepages and Spray Cliffs receive nutrients from the groundwater. Though the water may be acidic and fairly oligotrophic, they presumably are more fertile than many wetlands, though less so than floodplain communities. However, the stress of long-term saturation limits what plants can occur in these communities and presumably limits productivity.

Mountains Bogs and Fens also receive groundwater input. The reason for their lower nutrient status is not entirely clear, but probably is at least partly related to the chemistry of the water. How rapidly water moves through may also be important.

Most seepages are small enough that few trees are rooted in them. Canopy shade often comes largely from trees rooted in adjacent communities. As in other forests, trees are naturally uneven-aged and regenerate primarily in small gaps. The saturated soil may lead to shallow rooting by the trees that are rooted within the community, and this may make them more sensitive to windthrow than most forests. Because patches are small, even a small gap can temporarily change the environment over the entire patch.

These communities are generally quite stable. However, wetness may vary in response to rainfall and vegetation may shift in response to climatic cycles. Flowing water may act as a natural disturbance in Spray Cliff and Piedmont Boggy Streamhead; a few Low Elevation Seep and Rich Montane Seep occurrences may similarly be affected, but most will not be.

The saturated soil and limited flammability of the vegetation in most Upland Seepages and Spray Cliffs makes fire a limited influence. However, the small size of patches subjects most of them to fire effects from the adjacent communities. Some have natural firebreaks in the form of rock outcrops or large floodplains, but many others are surrounded by flammable upland communities. Fire appears to be more important, perhaps crucial, in Hillside Seepage Bog communities.

In areas with feral pigs, these introduced animals can cause severe disturbance in seeps. Rossell, et al. (2016) documented the effects of their rooting in Rich Montane Seep communities in the Great Smoky Mountains.

Comments: Upland Seepages and Spray Cliffs are among the smallest communities recognized in the 4th Approximation but they usually contrast strongly with the surrounding landscape. Examples can be well developed, with a dozen or more wetland plants not found in the surrounding communities, in patches just a few meters wide. They may be important habitat for smaller animals, supporting a high density of salamanders and distinct species of insects. However, they also can range to patches small enough to not show the community characteristics well, which presumably also are too small to support viable populations of most animals.

Upland Seepages and Spray Cliffs have generally received limited study. They often are not addressed in local quantitative studies of vegetation. However, two focused studies have contributed to understanding of some of them. Seymour (2011) is the primary basis for classifying of the Piedmont wetlands, many of the communities in this theme. Zartman and Pittillo (1998) provide excellent data on Spray Cliffs in part of their range. The small size of many examples of these communities makes it hard to fit standard plots into them but a number of CVS plots exist for some of the communities.

References:

Rossell, C.R., H.D. Clarke, M. Schultz, E. Schwartzman, and S.C. Patch. 2016. Description of Rich Montane Seeps and effects of wild pigs on the plant and salamander assemblages. American Midland Naturalist 175:139-154.

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

Zartman, C.E. and J.D. Pittillo. 1998. Spray cliff communities of the Chattooga Basin. Castanea 63:217-240.

KEY TO UPLAND SEEPAGES AND SPRAY CLIFFS

1. Community kept wet at least partially by spray from a waterfall..... **Spray Cliff**
1. Community not influenced by spray from a waterfall.
   2. Community along a Coastal Plain river or stream, occurring on a very steep bluff of clay wetted by seepage from above; vegetation consisting of bryophytes and sparse vascular plants. .... **Coastal Plain Seepage Bank**
   2. Community not a steep clay bank along a Coastal Plain river; occurring in any region of the state.
      3. Mountain or foothills community dominated by combinations of *Diphylleia cymosa, Laportea canadensis, Rudbeckia laciniata, Monarda didyma, Impatiens capensis*, or similar species of moderately rich sites. ..... **Rich Montane Seep**
      3. Community of any region, dominated by species more tolerant of less rich sites; the above species, if present, very limited in diversity and abundance.
         4. Community at high elevation, usually above 5000 feet, only rarely lower; vegetation fairly boggy, with extensive *Sphagnum* cover or presence of *Vaccinium macrocarpon* or other characteristic bog species (though with fewer such species than typical Southern Appalachian Bogs); vegetation generally dominated by grasses or *Carex* spp.; flora including species typical of high elevation, such as *Chelone lyonii, Impatiens pallida, Oclemena acuminata*, and *Hypericum graveolens*, along with more widespread species. ..... **High Elevation Boggy Seep**
         4. Community lower than 5000 feet elevation or, if occasionally higher, occurring on bedrock substrate without appreciable soil development; in any region of the state.
            5. Vegetation containing multiple woody Coastal Plain species such as *Smilax laurifolia, Cyrilla racemiflora*, and *Magnolia virginiana* along with other more widespread seep species; occurring in the Piedmont or occasionally in lower elevation Mountains.
               6. Community along a headwater stream in the central or eastern Piedmont, subject to brief flooding; containing a mixture of some richer species such as *Lindera benzoin* and upland species such as *Quercus alba*, along with Coastal Plain species and widespread seep species; well-developed canopy of trees rooted in the community usually present, consisting of species such as *Liriodendron tulipifera, Liquidambar styraciflua, Acer rubrum*, and upland species..... ..... **Piedmont Boggy Streamhead**
               6. Community not along a headwater stream channel, though a stream may issue from it and it may contain small rivulets without channel development; community on an upland slope or in an amphitheater-like recess in a slope; trees rooted in the community abundant or not.
                  7. Community in the foothills or occasionally in the Mountain Region; generally in a fairly large amphitheater-like basin; generally forming the headwaters of a stream; well-developed tree canopy usually present. .... **Low Elevation Seep (Piedmont/Mountain Springhead Subtype)**
                  7. Community in the central or eastern Piedmont; on an upland slope or in a small basin not along a stream; trees rooted in the community few or none under natural conditions .... **Hillside Seepage Bog**
            5. Community not containing *Smilax laurifolia, Cyrilla racemiflora*, or *Magnolia virginiana* in appreciable amounts, other than in rare seeps in the Coastal Plain;
               8. Mountain or rarely foothills community occurring on a substrate of bedrock with few fractures; occurring along a stream site, on the edge of a granitic dome, or on a steep cliff face; vegetation usually with extensive *Sphagnum* or other bryophyte cover..... ..... **Low Elevation Seep (Bedrock Subtype)**
               8. Community not occurring on bedrock substrate; generally with limited bryophyte cover; occurring in any region.

9. Community occurring on the edge of a well-developed floodplain of a river or stream in any region of the state; floodplain species such as *Fraxinus pennsylvanica* and *Acer negundo* usually present; species of wetter sites such as *Peltandra virginica, Saururus cernuus, Leersia oryzoides*, and *Persicaria sagittata*, often present, along with more widespread seep species. .....**Low Elevation Seep (Floodplain Subtype)**

9. Community not in a floodplain; on an upland slope, along a headwater stream, or in a recess on a slope above a floodplain.

10. Community in the Mountain Region or foothills; vegetation containing characteristic mountain species not typical of the Piedmont, such as *Micranthes micranthidifolia, Houstonia serpyllifolia, Thalictrum clavatum*, and *Chelone glabra*. .... **Low Elevation Seep (Montane Subtype)**

10. Community in the Piedmont or rarely in the Coastal Plain; characteristic mountain species lacking.....**Low Elevation Seep (Typic Subtype)**

SPRAY CLIFF

Concept: Spray Cliffs are communities of rock outcrops kept constantly wet by spray from falling water, sometimes supplemented by seepage. These communities are largely herbaceous but may contain some shrubs and trees. They are often small, sometimes vertical or nearly so, and may be partially shaded by trees rooted in adjacent forests.

Distinguishing Features: Spray Cliffs may be distinguished from all other communities by long-term wetness created by spray from falling water. They generally have well-developed bryophyte cover compared with adjacent dry Montane Cliff communities. The transition to drier cliff may be gradual. They are distinguished from forests by the absence of a closed tree canopy, due to steepness and lack of soil, though they may have substantial shade from trees rooted in adjacent forests. The presence of a well-developed spray zone depends on the configuration of the falls, though amount of water and distance of fall are important. Some large falls have little or no Spray Cliff present, while relatively small falls can have exemplary ones. Drier cliffs near waterfalls may be wet briefly from spray at times of unusually high stream flow.

Synonyms: *Vittaria appalachiana – Heuchera parviflora var. parviflora – Houstonia serpyllifolia / Plagiochila* spp. Herbaceous Vegetation (CEGL004302).
Ecological Systems: Southern Appalachian Spray Cliff (CES202.288).

Sites: Spray Cliffs occur in association with waterfalls, along streams in areas with high topographic relief and resistant rock. Most of their extent is very steep, but gently sloping or horizonal portions may be present. Many waterfalls also have a grotto or overhanging portion, where light levels are low. Most Spray Cliffs are in narrow gorges, where topography shelters them from drying sun and wind. The exposure to large amounts of water also buffers temperature extremes and keeps humidity high.

Soils: Generally no developed soil is present other than in small patches and in pockets in crevices.

Hydrology: Spray Cliffs are saturated or at least wet on the surface much or all of the year. Spray is an important and constant source of wetness, but seepage may also contribute to saturation. The high humidity created by falling water, spray, and topographic sheltering also reduces evaporation. Waterfalls are subject to the dynamics of the streams that form them. In times of flood, Spray Cliffs may be disturbed by scouring or movement of debris.

Vegetation: Vegetation of Spray Cliffs is highly variable among sites and is often extremely heterogeneous within a single example. Most portions of most examples have low cover of vascular plants. Rare examples have dense grass or sedge vegetation, and local portions may have high cover from shrubs or trees rooted in crevices. High cover and diversity of bryophytes is often noted. Many examples also are shaded by trees rooted in adjacent upland communities. When present, trees often include *Tsuga canadensis, Acer rubrum, Betula lenta, Liriodendron tulipifera*, or *Amelanchier laevis*, but *Aesculus flava, Tilia americana* var. *heterophylla*, or other species of Rich Cove Forest, as well as various oaks, may be present. *Rhododendron maximum* is by far the most frequent shrub, but a wide variety of species may be present, including *Leucothoe fontanesiana, Alnus serrulata, Xanthorhiza simplicissima, Hydrangea arborescens*, and many

others. *Parthenocissus quinquefolia, Toxicodendron radicans*, or other vines may drape part of the cliff. Vascular herbs usually include a distinctive combination of species typical of wetlands, upland forests, and rock outcrops. In the Chattooga basin, Zartman and Pittillo (1998) found the most frequent vascular plant species to be *Thalictrum clavatum, Houstonia serpyllifolia, Lobelia amoena, Chelone glabra, Eurybia divaricata, Heuchera villosa, Oxypolis rigidior, Trautvetteria carolinensis, Solidago patula, Lycopodioides (Selaginella) apodum*, *Viola cucullata*, and the exotic *Microstegium vimineum*. Elsewhere, *Thalictrum clavatum* is the most frequent species, and *Micranthes petiolaris* var. *petiolaris, Micranthes micranthidifolia, Micranthes careyana, Heuchera villosa, Heuchera parviflora, Impatiens capensis*, *Boykinia aconitifolia, Trautvetteria carolinensis*, and the fern gametophyes *Vittaria appalachiana* and *Trichomanes intricatum* are among the most frequently reported species. A great diversity of other species is present at low frequency, including additional wetland species such as *Chelone* spp., *Viola cucullata, Hydrocotyle americana*, and *Drosera rotundifolia*, species of dry rock outcrops, such as *Krigia virginica*, *Houstonia longifolia* var. *glabra,* and *Danthonia spicata*, and widespread species such as *Eurybia divaricata* and *Galax urceolata*, and rare habitat specialists such as *Huperzia porophila* and *Phegopteris connectilis*. One unique example has *Sporobolus (Spartina*) *pectinata* and *Andropogon gerardii*. Bryophytes are less often identified, even when their abundance is noted. The few species lists recorded suggest a diverse collection of both mosses and liverworts. Species found frequent in Zartman and Pittillo (1998) on the Chattooga River include *Thuidium delicatulum* to be by far the most frequent species. Other frequent species were *Plagiommium ciliare, Atrichum oerstedianum, Sphagnum lescurii, Scapina nemorosa, Campylium chrysophyllum, Mnium hornum, Philonotis fontana*, and *Dumortiera hirsuta*. Additional species noted repeatedly elsewhere include *Chiloscyphus appalachianus, Bazzania trilobata,* and *Hookeria acutiloba*.

Range and Abundance: Ranked G2 but possibly less rare. Spray Cliffs are scattered throughout the Mountain Region and foothills, with well over 50 known. They are most concentrated in the southern escarpment area. However, their aggregate acreage is very small. As defined, this is a Southern Appalachian endemic community, occurring in Tennessee, South Carolina, and Georgia.

Associations and Patterns: Spray Cliffs are small patch communities, with no examples more than a of couple acres in size. However, size data can be ambiguous because most of their surface is near vertical. They may be associated with Montane Cliffs, where dry open rock exists beyond the spray zone. Otherwise they usually are surrounded by Acidic Cove Forest or Rich Cove Forest.

Variation: Individual Spray Cliff occurrences are extremely variable in flora, as indicated by the large number of species with very low constancy. Patterns of variation have not been sorted out. Three variants are recognized.

1. Typic Variant includes examples in most of the Mountain Region and foothills.
2. Southern Escarpment Variant includes examples in the high-rainfall southern escarpment area, including the Chattooga, Whitewater, Horsepasture, and Toxaway rivers, Panthertown Valley, and nearby creeks. This area has a large number of rare species, among bryophytes and herbs, many of them associated with Spray Cliffs. The narrow range of *Hydrangea cinerea* means it may occur in the variant and is very rarely present in the Typic Variant.

3. Sloughgrass Variant covers the unique example where *Sporobolus pectinatus* is a dominant species, known only at Rainbow Falls.

The possibility of a rich variant should also be investigated. Examples surrounded by Rich Cove Forest share species with that community, which are absent in other examples. At least one extremely rich example is known, where *Ptelea trifoliata* is the most abundant shrub.

Dynamics: Spray Cliffs may have unique dynamics, sharing different aspects with different communities. Like Rocky Bar and Shore, portions of them may be naturally disturbed by floods. Otherwise, they appear to be extremely stable. The sheltered topography and flowing water ameliorate temperature fluctuations, allowing them to sustain plants of tropical affinities through drastic climatic fluctuation. The effects of drought too are ameliorated. Water is abundant and nutrients continually supplemented. Nevertheless, standing biomass and presumably primary productivity are low because of limited rooting space. More than perhaps any other community, lack of sunlight may also limit productivity.

Comments: The inclusion of Spray Cliff with upland seepages is marginal. They are unique in many ways, but their strongest ecological affinities seem to be to this theme.

Spray Cliffs are seldom the target of deliberate exploitation. Nevertheless, they are variably susceptible to disturbance by human visitation. While portions are vertical and inaccessible, flatter portions and grottos are particularly attractive and susceptible to trampling. Even vertical cliff bases may be heavily disturbed by "hand trampling."

Rare species:
Vascular plants: *Asplenium monanthes, Chelone obliqua, Chenopodium simplex, Grammitis nimbata, Huperzia porophila, Hymenophyllum tayloriae, Moranopteris nimbata, Phegopteris connectilis, Sanguisorba canadensis, Sporobolus pectinata,* and *Vandenboschia boschiana*.
Nonvascular plants: *Acrobolbus ciliatus, Aneura sharpii, Brachythecium roteanum, Bryocrummia vivicolor Bryoxiphium norvegicum, Bryum riparium, Cheilolejeunea evansii, Chiloscyphus appalacnianus, Chiloscyphus muricatus, Cirriphyllum piliferum, Dichodontium pellucidum, Didymodon tophaceus, Drepanolejeunea appalachiana, Fissidens asplenioides, Grimmia longirostris, Gymnoderma lineare, Homalia trichomanoides, Hydrothyria venosa, Lejeunea blomquistii, Mylia taylorii, Oxyrrhynchium pringlei, Philonotus cernua, Plagiochila echinata, Plagiochila ludoviciana, Plagiochila sullivantii* var. *spinigera*, *Plagiochila sullivantii* var. *sullivantii*, *Plagiochila virginica* var. *caroliniana*, *Plagiomnium carolinianum, Porella wataugensis, Racomitrium aciculare, Sphagnum flavicolans, Sphagnum squarrosum, Taxiphyllum alternans, Taxiphyllum cuspidifolium, Warnstorfia fluitans,* and *Radula voluta*.

References:
Zartman, C.E. and J.D. Pittillo. 1998. Spray cliff communities of the Chattooga Basin. Castanea 63:217-240.

HIGH ELEVATION BOGGY SEEP

Concept: High Elevation Boggy Seeps are communities intermediate between Mountain Bogs and Fens and Upland Seepages and Spray Cliffs. They occur in upland locations or along small headwater streams and generally have moderate to substantial slope. They often have substantial *Sphagnum* cover and contain more species with Southern Appalachian Bogs than most seeps do, but they also contain many species not characteristic of bogs. They are generally graminoid-dominated in the center, but some have enough tree or shrub cover to be considered woodlands or shrublands.

Distinguishing Features: High Elevation Boggy Seeps are distinguished from Rich Montane Seeps by having *Sphagnum* present and generally by having graminoid-dominated vegetation that includes characteristic species such as *Carex gynandra*, *Carex ruthii*., *Glyceria striata, Glyceria melicaria, Chelone lyonii*, and *Drosera rotundifolia*. They generally lack *Rudbeckia laciniata, Laportea canadensis, Monarda didyma*, and *Diphylleia cymosa*, though they may share species such as *Circaea alpina, Impatiens pallida, Oxypolis rigidior*, or *Micranthes* (*Saxifraga) micranthidifolia*. High Elevation Boggy Seeps are distinguished from Southern Appalachian Bogs most readily by topography, generally occurring on a pronounced slope at high elevation, also by floristic differences. Most of the same species mentioned above, such as *Carex ruthii* and *Glyceria*, are largely absent in bogs. High Elevation Boggy Seeps are generally at higher elevation than Low Elevation Seep (Montane Subtype), though the ranges may overlap. They share some species, but Low Elevation Seeps rarely have as extensive *Sphagnum*, and they contain low-elevation species such as *Lindera benzoin*.

Synonyms: *Carex gynandra – Platanthera clavellata – Drosera rotundifolia – Carex ruthii – Carex atlantica / Sphagnum* spp. Herbaceous Vegetation (CEGL007697). High Elevation Seep (3rd Approximation).
Ecological Systems: Southern Appalachian Seepage Wetland (CES202.317); Southern and Central Appalachian Bog and Fen (CES202.300)?

Sites: High Elevation Boggy Seeps occur on upland slopes or along small headwater streams. They usually have a distinct gentle-to-steep slope. Some are in amphitheater-like landforms that may have been formed by the groundwater discharge, and some are at distinct changes in slope that may reflect underlying impermeable layers. Others probably are associated with fractures in underlying bedrock that transport groundwater, but this is not well known. Most examples are above 5000 feet elevation, but some may occur to 4000 feet or possibly a bit lower.

Soils: Soils are usually a heterogeneous mix of loamy material, gravel, and muck, sometimes with boulders or small bedrock outcrops. Patches are too small to be distinguished in soil mapping.

Hydrology: High Elevation Boggy Seeps are saturated permanently or nearly so by discharging groundwater. The discharged water moves through the community, through the soil, sometimes in a shallow sheet, sometimes in rivulets with limited development of channels. The downhill edge of the community occurs where the water becomes concentrated in a deeper channel or where it sinks back deeper into the ground.

Vegetation: High Elevation Boggy Seeps have a dense herb layer. Most have few trees or shrubs rooted in the middle, but woody vegetation is common on the edges and may be dispersed throughout with low cover. Many examples are small enough to be shaded by trees rooted in adjacent forest. *Sphagnum* spp. usually forms mats with high cover. The herb layer is usually dominated by graminoid species, with *Carex ruthii, Carex flexuosa, Carex gynandra* or *crinita,* and other species of *Carex* often dominant. No plants other than *Sphagnum* have high constancy either in plot data or in site descriptions. Frequent species in one or both include *Houstonia serpyllifolia, Drosera rotundifolia, Parnassia asarifolia, Solidago patula, Krigia montana, Chelone lyonii, Glyceria melicaria, Thalictrum clavatum, Hypericum graveolens, Solidago glomerata, Danthonia compressa, Oclemena acuminata, Dennstaedtia punctilobula, Avenella flexuosa,* and *Carex atlantica*. A large number of wetland species occur at lower frequency, such as *Carex debilis, Carex howei, Carex intumescens, Juncus acuminatus, Osmundastrum cinnamomeum, Platanthera clavellata, Juncus gymnocarpus, Oxypolis rigidior, Calamagrostis coarctata, Rhynchospora capitellata, Micranthes micranthidifolia, Impatiens pallida,* and *Chelone glabra*. Many upland or broadly tolerant species may also be present with low frequency, including *Dennstaedtia punctilobula, Athyrium asplenioides, Eurybia chlorolepis, Parathelypteris noveboracensis, Mitchella repens, Carex aestivalis, Agrostis perennans, Ageratina altissima* var. *roanensis*, *Hypericum mitchellianum*, and *Nabalus* spp. The most constant tree species are *Acer rubrum, Betula alleghaniensis, Betula lenta,* and *Picea rubens*. *Abies fraseri, Sorbus americana, Tsuga canadensis*, and *Amelanchier arborea* are also fairly frequent. *Viburnum cassinoides* is the shrub with the highest frequency. Other fairly frequent species include *Hypericum densiflorum, Vaccinium corymbosum, Vaccinium simulatum, Rhododendron catawbiense, Kalmia latifolia, Diervilla sessilifolia, Vaccinium erythrocarpum*, *Aronia melanocarpa*, and *Lyonia ligustrina* var. *ligustrina*.

Range and Abundance: Ranked G2. Examples are scattered through the higher mountains but are most abundant and extensive in the Great Balsam Mountains. This community is a narrow Southern Appalachian endemic, occurring in Tennessee and possibly Virginia. None are reported in Georgia, but it could occur there.

Associations and Patterns: High Elevation Boggy Seeps are small patch communities. Well-developed patches may be less than 1 acre in size, but some may be several acres. They sometimes occur in clusters to that add up to larger acreage. High Elevation Boggy Seeps are naturally usually surrounded by Spruce-Fir Forest or Northern Hardwood Forest communities, potentially by High Elevation Red Oak Forest or other higher elevation forests. Many examples also occur in high elevation successional vegetation, where spruce was destroyed by past logging and slash fires.

Variation: High Elevation Boggy Seeps are highly variable among examples, but no patterns of variation have been clarified.

Dynamics: Dynamics of High Elevation Boggy Seeps are likely similar to other seeps. Productivity is limited by the short growing season and low temperatures at high elevation, as well as by wetness. Wetness is enhanced by the high rainfall, frequent fog, and low evapotranspiration at high elevation. The boggy character of these communities may be related to reduced organic matter decomposition in the cool climate. Groundwater provides some nutrients, but low nutrient content in the groundwater may be partly responsible for their boggy character.

High Elevation Boggy Seeps are susceptible to rooting by feral pigs, but probably are less attractive to them than Rich Montane Seeps because of the greater graminoid and moss dominance in the vegetation.

Comments: These communities are intermediate conceptually between Southern Appalachian Bogs and Montane Rich Seeps. They tend to occur at higher elevations than Rich Montane Seeps, but with substantial overlap. The difference likely depends on the nature of the groundwater. However, the character of High Elevation Boggy Seeps also depends on high elevation. Similar topographic settings and seeps at lower elevation do not have a similarly bog-like character.

This community was recognized in Wichmann (2009) as *Betula* spp./*Carex ruthii* - *Avenella flexuosa / Sphagnum* spp. Newell (1997) recognized a *Carex gynandra* wetland and a *Carex ruthii* wetland, based primarily on the same plots.

Rare species:
Vascular plants: *Carex oligosperma, Glyceria nubigena, Huperzia appalachiana, Lilium grayi, Lonicera canadensis, Lycopodiella inundata, Muhlenbergia glomerata, Phegopteris connectilis, Rhododendron vaseyi, Sanguisorba canadensis, Solidago uliginosa* var. *uliginosa, Triantha glutinosa, Vaccinium macrocarpon,* and *Stenanthium leimanthoides*.
Nonvascular plants: *Gymnoderma lineare.*

References:
Newell, C.L. 1997. Local and regional variation in the vegetation of the Southern Appalachian Mountains. Ph.D. dissertation, University of North Carolina, Chapel Hill.

Wichmann, B.L. 2009. Vegetation of geographically isolated montane non-alluvial wetlands of the southern Blue Ridge of North Carolina. M.S. Thesis, North Carolina State University, Raleigh.

RICH MONTANE SEEP

Concept: Rich Montane Seeps are non-boggy seeps. They generally lack *Sphagnum* and have lush herb layers dominated by forbs and sharing many species with Rich Cove Forest. They may or may not have trees rooted within the seep but are generally small enough to be shaded by trees from adjacent forests.

Distinguishing Features: Rich Montane Seeps are distinguished by saturated soil and an herb layer that includes a combination of the more water-tolerant Rich Cove Forest species along with some distinctive seep species. The characteristic acid-tolerant wetland herbs of the bog communities are absent or scarce and limited to a few species. Both High Elevation Boggy Seep and Low Elevation Seep have flora that suggests more acidic conditions and have much less affinity with Rich Cove Forests.

Synonyms: *Impatiens (capensis, pallida) – Monarda didyma – Rudbeckia laciniata var. humilis* Herbaceous Vegetation (CEGL004293). *Diphylleia cymosa – Saxifraga micranthidifolia – Laportea canadensis* Herbaceous Vegetation (CEGL004296). High Elevation Seep (3rd Approximation).
Ecological Systems: Southern Appalachian Seepage Wetland (CES202.317).

Sites: Rich Montane Seeps occur along small headwater streams or on upland slopes that are gentle to moderate. A few examples may occur at the base of cliffs and have substantial bedrock. They can occur over a very wide range of elevations, from 1000 feet to 5500 feet or higher. They are more likely to occur over or near mafic rocks such as amphibolite, but they may occur in any kind of geology.

Soils: Soils are usually wet loamy soils or gravel, but may include deep mucky areas, abundant boulders, or bedrock outcrops. Patches are too small to be distinguished in soil mapping.

Hydrology: Rich Montane Seeps are saturated permanently or nearly so by discharging groundwater. Often the ground water appears to be shallow and very local in origin. The water moves through the community and through the soil, sometimes in a shallow sheet, sometimes in rivulets with limited development of channels.

Vegetation: Rich Montane Seeps have a dense herb layer. Most have a few trees or shrubs rooted in the middle, but woody vegetation may be dispersed throughout with low cover. Most examples have substantial shading from the adjacent forest and do not have much shrub cover on the edges. The herb layer is dense, often lush, and most examples are dominated by large forbs. Some combination of *Diphylleia cymosa, Laportea canadensis, Monarda didyma*, and somewhat less frequently, *Rudbeckia laciniata, Impatiens capensis, Impatiens pallida, Micranthes micranthidifolia*, or *Chrysosplenium americanum* dominate most patches. Other herbs that occur with at least fairly high frequency in CVS plot data and site descriptions include *Tiarella cordifolia, Arisaema triphyllum, Veratrum viride, Chelone glabra, Chelone lyonii, Eurybia chlorolepis, Ageratina altissima* var. *roanensis, Viola cucullata, Packera aurea, Dryopteris intermedia, Galium triflorum, Thalictrum clavatum, Polystichum acrostichoides, Angelica triquinata, Athyrium asplenioides, Eutrochium purpureum, Huperzia lucidula, Trillium erectum,*

Solidago curtisii, Hydrophyllum canadense, Actaea podocarpa, Actaea racemosa, Cardamine diphylla, Osmorhiza claytonii, and *Circaea alpina*. Other species shared with other seep communities, though less frequently in this community, include *Trautvetteria carolinensis, Houstonia serpyllifolia, Oxypolis rigidior, Osmundastrum cinnamomeum*, and *Osmunda spectabilis*. *Carex* species may be present but are low in cover, low in constancy, and tend to be more species shared with mesic uplands rather than wetland species. Less frequent species that are nevertheless notable include *Aconitum reclinatum, Aconitum uncinatum, Lilium grayi, Platanthera psycodes*, and *Platanthera grandiflora*. The trees rooted in the community or shading it from the edges tend to be mesophytic species of Rich Cove Forest or Northern Hardwood Forest, most constantly *Aesculus flava, Acer saccharum,* and *Betula alleghaniensis*, but often *Fraxinus americana, Quercus rubra, Tilia americana* var. *heterophylla, Acer spicatum, Halesia tetraptera*, and *Magnolia acuminata*. Shrubs are generally scarce, but *Hydrangea arborescens* or *Hamamelis virginiana* may be present.

Range and Abundance: Ranked G3 but apparently more common. Aggregate acreage nevertheless is low. Examples are scattered throughout the Mountain Region but are not known in the foothills. This community is a Southern Appalachian endemic, ranging to Virginia, Georgia, South Carolina, and Tennessee.

Associations and Patterns: Rich Montane Seeps are small patch communities. Patches may be well under an acre, and the community may be well developed even when only a few meters wide. Many are narrow bands a few meters wide but running much farther along a drainage or down a slope. They usually are surrounded by Rich Cove Forest or Northern Hardwood Forest but may be surrounded by other upland forests.

Variation: Rich Montane Seeps are extremely variable. Early drafts of the 4th Approximation recognized subtypes corresponding to the two synonymized NVC associations, representing lower and higher elevation seeps. These proved impossible to apply as defined. Any combination of the potential dominant species can occur together, rather than segregating into distinct subtypes. Most of those species occur over a very wide elevational range. However, with further study, enough variation in associated species may be found to define variants or subtypes.

Dynamics: Dynamics of Rich Montane Seeps are similar to those of the Upland Seepage and Spray Cliffs theme as a whole. Their occurrence primarily in mesic forests makes them unlikely to burn frequently, and their lush forb vegetation is unlikely to carry fire well.

Where feral pigs are present, Rich Montane Seeps are particularly vulnerable to their damage. Rossell, et al. (2016) documented the effects of their rooting in Rich Montane Seep communities in the Great Smoky Mountains, which included loss of plant cover and severe loss of salamanders.

Comments: This community was recognized in Wichmann (2009) as *Betula* spp./*Viburnum cassinoides*/*Athyrium asplenioides*. She noted that it was extremely variable and would probably warrant further subdivision with more data but did not find a pattern matching the two NVC associations that have been lumped here.

Rich Montane Seeps may be particularly important habitat for salamanders. Rossell, et al. (2016), studying Rich Montane Seeps in the Great Smoky Mountains, found densities of up to 13 per square meter, with an average of 1.37 per square meter. Ten species were found, including one rare and two uncommon species.

Rare species:

Vascular plants: *Aconitum reclinatum, Bromus ciliatus, Cardamine clematitis, Cardamine rotundifolia, Chelone obliqua, Epilobium ciliatum* var. *ciliatum*, *Geum geniculatum, Helianthemum propinquum, Liatris aspera, Lilium grayi, Lilium philadelphicum* var. *philadelphicum, Lonicera canadensis, Lonicera canadensis, Meehania cordata, Micranthes caroliniana, Parnassia grandifolia, Phlox subulata, Platanthera grandiflora*. *Rhododendron vaseyi, Streptopus amplexifolius* var. *amplexifolius*, and *Veronica americana.*

Nonvascular plants: *Gymnoderma lineare.*

Vertebrate animals: *Desmognathus wrightii*.

References:

Rossell, C.R., H.D. Clarke, M. Schultz, E. Schwartzman, and S.C. Patch. 2016. Description of Rich Montane Seeps and effects of wild pigs on the plant and salamander assemblages. American Midland Naturalist 175:139-154.

Wichmann, B.L. 2009. Vegetation of geographically isolated montane non-alluvial wetlands of the southern Blue Ridge of North Carolina. M.S. Thesis, North Carolina State University, Raleigh.

LOW ELEVATION SEEP (TYPIC SUBTYPE)

Concept: Low Elevation Seeps are seepage-fed wetlands that are intermediate in apparent fertility and that lack the distinctive species composition and other characteristics of Hillside Seepage Bog, Piedmont Boggy Streamhead, High Elevation Boggy Seep, Sandhill Seep, and of Southern Appalachian Bogs and Fens on the one hand and of Rich Montane Seep on the other. Low Elevation Seep sites include small hollows on slopes, slope breaks, toe slopes, or edges of floodplains. They can be quite small but have vegetation that contrasts sharply with adjacent communities. The Typic Subtype covers seeps that occur on upland slopes in the Piedmont and Coastal Plain, that lack distinctive Blue Ridge flora, and that lack the characteristics of the other subtypes.

Distinguishing Features: Low Elevation Seeps are distinguished by abundant wetland vegetation, without the characteristic composition and setting of other seepage wetlands or bogs. *Sphagnum* is not generally abundant but may be present in limited amounts. Many species may be shared with Southern Appalachian Bogs, Hillside Seepage Bogs, and Piedmont Boggy Streamheads, including *Viburnum nudum, Viburnum cassinoides, Impatiens capensis, Osmundastrum (Osmunda) cinnamomeum, Osmunda regalis, Woodwardia areolata*, and *Carex* spp. However, other species indicative of less nutrient-poor conditions, such as *Saururus cernuus, Lycopus virginicus*, and *Lindera benzoin*, are also present.

The Typic Subtype may be distinguished from the Floodplain Subtype by occurring in uplands or at the heads of small streams, rather than on the edge of larger floodplains. It consequently lacks the admixture of floodplain and alluvial species found in the Floodplain Subtype, such as *Acer negundo, Fraxinus pennsylvanica*, and *Celtis laevigata*, as well as species of wetter conditions such as *Peltandra virginica, Sagittaria* spp., and *Cephalanthus occidentalis*.

Synonyms: *Acer rubrum var. trilobum / Viburnum nudum var. nudum / Osmunda cinnamomea - Saururus cernuus – Impatiens capensis* Forest (CEGL004426). Rich Foot-slope Seeps (Seymour 2011).
Ecological Systems: Piedmont Seepage Wetland (CES202.298).

Sites: They Typic Subtype occurs on upland slopes, usually lower to mid slopes, sometimes at the head of small drainages. Seymour (2011) described her equivalent group as occurring on foot-slopes, but many other known examples occur farther uphill. Some seeps may be caused by underlying rock fractures which conduct groundwater, others by an underlying layer of impermeable bedrock or clay. Some are associated with a distinct change in slope or with a small amphitheater-like basin, while some show no distinctive topographic expression.

Soils: Soils are saturated residual soils. Seymour (2011) described them as sandy, but it is unclear if this applies to all examples. Patches are too small to be distinguished in soil mapping.

Hydrology: Typic Subtype occurrences are saturated all or much of the year. A sheet of flowing water or small rivulets may uncommonly be present, but there is never significant surface flooding.

Vegetation: The Typic Subtype has moderate to dense herbaceous vegetation and may have sparse to moderate shrubs. Generally few or no trees are rooted in the community; most examples are fully shaded by trees rooted in the adjacent forest, but the canopy may be somewhat open. The most constant dominant herb is *Osmundastrum cinnamomeum*, which is almost always present. Other high constancy herbs reported by Seymour (2011) are *Saururus cernuus* and *Lorinseria areolata*, which had high average cover, and *Athyrium asplenioides, Arisaema triphyllum, Dichanthelium microcarpon (dichotomum* var. *ramulosum)*, and *Leersia virginica*, which had low average cover. Other herbs that were fairly frequent in Seymour (2011) include *Boehmeria cylindrica, Carex* spp. (*atlantica, crinita, debilis, laevivaginata*, and *lurida*), *Chasmanthium laxum, Cinna arundinacea, Dioscorea villosa, Glyceria striata, Impatiens capensis, Juncus effusus/pylaei, Lycopus virginicus, Mitchella repens, Polystichum acrostichoides, Solidago caesia, Solidago rugosa, Viola* spp., *Platanthera* sp., and the exotic *Microstegium vimineum*. Bryophytes in the genera *Sphagnum, Thuidium, Mnium*, and various liverworts were also frequent. *Sphagnum* is often present in clumps in the Typic Subtype but, in contrast to more boggy wetlands, has limited cover. Shrubs that are most frequently present in these seeps are *Vaccinium fuscatum, Vaccinium corymbosum/formosum, Viburnum nudum, Lindera benzoin*, *Euonymus americanus*, *Eubotrys racemosa, Arundinaria tecta, Aronia arbutifolia*, *Ilex verticillata*, and less frequently, *Alnus serrulata*. The most frequent dominant tree species rooted in the wetland is *Acer rubrum*. Other constant or frequent species include *Liriodendron tulipifera*, *Nyssa sylvatica, Carpinus caroliniana, Ilex opaca, Oxydendrum arboreum*, *Liquidambar styraciflua*, and *Magnolia virginiana*. *Fagus grandifolia, Quercus alba*, and other upland tree species often have cover and may occasionally be rooted in the wetland. Some vines are frequent, and *Smilax rotundifolia* or *Muscadinia rotundifolia* may have fairly high cover. *Parthenocissus quinquefolia, Bignonia capreolata, Campsis radicans*, and the exotic *Lonicera japonica* are also fairly frequent in small amounts.

Range and Abundance: Ranked G3? but possibly less rare. Locations for this community can neither be predicted by topography nor detected by remote sensing; the small patches must be encountered in field surveys. New examples continue to be found even in fairly well-studied sites. Occurrences are scattered throughout the central and eastern Piedmont, with few or none in the foothills. A handful of examples is known in widely scattered locations in more hilly parts of the Coastal Plain. This community also is attributed to South Carolina and Georgia.

Associations and Patterns: Low Elevation Seep (Typic Subtype) is a small patch community, often occurring in patches just a few meters wide. Patches may be round or funnel-shaped or may be elongated in a downhill direction. They may be surrounded by any mesic or dry-mesic upland community and may occasionally border a floodplain community on one side. Those at the head of a drainage may give way to a Piedmont Headwater Stream Forest.

Variation: Examples vary in composition in ways that reflect wetness, as well as potentially biogeographically. Examples may be well-developed even when very small, but some small examples are depauperate and appear to be less wet. Though differences are not well documented, two variants are recognized for further exploration, based on biogeography and geologic setting.
1. Piedmont Subtype includes the majority of examples, which are in the Piedmont.

2. Coastal Plain Subtype includes examples in the Coastal Plain, which are less well understood but are expected to have some floristic differences. It is unclear which examples in the fall zone are most likely to resemble this subtype.

Dynamics: Dynamics of the Typic Subtype are similar to those described for seeps in general. Water moving through the system provides some continual input of nutrients, though nutrient concentrations may be limited. Though plot data show them to be more fertile than the other Piedmont seepage wetlands, (with the exception of the Floodplain Subtype), they are acidic and not highly fertile.

The Typic Subtype occurs farther uphill than many seep communities, and it may be more prone to drying out in late summer or during drought. Because the surrounding upland communities may be either dry or mesic, exposure to fire in seeps under natural conditions varies. Though the seep vegetation and wet litter generally would not carry fire well, because patches are small, much of the community could be scorched if the surrounding vegetation is flammable. Coastal Plain examples tend to occur in places that are topographically sheltered from fire and are surrounded by hardwood forest rather than longleaf pine communities, and they are more often adjacent to floodplains, so their natural fire frequency may not be high.

Comments: The circumscription of subtypes of Low Elevation Seeps largely follows the comprehensive quantitative analysis by Seymour (2011). However, this subtype may be defined more broadly here. Seymour (2011) called her corresponding type Rich Foot-slope Seeps, and described it as occurring primarily on lower slopes near floodplains. However, a number of sites not represented in her study occur farther uphill but fit this group better than any other. The Rich Foot-slope Seeps are rich only in the context of other Piedmont seepage wetlands such as the Piedmont/Mountain Springhead Subtype and Hillside Seepage Bog. They are less fertile than the Floodplain Subtype. The flora does not indicate rich soil conditions, and it is not at all comparable to Rich Montane Seep for richness. In addition, the Typic Subtype includes similar seeps in the Coastal Plain, which was outside Seymour's scope.

The NVC association synonymized with this subtype does not describe the range of vegetation well. In addition, it can be difficult to characterize the vegetation structure of these communities. They may be considered either forests, because they usually have a tree canopy covering them, or herbaceous vegetation, because few trees are rooted in the community. Though this association is characterized as a forest, other associations with similar vegetation structure are treated as herbaceous vegetation.

Acer rubrum – Nyssa sylvatica – Magnolia virginiana / Viburnum nudum var. nudum / Osmunda cinnamomea – Woodwardia areolata Forest (CEGL006238) is a seepage swamp of states to the north, primarily in the Coastal Plain. It may be related.

Rare species:
Vertebrate animals: *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.

LOW ELEVATION SEEP (MONTANE SUBTYPE)

Concept: Low Elevation Seeps are seepage-fed wetlands that are intermediate in apparent fertility and that lack the distinctive species composition and other characteristics of Hillside Seepage Bog, Piedmont Boggy Streamhead, High Elevation Boggy Seep, Sandhill Seep, and of Southern Appalachian Bogs and Fens on the one hand and of Rich Montane Seep on the other. They can be quite small, but their vegetation contrasts sharply with adjacent communities.

The Montane Subtype covers examples of the Mountains and upper Piedmont, which have a number of distinctive Blue Ridge species that are scarce or absent farther east. They occur on slopes, in small cove bottoms, and along headwater streams.

Distinguishing Features: Low Elevation Seeps are distinguished by saturated soil and by abundant wetland vegetation and flora that includes species that are intermediate in nutrient needs, while lacking those most characteristic of High Elevation Boggy Seep and the Mountain Bogs and Fens communities.

Many species may be shared with High Elevation Boggy Seep and with various Mountain Bogs and Fens communities, including *Viburnum nudum, Viburnum cassinoides, Impatiens capensis, Osmundastrum (Osmunda) cinnamomeum, Osmunda regalis, Lorinseria areolata*, and some *Carex* spp. However, other species indicative of less nutrient-poor conditions, such as *Lycopus virginicus*, *Thalictrum clavatum,* and *Lindera benzoin*, are also present in Low Elevation Seep in large numbers. More narrowly distributed species of bogs, such as *Vaccinium macrocarpon, Sarracenia* spp., *Drosera rotundifolia*, and *Carex folliculata* are absent or very scarce in Low Elevation Seeps, and *Sphagnum* generally is not abundant.

Rich Montane Seeps share some species with the Montane Subtype but tend to be dominated by species rarely if ever found in it, such as *Laportea canadensis, Diphylleia cymosa,* and *Monarda didyma,* Other species characteristic of Rich Montane Seep communities, such as *Rudbeckia laciniata* may be present but have lower frequency and abundance. *Osmundastrum cinnamomeum* and *Osmunda spectabilis*, among the most important herbs in Low Elevation Seeps, are rarely present in Rich Montane Seeps.

The Montane Subtype is distinguished from the Typic Subtype by floristic differences, with the presence of species that are scarce or absent in Piedmont seeps, such as *Micranthes (Saxifraga) micranthidifolia, Houstonia serpyllifolia*, *Thalictrum clavatum*, and *Chelone glabra*. It is distinguished from the Floodplain Subtype by not occurring in a medium to large floodplain, lacking evidence of flooding, and by lacking the characteristic species of that subtype. It lacks most of the species of Coastal Plain affinities that characterize the Piedmont/Mountain Springhead Subtype. The Montane Subtype can have some bedrock present, as well as often having boulders or cobbles, but it lacks the continuous rock layer of the Bedrock Subtype.

Synonyms: *Glyceria striata – Carex gynandra – Chelone glabra – Symphyotrichum puniceum / Sphagnum* spp. Herbaceous Vegetation (CEGL008438).
Ecological Systems: Southern Appalachian Seepage Wetland (CES202.317).

Sites: The Montane Subtype may occur in several kinds of settings in mountainous terrain, including along intermittent or small perennial headwater streams, at the origin of such streams at the head of a valley, at the foot of slopes on the edges of cove bottoms, and occasionally on open mountain slopes.

Soils: Soils are saturated residual or colluvial soils, which may be deep or relatively shallow and rocky. Patches are too small to be distinguished in soil mapping.

Hydrology: Montane Subtype occurrences are saturated all or much of the year. A sheet of flowing water or small rivulets may often be present. Examples along drainages may rarely be affected by flash floods.

Vegetation: The Montane Subtype has moderate to dense herbaceous vegetation and may have sparse to fairly dense shrubs. Generally few or no trees are rooted in the community; those that are, are primarily *Liriodendron tulipifera* and *Acer rubrum*. Most examples are fully shaded by trees rooted in the adjacent forest, but the canopy may be somewhat open. The most constant herbs are *Osmundastrum cinnamomeum* and *Osmunda spectabilis*, which may dominate, and *Chelone glabra*. Other frequent herbs in site descriptions include *Thalictrum clavatum, Carex bromoides, Oxypolis rigidior, Impatiens capensis, Houstonia serpyllifolia, Lycopus virginicus, Lobelia amoena, Athyrium asplenioides, Platanthera clavellata*, *Micranthes micranthidifolia,* and *Lobelia cardinalis*. Fairly frequent also are *Carex intumescens, Eurybia divaricata, Solidago patula, Rudbeckia laciniata, Viola blanda, Viola cucullata, Juncus gymnocarpus*, and *Leersia virginica*. A great diversity of other *Carex* species occur occasionally, including *scabrata, debilis, styloflexa, leptalea, atlantica, gynandra*, and many others. The most constant shrubs, which may dominate, are *Lindera benzoin, Alnus serrulata*, *Ilex verticillata*, and *Viburnum nudum*. *Xanthorhiza simplicissima* is also often present if there is a rocky channel in the seep. A great variety of other wetland shrubs may be present at lower frequency, including *Leucothoe fontanesiana, Sambucus canadensis, Vaccinium fuscatum, Rhododendron maximum, Rhododendron arborescens, Clethra acuminata, Viburnum cassinoides*, *Cornus amomum*, and many others.

Range and Abundance: Ranked G2G3 but possibly less rare. Locations for this community cannot be predicted by topography nor detected by remote sensing; the small patches must be encountered in field survey. Examples may have sometimes been overlooked in earlier site surveys. Occurrences are scattered throughout the Mountain Region, with a few in the foothills area of the Piedmont. The synonymized NVC association ranges southward to Georgia and possibly Alabama, and also occurs in Tennessee.

Associations and Patterns: Low Elevation Seep (Montane Subtype) is a small patch community. It sometimes occurs in patches that are just a few meters wide or may occur in narrow bands along small streams, though many patches are larger. It may occur in complexes that amount to several acres.

Variation: Examples of the Montane Subtype are extremely variable. Variation clearly results from different physical settings, particularly depth or rockiness of the soil and amount of water. Other variation may relate to elevation or to biogeographic patterns. No variants have been recognized.

Dynamics: Dynamics of the Montane Subtype are similar to those described for seeps in general. Though plot data show them to be more fertile than various bogs, they are less fertile than the Floodplain Subtype and less fertile than Rich Montane Seep. This presumably is because of the chemistry of the water moving through them.

Fire is probably of limited importance in the Montane Subtype even under natural conditions. Fire is unlikely to carry well through the forb-dominated vegetation and moist litter, and most are surrounded by mesic communities where fire is likely uncommon and of low intensity.

Comments: Defining the vegetation structure of this subtype, as in some others, is problematic. Patches tend to be small, and often are largely shaded by trees rooted in adjacent communities, in combination with only a few trees rooted in the seep. The association for this subtype is named as herbaceous vegetation, while those synonymized to other subtypes are named as forests, but the canopy cover and light levels are very similar.

The association linked to this subtype is problematic and the linkage may be inappropriate. An earlier description that seemed to link it to the boggy openings in Swamp Forest–Bog Complex was changed to one that appears more like the Montane Subtype. However, Wichmann (2011) characterized her Low Elevation Saturated Forest type, which was primarily related to Swamp Forest–Bog Complex, as including this association. The NVC describes the association as occurring in floodplains and being subject to occasional flooding, perhaps making it a subset of the Floodplain Subtype. A new association may be needed to represent the Montane Subtype.

Rare species:
Vascular plants: *Chelone obliqua* and *Collinsonia tuberosa*.
Vertebrate animals: *Plethodon wehleri*.

References:
Wichmann, B.L. 2009. Vegetation of geographically isolated montane non-alluvial wetlands of the southern Blue Ridge of North Carolina. M.S. Thesis, North Carolina State University, Raleigh.

LOW ELEVATION SEEP (FLOODPLAIN SUBTYPE)

Concept: Low Elevation Seeps are seepage-fed wetlands that lack the distinctive species composition and other characteristics of Hillside Seepage Bog, High Elevation Boggy Seep, Rich Montane Seep, Sandhill Seep, and other seepage wetland communities. The Floodplain Subtype represents seeps on medium to large floodplains, where upland seepage dominates hydrology but where flooding, alluvial deposition, and potentially blocking of drainage by alluvial landforms or beaver impoundment are also influences. It occurs in the Piedmont and Mountains.

Distinguishing Features: Low Elevation Seeps are distinguished by abundant wetland vegetation, without the characteristic composition and setting of other seepage wetlands or bogs.

The Floodplain Subtype generally is readily distinguished by the physical environment, which has at least occasional flooding as well as seepage. It generally is in a recognizable floodplain, with alluvial soil. It also contains plants characteristic of floodplains as well as seeps, and often contains plants of wetter conditions. Species frequent in the Floodplain Subtype and seldom in other seepage wetlands include *Cinna arundinacea*, *Persicaria sagittata*, *Carex tribuloides*, *Carex laevivaginata*, *Carex lurida*, *Impatiens capensis*, species of wetter areas such as *Peltandra virginica*, *Sagittaria* spp., and *Cephalanthus occidentalis*, and floodplain species such as *Acer negundo*, *Fraxinus pennsylvanica*, and *Betula nigra*. This subtype also tends to have nonnative species characteristic of floodplains and scarce in uplands, including *Microstegium vimineum*, *Murdannia keisak*, and *Persicaria longiseta*. Other species that are often dominant and that are most common in the Floodplain Subtype (compared to other subtypes) include *Boehmeria cylindrica*, *Glyceria striata*, *Saururus cernuus*, *Leersia oryzoides*, and *Lindera benzoin*. Species seldom found in the Floodplain Subtype include *Vaccinium fuscatum*, *Viburnum nudum*, *Ilex opaca*, *Osmundastrum cinnamomeum*, *Osmunda spectabilis, Platanthera* spp., *Arisaema triphyllum*, *Viola primulifolia*, and *Lorinseria areolata*.

Synonyms: *Acer rubrum* / *Alnus serrulata – Lindera benzoin* / *Glyceria striata – Impatiens capensis* –Forest (CEGL007031). Floodplain Seep (Seymour 2011).
Ecological Systems: Southern Piedmont Seepage Wetland (CES202.298). Southern Appalachian Seepage Wetland (CES202.317).

Sites: The Floodplain Subtype occurs on flat ground at the edges of medium to large bottomlands. It generally is right at the base of the upland slope, extending as far into the floodplain as the seepage keeps the soil saturated.

Soils: The Floodplain Subtype has silty or clayey alluvial soil that shows evidence of saturation. It is generally mapped as part of larger map units of alluvial soils such as Chewacla (Fluvaquentic Dystrudept), Wehadkee (Typic Fluvaquent), or Iotla (Fluvaquentic Dystrudept), but likely represents a more hydric related soil. A few examples are included in upland soil map units.

Hydrology: Floodplain Subtype occurrences are saturated year-round. A thin sheet of flowing or standing water or small rivulets may uncommonly be present, or water may move solely through the soil. They are flooded at least occasionally, if not yearly, by overflow from the river.

Vegetation: The Floodplain Subtype generally has dense herbaceous vegetation with abundant graminoids. *Glyceria striata, Cinna arundinacea*, or the exotic *Microstegium vimineum* may dominate, and a number of *Carex* species may be abundant, including *lurida, atlantica, howei, laevivaginata, crinita, tribuloides*, and *radiata*. Other constant or high-frequency herbs include *Impatiens capensis, Lycopus virginicus, Boehmeria cylindrica, Sagittaria latifolia*, and *Persicaria sagittata*. *Sphagnum* sp. maybe present, but only in small amounts. *Mnium* spp. and other mosses and liverworts may also be present. Other herbs with moderate frequency include *Dichanthelium dichotomum* var. *ramosum, Dioscorea villosa, Galium tinctorium, Hypericum mutilum, Juncus effusus/pylaei, Lycopus virginicus, Persicaria sagittifolia, Saururus cernuus, Solidago caesia, Symphyotrichum puniceum* var. *puniceum, Viola* spp., and the exotics *Murdannia keisak* and *Persicaria longiseta*. The shrub layer may be sparse or fairly dense. *Alnus serrulata* may dominate thickets, or it and *Lindera benzoin* may dominate more open stands. A few vines are usually present, though cover is generally low. These include *Toxicodendron radicans, Parthenocissus quinquefolia*, *Smilax rotundifolia*, and *Lonicera japonica.* Trees rooted in the community are variable, with *Acer rubrum, Fraxinus pennsylvanica,* and *Liquidambar styraciflua* most frequent and *Betula nigra* and other alluvial species also common.

Range and Abundance: Ranked G4. This community is scattered throughout the Piedmont and, more sparsely, in the Mountains. A few examples are known in the Coastal Plain. It is thus one of the most widespread communities in the state. The synonymized association is definitively attributed only to North Carolina and questionably to South Carolina but may be present in Georgia.

Associations and Patterns: The Floodplain Subtype is a small patch community. Occurrences tend to be larger than the Typic or Montane Subtype, because of flatter topography, generally wetter surrounding conditions, and perhaps because of greater amounts of groundwater, but most are still a few acres or less in size. They generally are surrounded by Piedmont Alluvial Forest or Piedmont Bottomland Forest but are often bordered by an upland community on one side.

Variation: Examples of the Floodplain Subtype vary with wetness. Seymour (2011) noted that this group of plots had the highest internal consistency of any of her Piedmont seepage wetland groups. The constraints of the environment allow communities recognizable as the same subtype to occur in all three regions of the state. Nevertheless, though not large, variants are recognized based on expected biogeographic differences.

1. Mountain Variant occurs in the Mountain Region and possibly in the foothills area.
2. Piedmont Variant occurs in the central and eastern Piedmont, and potentially in the foothills area.
3. Coastal Plain Variant encompasses the few Coastal Plain examples. Examples are known on both brownwater and blackwater floodplain, which may suggest a further division of variants.

Dynamics: Dynamics of the Floodplain Subtype are a mix of those of other Low Elevation Seep subtypes and floodplain communities. Because saturation by seepage is perennially present, it is the stronger influence. However, this is the most fertile group of Piedmont seeps because of the fertility of the alluvium as well as nutrients brought in by seepage. Seeps are also subject to flooding, which may bring in new sediment deposition and a pulse of nutrients. Though probably rare, they may also be subject to changes in drainage caused by movement of sediment in outlet

channels and to flooding by beaver ponds. Like floodplain communities, the Floodplain Subtype of Low Elevation Seep is particularly susceptible to invasion by exotic plants. *Microstegium vimineum, Murdannia keisak, Lonicera japonica*, and *Ligustrum sinense* may all be abundant and can come to dominate in disturbed examples.

Comments: This subtype fits quite well with the Floodplain Seeps type of Seymour (2011) within the Piedmont, but it is broadened to include similar communities in the Mountains and Coastal Plain. Seymour (2011) found it to be the most distinctive of her five types of Piedmont seeps, more distinct than the Hillside Seepage Bog or Piedmont Boggy Streamhead types. This suggests consideration should be given to treating it as a full type rather than a subtype in the future. It does, however, appear to have more overlap in composition in some examples than her general analysis suggests.

Several extensive, very wet, marsh-like communities that have been called Piedmont Fens are included here. They have had limited study and need further exploration to clarify their ecological character. They may represent an unrecognized subtype or may represent examples of the Floodplain Subtype that have been affected by beaver or human impoundments.

Rare species:
Vascular plants: *Platanthera peramoena* and *Silphium connatum*.
Vertebrate animals: *Glyptemys muhlenbergii* 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.

LOW ELEVATION SEEP (BEDROCK SUBTYPE)

Concept: Low Elevation Seeps are seepage-fed wetlands that are intermediate in apparent fertility and that lack the distinctive species composition and other characteristics of Hillside Seepage Bog, Piedmont Boggy Streamhead, High Elevation Boggy Seep, Sandhill Seep, and of Southern Appalachian Bogs and Fens on the one hand and of Rich Montane Seep on the other. They can be quite small, but their vegetation contrasts sharply with adjacent communities. The Bedrock Subtype consists of large seeps in shallow soil over unfractured bedrock, such as the edges of granitic domes or along bedrock stream beds.

Distinguishing Features: Low Elevation Seeps are distinguished by saturated soil and by abundant wetland vegetation and flora that includes species that are intermediate in nutrient needs, while lacking those most characteristic of High Elevation Boggy Seep and the Mountain Bogs and Fens communities.

The Bedrock Subtype is distinguished from other subtypes by occurring on shallow soil over bedrock and having a distinctive flora that includes some bog species. Small seepage patches are common in various rock outcrop communities and in Spray Cliffs, but this subtype is reserved for larger patches that are well-differentiated from the adjacent community and have a substantial wetland flora. Examples should be at least several meters wide and tens of meters long. Though treated as a subtype of Low Elevation Seep, the Bedrock Subtype can occur over a wide range of elevations, overlapping with High Elevation Granitic Dome, Northern Hardwood Forest, and other higher elevation communities.

Low Elevation Acidic Glade (Biltmore Sedge Subtype) is similar to some examples of the Bedrock Subtype in occurring in bedrock seepage areas on granitic dome outcrops; it is distinguished by longer-term wet conditions and by vegetation that is not dominated by *Carex biltmoreana*.

Synonyms: *Oxypolis rigidior – Drosera rotundifolia – Platanthera clavellata – Rhexia mariana* var. *mariana* Seep Herbaceous Vegetation (CEGL007043). Cataract Bog (various usages).
Ecological Systems: Southern Appalachian Seepage Wetland (CES202.317).

Sites: The Bedrock Subtype occurs on smooth, largely unfractured rock outcrops, usually at the edges of granitic domes or on exposed bedrock on edges of stream beds, occasionally on vertical cliff faces. Seepage emerges from soil on the edge of the rock outcrop. Examples range widely in elevation, with most in the 3000-4500 foot range but with one example at 5400 feet.

Soils: The substrate is shallow organic or sediment mats and areas of bare bedrock.

Hydrology: The Bedrock Subtype is wet perennially or through most of the growing season, though it may dry out during drier periods. Shallow groundwater or soil water moving through permeable soil is discharged at the edge of the rock outcrop. It flows in a sheet over the bare rock and saturates the shallow soil mats that may be present. A better developed stream with a bedrock bed may run through or adjacent to the community.

Vegetation: The Bedrock Subtype consists of moderate to dense herbaceous vegetation. *Sphagnum lescurii*, possibly other *Sphagnum* species, usually occur as scattered patches or as extensive mats. *Aulacomium palustre, Philonotis fontana*, and a variety of other mosses and liverworts are usually abundant. Vascular plants are sparse to moderate in density and are extremely variable. The only species occurring in more than half of the known examples is *Oxypolis rigidior*. *Drosera rotundifolia, Thalictrum clavatum, Solidago patula, Rhexia mariana, Platanthera clavellata,* and *Calopogon tuberosus* occur in multiple examples. *Rhynchospora*, perhaps usually *capitellata*, occurs in several. Several species of *Carex* have been reported, including *folliculata, virescens*, and *styloflexa*. A wide variety of species occurs in one or two examples. Many are species shared with the Montane Subtype or with High Elevation Boggy Seep, such as *Impatiens capensis, Diphylleia cymosa, Vila primulifolia, Solidago patula, Eupatorium perfoliatum*, and *Lobelia cardinalis*. A number of additional species are more characteristic of the Coastal Plain, such as *Pogonia ophioglossoides, Xyris torta, Bartonia virginica*, and *Utricularia subulata*. Some are species shared with the adjacent rock outcrop community, such as *Carex biltmoreana, Micranthes petiolaris*, and *Packera millefolium*. No trees are present in these seeps. Shrubs may be present at low density. Only *Aronia arbutifolia* and *Alnus serrulata* are known in more than a single example. A variety of other wetland shrubs may occur, along with shrubs of the adjacent communities.

Range and Abundance: Ranked G1 but perhaps G2. Fewer than ten examples are known in North Carolina. A few more may be found. They are sparsely scattered over the Mountain Region, with one example known in the foothills. They are somewhat more concentrated in the Cowee Mountains area where granitic domes are abundant. This community is also known in South Carolina.

Associations and Patterns: The Bedrock Subtype is a small patch community. Most examples are no more than one acre in size. They are associated with Low Elevation Granitic Dome or High Elevation Granitic Dome communities. They usually are on the edge and are bordered by an upland forest community on one side. A few examples occur along streams, where they are bordered by mesic forest communities. Examples may potentially be associated with Montane Cliff communities as well.

Variation: The Bedrock Subtype is extremely variable, with most examples sharing only a few species with others. Examples appear to vary with gradation to other communities. Some are more bog-like, with extensive *Sphagnum* and with other plants characteristic of bogs. Some share a few species with Rich Montane Seeps. Some have large numbers of Coastal Plain species while some have few or none. The highest elevation example has species typical of higher elevations. While systematic differences might be expected between those on granitic domes and those on stream sides, no repeating pattern has been identified. A separate variant should be recognized for the most bog-like examples, known as cataract bogs, in South Carolina, but none of these are known in North Carolina.

Dynamics: Low Elevation Seep (Bedrock Subtype) communities are primary successional communities that may share more of their dynamics with rock outcrop communities than with other seeps. Despite abundant moisture and, presumably, at least some steady supply of nutrients, lack of soil limits the stature of their vegetation. While wet conditions might be expected to hasten

weathering of the rock and promote soil development, the presence of plants not typical of the region suggests great antiquity of at least some examples. Examples on granitic domes presumably are renewed in the same way as the drier communities, by soil mats sloughing off and by occasional spalling of the rock surface along exfoliation joints. Examples along streams also usually occur on exfoliated granitic rock. They probably are subject to occasional disturbance by flooding, which could be a catastrophic disturbance. Flowing water could easily remove the shallowly rooted vegetation and think soil mats. Drought presumably is also a natural disturbance in these communities, though it is unclear how severe it might be. Fire likely has little influence in them.

The Bedrock Subtype, like rock outcrop communities, is extremely sensitive to trampling. It may also be altered, potentially seriously degraded, by hydrological changes in the adjacent forest where seepage water originates.

Comments: The Bedrock Subtype was recognized relatively late in development of the 4th Approximation. Many of the known examples had already been described, being characterized as bogs, as part of the rock outcrop community, or as Low Elevation Seep. This subtype perhaps only marginally fits the general concept of Low Elevation Seep. Future consideration may lead to recognition as a new type. Because they are extremely hazardous to work in, almost no plot data exist for these communities. A few plots have been sampled in South Carolina but none in North Carolina.

The Bedrock Subtype incorporates the cataract bogs of South Carolina. Those communities are known for their bog-like character and for the presence of rare bog species such as *Sarracenia jonesii*. They also have a large pool of Coastal Plain species, some shared with North Carolina examples but many not. North Carolina's bedrock seeps appear to be of similar size but are less diverse and do not contain rare plants. However, North Carolina examples have fairly diverse flora that includes regionally rare species and species of Coastal Plain affinities.

Rare species:
Vascular plants: *Packera millefolium.*

References:

LOW ELEVATION SEEP (PIEDMONT/MOUNTAIN SPRINGHEAD SUBTYPE)

Concept: Low Elevation Seeps are seepage-fed wetlands that lack the distinctive species composition and other characteristics of Hillside Seepage Bog, High Elevation Boggy Seep, Rich Montane Seep, or Sandhill Seep communities. The Piedmont/Mountain Springhead Subtype covers rare examples of very acidic seeps of the upper Piedmont and Mountains, with a component of Coastal Plain species such as *Nyssa biflora, Viburnum nudum*, and *Smilax laurifolia*. They generally occur at the headwaters of small streams in relatively subdued topography and are sometimes associated with amphitheater-like basins.

Distinguishing Features: The Piedmont/Mountain Springhead Subtype is distinguished from all other communities by the presence of multiple Coastal Plain plant species in a saturated wetland in the upper Piedmont or Mountains, while lacking the distinctive flora of Hillside Seepage Bog, Piedmont Boggy Streamhead, French Broad Valley Bog, Low Mountain Seepage Bog, and Southern Appalachian Bog, and not occurring in larger floodplains. It appears not to overlap the range of the Typic Subtype or Piedmont Boggy Streamhead. More than most other communities in the Upland Seepages and Spray Cliffs theme, this subtype tends to have a substantial component of trees and shrubs rooted in the wetland.

Wetlands that are known to once have had the more distinctive herbs typical of the Hillside Seepage Bog type, such as *Sarracenia flava, Sarracenia purpurea*, and *Helenium brevifolium*, should be treated as degraded Hillside Seepage Bogs rather than as this subtype.

Synonyms: *Acer rubrum / Viburnum nudum – Photinia pyrifolia / Smilax laurifolia / Carex debilis var. pubera* Seepage Forest (CEGL007041). Infertile Swampy Seeps (Seymour 2011).
Ecological Systems: Piedmont Seepage Wetland (CES202.298). Southern Appalachian Seepage Wetland (CES202.317).

Sites: The Piedmont/Mountain Springhead Subtype usually occurs at the head of a small stream in areas of gentle slope. Some are in broad amphitheater-like basins with seepage seeming to come from several sides. These may have been formed by sapping by the groundwater discharge.

Soils: Soils are soft and show evidence of wetland conditions. Though patches often are large enough to be mapped, their treatment varies substantially. Some are mapped as floodplain soils such as Wedhadkee (Typic Fluvaquent). Some in Polk Country are mapped as Dogue (Aquic Hapludult) and Roanoke (Typic Endoaqualt), Coastal Plain soils of nonriverine wetlands. Others are treated as inclusions in upland soils.

Hydrology: Piedmont/Mountain Springheads are permanently saturated by seepage. They appear to be wetter than other subtypes of Low Elevation Seep or other wetlands in this theme. Multiple rivulets in the community and a well-developed stream exiting the wetland are common.

Vegetation: The Piedmont/Mountain Springhead Subtype usually has a well-developed, though sometimes short or open, canopy of trees rooted in the wetland. *Acer rubrum* and *Nyssa sylvatica* or *Nyssa biflora* usually dominate, though *Liriodendron tulipifera*, *Liquidambar styraciflua*, or other species may also be present. The understory consists primarily of the same species but may

have *Magnolia virginiana*. The shrub layer is generally well developed and often relatively diverse. *Viburnum nudum* is most constant and often dominant. Other frequent shrubs in Seymour (2011) and in site descriptions include *Eubotrys racemosa, Aronia arbutifolia, Vaccinium corymbosum, Vaccinium fuscatum, Toxicodendron vernix, Alnus serrulata, Ilex verticillata, Itea virginica*, and *Xanthorhiza simplicissima*. Vines may be prominent and may represent a fairly diverse collection of species, including *Smilax rotundifolia, Smilax laurifolia, Smilax walteri, Toxicodendron radicans, Hydrangea* (*Decumaria*) *barbara*, and *Parthenocissus quinquefolia*. The herb layer may range from sparse to dense, or it may be patchy. *Osmundastrum cinnamomeum* and *Osmunda spectabilis* are the most frequent and most often dominant species in site descriptions. Also frequent are *Lorinseria areolata, Oxypolis rigidior, Parathelypteris noveboracensis*, and *Platanthera clavellata*. Less frequent species include *Arisaema triphyllum, Lycopus virginicus, Leersia virginica, Chelone* spp., and a diversity of other species that occur in single examples. Seymour (2011) and site reports note a diversity of *Carex* species, none with high frequency, including *alleghaniensis, leptalea, atlantica, howei, lurida, debilis*, and *folliculata*. *Sphagnum* spp. is present in limited amounts in fewer than half the examples.

Range and Abundance: Ranked G2. Fewer than ten examples are known in North Carolina. There is a small cluster in the Piedmont part of Polk County. Other examples are widely scattered in the western Piedmont with a few in the Mountains. This community is also known in South Carolina and could potentially occur in Georgia.

Associations and Patterns: The Piedmont/Mountain Springhead Subtype is a small patch community, but patches are larger than most other communities in this theme. Most examples are several acres. A Piedmont Headwater Stream Forest may occur along the outlet stream, and other floodplain communities may be nearby. Otherwise, examples are surrounded by mesic or dry-mesic upland communities.

Variation: Variation of this subtype has not been sorted out. A cluster of examples appears fairly similar to each other, while several other examples each appear unique. A particularly diverse example in South Carolina probably warrants a different variant, perhaps a different subtype.

Dynamics: Dynamics of this subtype are particularly uncertain. It is unclear how these sites came to have multiple species typical of the Coastal Plain. The same species occur in French Broad Valley Bogs and a few other mountain communities, but they are generally lacking in the surrounding landscape, and sometimes they are disjunct considerable distances from other populations.

Piedmont/Mountain Springheads are wetter than most seeps, apparently due to greater groundwater discharge, and Seymour (2011) characterized them as infertile even among the generally infertile seeps she studied. This presumably leads to slow plant growth and low productivity, as well as limiting the species present. Given the width of patches, sheltering topography, the wet substrate, and limited graminoid vegetation, fire likely seldom penetrated them even when the surrounding landscape burned.

There is some question whether occurrences may once have been more open. The dominant woody species include many that sometimes invade open wetland communities such as Southern

Appalachian Bogs, and the herbs are largely the more shade-tolerant wetland species. Seymour (2011) found that plots from degraded, formerly open Hillside Seepage Bog occurrences clustered with the well-developed Piedmont/Mountain Springhead plots, presumably because of their high tree and shrub cover. However, Piedmont/Mountain Springheads occur in a different geographic range, and none are known to have previously been more open. Only one example, at Hanging Rock State Park, is associated with an open herbaceous wetland, and it occurs in a distinctly different microsite. The *Sarracenia* that drew early attention to Hillside Seepage Bogs have never been reported in most counties where Piedmont/Mountain Springhead examples occur.

Comments: The Piedmont/Mountain Springhead Subtype was not known at the time of the 3rd Approximation. When examples were discovered, they were first treated as anomalous Hillside Seepage Bog, Southern Appalachian Bog, or Low Elevation Seep communities. This subtype is distinctive in occurring in the upper Piedmont but having characteristically Coastal Plain species that are lacking in most eastern Piedmont seeps (but many of which are present in French Broad Valley Bogs). It corresponds to one of Seymour's (2011) five distinct types of Piedmont seeps. Its vegetation grouped most closely with the less acidic and more widespread seeps of lower slopes (the Typic Subtype), rather than with Hillside Seepage Bogs or Piedmont Boggy Streamheads, but it was distinctly more acidic and nutrient poor. She did not have data from the mountain examples. Though she included some plots from Hillside Seepage Bogs in Iredell County that have lost their characteristic open bog flora, this resemblance appears to be superficial. They are not included in the concept of this subtype here.

Rare species:
Vascular plants: *Hexastylis naniflora* and *Hexastylis rhombiformis*. Though not known in North Carolina, *Sagittaria fasciculata* occurs in this community in South Carolina.

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

HILLSIDE SEEPAGE BOG

Concept: Hillside Seepage Bogs are sloping seepage wetlands of the Piedmont that have a distinctive acid-tolerant, bog-like flora that generally includes *Sarracenia flava* or *Sarracenia purpurea*, *Sphagnum*, and often herbaceous species of Coastal Plain affinities.

Distinguishing Features: Hillside Seepage Bogs share many woody species with other Piedmont upland seeps, including multiple species of Coastal Plain affinities, such as *Magnolia virginiana, Smilax laurifolia, Nyssa biflora,* and *Viburnum nudum*. They also share widespread species of saturated wetland, such as *Osmundastrum (Osmunda) cinnamomeum*, *Osmunda spectabilis*, and *Sphagnum* spp. They are distinguished by a collection of more acid-tolerant herbs, many of which also have Coastal Plain affinities. *Sarracenia flava* or *Sarracenia purpurea* are usually, though not always, present. *Sphagnum* is generally more extensive than in other Piedmont seeps. When examples are burned, a variety of herbaceous species not found in other seeps are present, including *Symphyotrichum dumosum*, *Rhexia mariana, Danthonia sericea, Eupatorium leucolepis*, *Drosera brevifolia*, and *Helenium brevifolium*. Low Elevation Seep (Typic Subtype) communities may occur in similar uphill settings but contain less acid-tolerant species. Species such as *Arisaema triphyllum ssp. triphyllum, Glyceria striata, Boehmeria cylindrica*, and *Saururus cernuus* are characteristic of Low Elevation Seeps but are not generally present in Hillside Seepage Bogs. Low Elevation Seep (Piedmont/Mountain Springhead) communities have a similar collection of Coastal Plain woody species but lack the natural herbaceous component. Piedmont Boggy Streamheads lack most of these specialized herbaceous species, and they contain a few more widespread floodplain species such as *Lindera benzoin* and *Xanthorhiza simplicissima*. Low Elevation Seep (Floodplain Subtype) communities have even more floodplain species and more species of richer soils.

Many Hillside Seepage Bogs have been overgrown by shrubs and trees, in response to lack of fire and to hydrologic alteration. These lack the distinctive herbaceous component and are very difficult to distinguish from other seeps without knowing that they once harbored these species. Their vegetation may be very similar to that of Low Elevation Seep (Piedmont/Mountain Springhead), but they should be treated as degraded Hillside Seepage Bogs. The ranges of these two communities are not known to overlap. Hillside Seepage Bogs are known only from the middle and lower Piedmont.

The Low Mountain Seepage Bog community type shares a similar topographic and hydrologic setting with Hillside Seepage Bogs, along with sharing some species, but its location in the western Mountains leads to a substantially different flora.

Synonyms: *Acer rubrum var. trilobum / Morella caroliniensis - Gaylussacia frondosa / Andropogon glomeratus - (Sarracenia flava)* Woodland (CEGL004781). Headwater Boggy Seep (Seymour 2011).
Ecological Systems: Piedmont Seepage Wetland (CES202.298).

Sites: Hillside Seepage Bogs occur on sloping uplands, generally on mid to lower slopes. They are not on floodplains of even small streams, though they may have rivulets and some may have a headwater stream issuing from them. Seymour (2011) described them as having the nearest stream

being the smallest and steepest of any Piedmont seeps. Some Hillside Seepage Bogs are in distinct amphitheater-like indentations in the slope, suggesting effects of sapping. A few may have a distinct steepening of the slope, suggesting a different underlying layer. Some have no obvious difference from the adjacent slope.

Soils: Soils are saturated residual soils, which may or may not have a substantial organic component. Seymour (2011) found this to be the most acidic and infertile of her five groups of Piedmont seep communities, with soils high in clay. Some other examples are distinctly silty. Examples are generally too small to be distinguished in soil mapping and are included with adjacent upland soils.

Hydrology: Hillside Seepage Bogs are perennially saturated. They tend to be wetter than Low Elevation Seeps of most subtypes.

Vegetation: Hillside Seepage Bogs in natural condition have moderate to dense herbaceous vegetation and have sparse trees and sparse-to-moderate shrubs. *Sphagnum* spp. is usually present and often extensive. *Osmundastrum cinnamomeum* and *Osmunda spectabilis* are highly constant and often codominant. *Sarracenia flava* and *Sarracenia purpurea* are frequent in examples that have stayed open; they were apparently were more constant in the recent past but have been lost from a number of sites. Other frequent herbs in both Seymour (2011) and in site descriptions include *Lorinseria areolata, Viola primulifolia, Chasmanthium laxum, Eleocharis tuberculosa, Scleria triglomerata*, *Andropogon* spp. (*glomeratus, virginicus*, and possibly others), and *Rhexia mariana*. *Carex* is fairly constant as a genus; species include c*rinita, intumescens, leptalea, folliculata, complanata, lurida*, and several others, no one of which has high frequency. *Rhynchospora capitellata* and *Rhynchospora glomerata* are frequent and may be abundant in patches. A large suite of less frequent species of open wetlands may be present, including *Pteridium pseudocaudatum (aquilinum), Rhexia mariana, Mitchella repens, Sophronanthe (Gratiola) pilosa, Eupatorium rotundifolium, Eupatorium pilosum, Eupatorium leucolepis, Danthonia sericea, Erianthus* spp., *Calamagrostis coarctata (cinnoides*), *Sporobolus (Calamovilfa*) *brevipilis*, *Drosera brevifolia, Polygala lutea, Platanthera clavellata, Pogonia ophioglossoides, Calopogon tuberosus, Calopogon pulchellus, Xyris caroliniana, Juncus coriaceus, Scutellaria integrifolia, Scleria ciliata, Scutellaria integrifolia, Asclepias rubra, Danthonia spicata*, *Medeola virginiana*, *Drosera rotundifolia, Oxypolis rigidior,* and number of others. The shrubs that most often codominate are *Viburnum nudum, Alnus serrulata, Eubotrys racemosa, Aronia arbutifolia*, and *Vaccinium* spp. (*fuscatum, formosum,* possibly *corymbosum*), but *Gaylussacia frondosa* dominates patches in a few examples. Other shrubs include *Cyrilla racemiflora, Morella caroliniana, Clethra alnifolia, Lyonia ligustrina, Arundinaria tecta, Ilex laevigata*, and *Itea virginica*. *Smilax laurifolia* occur with high frequency and sometimes forms large tangles. The tree canopy is most often *Acer rubrum*, at least some of which is *trilobum*, and *Liriodendron tulipifera*. *Nyssa sylvatica, Pinus taeda, Pinus echinata, Liquidambar styraciflua*, and other species sometimes are present. Upland species such as *Quercus alba* and *Quercus stellata* appear in plot data; they may be rooted in the edge of the wetland but may represent overhanging canopy. Understory trees include *Magnolia virginiana* and *Ilex opaca*, as well as canopy species.

Range and Abundance: Ranked G2. This community is endemic to North Carolina. There are two distinct clusters of occurrences, one in northern Iredell County, the other in the Uwharrrie area of Montgomery and Randolph County. Only a couple of examples of questionable identification are in other Piedmont locations.

Associations and Patterns: Hillside Seepage Bogs are generally surrounded by upland forests. In the Uwharrie cluster, many of the examples are associated with Piedmont Longleaf Pine Forest, though some may be in Dry Oak–Hickory Forest. Many examples in the Iredell County cluster have lost their natural surroundings, but they appear to be associated with Dry-Mesic Oak–Hickory Forests or Mesic Mixed Hardwood Forest.

Variation: The two geographic clusters correspond to marked floristic differences; they are recognized as variants and could potentially be regarded as subtypes.
1. Uwharrie Variant occurs in eastern Piedmont. It has a large component of Coastal Plain herbs, with particular affinities to Sandhill Seep communities of the nearby Sandhills Region.
2. Iredell Variant occurs in the central Piedmont. It has fewer Coastal Plain species, though a number are still present in good examples. It may have some species more typical of mountain wetlands, such as *Oxypolis rigidior, Drosera rotundifolia,* and *Symphyotrichum puniceum*.

Dynamics: Hillside Seepage Bogs are tied to distinct, rare, specialized environments and, given their distinctive flora containing disjunct species, presumably have persisted in them for a very long time. However, they appear to be unstable communities under current environmental conditions. They are prone to increases in trees and shrubs, with the loss of the distinctive herbaceous component and reduction of the herb layer to the few most shade-tolerant species. This change has occurred over the last several decades, so that examples that were described as diverse herbaceous communities containing *Sarracenia* in the 1970s-1990s now are shaded and have few distinctive nonwoody species. Seymour (2011) found plots from several well-known sites had lost their distinctive character enough that they clustered with the woody-dominated Low Elevation Seep (Piedmont/Mountain Springhead Subtype) plots rather than with more intact Hillside Seepage Bogs.

Despite their wetness, Hillside Seepage Bogs appear to be highly dependent on fire and presumably burned under natural conditions. This is abundantly clear in the Uwharrie Variant, where most examples are associated with longleaf pine communities. The examples with the most diverse vegetation, strongest herb dominance, and strongest Coastal Plain affinities are those that have had prescribed burning in recent years. A few unburned examples that were clearcut retained herbaceous flora longer but ultimately became shaded by dense saplings and shrubs. Where subject to prescribed fires, fire usually spreads at least partway across the community patches. It is llikely that feedback between vegetation and fire is important, with fire promoting more flammable graminoid-dominated vegetation.

The role of fire is less clear in the Iredell Variant. Prehistorically, they presumably burned at the same frequency as the Piedmont oak forest landscape that surrounded them, but evidence of fire was not noted in any of the twentieth century descriptions of diverse herbaceous vegetation. However, many are associated with pasture lands at present, and it is possible burning of pastures subjected them to fire through part of that century.

Hydrology is also clearly important to the persistence of Hillside Seepage Bogs. They appear to have more discharge than most Piedmont seeps, and wetness excludes most upland species and limits tree growth. The lower pH in them may reflect the source of groundwater. The deterioration of some of the Iredell County bogs is clearly related to increased drainage driven by entrenchment or headward erosion of small streams. The author witnessed new headward erosion at one site some 30 years ago, with a knickpoint on the nearby stream having just reached the bog but the vegetation in good condition. A visit 20 years later found the stream channel entrenched along the entire edge of the bog, the knickpoint far upstream, dense young trees over most of the bog area, and only a few patches of wetland vegetation remaining where water seeped in the channel bank. Several other examples now retain saturated soil only on the edge of an entrenched channel that likely was not present 50 years before. The cause of this ongoing erosion is unclear, given that it comes after more than a century of agricultural land use in the vicinity and is not associated with new urban development or land clearing. While hydrology is clearly important in the Uwharrie bogs, the recent deterioration of examples there is not associated with known hydrological changes.

Comments: Seymour (2011), in her study of Piedmont seep vegetation, recognized a Headwater Boggy Seep type that corresponded to Hillside Seepage Bogs. She said it was more broadly defined than the corresponding NVC association, but it appears more narrowly defined than the 4th Approximation concept because she had intact plots only in the Uwharrie Variant. The plots from Iredell Variant bogs were taken after they had become overgrown, and her analysis did not group the altered vegetation with the intact Uwharrie Variant plots. The description here is based on information from more intact vegetation.

Rare species:
Vascular plants: *Danthonia epilis, Fothergilla major, Helenium brevifolium,* and *Lindera subcoriacea.*

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

PIEDMONT BOGGY STREAMHEAD

Concept: Piedmont Boggy Streamheads are conceptually intermediate between other Piedmont seepages and Piedmont Headwater Stream Forest. Saturated soil caused by seepage creates wetland conditions but brief flooding and movement of sediment also occurs. The vegetation is a mix of widely tolerant acidic seepage species and of species shared with Piedmont Headwater Stream Forests and uplands, often with some characteristic Coastal Plain species.

Distinguishing Features: Piedmont Boggy Streamheads are distinguished by the combination of extensive seepage-saturated soil with a headwater stream setting. A recognizable channel and usually evidence of flooding is present. They contain a suite of species, many of them more characteristic of the Coastal Plain, that distinguish them from most subtypes of Low Elevation Seep, including *Smilax laurifolia, Cyrilla racemiflora,* and *Magnolia virginiana*, as well as being more likely to have *Vaccinium fuscatum, Vaccinium formosum*, and *Osmunda spectabilis*. Though Piedmont Boggy Streamheads share many of these species with Hillside Seepage Bogs, they lack *Sarracenia flava*, *Sarracenia purpurea*, and most of the diverse collection of herbaceous species characteristic of that community. At the same time, they have some plants of richer and better drained communities that are generally absent in Hillside Seepage Bogs, such as *Lindera benzoin*, *Toxicodendron radicans, Fraxinus* spp., *Glyceria striata, Eutrochium fistulosum,* and *Lobelia cardinalis*.

Many of the species of Piedmont Boggy Streamheads are shared with the Piedmont/Mountain Springhead Subtype of Low Elevation Seep than with the other subtypes (e.g., *Vaccinium* spp., *Viburnum nudum, Ilex opaca, Alnus serrulata, Smilax laurifolia, Lorinseria areolata*). However, the geographic ranges of these communities do not overlap. Piedmont/Mountain Springheads tend to lack other characteristic species of Piedmont Boggy Streamheads, such as *Liquidambar styraciflua, Morella caroliniensis (= Myrica heterophylla), Cyrilla racemiflora, Gaylussacia frondosa, Pinus taeda*, and *Chasmanthium laxum*, and are more likely to have other species such as *Toxicodendron vernix, Hydrangea* (*Decumaria*) *barbara*, and various species of *Carex*.

Some of the wetland species of Piedmont Boggy Streamheads, such as *Osmundastrum* and *Viburnum nudum*, may also occur in Piedmont Headwater Stream Forest, but there they have low frequency, have low diversity in any given occurrence, and are confined to small wet microsites.

Synonyms: *Acer rubrum var. trilobum – Liriodendron tulipifera / Ilex opaca var. opaca / Osmunda cinnamomea* Forest (CEGL004551). Streamhead Seep (Seymour 2011).
Ecological Systems: Piedmont Seepage Wetland (CES202.298).

Sites: Piedmont Boggy Streamheads occur along headwater streams, generally intermittent or 1st to 2nd order streams with a moderate gradient. Many occur in relatively low relief areas underlain by argillite or other silty/clayey substrates, but some are in more rugged rocky areas of granite or hard volcanic rocks. A well-developed channel generally is present, which may be entrenched but not deeply. There may be distinct areas where strong seepage emerges, sometimes in basins that appear to result from sapping, or seepage may be diffuse over much of the site.

Soils: Soils are probably mainly residual, with local pockets of alluvial material. Most do not appear to be mucky, except in small pockets. Most examples are too narrow to be distinguished in soil mapping and are included in upland soil units. The Secrest series (Aeric Epiaquult) is mapped for a few, and it may represent the identity of inclusions in other map units.

Hydrology: Piedmont Boggy Streamheads are saturated by seepage through much or all of the year. Wetness may be heterogeneous, in response to multiple discharge locations and varying dispersal of water. Areas nearest the channel may be drier due to the drainage effect of the channel, but they may be wetter, as indicated by *Sphagnum* clumps. Stream flooding is intermittent and of brief duration but may have enough current to move litter and to scour the ground in small areas.

Vegetation: Piedmont Boggy Streamheads generally have a substantial tree canopy, which may be as dense as a typical forest or may be somewhat open. They are dominated by a mix that most often includes *Acer rubrum*, sometimes var. *trilobum*, *Liriodendron tulipifera, Liquidambar styraciflua*, *Quercus alba*, and less often, *Nyssa sylvatica, Pinus taeda, Quercus rubra, Fraxinus pennsylvanica, Fraxinus profunda*, or other species. *Magnolia virginiana, Oxydendrum arboreum* and *Ilex opaca* are the most frequent understory species. Shrubs are usually moderate in density and fairly diverse. The most constant species in Seymour (2011) and in site descriptions are *Viburnum nudum, Vaccinium fuscatum, Vaccinium formosum, Eubotrys racemosa*, *Alnus serrulata*, and *Arundinaria tecta*. Also frequent are *Morella caroliniana, Aronia arbutifolia, Ilex verticillata, Itea virginica*, *Gaylussacia frondosa*, *Euonymus americanus*, and *Lindera benzoin*. *Toxicodendron vernix* and the rare *Lindera subcoriacea* have also been found. Vines are often abundant, especially *Smilax rotundifolia* and *Smilax laurifolia*, but also *Toxicodendron radicans, Smilax glauca, Muscadinia rotundifolia*, and occasionally *Smilax walteri*. The herb layer is usually moderate in density. *Osmundastrum cinnamomeum* and *Osmunda spectabilis* are the most constant species and often the most abundant. Other constant or frequent species include *Lorinseria areolata, Chasmanthium laxum, Mitchella repens, Arisaema triphyllum, Lycopus virginicus, Scutellaria integrifolia, Viola primulifolia, Carex debilis, Athyrium asplenioides, Eutrochium fistulosum, Medeola virginiana, Uvularia puberula, Dioscorea villosa, Dichanthelium microcarpon (dichotomum* var. *ramulosum)*, *Chelone glabra*, and *Solidago caesia*. Infrequent but notable species include *Glyceria striata, Orontium aquaticum, Dryopteris cristata, Triadenum walteri, Platanthera clavellata, Solidago salicina (patula* var. *strictula), Lobelia cardinalis, Hypoxis hirsuta*, and *Oxypolis rigidior*. *Sphagnum* spp. is present in clumps but generally does not have extensive cover. Clumps may be scattered or may be concentrated on the channel banks or in pockets along the upland edge where seepage is stronger. Exotic plant species such as *Lonicera japonica* and *Microstegium vimineum* may occur in Piedmont Boggy Streamheads but are less frequent and less abundant than in floodplain communities.

Range and Abundance: Ranked G2G3. Fewer than 20 examples are known; they may tend to be overlooked or unreported in older site descriptions but appear to be rare. In North Carolina they are strongly concentrated in the Uwharrie region, with other examples widely scattered in the eastern Piedmont. The NVC association also occurs in Georgia and probably South Carolina.

Associations and Patterns: Piedmont Boggy Streamheads are small patch communities, occurring as narrow bands that generally have only limited length. However, they can occur in clusters that may amount to 10–50 acres, lining multiple drainages in sites where conditions are

suitable. Patches give way to Piedmont Headwater Stream Forest or Piedmont Alluvial Forest downstream, where seepage ends or where the stream channel and floodplain become better developed. Otherwise, they are surrounded by upland communities, typically Dry-Mesic or Dry Oak–Hickory Forest. Many examples in the Uwharrie area are surrounded by Dry Piedmont Longleaf Pine Forest. Piedmont Boggy Streamheads may occur in the same sites as Hillside Seepage Bogs but usually are not directly connected.

Variation: Patterns of variation have not been identified.

Dynamics: The dynamics of Piedmont Boggy Streamheads are not well known. Given their occurrence in upland landscapes with flammable oak or longleaf pine vegetation, they would naturally be exposed to frequent fire. Prescribed fires appear to penetrate them sometimes but not always. When they burn, shrubs and small trees may be killed but readily resprout. The larger canopy trees are generally not harmed by fires, but chronic fire likely would reduce canopy density and reduce the amount of *Acer rubrum*. As in Hillside Seepage Bogs, it is possible there is a vegetation-fire feedback, with fire promoting more flammable vegetation.

As in other seeps, groundwater input presumably provides a nutrient subsidy to the community, but the water may often be very acidic and low in nutrients. Flooding also provides input on nutrients. Input of ash when the surrounding landscape burns, even if the streamhead does not burn, also would provide nutrient input.

Comments: The Piedmont Boggy Streamhead was not recognized in the 3rd Approximation; it was recognized and tracking begun shortly after its publication. Definition of the conceptual boundary with Hillside Seepage Bog has always been difficult because of the loss of herbaceous flora in many Hillside Seepage Bogs. Some examples may remain ambiguous. However, analysis by Seymour (2011) found this to be a distinct group of communities.

Rare species:
Vascular plants: *Fothergilla major, Lindera subcoriacea,* and *Magnolia macrophylla.*

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

COASTAL PLAIN SEEPAGE BANK

Concept: Coastal Plain Seepage Banks are rare communities of very steep, wet clay bluffs along Coastal Plain rivers. Though the lower parts may occasionally be flooded, they are kept constantly wet by seepage from more permeable sediment layers above. They are usually dominated by liverworts and mosses and have only sparse vascular plants.

Distinguishing Features: Coastal Plain Seepage Banks are distinguished from cliff communities by having a substrate composed primarily of dense clay which is permanently or semi-permanently wetted by seepage, and by having predominantly wetland plants. *Viola primulifolia* appears to be the most common vascular plant. Coastal Plain Cliff communities and cliffs in other regions may have local saturated seepage zones, but these are limited in extent and tend to support denser vegetation. Edges of this community may have sandy soil which is also saturated and supports wetland shrubs. Sandhill Seeps may have steep clay faces covered with seepage, but do not occur along rivers and have dense vascular vegetation.

Synonyms: *Pallavicinia lyellii – Sphagnum* sp. Nonvascular Vegetation (CEGL004779). Little River Seepage Bank.
Ecological Systems: Piedmont Seepage Wetland (CES202.298) [System name to be changed to reflect broadening to include Coastal Plain]

Sites: Coastal Plain Seepage Banks occur along rivers or large creeks in the Coastal Plain where dense clay beds are exposed in steep outcrops created by undercutting by the flowing water. The substrate generally is one of the Cretaceous age units that underlie the Coastal Plain, such as the Cape Fear Formation. Most examples are in the eastern Sandhills region, where apparent geologic uplift has led the Cape Fear River and its major west-side tributaries to carve deep valleys. However, they may occur anywhere else in the Coastal Plain where rivers flow against uplands and where the underlying substrate includes a thick clay bed at the right elevation.

Soils: Coastal Plain Seepage Banks do not have developed soil. The surface is dense clay and is nearly vertical.

Hydrology: Coastal Plain Seepage Banks are perennially wet. Shallow groundwater moving through permeable sediment is blocked by the impermeable clay and discharged in the bluff. It flows in a thin sheet across the face of the clay layer.

Vegetation: Vascular vegetation is sparse over most of the extent of Coastal Plain Seepage Banks. Some portions may have high cover of liverworts, while others have extensive bare wet clay. The taxa of liverworts are not well known, though the *Pallavicinia lyellii* used in the NVC name likely is important. Mosses, *Sphagnum, Polytrichum*, and others, may be abundant. The most frequent and usually most abundant vascular plants are *Erigeron vernus, Viola primulifolia*, and *Lorinseria areolata*. Other species that are fairly frequent include *Drosera capillaris*, *Mikania scandens, Lygodium palmatum, Hydrocotyle verticillata, Hydrocotyle tribotrys (verticillata* var. *triradiata), Rhynchospora* spp. (*gracillima, gracilescens*), and *Boehmeria cylindrica*. In Sandhills examples, *Drosera rotundifolia*, disjunct from the Mountain Region, is also frequent. A variety of other herbs of Sandhill Seeps, savannas, or other wetlands may be present, including *Hypericum walteri,*

Hypericum virginicum, Carex debilis, Dichanthelium ensifolium, *Sarracenia purpurea, Xyris baldwiniana, Platanthera clavellata*, and *Aletris aurea*. Shrubs are scarce or absent on the main clay face but are usually present, sometimes dense, on the edge. Frequent species include *Xanthorhiza simplicissima, Cyrilla racemiflora, Eubotrys racemosum, Symplocos tinctoria, Kalmia latifolia, Alnus serrulata*, and *Vaccinium elliottii*. Trees generally do not root in the seep but often shade it from the edge. Several have *Chamaecyparis thyoides* on the edge, along with *Pinus taeda, Acer rubrum, Quercus nigra*, and other species.

Range and Abundance: Ranked G3 but probably rarer. In North Carolina, only a handful of locations are known, though some are extensive complexes. Almost all examples are in the eastern Sandhills Region, along entrenched tributaries of the Cape Fear River. However, one example farther out in the Coastal Plain is known and more may be found. The total number of occurrences is likely to remain fewer than ten. The synonymized association is considered potentially wide-ranging but is apparently poorly known. Besides North Carolina, it is attributed definitively only to Mississippi and Texas, though it could occur in any of the states between. In none is it reported to be common. It may be wondered whether communities over such a wide range are really similar enough to be the same association.

Associations and Patterns: Coastal Plain Seepage Bank is a small patch community. Area is difficult to define because the sites are usually so steep that they may have almost no area in map projection. Individual patches may range up to 200 meters long and are less than 10 meters high. Multiple patches often occur along a river, occasionally adding up to areas of a few acres of surface area. They are usually bordered by a riverbank below, though they potentially could have floodplain at the base. Some are associated with Cape Fear Valley Mixed Bluff Forest, a community confined to the deeply entrenched valleys of Cape Fear tributaries. Most probably were naturally bordered by dry longleaf pine communities above, but some may have occurred with mesic hardwood forests on adjacent bluffs.

Variation: Variation is not well known. The examples in the Sandhills appear fairly similar, with the one in the northern Coastal Plain somewhat different.

Dynamics: Coastal Plain Seepage Banks may be flooded in their lower portions. It is unclear what effect this has on the community. Portions that get flooded too frequently appear to lack bryophytes and to stay largely bare, but for portions that flood rarely, scouring or battering by floating material may be a periodic natural disturbance that strips the plants from local areas.

The long-term dynamics of Coastal Plain Seepage Banks are not well known. They seem to be primary successional communities. The lack of denser vegetation presumably is due to difficulty rooting in the dense clay, perhaps combined with the steepness, rather than wetness itself. Over time, erosion of the clay banks might reduce the steepness, allowing loose material to accumulate and form soil. The community might succeed to something like a Low Elevation Seep or Cape Fear Valley Mixed Bluff Forest. However, undercutting by the river probably causes periodic collapse of the faces, creating new bare clay surfaces and driving a kind of cyclic succession. It is unclear how often this happens, or how often it is needed to maintain these communities indefinitely. Collapse could also contribute to succession; if fallen material is not removed by stream erosion, it will pile up at the base and eventually bury the steep face.

Comments: This community type was not known in 1990 and had no close equivalent in the 3rd Approximation. It was first described by Bruce Sorrie and Brian van Eerden in Natural Heritage survey work on Fort Bragg, with additional examples found in county natural area inventories in the Sandhills counties. These communities are virtually impossible to sample with standard plot sampling techniques, and no CVS plot data exist.

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

References: