PIEDMONT AND MOUNTAIN GLADES AND BARRENS

Contents

PIEDMONT AND MOUNTAIN GLADES AND BARRENS THEME

Concept: Piedmont and Mountain Glades and Barrens are more heavily vegetated than rock outcrop communities but are more open than the forests that typically develop with the climate and natural fire regimes of the Piedmont and Mountain regions. Some aspect of their soil or topography makes them unable to support typical forest, though they may additionally depend on fire to maintain their natural character. A variety of such factors are represented by the communities within this theme. These communities may naturally have the structure of an open woodland or savanna, or they may have a heterogeneous structure that mixes tree, shrub, and herb dominance in a fine-scale mosaic.

Distinguishing Features: Piedmont and Mountain Glades and Barrens are distinguished from forest communities by having a more open tree canopy. Tree cover is naturally less than 50% in all but a couple of the communities in this theme. It may be denser at present in communities that depend on fire for their maintenance but almost never is a fully closed canopy. While many forests in these regions are believed to have been more open with more regular fire, the canopies of Piedmont and Mountain Glades and Barrens are more open still.

Piedmont and Mountain Glades and Barrens are distinguished from High Elevation Rock Outcrops and Low Elevation Cliffs and Rock Outcrops by having denser vegetation and more soil. Rock outcrop communities have sparse vegetation at least in the center of community patches. While individual trees in them may have significant cover, rooted plants are limited to crevices, soil mats, or similar microsites that make up a small minority of area of the community. In contrast, Piedmont and Mountain Glades and Barrens have at least shallow soil cover and rooted plants over the majority of their area. Granitic Flatrocks generally can be distinguished from Piedmont and Mountain Glades and Barrens in the same way as the Rock Outcrops. The Granitic Flatrock Border Woodland could be placed in either theme, as it is similar in structure to some Piedmont and Mountain Glades and Barrens but can be distinguished by its association with granitic flatrocks – flat or gently sloping exfoliated granite surfaces in the Piedmont.

Synonyms:

Sites: Piedmont and Mountain Piedmont and Mountain Glades and Barrens occupy a wide variety of sites that have in common that they limit tree cover without being predominantly bare rock. Glades are communities where bedrock is near the surface, so that shallow soil limits tree cover. Communities named as woodlands are less extreme and have more tree cover, but still have cover limited by some aspect of the substrate. Some, the shale slope woodlands, have shallow soil but are also affected by slope instability. The shale breaks into flat fragments that, on steep slopes, shift readily and make rooting of plants difficult. Barrens are woodland or savanna communities that have soils that are deep but that have physical or chemical properties that are extreme and limit tree cover. Though the term “forest” is retained in the names of the Xeric Hardpan Forests, they are more truly barrens.

Soils: Soils vary drastically among the different communities in this theme. In glade communities they are shallow, with bedrock near the surface. These soils may consist of shallow mats or deep fill in crevices and are often extremely heterogeneous. In other communities, soils are deep, but have extreme physical or chemical properties. Hardpan soils have montmorillonite as the predominant clay mineral, and their shrink-swell behavior in response to changes in water content limits the rooting ability of woody plants. Soils derived from ultramafic rocks have unusual chemistry, with low calcium to magnesium ratios and high content of toxic metals such nickel and chromium.

Hydrology: Hydrology varies, and moisture conditions may vary in ways that do not fit the normal moisture gradients. The shallow soils of glades dry quickly between rains and are prone to extreme drought stress. Hardpan soils can perch water on the surface, creating short-lived wet conditions, but the lack of water penetration, combined with limitations on plant rooting, subjects plants to drought stress. Ultramafic rock sites may have normal moisture levels consistent with their topographic position, but consistently support vegetation suggestive of drier conditions.

Vegetation: Vegetation in Piedmont and Mountain Glades and Barrens varies greatly among the different communities. Common to all is limited tree cover, less than in typical forests, and substantial cover by herbs, or less often, low shrubs. Most trees are species shared with drier forest communities, such as *Quercus stellata, Quercus montana, Quercus marilandica, Pinus virginiana, Pinus echinata, Pinus rigida, Carya pallida*, and *Juniperus virginiana*. Shrubs vary even more, reflecting soil chemistry as well as dry conditions. Acidic communities may have beds of *Vaccinium pallidum, Kalmia latifolia*, or *Gaylusascia baccata*, while basic communities may have *Rhus aromatica* or an abundance of vines such as *Toxicodendron radicans.* Herb layers usually are dominated by grasses. Because of the open canopy, most contain many species intolerant of shade, while the dry site conditions also favor drought-tolerant species. Herbs common to many communities include *Schizachyrium scoparium, Danthonia spicata, Dichanthelium* spp., *Coreopsis major,* and somewhat less frequently, *Sorghastrum nutans, Andropogon gerardii*, and *Piptochaetium avenaceum*. Glades, especially, may contain species shared with rock outcrop communities, including *Bryodesma rupestre*, *Hypericum gentianoides*, and *Phemeranthus teretifolius*, as well as a variety of bryophytes and lichens. Basic communities contain species shared with communities with richer soils; they may even contain typical floodplain species such as *Elymus hystrix, Elymus virginicus*, and *Chasmanthium latifolium*. Ultramafic barrens contain particularly odd mixes of species, since their composition is determined by tolerance to unusual soil chemistry. Species such as *Podophyllum peltatum* may occur beneath drought tolerant species such as *Quercus marilandica*. Ultramafic barrens also may have narrowly endemic species, such as *Symphyotrichum rhiannon* or notable disjunct species such as *Sporobolus heterolepis*.

Dynamics: The dynamics of Piedmont and Mountain Glades and Barrens varies widely, but all of these communities represent stable open communities. While they are sometimes called "early successional," this characterization is incorrect. They are not created by severe disturbance and are not dominated by ruderal or pioneer species. Under natural disturbance regimes they do not change in a directional way toward forest. Even with present-day altered disturbance regimes, where woody vegetation is denser, most do not form closed forests. In the language of succession, glades and barrens are edaphic climax or disclimax communities, closely tied to distinctive environments,

and generally dominated by long-lived herbaceous as well as woody species, most of them species that do not readily colonize disturbed sites.

The relationship of Piedmont and Mountain Glades and Barrens to the prevailing regional natural fire regimes varies. Because they tend to occur as small patches, most natural and earlier anthropogenic ignition must have occurred by fire spreading from adjacent forests. While the rare lightning ignition might have been more likely to spread in the grassy vegetation of some barrens, fire frequency could not have been appreciably higher than in the surrounding landscape. In barrens, with continuous fuels, fire frequency presumably matched that of the surrounding landscape. In these communities, fire often is important in determining their natural structure. These are places where "a little fire goes a long way." The same fire regime that prevailed in the surrounding forests can produce stronger ecological effects in barrens, leading to more open vegetation because of the more extreme environment and slower recovery of woody species. Although chronic fire would produce a more open structure than at present in the widespread forest communities, suggesting reduced contrast between them and the barrens, it may actually increase the contrast in vegetation structure.

In contrast, glade communities often have discontinuous fuels, with patches of rock, bryophyte or lichen areas, and only irregular distribution of litter. They may not carry fire well and tend to burn in a patchy manner. Different patches may burn, depending on the direction of the fire's approach, but some patches may almost never burn. Fire may still be important in determining the vegetation structure of the edges and of better-connected portions, but it may have little influence on other parts.

Piedmont and Mountain Glades and Barrens may also be affected more by other natural disturbances and environmental stresses than the surrounding forests are. Shallowly rooted trees are more susceptible to blowing down in storms. Drought is more likely to kill trees with limited rooting depth. Periodic drought-caused tree mortality may be an important cause of the open structure of these communities. The author has observed numerous cases of substantial tree mortality in glades during droughts which, while fairly severe, did not kill any trees in the adjacent forest. Though less obvious, mortality of tree seedlings in drought may also contribute to openness. It may take a series of unusually moist years to allow new trees to mature in these communities. Because of these dynamics, tree stands in some glade communities may be more even-aged than typical natural forests or have most of their trees limited to a few cohorts. While the same could be true in barren communities, their more uniform vegetation and more regular exposure to prevailing fire regimes makes it more likely that they have continuous tree regeneration and uneven-aged structure similar to natural forests.

Comments: Much attention has been given to "Piedmont prairies" in the last several decades (Barden 1997). Though much of the interest in prairies was created by rediscovery of early historical writings describing large open areas, the existence of open sunny communities in the Piedmont is attested to by a substantial native flora that is now largely confined to roadsides, power line corridors, and other areas that are kept open by mowing but without soil disturbance. A large number of rare plants species with prairie affinities, either also occurring in Midwestern prairies or being closely related to species that occur there, are present in several areas in the Piedmont.

The popular concept of prairie as currently used in North Carolina, however, confounds several different kinds of vegetation, and this has led to confusion and misdirected effort. Some of it comes from states farther west, which had large prairie landscapes that did not exist in North Carolina. Some is based on the early successional vegetation in abandoned fields. The Piedmont and Mountain Glades and Barrens communities in this theme are the more natural component of the prairie concept. Though they almost certainly existed primarily as open grassy woodlands or savannas rather than treeless grasslands in presettlement and early colonial times, they are the habitat for almost all of the rare species of prairie affinities. These species occur on roadsides almost exclusively in areas with concentrations of the distinctive soils and with remnants of the natural communities in this theme. Such species have not become widespread on roadsides in other, even nearby, parts of the Piedmont.

Most of the early description of open areas cited as evidence of widespread Piedmont prairies was probably not based on Piedmont and Mountain Glades and Barrens. Early travelers generally followed existing trails and lodged in native villages, rather than sampling cross-country transects. Their observations were heavily biased toward the areas most altered by human settlement. In a rare description of a journey that was a more objective transect, the border between Virginia and North Carolina, (Byrd 1728) mentions Indians burning the woods but does not describe extensive open areas beyond immediate settlements.

Though detailed understanding of plant species composition in early accounts is generally impossible, these areas almost certainly were primarily abandoned fields, which would have been especially numerous in the years following decimation of the native population by European diseases and may not have been recognized as such by early travelers. Old field vegetation, a few years after abandonment, is dominated by *Andropogon virginicus* (Oosting 1942, Keever 1950, Schafale 1986), a species that superficially resembles the *Schizachyrium scoparium* that dominates many Piedmont and Mountain Glades and Barrens but which has a distinctly different ecology. Most old field species have ruderal adaptations and are different species from those typical of Piedmont and Mountain Glades and Barrens. While some ruderal old field species have prospered on roadsides, the rare species and many other species associated with them on roadsides are not typical of old fields.

Though early writers sometimes enthusiastically described riding for miles through open sunny areas (e.g., Bartram 1793), it should be noted that such writings do not indicate that any kind of grassland was the predominant vegetation of the Piedmont. Their descriptions are not those of the endless prairies of the Midwest. Indeed, much of their enthusiasm seems to come from the contrast with the prevailing forest that hemmed in the rest of their journeys.

References:

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KEY TO PIEDMONT AND MOUNTAIN GLADES AND BARRENS

1. Community in the Mountains or mountain-like foothills, associated with other mountain communities. In ambiguous cases, flora more typical of the mountains present, though species of the Piedmont may also be present.
   2. Substrate of unstable fragments of shale or other thin-bedded rock; openness of vegetation driven more by instability than by limited soil depth; rare communities known primarily in the vicinity of Hot Springs and the lower French Broad River gorge.
      3. Substrate of calcareous shale or siltstone; flora showing evidence of higher pH and base status; *Juniperus virginiana* abundant; multiple calciphilic species present. .... **Calcareous Shale Slope Woodland**
      3. Substrate of acidic shale or siltstone; *Pinus virginiana* dominant; *Juniperus virginiana* absent or rare; flora lacking calciphilc species. ..... **Acidic Shale Slope Woodland**
   2. Substrate primarily of bedrock or stable soil; openness of vegetation driven by shallow soil, soil chemistry, or other factors but not primarily by slope instability; throughout the Mountain and foothills region.
      4. Substrate of ultramafic rock such dunite, peridotite, or serpentinite, either deep or shallow soil; vegetation more open and appearing more xerophytic than expected for the soil depth and topography; vegetation containing unusual combinations of xerophytic and mesophytic species not typical of shallow soils; open vegetation structure apparently driven by unusual soil chemistry (though also dependent on fire); species known to be ultramafic endemics, such as *Symphyotrichum rhiannon*, and prairie species confined to ultramafic substrates in North Carolina, such as *Sporobolus heterolepis*, usually present; extremely rare communities known in only several sites.
         5. Vegetation a woodland or open forest dominated by *Pinus rigida*; known from Buck Creek Barrens ..... **Ultramafic Outcrop Barren (Pitch Pine Subtype)**
         5. Vegetation not dominated by *Pinus rigida*
            6. Vegetation a woodland or open forest dominated by *Quercus alba*; known from Buck Creek Barrens. ..... **Ultramafic Outcrop Barren (White Oak Subtype)**
            6. Vegetation dominated by *Pinus virginiana*; known from Webster and possibly other lower elevation sites. ..... **Ultramafic Outcrop Barren (Virginia Pine Subtype)**
      4. Substrate not ultramafic rock, or if rarely so, not showing the distinctive vegetation characteristics of Ultramafic Outcrop Barrens; open vegetation structure apparently caused primarily by shallow soil and bedrock; species composition reflecting dry conditions caused by shallow soil (though local wet areas may be present); ultramafic endemic species absent; widespread in the region.
         7. Flora containing species indicative of higher pH, higher base saturation conditions, such as *Fraxinus* spp., *Carya* spp., *Juniperus virginiana, Aquilegia canadensis, Hylotelephium (Sedum) telephioides, Dodecatheon meadia, Sedum glaucophyllum, Myriopteris (Cheilanthes) lanosa, Borodinia (Boechera) laevigata*, and *Penstemon canescens*, though more widespread species such as *Quercus montana, Pinus* spp,. *Danthonia* spp., and *Schizachyrium scoparium* may be more abundant; substrate often clearly amphibolite, calc-silicate, or other rock that produces basic conditions, but sometimes granite or other felsic rocks that nevertheless support flora of basic conditions.
            8. Vegetation a woodland or open forest; soils only marginally shallow enough to produce open vegetation; usually associated with exfoliated granitic rock outcrops and communities such as Low Elevation Granitic Dome or Low Elevation Basic Glade.
               9. Vegetation nearly a closed forest, dominated by *Carya* spp. or *Fraxinus* spp., sometimes in combination with oaks. ..... **Granitic Dome Basic Woodland**

9. Vegetation an open woodland or savanna dominated or codominated by *Juniperus virginiana*. ..... **Montane Red Cedar–Hardwood Woodland**

8. Vegetation a glade, either a fine-scale patchy mosaic of bare rock, herbaceous vegetation, and woody vegetation or continuous herbaceous vegetation with sparse to moderate tree cover.

10. Glade occurring at high elevation (above 4000 feet) and on amphibolite substrate; very rare community known only at Bluff Mountain, Mount Jefferson, and one Virginia site. ....**High Elevation Mafic Glade**

10. Glade generally occurring below 4000 feet, or if rarely higher, with a dry slope aspect and containing species typical of lower elevations.

11. Glade in the Brushy Mountains region of the foothills, containing a distinctive suite of species that includes *Croton willdenowii (= Crotonopsis elliptica), Hypericum radfordianum, Allium keeverae, Pseudognaphalium obtusifolium, Coreopsis tripteris, Senna marilandica*, and *Hexasepalum (Diodia) teres*. ..... **Low Elevation Basic Glade (Brushy Mountains Subtype)**

11. Glade not in the Brushy Mountains, elsewhere in the Mountains or foothills; vegetation various but lacking most of the characteristic species of the Brushy Mountains Subtype..... .....**Low Elevation Basic Glade (Typic Subtype)**

7. Flora not containing species indicative of higher pH or higher base saturation as above; all flora tolerant of strongly acidic conditions; substrate felsic rock or other rock that produces acidic soils.

12. Vegetation predominantly herbaceous, dominated by *Carex biltmoreana*; periodically saturated by seepage; often associated with exfoliated granitic outcrops and communities such as Low Elevation Granitic Dome. .....**Low Elevation Acidic Glade (Biltmore Sedge Subtype**)

12. Vegetation various, either predominantly herbaceous and dominated by *Danthonia, Schizachyrium*, or species other than *Carex biltmoreana*, or a mosaic of rock, herbaceous, and woody vegetation in small patches. ..... **Low Elevation Acidic Glade (Typic Subtype)**

1. Community in the Piedmont away from the mountain-like foothills, associated with Piedmont communities; flora more typical of the mountains absent.

13. Openness of vegetation driven primarily by shallow soil over bedrock, rarely in combination with slope instability; vegetation structure a glade, with either a fine-scale patchy mosaic of bare rock, herbaceous vegetation, and woody vegetation or continuous herbaceous vegetation with sparse to moderate tree cover.

14. Community containing species of soils with higher pH and higher base saturation, such as *Fraxinus* spp., *Cercis canadensis, Rhus aromatica, Myriopteris (Cheilanthes) tomentosa*, and *Myriopteris lanosa*, with species such as *Chionanthus virginicus* and *Carya* spp. typically more abundant, though widespread acid-tolerant species may also be abundant; occurring on substrates of mafic rock such as diabase or gabbro or occasionally on calcareous meta-sedimentary rock.

15. Community resembling a flatrock, consisting of diabase outcropping in a level bedrock pavement with open rock areas interspersed with shallow soil mats; flora combines species similar to Granitic Flatrocks, such as *Portulaca smallii*, *Cyperus granitophilus*, and *Isoetes piedmontana*, with species needing high base status, such as *Ruellia humilis, Berberis canadensis, Symphoricarpos orbiculatus, Matelea decipiens, Lithospermum canescens* and *Clematis ochroleuca*; very rare community known only around Butner. ..... **Diabase Glade**

15. Community without the characteristic suite of species of Diabase Glade, though many other species are shared; generally without most species shared with Granitic Flatrock; site flat to steeply sloping but not a pavement of diabase.

16. Substrate somewhat unstable, consisting of loose, flat fragments of thin-bedded meta-sedimentary rock; open vegetation with abundant *Pinus virginiana* and limited dense grass

patches; very rare community currently known only near Falls Dam in and near Uwharrie National Forest..... **Piedmont Basic Glade (Falls Dam Slope Subtype)**

16. Substrate largely stable, consisting of a mosaic of shallow soil and limited bedrock outcrops, generally highly fractured; vegetation various, occasionally with abundant *Pinus virginiana* but more often with *Carya* spp., *Quercus stellata*, *Ulmus alata, Pinus echinata*, or other species; grassy patches often extensive.....**Piedmont Basic Glade (Typic Subtype)**

14. Community lacking species of higher pH or higher base status; vegetation dominated by more widespread acid-tolerant species.....***Piedmont Acidic Glade***

13. Openness of vegetation not driven primarily by shallow soil or unstable substrate; soil rocky or not but open conditions more caused by a hardpan, shrink-swell soil (generally mapped as Iredell or related vertic or montmorillonitic series), or by a steep slope with a southerly or westerly aspect, in combination with fire; community an open woodland with substantial tree cover, generally dominated by *Quercus stellata, Quercus marilandica*, or *Pinus echinata*, or an open prairie savanna with a dense herbaceous layer and sparser trees of these species.

17. Substrate of ultramafic rock such dunite, peridotite, or serpentinite, with either deep or shallow soil; vegetation more open and appearing more xerophytic than expected for the soil depth and topography; vegetation containing unusual combinations of xerophytic and mesophytic species not typical of shallow soils; open vegetation structure apparently driven by unusual soil chemistry .... **Ultramafic Outcrop Barren (Piedmont Subtype)**

17. Substrate not of ultramafic rock, or if rarely so, not showing the distinctive vegetation characteristics of Ultramafic Outcrop Barrens; open conditions caused by a hardpan, shrink-swell soil, or by a steep slope with a southerly or westerly aspect.

18. Open conditions driven primarily by a steep slope with a southerly or westerly aspect and fire, though rocky soil may contribute; vegetation consisting of species tolerant of extremely acidic conditions.....**Xeric Piedmont Slope Woodland**

18. Open conditions caused by a dense clay hardpan or shrink-swell soil (generally mapped as Iredell or related vertic or montmorillonitic series); community on unusually flat uplands or on ridgetops or upper slopes; vegetation may consist of acid-tolerant species or species requiring less acidic conditions.

19. Vegetation a woodland or open forest consisting solely of acid-tolerant species; species of higher pH sites absent; *Vaccinium* spp. generally abundant; substrate clayey sedimentary or meta-sedimentary rock.....**Xeric Hardpan Forest (Acidic Subtype)**

19. Vegetation a woodland or open forest containing species associated with higher pH and base saturation, or an open prairie savanna with a dense grassy herb layer; *Vaccinium* spp. generally scarce or absent; substrate diabase, gabbro, or other mafic rock.

20. Vegetation containing a substantial number of species of limited abundance associated with open prairie conditions, such as *Silphium terebinthinaceum, Cirsium carolinianum, Elymus canadensis, Eryngium yuccifolium, Liatris squarrosa, Parthenium auriculatum, Parthenium integrifolium, Tragia urticifolia*, and *Sorghastrum nutans*; believed to have occurred naturally as an open prairie savanna though now known only from degraded remnants. These communities appear to have occurred only where hardpan or vertic soil conditions on flat ground are extensive, primarily around northeast Durham and Butner and around Charlotte.

21. Community around northeast Durham or Butner; containing characteristic species such as *Echinacea laevigata, Oligoneuron album*, *Lithospermum canescens*, and *Baptisia aberrans*. ..... **Xeric Hardpan Forest (Northern Prairie Barren Subtype)**

21. Community around Charlotte; containing characteristic species such as *Symphyotrichum georgianum var. georgianum* and *Helianthus schweinitzii*..... ..... **Xeric Hardpan Forest (Southern Prairie Barren Subtype)**

20. Vegetation not as above; vegetation open forest or woodland that was likely more open and had more grass cover in the past, but which lacks most of the characteristic species of the Northern and Southern Prairie Barren Subtypes. These communities occur where areas of hardpan or vertic soil conditions are less extensive, perhaps affecting fire dynamics and species pools in the past.

22. Community on a ridge top or upper slope in hilly terrain on gabbro or other mafic rocks, primarily in the Uwharrie Mountains area; sites with boulders and sometimes small rock outcrops; canopy usually with *Carya carolinae-septentrionalis* dominant or codominant with *Quercus stellata*..... **Xeric Hardpan Forest (Basic Rocky Subtype)**

22. Community on unusually flat upland terrain, on gabbro, diabase, or basalt; woodland dominated by *Quercus stellata*, with limited *Carya carolinae-septentrionalis*..... .....**Xeric Hardpan Forest (Basic Hardpan Subtype)**

HIGH ELEVATION MAFIC GLADE

Concept: High Elevation Mafic Glades are very rare glade communities of high elevation amphibolite or hornblende gneiss outcrops. They have patchy shallow soils that support a mosaic of grass and shrub vegetation alternating with bare rock and lichen cover.

Distinguishing Features: High Elevation Mafic Glades are distinguished by smooth, unfractured mafic bedrock with irregular shallow soil cover. They may be steep or nearly flat. They have a characteristic species composition that includes *Schizachyrium scoparium, Helianthemum bicknellii, Ionactis linariifolia (= Aster linariifolius), Coreopsis major, Danthonia spicata, Cladonia* spp., and *Cladina* spp. The Little Bluestem Basic Subtype of High Elevation Rocky Summit similarly has abundant *Schizachyrium scoparium* and *Coreopsis major* but lacks the other species. It has more fractured rock but has more bare rock with less plant cover.

Synonyms: *(Kalmia latifolia, Physocarpus opulifolius) / Schizachyrium scoparium - Thalictrum revolutum - Sibbaldiopsis tridentata* Shrub Herbaceous Vegetation (CEGL004238).
Ecological Systems: Southern and Central Appalachian Mafic Glade and Barrens (CES202.348).

Sites: High Elevation Mafic Glades occur on relatively unfractured outcrops of mafic bedrock that have substantial shallow soil cover. They occur at elevations above 4,000 feet.

Soils: Soils consist of shallow mats of organic matter and accumulated mineral material lying on bedrock.

Hydrology: High Elevation Mafic Glades are generally dry because of shallow soil. However, local seepage may be present on the edges, and water may be trapped on the rock surface or drain slowly after heavy rains.

Vegetation: The vegetation of High Elevation Mafic Glades is patchy and irregular in structure. Areas of lichen-covered bedrock, grassy herbaceous vegetation, shrub thickets, and stunted trees form a fine-scale mosaic. Lichens, *Cladonia* or *Cladina* spp., may dominate the more open areas. Plants typical of rock outcrops, such as *Hypericum gentianoides, Micranthes petiolaris, Campanula divaricata*, *Crocanthemum propinquum*, or *Hylotelephium telephioides*, occur sparsely in the shallowest soil accumulations. Somewhat deeper soil mats are dominated by *Schizachyrium scoparium*, which is generally the herb with the highest cover. Other herbs that are fairly abundant include *Coreopsis major, Danthonia compressa, Danthonia spicata, Ionactis linariifolia, Thalictrum revolutum, Avenella flexuosa,* and *Sibbaldia retusa*. Additional herbs may include *Pycnanthemum tenuifolium, Carex* spp., *Solidago nemoralis, Dichanthelium meridionale, Aletris farinosa*, *Pyrola americana*, and *Gaultheria procumbens*. Woody patches are dominated by thickets of *Rhododendron catawbiense, Kalmia latifolia*, or *Physocarpus opulifolius*. Other shrubs include *Vaccinium corymbosum, Vaccinium stamineum*, and *Vaccinium pallidum*. Stunted trees are often present with the shrubs. These include *Quercus alba, Quercus rubra, Quercus montana,* and *Amelanchier laevis*.

Range and Abundance: Ranked G1. Only three examples are known, two in North Carolina, one in Virginia.

Associations and Patterns: High Elevation Mafic Glades are small patch communities that, in the few known examples, are surrounded by oak forests.

Variation: Each of the few examples is different enough to recognize as a variant. Though the most abundant species are the same, there are substantial differences in the other plants present:
1. Bluff Mountain Variant is nearly flat and has extensive cover of *Cladonia/Cladina* lichens.
2. Mount Jefferson Variant is steeply sloping and has little lichen cover.

Dynamics: Next to nothing is known about the dynamics of High Elevation Mafic Glades. Their open structure appears to be maintained by shallow soil and perhaps by periodic drought, but occasional fire may affect them. Though not well documented, there is some suggestion that at least one example has increased in woody cover in recent decades.

Comments: This community was originally defined as unique to Bluff Mountain. The type has been merged with two other high elevation amphibolite glades, at Mountain Jefferson and at Buffalo Mountain in Virginia, though the three are different enough to be recognized as distinct variants. There is a published description fo the Mount Jefferson glade in Poindexter and Murrell (2008).

Rare species:
Vascular plants: *Crocanthemum bicknellii, Crocanthemum propinquum, Gentianopsis crinita, Lilium philadelphicum, Phlox subulata,* and *Spiranthes ochroleuca*.
Nonvascular plants: *Cladonia psoromica*.

References:
Poindexter, D.B., and Z. E. Murrell. 2008. The vascular flora of Mount Jefferson State Natural Area and environs, Ashe County, North Carolina. Castanea 73: 283-327.

LOW ELEVATION ACIDIC GLADE (GRASS SUBTYPE)

Concept: Low Elevation Acidic Glades are communities of shallow soils, with limited tree cover but with extensive ground cover, occurring on acidic rocks and lacking plants indicative of base-rich conditions. Most occur on rock surfaces that are undulating or irregular but lack the characteristics of Granitic Dome sites. Vegetation generally includes dense grass with patches of shrubs and sometimes trees, but it may occasionally include moderate tree cover and more extensive low shrub cover throughout the community. The Grass Subtype encompasses all examples not dominated by *Carex biltmoreana*.

Distinguishing Features: Low Elevation Acidic Glades are distinguished from Low Elevation Granitic Domes by the predominance of extensive soil mats, capable of supporting grasses or sedges. Lichen-covered bare rock and thin mats dominated by species such as *Bryodesma* are usually present but occupy only a small part of the area, while grassy mats and low shrub patches are more prominent. Trees may be largely confined to the edge or to rare microsites, as in Granitic Domes, but may also be dispersed through much of the community. Low Elevation Acidic Glade should be recognized only where grassy or shrubby vegetation rather than rock predominates over an entire rocky patch or where it covers a large enough contiguous area to be regarded as a separate community.

Low Elevation Acidic Glades are distinguished from Low Elevation Basic Glades by the absence of plant species characteristic of higher pH conditions, such as *Hylotelephium telephioides (= Sedum telephioides), Dodecatheon meadia, Sedum glaucophyllum, Cheilanthes lanosa, Arabis laevigata*, and *Penstemon canescens.* Low Elevation Acidic Glades are distinguished from Low Elevation Rocky Summits by having few crevices and having more continuous vegetation. They have abundant grassy or low shrub mats in shallow soil but relatively few forbs or woody plants rooted in crevices.

Low Elevation Acidic Glades are distinguished from Montane Red Cedar—Hardwood Woodland, Granitic Dome Basic Woodland, and from other forests and woodlands by having limited tree cover –generally well less than 50% even when undisturbed.

The Grass Subtype is distinguished from the Biltmore Sedge Subtype by having grassy mats predominantly consisting of *Schizachyrium scoparium, Danthonia spicata*, or other dry-site grasses or herbs rather than *Carex biltmoreana* or other *Carex* spp. The few examples with extensive cover of *Vaccinium pallidum* are also included in the Grass Subtype.

Synonyms: *(Quercus prinus) / Vaccinium pallidum / Schizachyrium scoparium - Danthonia spicata / Cladonia* spp. Herbaceous Vegetation (CEGL004990).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Sites: Low Elevation Acidic Glades occur on rock surfaces with extensive cover of shallow soil and only limited bare rock. Examples range from 1000-4000 feet in elevation. Most are on gentle to moderate slopes. In the Herb Subtype, the rock generally has few of the deep fractures that commonly occur in Rocky Summits. The surface is undulating, pitted, or somewhat irregular,

unlike the smoother rock of Granitic Domes. Many are on granitic rocks that are prone to exfoliation, with some on dip slopes of bedded rock.

Soils: Soils are shallow mats of accumulated organic matter and small rock fragments. They generally are not distinguished in soil surveys or are mapped as rock.

Hydrology: The Grass Subtype of Low Elevation Acidic Glade generally is dry because of shallow soils. During drought periods moisture stress may quickly become extreme. Small portions may be saturated by seepage for part of the year or in wet periods.

Vegetation: The vegetation is patchy but generally includes extensive cover of grass. *Schizachyrium scoparium, Danthonia sericea*, or *Danthonia spicata* usually dominate. Other frequent herbs in either CVS plots or site descriptions include *Coreopsis major, Helianthus divaricatus, Solidago odora, Tephrosia virginiana, Sorghastrum nutans, Andropogon gerardii, Dichanthelium acuminatum,* and *Asplenium platyneuron*. Rock outcrop species such as *Micranthes petiolaris, Hypericum gentianoides, Bryodesma rupestre*, *Campanula divaricata*, and *Phemeranthus teretifolius* are often present in small numbers. Additional herbs that may be fairly abundant include *Packera anonyma, Symphyotrichum patens, Aristida purpurascens, Panicum virgatum*, and *Dennstaedtia punctilobula*. Other herbs that may be present include *Dichanthelium dichotomum* var. *dichotomum*, *Houstonia purpurea, Juncus dichotomus, Krigia virginica, Lechea racemulosa*, *Linum striatum, Solidago pinetorum, Pityopsis graminifolia, Baptisia tinctoria, Ionactis linariifolia, Cunila origanoides, Antennaria plantaginea, Agrostis perennans*, and *Avenella (Deschampsia) flexuosa*. Trees are usually present with low cover. *Quercus montana* usually dominates. *Carya glabra, Pinus pungens, Pinus rigida*, *Pinus virginiana, Amelanchier arborea, Juniperus virginiana, Ulmus alata*, or other species may be present. *Vaccinium pallidum* is usually present, sometimes has substantial cover. *Vaccinium stamineum, Kalmia latifolia, Gaylussacia baccata, Hypericum prolificum*, or *Amorpha glabra* are often present, as are *Smilax rotundifolia*, *Smilax glauca*, and *Parthenocissus quinquefolia*.

Range and Abundance: Ranked G1G2. North Carolina examples range throughout the mountains, with a few in the foothills area. The synonymized association is definitively known only in North Carolina but may occur in South Carolina and could possibly be found in Georgia.

Associations and Patterns: Low Elevation Acidic Glades occur as small patches, generally surrounded by drier forest communities such as Chestnut Oak Forest or Montane Oak—Hickory Forest. They may sometimes be associated with more open rock outcrop communities, especially Low Elevation Granitic Dome. Because of a difference in elevational cutoff, they may conceivably be associated with High Elevation Granitic Domes.

Variation: No variants are defined. Examples vary in the density of vegetation and amount of bare rock, as well as in the dominant plants.

Dynamics: Low Elevation Acidic Glades are maintained in a non-forested state primarily by physical conditions. Limited moisture holding capacity and shallow rooting depth limit tree growth and stature. Drought periodically causes mortality and probably is an important mechanism maintaining vegetation structure. As with other glades, vegetation may be continuous

enough to carry fire in some parts of the community but not others, so that fire effects are patchy. As small patches, ignition in these communities comes from the surrounding forests and fires in flammable parts presumably are similar in frequency. Fire may be important for maintaining grass dominance and limiting abundance of shrubs and trees, though glades stay open at least for long periods in the absence of fire.

It is possible that these glades represent a later stage in the weathering of exfoliation surfaces, developing if spalling does not create a fresh surface periodically. The irregular rock surface that is present in most examples appears to be a result of greater weathering, though the substrate remains hard bedrock. It is also possible that the irregular surface results from differences in the rock, perhaps less uniform composition or texture. The irregular surface presumably contributes to the more extensive soil development in Low Elevation Acidic Glades compared to Granitic Domes by making sloughing of soil mats less likely. Nevertheless, it is possible that, like Granitic Domes and Granitic Flatrocks, Low Elevation Acidic Glades are maintained in a cyclic succession by the occasional destruction of soil mats by falling trees.

Comments: There is no analogous high elevation acidic glade community defined. Such a community could exist but none are known in the state.

The definition of Low Elevation Acidic Glades conceptually is based on predominant vegetation in a fine-scale mosaic, and thus depends on scale. Vegetation similar to these glades can occur in patches as a minority of the mosaic in Low Elevation Granitic Domes or Low Elevation Rocky Summits. Conversely, bare rock and vegetation similar to Low Elevation Granitic Dome or Low Elevation Rocky Summit can occur in small amounts in Low Elevation Acidic Glades.

Rare species:
Vascular plants: *Packera millefolium*.
Vertebrate animals: *Crotalus horridus*

References:

LOW ELEVATION ACIDIC GLADE (BILTMORE SEDGE SUBTYPE)

Concept: Low Elevation Acidic Glades are communities of shallow soils, with limited tree cover but with extensive ground cover, occurring on acidic rocks and lacking plants indicative of base-rich conditions. The Biltmore Sedge occurs on smooth exfoliated granitic rock where some seepage is present and where *Carex biltmoreana* is dominant or abundant.

Distinguishing Features: Low Elevation Acidic Glades are distinguished from Low Elevation Granitic Domes by the predominance of extensive soil mats, capable of supporting dense grasses or sedges. The Biltmore Sedge Subtype is distinguished from the Grass Subtype by having abundant *Carex biltmoreana*. It is similarly distinguished from Low Elevation Granitic Dome and High Elevation Granitic Dome, which may also contain small patches of *Smilax biltmoreana*, by greater cover of graminoids and herbs and smaller amounts of bare and lichen-covered rock and shallow mats dominated by *Selaginella*. While patches of *Smilax biltmoreana* may occur on Granitic Domes, only ones that are extensive enough to be a free-standing community should be treated as this subtype.

Synonyms: *Carex biltmoreana* - *Pycnanthemum* spp. - *Krigia montana* Herbaceous Vegetation (CEGL004523).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Sites: Low Elevation Acidic Glades occur on rock surfaces with extensive cover of shallow soil and only limited bare rock. In the Biltmore Sedge Subtype the rock is usually smooth exfoliated granitic bedrock but it may be the undulating, irregular, or pitted bedrock typical of the Grass Subtype. Patches may be gently sloping or steep. At least one example appears to be an old landslide scar but most are on the edges of larger granitic dome complexes. Examples are known from 2500 to 4800 feet elevation.

Soils: Soils are shallow mats of accumulated organic matter and small rock fragments. They generally are not distinguished in soil surveys or are mapped as rock.

Hydrology: The Biltmore Sedge Subtype is generally seasonally saturated but may be nearly permanently saturated.

Vegetation: The vegetation of the Biltmore Sedge subtype may be patchy or may be a relatively continuous stand. *Carex biltmoreana* is dominant or abundant. Other species that are fairly frequent and at least sometimes fairly abundant include *Krigia montana, Micranthes (Hydatica) petiolaris, Coreopsis pubescens, Dichanthelium dichotomum* var. *dichotomum, Oenothera fruticosa, Thalictrum revolutum, Thalictrum clavatum,* and *Oxypolis rigidior*. Species less frequent but sometimes abundant include *Pycnanthemum montanum, Heuchera villosa, Heuchera americana, Solidago patula, Houstonia serpyllifolia, Viola cuculata, Viola primulifolia, Andropogon gerardii, Physostegia virginiensis, Eryngium yuccifolium, Eurybia divaricata,* and *Trautvetteria carolinensis*. Woody species may be absent but shrub patches and small trees may be rooted in the community. *Diervilla sessilifolia, Hydrangea arborescens, Kalmia latifolia, Rhododendron maximum*, or *Hamamelis virginiana* are among the shrubs that may be present. Trees may include *Quercus montana, Pinus* spp., *Quercus rubra,* or other species.

Range and Abundance: The synonymized association is ranked G2G3 but is probably rarer. The Biltmore Sedge Subtype is known from a handful of sites in the Mountains, Blue Ridge escarpment, and foothills, primarily south of Asheville. It also is reported to occur in South Carolina and Georgia.

Associations and Patterns: The Biltmore Sedge Subtype usually occurs adjacent to Low Elevation Granitic Dome or High Elevation Granitic Dome communities. Less often it may be associated with Low Elevation Basic Glade or with the Grass Subtype of Low Elevation Acidic Glade. It generally is bordered on one side by Chestnut Oak Forest, Montane Oak–Hickory Forest, or other upland forest communities and may be surrounded by them.

Variation: This is a narrowly defined community with limited variation.

Dynamics: The dynamics of the Biltmore Sedge Subtype are poorly known. Like the Grass Subtype, they may be relatively stable. Or, like the smaller herb mats in Low and High Elevation Granitic Domes, they may periodically slough off or be pulled up by falling trees, resetting primary succession. Because the Biltmore Sedge Subtype is wet much of the time, fire is unlikely to carry through it. However, burning is possible during dry periods. The effect of fire on this community is not known.

Comments: The relationship between the Biltmore Sedge Subtype and the Grass Subtype is less close than between most subtypes in the Fourth Approximation. Given the role of seepage, the Biltmore Sedge Subtype could almost as easily be regarded as a subtype of Low Elevation Seep akin to its Bedrock Subtype. It appears to be transitional to that community. In addition, the typical patch size is small enough that it might almost be regarded as merely a part of the mosaic of granitic dome communities. However, its absence in most granitic dome communities is a reason for tracking it as a separate entity. *Carex biltmoreana* as a species is rare enough to be on the Natural Heritage Program's watch list.

Rare species:
Vascular plants: *Packera millefolium*.

References: No references specific to this community have been identified.

LOW ELEVATION BASIC GLADE (MONTANE SUBTYPE)

Concept: Low Elevation Basic Glades are communities of shallow soils, with limited tree cover but with extensive ground cover, occurring on many kinds of rock and containing plants indicative of base-rich conditions. Most occur on rock surfaces that are relatively unfractured, but which are undulating or irregular and lack the characteristics of Granitic Dome sites. Vegetation generally includes dense grass or other herbs with patches of shrubs and sometimes trees, but it may occasionally include moderate tree cover and more extensive low shrub cover throughout the community.

The Montane Subtype encompasses most examples in the Mountains and most examples in the foothills, with the exception of the distinctive examples in the Brushy Mountains Subtype.

Distinguishing Features: Low Elevation Basic Glades are distinguished from both Low Elevation Granitic Domes and Low Elevation Acidic Glades by the presence of plants characteristic of higher pH soils, such as *Hylotelephium (Sedum) telephioides, Dodecatheon meadia, Sedum glaucophyllum, Myriopteris (Cheilanthes) lanosa, Borodinia (Boechera) laevigata*, and *Penstemon canescens.* In the woody strata, *Fraxinus biltmoreana, Juniperus virginiana*, *Chionanthus virginiana*, and *Carya glabra* are generally abundant while *Pinus* spp. are scarce.

Low Elevation Basic Glades are distinguished from High Elevation Mafic Glades by occurring below 4000 feet elevation and by the absence of characteristic high elevation species such as *Sibbaldiopsis tridentata*. Low Elevation Basic Glades are distinguished from Low Elevation Rocky Summits by having few crevices or fractures in the rock, by having fewer deep-rooted forbs, shrubs, and trees that depend on deeper soil, and by having more extensive plant cover and limited bare rock.

The Montane Subtype is distinguished from the Brushy Mountains Subtype by largely lacking a suite of distinctive plant species, including *Croton willdenowii (Crotonopsis elliptica), Hypericum radfordiorum, Allium keeverae, Pseudognaphalium obtusifolium, Coreopsis tripteris, Senna marilandica*, and *Hexasepalum (Diodia) teres*.

Synonyms: *Selaginella rupestris - Schizachyrium scoparium - Hylotelephium telephioides - Allium cernuum* Herbaceous Vegetation (CEGL004991).
Ecological Systems: Southern and Central Appalachian Mafic Glade and Barrens (CES202.348).

Sites: Low Elevation Basic Glades occur on rock surfaces with extensive cover of shallow soil and only limited bare rock. Most are on gentle-to-moderate slopes. The rock generally has few of the deep fractures that commonly occur in Rocky Summits. The surface is undulating, pitted, or somewhat irregular, unlike the smoother rock of Granitic Domes. Some examples occur on amphibolite or other mafic rocks but many occur on felsic rocks without an obvious reason to support the flora of basic sites. Some are on granitic rocks that are prone to exfoliation, some on dip slopes of rock beds or metamorphic foliation, some on other kinds of rock surfaces. Examples are known from 1500-4600 feet in elevation but could occur somewhat lower or higher.

Soils: Soils are shallow mats of accumulated organic matter and small rock fragments. They generally are not distinguished in soil surveys or are mapped as rock. Based on the flora, they are presumed to be relatively high in base saturation, if not in pH.

Hydrology: Low Elevation Basic Glades generally are dry because of shallow soils. During drought periods moisture stress may quickly become extreme. Small portions may be saturated by seepage for part of the year or in wet periods.

Vegetation: The vegetation is patchy but generally includes extensive cover of grass. Dominant grasses in patches may include *Schizachyrium scoparium, Andropogon gerardii, Danthonia spicata, Danthonia sericea, Piptochaetium avenaceum*, and rarely, *Chasmanthium latifolium, Carex biltmoreana, Elymus virginicus*, or other species. The herbaceous flora usually is moderately to very diverse, with much variation among examples. Some of the most frequent species in CVS plots or site descriptions include *Coreopsis major, Hylotelephium telephioides, Hypericum punctatum, Hypericum gentianoides, Packera anonyma, Antennaria plantaginifolia, Campanula divaricata, Penstemon canescens, Helianthus divaricatus, Micranthes (Hydatica) petiolaris, Tradescantia subaspera, Euphorbia pubentissima, Parthenium integrifolium, Coreopsis pubescens, Lespedeza virginica, Packera anonyma, Polygonatum biflorum*, and *Ambrosia artemisiifolia*. A large pool of less frequent herbs may be present, including *Aquilegia canadensis, Amsonia tabernaemontana, Dodecatheon meadia, Rudbeckia triloba* var. *pinnatiloba*, *Elymus hystrix, Liatris* spp., *Solidago* spp. (*sphacelata, speciosa, nemoralis, pinetorum*, and others), *Symphyotrichum* spp. (*patens, lateriflorum, undulatum*, and others), *Agalinis tenuifolia, Apocynum cannabinum, Allium allegheniense, Krigia montana, Pycnanthemum montanum, Micranthes virginiensis, Micranthes careyana, Muhlenbergia capillaris, Muhlenbergia tenuiflora, Scleria ciliata*, *Tephrosia virginiana, Sericocarpus linifolius,* and many others. In addition, plants of more open rock outcrops, such as *Heuchera villosa, Heuchera americana, Bryodesma (Selaginella) rupestris, Bryodesma tortipilum, Bulbostylis capillaris, Myriopteris (Cheilanthes) tomentosa, Myriopteris lanosa*, and *Corydalis sempervirens* are often present in limited portions. Woody vegetation tends to be patchy, though occasionally trees are dispersed throughout the community in an open canopy. *Quercus montana* is the most frequent species, but *Juniperus virginiana* is in most examples. *Carya* spp. (*pallida, tomentosa, glabra*, or *ovata*) is often prominent. Other frequent tree species include *Fraxinus biltmoreana, Fraxinus americana, Chionanthus virginicus, Crataegus* spp., *Diosypros virginiana*, and *Amelanchier sanguinea. Pinus virginiana* and other pines, as well as other *Quercus* species, may be present but with lower frequency. Shrubs are patchy. *Rosa carolina* is the most frequent species. Both characteristic shrubs of basic sites, such as *Philadelphus hirsutus, Philadelphus inodorus*, and *Physocarpus opulifolius*, and widespread acid-tolerant species, such as *Vaccinium pallidum, Vaccinium stamineum*, and *Kalmia latifolia,* are fairly frequent and can dominate patches. Other species may include *Hypericum densiflorum, Hypericum prolificum, Amorpha glabra, Rubus flagellaris*, *Rhus aromatica*, *Celtis tenuifolia*, *Ptelea trifoliata*, *Ceanothus americana*, and *Lonicera sempervirens*.

Range and Abundance: Ranked G2. Examples are scattered throughout the mountains and foothills. This community occurs in adjacent Virginia, likely in South Carolina, and possibly in the Blue Ridge portion of Tennessee.

Associations and Patterns: Low Elevation Basic Glades occur as small patches. They may occupy an entire open area or may be associated with Montane Red Cedar–Hardwood Woodland, Low Elevation Rocky Summit, Low Elevation Granitic Dome, High Elevation Granitic Dome, or Montane Cliff. The majority are surrounded by dry basic forest communities such as Montane Oak–Hickory Forest (Basic Subtype), but a significant number are associated with more common acidic forest communities.

Variation: The Montane Subtype is one of the most variable communities in the 4th Approximation. It likely should be divided into several subtypes when further study clarifies the patterns of variation. Four variants are tentatively defined based on the most likely axes of variation. They need further investigation.

1. Montane Rich Variant occurs within the Blue Ridge at all but the lowest elevations and has flora that suggests strongly basic conditions. Species such as *Philadelphus hirsutus, Philadelphus inodorus*, *Physocarpus opulifolius, Ptelea trifoliata, Dodecatheon meadia*, and *Aquilegia canadensis* are widespread in the community.
2. Montane Intermediate Variant occurs within the Blue Ridge at all but the lowest elevations and has flora suggestive of less strongly basic conditions, with a lower diversity and abundance of plants exclusive to basic sites. Species of wide tolerance make up much of the community, but enough basic site species are present to distinguish the community from Low Elevation Acidic Glade.
3. Foothills Rich Variant occurs in the foothills, Blue Ridge escarpment, and a few lower elevation or drier sites within the interior of the Blue Ridge. It has flora that suggests strongly basic conditions.
4. Foothills Intermediate Variant occurs in the foothills, Blue Ridge escarpment, and a few lower elevation or drier sites within the interior of the Blue Ridge. It has flora suggestive of marginally basic conditions, with species of wide tolerance making up much of the community.

As with many small patch communities, composition varies widely from one occurrence of Low Elevation Basic Glade to another. A few occurrences, such as the cluster at Box Creek Wilderness, seem particularly distinctive.

Dynamics: Dynamics of Low Elevation Basic Glades are similar to those described for Low Elevation Acidic Glade (Grass Subtype). They remain more open than typical forests in the absence of disturbance, but periodic mortality caused by drought may be important for keeping them open. Fire, though likely patchy within the community, may also be influential.

The cause of basic conditions is often obvious, with the community occurring on amphibolite, hornblende gneiss, or similar rocks. However, some examples, especially of the Montane Intermediate and Foothills Intermediate variants, occur on granitic rocks. In some cases they are associated with seepage, which may bring in additional nutrients, but in others it is not clear why they support flora of basic sites.

Comments: The type is called Basic rather than Mafic because many examples occur on felsic rocks which show floristic evidence of higher pH soils. The name Montane Subtype is generic, meant only to distinguish this subtype from the Brushy Mountains Subtype. It is less than ideal

because some examples occur in the foothills region of the Piedmont at low elevations. All occur in association with other mountain communities.

Study of Low Elevation Basic Glades is limited, though many are described in site reports. Feil (1988) described the glades of Hickorynut Gorge, naming clusters as *Fraxinus americana*/mixed herbs, *Fraxinus americana/Carex biltmoreana*, and *Juniperus virginiana*/mixed herbs. Only a handful of CVS plots have been sampled.

Rare species:

Vascular plants: *Amelanchier sanguinea, Arabis patens, Arabis adpressilis*, *Calamagrostis porteri* ssp. *porteri, Dicentra eximia*, *Draba ramosissima, Euphorbia commutata, Huperzia porophila, Liatris aspera, Liatris microcephala, Lonicera flava, Mononeuria groenlandica, Phlox subulata, Prunus alleghaniensis, Rudbeckia triloba* var. *pinnatiloba*, *Sedum glaucophyllum, Packera millefolium*, *Silene ovata, Solidago simulans, Tradescantia virginiana, Trichophorum cespitosum,* and *Woodsia appalachiana*.

Nonvascular plants: *Gymnoderma lineare, Macrocoma sullivantii*, *Scopelophila ligulata,* and *Tortula ammonsiana.*

Vertebrate animals: *Crotalus horridus.*

Invertebrate animals: *Hypochilus coylei.*

References:

Feil, E.G. 1988. Floristics and vegetation of Chimney Rock Park, Rutherford County, North Carolina. M.S. Thesis, University of North Carolina, Charlotte.

LOW ELEVATION BASIC GLADE (BRUSHY MOUNTAINS SUBTYPE)

Concept: Low Elevation Basic Glades are communities of shallow soils, with limited tree cover but with extensive ground cover, occurring on many kinds of rock and containing plants indicative of base-rich conditions. The Brushy Mountains Subtype covers the floristically distinctive examples currently known only in from the Brushy Mountains.

Distinguishing Features: Low Elevation Basic Glades are distinguished from both Low Elevation Granitic Domes and Low Elevation Acidic Glades by the presence of plants characteristic of higher pH soils. The Brushy Mountains Subtype is distinguished by a suite of distinctive plant species, including *Croton willdenowii (Crotonopsis elliptica), Hypericum radfordiorum, Allium keeverae, Pseudognaphalium obtusifolium, Coreopsis tripteris, Senna marilandica*, and *Hexasepalum (Diodia) teres*.

Synonyms: *Selaginella rupestris - Croton willdenowii - Cheilanthes tomentosa - (Allium cuthbertii)* Herbaceous Vegetation (CEGL004992).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Sites: The Brushy Mountains Subtype of Low Elevation Basic Glade occurs on smooth to gently undulating or pitted outcrops of granitic rock on upper to middle slopes. All examples appear to be on exfoliation surfaces. Examples range from 1200-2300 feet in elevation.

Soils: Soils are shallow mats of accumulated organic matter and small rock fragments. They generally are not distinguished in soil surveys or are mapped as rock. Based on the flora, they are presumed to be relatively high in base saturation, if not in pH.

Hydrology: Low Elevation Basic Glades generally are dry because of shallow soils. During drought periods moisture stress may quickly become extreme. Small portions may be saturated by seepage for part of the year or in wet periods.

Vegetation: The vegetation is patchy. It may include substantial areas of rock covered by crustose lichens, *Cladonia* spp., the moss *Grimmia laevigta*, or *Brysodesma (Selaginella) rupestre*. Shallow soil mats dominated by herbs are generally extensive. Species with high constancy in CVS plots or in site reports include *Opuntia mesacantha* ssp. *mesacantha*, *Phemeranthus teretifolius, Hypericum gentianoides, Croton wildenowii (Crotonopsis elliptica), Allium keeverae, Hypericum radfordiorum, Commelina erecta, Linaria canadensis, Myriopteris (Cheilanthes) lanosa, Myriopteris tomentosa, Pycnanthemum incanum, Dichanthelium acuminatum* var. *fasciculatum*, *Juncus dichotomus, Krigia virginica, Andropogon virginicus*, and *Yucca filamentosa*. Also fairly frequent are *Diamorpha smallii, Phlox nivalis, Schizachyrium scoparium, Danthonia sericea, Agrostis hyemalis, Micranthes (Hydatica) petiolaris, Asplenium platyneuron, Dichanthelium depauperatum, Houstonia caerulea, Coreopsis tripteris, Micranthes virginiensis*, and *Fleischmannia (Eupatorium) incarnata*. Other herbs that are less frequent but that are notable in showing the character of the community include *Hylotelephium telephioides, Aquilegia canadensis, Penstemon australis, Borodinia (Boechera) canadensis, Senna marilandica, Asplenium trichomanes, Woodsia obtusa, Phacelia dubia, Micranthes virginiensis*, and *Tradescantia ohiensis*. Woody plants are patchy, with trees and shrubs present in the deeper soil

patches and on the edges. The most frequent dominant tree is *Juniperus virginiana*, and *Fraxinus americana* or *Fraxinus biltmoreana*, *Carya glabra*, and *Pinus virginiana* are frequent. Other fairly frequent trees include *Ulmus alata* and *Chionanthus virginicus*. Shrubs noted, generally at low frequency, include *Rhus glabra, Rosa carolina, Symphoricarpos orbiculatus*, and *Ptelea trifoliata*.

Range and Abundance: Ranked G2. The Brushy Mountains Subtype is endemic to North Carolina and occurs only in the Brushy Mountains area in the foothills of Alexander and Wilkes counties. The entire global extent appears to be on the order of approximately 100 acres.

Associations and Patterns: Low Elevation Basic Glades are small patch communities. The Brushy Mountains Subtype generally is not associated with any rock outcrop communities, but it sometimes occurs with Montane Red Cedar–Hardwood Woodland or Granitic Dome Basic Woodland. Otherwise, it is surrounded by typical upland forest communities which may be either basic or acidic.

Variation: The Brushy Mountains Subtype is a narrowly defined community. Variants have not been defined.

Dynamics: Dynamics of the Brushy Mountains Subtype are presumed to be generally comparable to those of other glade communities. They remain more open than typical forest in the absence of disturbance, but periodic mortality caused by drought may be important for keeping them open. Fire, though likely patchy within the community, may also be influential. The Brushy Mountains Subtype is more similar to Low Elevation Granitic Dome than are other glade communities and may be more subject to the cyclic succession dynamics of vegetation mats in that community. The sequence of primary succession on Rocky Face Mountain, one example of this subtype, is described in detail in Keever, et al. (1951), and they mentioned the destruction of soil mats by uprooting trees.

As in some examples of the Montane Subtype, it is not obvious why the examples of the Brushy Mountains Subtype appear to have high base status given that they occur on felsic rocks that normally support acidic communities.

Comments: Examples of the Brushy Mountains Subtype were treated as part of the Low Elevation Granitic Dome community in the 3rd Approximation. They resemble granitic domes more than do other glade communities, and it has been uncertain whether they are best regarded as a subtype of Low Elevation Basic Glade or of Low Elevation Granitic Dome. It appears that most of the rock outcrops in the Brushy Mountains are relatively heavily vegetated and therefore more appropriate to treat as glades, though they are less vegetated than most examples in the Montane Subtype. However, the description in Keever, et al. (1951) emphasizes bare rock and makes the site appear very similar to a Low Elevation Granitic Dome. A few of the largest outcrops in the Brushy Mountains have open areas that are better classified as Low Elevation Granitic Dome.

The floristic differences that warrant recognition of the Brushy Mountains Subtype include a greater component of Piedmont species, some affinities to Granitic Flatrock communities, and the frequent occurrences of several endemic and long distance disjunct species not found in any other community. The collection of rare plant species associated with this subtype is large.

Helianthus (Viguiera) porteri, an endemic species of granitic flatrocks and domes in states to the south, was introduced in an ecological experiment in one example of the Brushy Mountains Subtype. It has developed into an aggressive weedy species there.

Rare species:
Vascular plants: *Allium keeverae, Anemone berlandieri, Arabis adpressilis, Corydalis micrantha, Cyperus granitophilus, Dichanthelium bicknellii, Fleishmannia incarnata, Hypericum radfordianum, Matelea decipiens, Pellaea atropurpurea, Pellaea wrightiana,* and *Trichostema setaceum*.
Nonvascular plants: *Orthotrichum keeverae*.
Vertebrate animals: *Crotalus horridus.*

References:
Keever, C., H.J. Oosting, and L.E. Anderson. 1951. Plant succession on exposed granite of Rocky Face Mountain, Alexander Co., N.C. Bull. Torrey Bot. 78:401-421.

MONTANE RED CEDAR–HARDWOOD WOODLAND

Concept: Montane Red Cedar–Hardwood Woodlands are rare open-canopy woodlands of the mountains and foothills, on shallow soils over bedrock, containing plants indicative of circumneutral soil conditions. *Juniperus virginiana* is dominant or codominant, *Fraxinus americana* or *Carya* spp. are abundant, and *Quercus montana* or other oaks may also be abundant.

Distinguishing Features: Montane Red Cedar–Hardwood Woodlands are distinguished from other forest and woodland communities by having an open but substantial canopy that includes abundant *Juniperus virginiana* along with *Fraxinus americana* or *Carya* spp. and having lower strata that include both species needing high light levels and species typical of circumneutral soil conditions. Characteristic species include *Schizachyrium scoparium, Danthonia* spp., *Coreopsis pubescens, Physocarpus opulifolius, Philadelphus hirsutus*, and *Dodecatheon meadia*. Montane Red Cedar–Hardwood Woodlands are distinguished from Low Elevation Basic Glades and various rock outcrop communities by vegetation structure. The rock outcrop communities may have trees on the edges and sparsely in the interior of the community but have less than 25% cover of trees. Low Elevation Basic Glade communities have more vegetation cover and usually more trees than the rock outcrop communities, but also are more open and have more bare rock than Montane Red Cedar–Hardwood Woodland. The similar Granitic Dome Basic Woodland has a denser canopy more strongly dominated by *Carya, Quercus*, and *Fraxinus* with little *Juniperus* and has limited shade-intolerant flora.

Synonyms: *Carya (glabra, alba) - Fraxinus americana - (Juniperus virginiana var. virginiana)* Woodland (CEGL003752). Montane Red Cedar–Hardwood Woodland; Low Elevation Granitic Dome (in part) (Third Approximation).
Ecological Systems: Southern and Central Appalachian Mafic Glade and Barrens (CES202.348).

Sites: Montane Red Cedar–Hardwood Woodlands occur on upper slopes with shallow but extensive soil. Rock outcrops are usually present in the community but represent a small minority of the area.

Soils: Soils are shallow accumulations of weathered rock and organic matter lying over bedrock. They are generally treated as inclusions in soil surveys or mapped as rock outcrops.

Hydrology: Moisture conditions are generally dry because of the shallow soil, and they can become extreme during drought. Some limited seepage may be present along uphill edges.

Vegetation: The vegetation is a woodland, with an open but fairly continuous canopy of small trees. Vegetation was described in detail by Small and Wentworth (1998), and earlier and later site reports and plot data are similar. *Juniperus virginiana* dominates the canopy. *Carya glabra* or *Fraxinus americana/biltmoreana* have high constancy and may be abundant. *Quercus montana, Quercus rubra, Quercus alba, Carya tomentosa,* and *Pinus virginiana* are also highly constant; they, along with *Ulmus alata,* may less often be abundant. Shrubs are sparse to moderate in density. *Chionanthus virginicus*, *Vaccinium stamineum,* and *Rubus canadensis* are most constant, and *Symphoricarpos orbiculatus* is also frequent. Vines are not extensive, but *Parthenocissus quinquefolia*, *Smilax glauca,* and *Toxicodendron radicans* are constant or frequent. The herb layer

is generally dense and is diverse. Species with greater than 50% constancy in Small and Wentworth (1998) plots include *Carex pensylvanica, Danthonia spicata, Dichanthelium scoparium, Potentilla canadensis, Heuchera americana* var. *americana, Schizachyrium scoparium, Stylosanthes biflora, Dichanthelium laxiflorum, Antennaria plantaginifolia, Asplenium platyneuron, Erigeron strigosus, Penstemon canescens, Polygonatum biflorum, Polypodium appalachianum, Micranthes (Hydatica) petiolaris, Eurybia divaricata, Hypericum punctatum, Campanula divaricata, Pseudognaphalium obtusifolium, Lespedeza hirta, Coreopsis pubescens* var. *pubescens, Sorghastrum nutans, Euphorbia corollata, Oxalis grandis, Phemeranthus teretifolius, Viola palmata, Eurybia undulata, Dichanthelium boscii, Houstonia lanceolata*, *Oenothera tetragona* var. *Fraseri*, *Solidago erecta*, *Danthonia sericea, Houstonia caerulea, Packera anonyma, Amphicarpaea bracteata, Andropogon gerardii, Carex normalis, Helianthus hirsutus, Lechea racemulosa, Pycnanthemum montanum, Silene virginica, Thalictrum revolutum, Lobelia puberula, Viola sororia, Borodinia (Boechera) laevigata*, and *Pycnanthemum incanum*. Other herbs with slightly lower frequency but indicative of basic conditions include *Dodecatheon meadia, Myriopteris tomentosa, Tradescantia hirsuticaulis*, *Elymus hystrix,* and *Solidago sphacelata*.

Range and Abundance: Ranked G2. Examples occur in the mountains and foothills. There is a cluster of occurrences in Macon and Jackson counties and one in the Brushy Mountains of Alexander County, with only a handful of examples scattered elsewhere. The community is also believed to occur in Georgia, and plots have been attributed to it in Virginia.

Associations and Patterns: Montane Red Cedar–Hardwood Woodlands are small patch communities usually associated with one of the subtypes of Low Elevation Basic Glade, less often with some other more open community such as Low Elevation Granitic Dome. They are generally surrounded by communities of the Mountain Oak Forests theme. Though Montane Red Cedar–Hardwood Woodland has flora suggesting high base status in the soil, the surrounding oak forests often are typical acidic subtypes.

Variation: Small and Wentworth (1998) found that plot data were grouped geographically, with samples from the Brushy Mountains most distinct from those in the Blue Ridge. Though only a single Brushy Mountains site was represented in their plots, these are tentatively recognized as variants. Study of other examples in the Brushy Mountains is needed to verify that they show a similar pattern.

1. Montane Variant occurs within the Blue Ridge proper and is usually associated with the Montane Subtype of Low Elevation Basic Glade.
2. Brushy Mountains Variant occurs in the Brushy Mountains, at lower elevations and generally associated with the Brushy Mountains Subtype of Low Elevation Basic Glade. If examples are found in the South Mountains, they may belong with this variant or may fit better with the Montane Variant.

Dynamics: Montane Red Cedar–Hardwood Woodland dynamics probably are similar to those of Low Elevation Acidic Glade and Low Elevation Basic Glade. The impact of drought, though less severe than in those communities with less soil, is probably important in keeping the canopy open and allowing *Juniperus* to survive amid potentially taller hardwoods. Small and Wentworth (1998)

report tree diameter data suggestive of a stable, uneven-aged population. Fire is possible at the same frequency as in the surrounding oak forests, but the less continuous litter layer would limit its intensity and the frequency at which it influences most of the community. *Juniperus virginiana* is not very resistant to fire, and its long-term persistence suggests a limited role of fire. However, fire may be important in determining boundaries between Montane Red Cedar–Hardwood Woodland and adjacent communities.

Comments:

Rare species:
Vascular plants: *Allium keeverae, Corydalis micrantha, Primula (Dodecatheon) meadia, Fleischmannia incarnata, Hypericum radfordiorum, Matelea decipiens, Parthenium auriculatum, Sedum glaucophyllum, Silene ovata, Sisyrinchium dichotomum,* and *Trichostema setaceum*.
Nonvascular plants: *Macrocoma sullivantii* and *Orthotrichum keeverae.*
Invertebrate animals: *Megathymus cofaqui cofaqui* and *Papilio cresphontes.*

References:
Small, C.J., and T.R. Wentworth. 1998. Characterization of Montane Red Cedar-Hardwood Woodlands in the Piedmont and Blue Ridge provinces of North Carolina. Castanea 63:241-261.

GRANITIC DOME BASIC WOODLAND

Concept: Granitic Dome Basic Woodlands are rare open forests of *Quercus, Carya*, and *Fraxinus* associated with exfoliated rock outcrops in the Blue Ridge escarpment and foothills portions of the state. They are similar to Montane Red Cedar–Hardwood Woodlands but are denser and are dominated by hardwoods. The concept should be reserved for substantial expanses of woodland or forest, not for the small woody patches that are a normal part of Low Elevation Granitic Dome or glade communities.

Distinguishing Features: Granitic Dome Basic Woodlands are distinguished by being only slightly more open than typical forests, and by their association with foothills granitic dome exfoliated rock outcrops. They differ in canopy composition and structure from typical mountain forests in ways that suggest influence of high soil base status and effects of shallow soil and drought. Granitic Dome Basic Woodlands are distinguished from Montane Red Cedar–Hardwood Woodlands by having a denser canopy that is dominated by hardwoods, with little or no *Juniperus virginiana*, though pines may be present in either. They often have extensive grassy herb layers dominated by *Piptochaetium avenaceum* but do not have the high species richness of Montane Red Cedar–Hardwood Woodland. Granitic Dome Basic Woodlands are similar to Granitic Flatrock Border Woodland communities in vegetation and soil structure, but they differ biogeographically. The Granitic Dome Basic Woodland flora is distinctly tied to the Blue Ridge; the Granitic Flatrock Border Woodland flora represents the lower Piedmont.

Synonyms: *Fraxinus americana – Carya glabra / Symphoricarpos orbiculatus - Rhus aromatica / Piptochaetium avenaceum* Woodland (CEGL003684). Basic Oak–Hickory Forest. [Called Montane Red Cedar–Hardwood Woodland (Piedmont Dome Subtype) in earlier drafts.]
Ecological Systems: Southern Piedmont Glades and Barrens (CES202.328).

Sites: Granitic Dome Basic Woodland communities occur on upper slopes, ridge tops, or tops of knobs underlain by massive granitic rocks that are prone to exfoliation. Though not carefully studied, they presumably have relatively shallow soils with unfractured bedrock beneath. Rock outcrops are absent or scarce within them.

Soils: Soils are continuous but are presumed to be shallow and probably are sandy. In all the known examples, the soils are mapped as "rock outcrop complex."

Hydrology: Sites are dry both because of shallow soil and because of high topographic position. However, if the underlying bedrock is unfractured, rainwater may be retained near the surface for longer than might be expected on hilltops. These soils are sometimes the source of seepage onto adjacent Low Elevation Granitic Domes.

Vegetation: The vegetation is a continuous canopy that may range from somewhat open to nearly as dense as a forest. The canopy is dominated by combinations of *Carya glabra* and *Fraxinus americana/biltmoreana*, sometimes with abundant *Quercus montana* or *Ulmus alata*. The understory generally is sparse but frequently includes *Juniperus virginiana, Acer rubrum, Nyssa sylvatica, Chionanthus virginicus*, *Celtis tenuifolia, Prunus serotina, Diospyros virginiana,* and *Crataegus uniflora,* as well as canopy species. The shrub layer is generally sparse. *Vaccinium*

stamineum, Vaccinium pallidum, and *Rhus aromatica* occur with high constancy in CVS plot data, and *Rosa carolina*, *Symphoricarpos orbiculatus*, *Ptelea trifoliata,* and various tree species may also occur. Vines are not prominent, but *Parthenocissus quinquefolia* occurs with high constancy. The herb layer is generally dense, often with *Piptochaetium avenaceum* strongly dominant. *Danthonia spicata* is highly constant in plot data and can be fairly abundant. Other constant or frequent species in plot data include *Dichanthelium boscii, Dichanthelium laxiflorum, Heuchera americana, Endodeca serpentaria, Verbesina occidentalis, Galium pilosum, Aquilegia canadensis, Eupatorium sessilifolium, Dryopteris marginalis, Houstonia longifolia* var. *compacta, Micranthes (Hydatica) petiolaris, Opuntia mesacantha* var. *mesacantha*, *Packera anonyma, Galium circaezans, Hieracium venosum, Phlox nivalis, Polygonatum biflorum, Schizachyrium scoparium,* and *Sanicula canadensis*.

Range and Abundance: Ranked G2, but potentially G1. Only a handful of sites are known in North Carolina, all in the Brushy Mountains and northern Blue Ridge escarpment. The association is also attributed to Georgia and could conceivably occur in South Carolina.

Associations and Patterns: Granitic Dome Basic Woodlands are small-to-large patch communities associated with Low Elevation Granitic Dome or Low Elevation Basic Glade communities. They generally occur at the highest local elevation and may grade downslope to Mountain Oak Forests or Mountain Cove Forests where rock outcrops are not present.

Variation: Little is known about variation.

Dynamics: Granitic Dome Basic Woodland communities likely have dynamics similar to other barrens communities, or intermediate between those of glades or rock outcrops and dynamics of forests. Canopies probably are largely uneven-aged, with tree reproduction in gaps, but natural disturbance and regeneration may be more severe and more episodic than in most forests because of the greater effects of drought and shallow soil. Given the continuous litter layer and often continuous grass layer in these communities, natural fire likely is as frequent as in most oak forests and may be an important influence.

Comments: As with the Low Elevation Basic Glade community, the presence of flora of high-base sites in Granitic Dome Basic Woodland is mystifying. The associated rocks are usually felsic rocks that otherwise tend to produce acidic soils. The associated forest communities generally are acidic.

Quercus prinus - Quercus stellata - Carya glabra / Vaccinium arboreum - Viburnum rufidulum Forest (CEGL004416) is an association with a somewhat confusing description, which may partly overlap this community type and the association synonymized above.

Rare species:
Vascular plants: *Fleischmannia incarnata.*

References: No references specific to this community have been identified.

ULTRAMAFIC OUTCROP BARREN (PITCH PINE SUBTYPE)

Concept: Ultramafic Outcrop Barrens are very rare woodlands with distinctive structure and floristic composition associated with soils developed on ultramafic rock substrates such as serpentinite, peridotite, or dunite. Characteristics include low overall plant species richness due to exclusion of some species by soil chemistry, unusual combinations of plants with different typical moisture tolerances, and generally, unusually open, grassy vegetation. The Pitch Pine Subtype covers the more extremely developed examples at elevations above about 3000 feet, where *Pinus rigida* dominates or codominates a generally open canopy. A well-developed herb layer dominated by prairie grasses is generally present.

Distinguishing Features: Ultramafic Outcrop Barrens are distinguished by an unusually open, barren vegetation structure unexpected for the topographic setting and soil depth, unusual vegetation composition that includes combinations of species with different moisture tolerances, endemic species such as *Symphyotrichum rhiannon*, and association with ultramafic rock. Not all recognizable ultramafic rock bodies support these communities. The Pitch Pine Subtype is distinguished from the Virginia Pine Subtype by the predominance of *Pinus rigida* and scarcity of *Pinus virginiana*. It is distinguished from the White Oak Subtype by having a more open canopy with *Pinus rigida* dominant or codominant.

Synonyms: Synonyms: *Pinus rigida - Quercus alba / Sporobolus heterolepis - Andropogon gerardii* Woodland (CEGL003768).
Ecological Systems: Eastern Serpentine Woodland (CES202.347).

Sites: Ultramafic Outcrop Barrens occur on substrates of ultramafic rock such as dunite, peridotite, and serpentinite. The Pitch Pine Subtype occurs on convex slopes at moderate elevation, around 3000 feet. It is presently known only at Buck Creek Barrens and is unlikely to be found elsewhere.

Soils: Soils derived from ultramafic rocks are known for their unusual chemistry, which includes high levels of magnesium, low calcium to magnesium ratio, and high levels of nickel and chromium. The soils at the one known occurrence are mapped as Evard-Cowee complex (Typic Hapludults) but Mansberg (1981) described them as a Mollisol.

Hydrology: The Pitch Pine Subtype is dry to dry-mesic, generally occurring on well-drained slopes. Local seepage areas may be present.

Vegetation: The Pitch Pine Subtype is an open woodland or savanna dominated by *Pinus rigida*. *Quercus alba* is abundant. Other trees with high constancy, though limited cover, in CVS plot data include *Acer rubrum* and *Tsuga canadensis*. Shrubs may have sparse to dense cover. *Kalmia latifolia, Vaccinium stamineum, Physocarpus opulifolius, Viburnum cassinoides, Sassafras albidum, Lyonia ligustrina, Gaylussacia baccata, Vaccinium pallidum*, and *Vaccinium simulatum* have high constancy in plots, and the first five also can have moderate to high cover. *Smilax glauca* and *Smilax rotundifolia* are constant and may be fairly extensive. The herb layer is dense wherever shrubs are not too abundant. Grasses dominate, particularly *Andropogon gerardii*, *Schizachyrium scoparium*, and *Sporobolus heterolepis*. *Dichanthelium dichotomum, Elymus trachycaulus, Danthonia spicata, Sorghastrum nutans, Dichanthelium commutatum, Dichanthelium laxiflorum,*

Panicum virgatum var. *virgatum*, and *Muhlenbergia glomerata* also occur with high constancy. Other herbs with high constancy and sometimes moderate cover include *Hexastylis arifolia* var. *ruthii, Packera serpenticola, Thalictrum macrostylum, Pteridium latiusculum*. *Sanguisorba canadensis*, and *Carex echinata* ssp. *echinata*. Additional less abundant herbs that are constant or moderately frequent in plots include *Solidago bicolor, Coreopsis major, Oenothera fruticosa, Prunella vulgaris, Asplenium platyneuron, Campanula divaricata, Polygaloides pauciflora, Epigaea repens, Helianthus microcephalus, Houstonia serpyllifolia, Lobelia puberula, Parnassia grandifolia, Solidago nemoralis, Symphyotrichum phlogifolium, Zizia trifoliata, Goodyera pubescens, Phlox ovata, Festuca subverticillata, Gillenia trifoliata, Packera anonyma, Polystichum acrostichoides, Symphyotrichum laeve*, and *Viola sagittata*.

Range and Abundance: Ranked G1. Only one occurrence is known and no more are likely to be discovered.

Associations and Patterns: The Pitch Pine Subtype is a large patch community. It occurs in conjunction with the White Oak Subtype.

Variation: The one known example is heterogeneous in canopy and shrub layer density, perhaps reflecting variations in soil depth, rockiness, or recent fire history.

Dynamics: Ultramafic Outcrop Barrens, the Pitch Pine Subtype in particular, remain open woodlands in the absence of natural disturbance, due to the extreme soil conditions. The presence of endemic and long-distance disjunct plant species that require high light levels attests to the persistence of open conditions through a variety of climate changes. However, fire appears to be important to maintaining the natural structure of this community. The grassy herb layer should readily carry fire. Given the small size of the occurrence, with ignition primarily by spread of fire from the adjacent forests, the community likely burned no more frequently than the surrounding landscape. As with many barrens and woodland communities, extreme site conditions allow fire to have a greater effect on vegetation structure than it does in adjacent forests with the same fire regime. As with other barrens communities, in the absence of fire the canopy becomes denser, shrub cover increases, and herb cover is reduced. It has been suggested that vegetation of the White Oak Subtype spreads at the expense of the Pitch Pine Subtype in the absence of fire.

Comments: Ultramafic rocks are associated with unusual barren vegetation in many places, including Georgia, Virginia, Maryland, and Maine, as well as Oregon, California, and more distant locations. However, the distance between sites in and near North Carolina leads to extreme differences among them. The Pitch Pine Subtype and the White Oak Subtype likely are unique to the single known site because no ultramafic rock sites comparable in elevation and climate exist on the continent. However, some known occurrences of ultramafic rock do not have distinctive vegetation, perhaps due to alteration of the rock so that its distinctive influence on soils is not effective.

Buck Creek has long been recognized in the botanical community as a distinctive place. Detailed studies of Buck Creek Barrens (Mansberg 1981; Mansberg and Wentworth 1984) appear to focus primarily on the Pitch Pine Subtype. Radford (1948) did earlier floristic work here. The vegetation also is well characterized by seven CVS plots. Despite early study and recognition of unusual flora,

the endemic species were slow to be recognized. *Symphyotrichum rhiannon*, the first formally recognized, was published in 2004, *Packera serpenticola* in 2014. Several other populations initially treated as disjunct species or recognized as odd forms are under study and may turn out to be additional endemic taxa.

Rare species:

Vascular plants: *Brachyelytrum aristosum, Calamagrostis porteri* ssp. *porteri, Cypripedium parviflorum* var. *parviflorum, Deschampsia cespitosa* ssp. *glauca*, *Elymus trachycaulus* ssp. *trachycaulus*, *Muhlenbergia glomerata, Packera serpenticola, Parnassia grandifolia, Poa saltuensis, Ranunculus fascicularis, Sporobolus heterolepis, Symphyotrichum concinnum, Symphyotrichum rhiannon, Thalictrum macrostylum,* and *Viola appalachiensis*.

Nonvascular plants: *Drepanolejeunea appalachiana, Macrocoma sullivantii,* and *Schlotheimia lancifolia*.

Vertebrate animals: *Certhia americana, Myotis lucifugus, Myotis septentrionalis, Perimyotis subflava,* and *Sylvilagus obscurus*

Invertebrate animals: *Celastrina nigra, Chlosyne gorgone, Erynnis martialis,* and *Phyciodes batesii macronensis*.

References:

Mansberg, L. 1981. Vegetation, soils, and canopy age structure of the Buck Creek Serpentine Pine Barren, Macon County, North Carolina. M.S. Thesis, North Carolina State University, Raleigh, NC.

Mansberg, L. and T.R. Wentworth. 1984. Vegetation and soils of a serpentine barren in western North Carolina. Bulletin of the Torrey Botanical Club 111:273-286.

Radford, A.E. 1948. The vascular flora of the olivine deposits of North Carolina and Georgia. Journal of the Elisha Mitchell Scientific Society 64:45-106.

ULTRAMAFIC OUTCROP BARREN (WHITE OAK SUBTYPE)

Concept: Ultramafic Outcrop Barrens are very rare woodlands with distinctive structure and floristic composition associated with soils developed on ultramafic rock substrates. Characteristics include low overall plant species richness due to exclusion of some species by soil chemistry, unusual combinations of plants with different typical moisture tolerances, and, generally, unusually open, grassy vegetation. The White Oak Subtype covers the more mesic, less barren examples at elevations above about 3000 feet, where *Quercus alba* or other more mesophytic species form an open to nearly closed canopy.

Distinguishing Features: Ultramafic Outcrop Barrens are distinguished by an unusually open, barren vegetation structure unexpected for the topographic setting and soil depth, unusual vegetation composition that includes combinations of species with different moisture tolerances, endemic species such as *Symphyotrichum rhiannon*, and association with ultramafic rock. The White Oak Subtype is distinguished from the Pitch Pine Subtype and the Virginia Pine Subtype by a greater canopy density and by the predominance of *Quercus alba* in the canopy, with only a minority of *Pinus rigida, Pinus virginiana*, or other more xerophytic species.

Synonyms: *Quercus alba / Physocarpus opulifolius / Packera plattensis - Hexastylis arifolia var. ruthii* Forest (CEGL007296).
Ecological Systems: Eastern Serpentine Woodland (CES202.347).

Sites: Ultramafic Outcrop Barrens occur on substrates of ultramafic rock such as dunite, peridotite, and serpentinite. The White Oak Subtype occurs on concave and more sheltered slopes at moderate elevation, around 3000 feet. It is presently known only at Buck Creek Barrens and is unlikely to be found elsewhere.

Soils: Soils derived from ultramafic rocks are known for their unusual chemistry, which includes high levels of magnesium, low calcium to magnesium ratio, and high levels of nickel and chromium. The soils at the one known occurrence are mapped as Evard-Cowee complex (Typic Hapludults) but probably are some kind of Alfisol or Mollisol.

Hydrology: The White Oak Subtype probably is dry-mesic to mesic. Local seepage areas create wetter conditions.

Vegetation: The White Oak Subtype is an open woodland or savanna, ranging to nearly closed forest. In the only known example the canopy is nearly closed, but it probably existed as an open savanna or woodland under the natural fire regime. The canopy is dominated by *Quercus alba*, with lesser amounts of *Tsuga canadensis* or *Pinus rigida*. The understory may include *Magnolia acuminata, Acer rubrum, Amelanchier arborea, Betula lenta*, *Oxydendrum arboreum,* or other species, in addition to canopy species. The shrub layer ranges from moderate to dense. *Kalmia latifolia* dominates dense patches under current conditions. *Physocarpus opulifolius, Vaccinium stamineum, Viburnum cassinoides,* or *Sassafras albidum* may occur. The herb layer ranges from a dense grassy bed in openings to sparse beneath dense shrubs. Prairie grasses such as *Andropogon gerardii, Schizachyrium scoparium, Sporobolus heterolepis*, and *Elymus trachycaulus* may be abundant in patches, as may *Packera serpenticola*. Other herbs include *Polygaloides paucifolia,*

Hexastylis arifolia var. ruthii, Asplenium platyneuron, Pteridium latiusculum, Thalictrum macrostylum, Epigaea repens, Mitchella repens, Phlox stolonifera, Carex appalachica, Chamaelirium luteum, Coreopsis major, Dichanthelium dichotomum, Dichanthelium commutatum, Dichanthelium boscii, Packera anonyma, Helianthus microcephalus, Gillenia trifoliata, Prunella vulgaris, Uvularia puberula, Thaspium barbinode, and a variety of other species. Seepage areas may contain additional species such as *Omunda spectabilis, Oxypolis rigidior, Parnassia grandifolia*, and *Gentianopsis crinita*.

Range and Abundance: Ranked G1. Only one occurrence is known and no more are likely to be discovered.

Associations and Patterns: The White Oak Subtype occurs as a large patch community, in association with the Pitch Pine Subtype.

Variation: Variation is not well known. The one known example is heterogeneous in canopy density, which may reflect recent fire history. The seepage areas need further study; they may warrant recognition as a different community.

Dynamics: Ultramafic Outcrop Barrens in general remain open in the absence of natural disturbance, due to the extreme soil conditions. This appears to be less true for the White Oak Subtype than other subtypes, presumably because of more mesic conditions. It may thus be more dependent on fire to maintain its natural structure. As with many barrens and woodland communities, extreme site conditions allow fire to have a greater effect on vegetation structure than it does in adjacent forests with the same fire regime. In its absence the canopy becomes denser, shrub cover increases, and herb cover is reduced. It is possible that vegetation of the White Oak Subtype spreads at the expense of the Pitch Pine Subtype in the absence of fire.

Comments: The White Oak Subtype is less well documented than the Pitch Pine Subtype at the same single site. Only one CVS plot is definitively attributed to this subtype. Because the two communities are only recently distinguished and their distribution within the site is not well mapped, it is difficult to tell what descriptive material applies to which. Mansberg (1981) and Mansberg and Wentworth (1984) did not mention a separate second community and focused on the pine-dominated vegetation.

Rare species:
Vascular plants: *Brachyelytrum aristosum, Calamagrostis porteri* ssp. *porteri, Cypripedium parviflorum* var. *parviflorum, Deschampsia cespitosa* ssp. *glauca*, *Elymus trachycaulus* ssp. *trachycaulus*, *Gentianopsis crinita ,Muhlenbergia glomerata, Packera serpenticola, Parnassia grandifolia, Pedicularis lanceolata, Poa saltuensis, Ranunculus fascicularis, Sporobolus heterolepis, Symphyotrichum concinnum, Symphyotrichum rhiannon, Thalictrum macrostylum,* and *Viola appalachiensis*.
Nonvascular plants: *Drepanolejeunea appalachiana, Macrocoma sullivantii,* and *Schlotheimia lancifolia*.
Vertebrate animals: *Certhia americana, Myotis lucifugus, Myotis septentrionalis, Perimyotis subflava,* and *Sylvilagus obscurus.*

Invertebrate animals: *Celastrina nigra, Chlosyne gorgone, Erynnis martialis,* and *Phyciodes batesii macronensis*.

References:

Mansberg, L. 1981. Vegetation, soils, and canopy age structure of the Buck Creek Serpentine Pine Barren, Macon County, North Carolina. M.S. Thesis, North Carolina State University, Raleigh, NC.

Mansberg, L. and T.R. Wentworth. 1984. Vegetation and soils of a serpentine barren in western North Carolina. Bulletin of the Torrey Botanical Club 111:273-286.

Radford, A.E. 1948. The vascular flora of the olivine deposits of North Carolina and Georgia. Journal of the Elisha Mitchell Scientific Society 64: 45-106.

ULTRAMAFIC OUTCROP BARREN (VIRGINIA PINE SUBTYPE)

Concept: Ultramafic Outcrop Barrens are very rare woodlands with distinctive structure and floristic composition associated with soils developed on ultramafic rock substrates. Characteristics include low overall plant species richness due to exclusion of some species by soil chemistry, unusual combinations of plants with different typical moisture tolerances, and generally, unusually open, grassy vegetation. The Virginia Pine Subtype covers lower elevation Blue Ridge examples with *Pinus virginiana* or other low elevation species as major parts of the canopy.

Distinguishing Features: Ultramafic Outcrop Barrens are distinguished by occurrence on ultramafic rock substrate and unusually open, barren vegetation structure. The Virginia Pine Subtype is distinguished from the higher elevation subtypes by occurrence at elevations below about 3000 feet and abundance of typically lower elevation plants such as *Pinus virginiana, Pinus echinata*, and *Quercus stellata*. It is distinguished from the Piedmont Subtype by the abundance of *Pinus virginiana* as well as by location in the Blue Ridge.

Synonyms: *Pinus virginiana - Pinus rigida - Quercus stellata / Ceanothus americanus - Kalmia latifolia / Thalictrum revolutum* Woodland (CEGL007721).
Ecological Systems: Eastern Serpentine Woodland (CES202.347).

Sites: Ultramafic Outcrop Barrens occur on substrates of ultramafic rock such as dunite, peridotite, and serpentinite. The Virginia Pine Subtype occurs at lower elevations in the Blue Ridge, at 3000 feet or lower. The one known remaining site occurs on a south-facing lower slope adjacent to a large river.

Soils: Soils derived from ultramafic rocks are known for their unusual chemistry, which includes high levels of magnesium, low calcium to magnesium ratio, and high levels of nickel and chromium. The soils at the one remaining North Carolina occurrence are mapped as Ellijay, a Rhodic Kanhapludalf.

Hydrology: The Virginia Pine Subtype is dry through most of its extent, but local seepage areas may be present.

Vegetation: The Virginia Pine Subtype is an open woodland or savanna where *Pinus virginiana*, *Pinus echinata*, *Quercus stellata*, *Quercus falcata*, or other species of lower elevations are important. *Pinus rigida*, *Quercus alba, Quercus coccinea, Quercus velutina*, even *Quercus imbricaria* may also be present. Understory species may include *Acer rubrum, Betula lenta, Nyssa sylvatica*, *Cornus florida*, and *Oxydendrum arboreum*, as well as canopy species. Shrubs may include *Kalmia latifolia, Ceanothus americanus, Rhododendron maximum, Rhododendron calendulaceum, Pyrularia pubera, Castanea pumila*, *Lyonia ligustrina*, and *Vaccinium stamineum*. Vines, particularly *Smilax rotundifolia* and *Smilax glauca*, are locally abundant. Where shrubs are not dense, the herb layer is well developed. Species reported at the one North Carolina site include *Schizachyrium scoparium, Andropogon ternarius, Sorghastrum nutans, Sporobolus heterolepis, Danthonia spicata, Danthonia sericea, Aristida virgata, Dichanthelium* spp., *Thalictrum revolutum, Solidago odora, Chrysopsis mariana, Silphium asteriscus* var. *trifoliatum, Eurybia cordifolia, Pteridium latiusculum, Polystichum acrostichoides, Myriopteris lanosa, Dennstaedtia*

punctilobula, and *Viola* sp. Additional species in the Georgia example that could be found in North Carolina include *Osmunda spectabilis, Asclepias verticillata, Helianthus microcephalus, Panicum virgatum* var. *virgatum, Ageratina aromatica, Allium cernuum, Apocynum cannabinum, Arnoglossum atriplicifolium, Baptisia tinctoria, Clitoria mariana, Eryngium yuccifolium* var. *yuccifolium*, *Galactia regularis, Mimosa microphylla, Parthenium integrifolium, Silphium compositum*, and *Tephrosia spicata*.

Range and Abundance: Ranked G1. Only one remaining example is known in North Carolina but several others may once have occurred. At least one example exists in Georgia.

Associations and Patterns: The Virginia Pine Subtype, at least in North Carolina, occurs as a small patch community. The natural context has been lost in the remaining example but likely was some Mountain Oak Forest or Mountain Cove Forest community at the edge of the ultramafic rock body.

Variation: There are substantial differences in flora between the remaining North Carolina example and the one plot in Georgia. It is uncertain how much these differences are due to biogeography and how much they are due to differences in alteration or in fire history.

Dynamics: The natural dynamics of the Virginia Pine Subtype are probably similar to those of the Pitch Pine Subtype. Fire probably is important in maintaining the natural vegetation structure and composition. However, since *Pinus virginiana* is not very tolerant of fire, the composition of the community may have been different under a more natural fire regime, with the more tolerant *Pinus echinata* and oaks more important. The canopy is expected to stay somewhat open in the absence of disturbance due to extreme soil conditions, but the openness may be marginal. The known site has one long distance disjunct species and only one of the potential new endemic plants. This may be sufficient to suggest that, like the other subtypes, it has remained open through a long history.

Comments: The one occurrence remaining in North Carolina is less well known than the other subtypes of Ultramafic Outcrop Barrens. No plots have been sampled there. It also appears to be more altered. It is unclear if the smaller number of rare species and lack of endemic species is due to one of these factors or if the site is less distinctive.

Pinus rigida - *Quercus stellata* / *Andropogon gerardii* - *Packera paupercula* Woodland (CEGL004968) is a related community of Virginia.

Rare species:
Vascular plants: *Sporobolus heterolepis*.

References:
Radford, A.E. 1948. The vascular flora of the olivine deposits of North Carolina and Georgia. Journal of the Elisha Mitchell Scientific Society 64:45-106.

ULTRAMAFIC OUTCROP BARREN (PIEDMONT SUBTYPE)

Concept: Ultramafic Outcrop Barrens are very rare woodlands with distinctive structure and floristic composition associated with soils developed on ultramafic rock substrates. The Piedmont subtype covers the one known distinct Piedmont example in North Carolina.

Distinguishing Features: Ultramafic Outcrop Barrens are distinguished by occurrence on ultramafic rock substrate and unusually open, barren vegetation structure. Some ultramafic rock bodies in the Piedmont have vegetation that is not distinguishable structurally or floristically from those of ordinary mafic rock substrates, and these should not be classified here. The one known Piedmont example has an open canopy of *Quercus velutina* and *Pinus echinata*, with an herb layer that includes *Piptochaetium avenaceum, Dichanthelium boscii*, and *Chasmanthium latifolium*, but any additional Piedmont occurrence of unusually open vegetation on ultramafic substrate should also be classified as this type.

Synonyms: *Pinus echinata - Quercus velutina - Quercus marilandica / Piptochaetium avenaceum* Ultramafic Woodland (CEGL007045).
Ecological Systems: Eastern Serpentine Woodland (CES202.347).

Sites: Ultramafic Outcrop Barrens occur on substrates of ultramafic rock such as dunite, peridotite, and serpentinite. The one known example on the Piedmont Subtype occurs on a convex upper north-facing slope.

Soils: Soils derived from ultramafic rocks are known for their unusual chemistry, which includes high levels of magnesium, low calcium to magnesium ratio, and high levels of nickel and chromium. The soils at the one known North Carolina occurrence are mapped as Wilkes, a Typic Hapludalf.

Hydrology: The known site is dry or mesic. The northern aspect may mitigate the convex upper slope position to some degree.

Vegetation: The Piedmont Subtype, as it currently exists, is a slightly open forest. It is likely to have existed as a more open woodland in the past. The canopy consists primarily of *Quercus marilandica, Quercus stellata, Quercus alba, Quercus velutina*, and *Pinus echinata*. Some *Acer rubrum* and *Fagus grandifolia* also are present. The understory additionally includes *Oxydendrum arboreum, Sassafras albidum*, *Nyssa sylvatica*, *Cornus florida, Juniperus virginiana*, and *Crataegus collina*. Shrub cover is low, but some *Vaccinium pallidum* is present, along with small individuals of tree species. Vines, particularly *Muscadinia rotundifolia* and *Vitis labrusca* may be locally abundant, primarily on the ground. The herb layer is patchy, ranging from moderate to dense. *Piptochaetium avenaceum, Schizachyrium scoparium, Dichanthelium boscii, Chasmanthium latifolium*, and *Podophyllum peltatum* are fairly abundant. Other herbs include *Clematis ochroleuca, Danthonia spicata, Scleria oligantha, Polystichum acrostichoides, Dichanthelium commutatum, Euphorbia pubentissima, Hexastylis minor, Houstonia tenuifolia, Sphenopholis obtusata*, and *Viola primulifolia*.

Range and Abundance: Ranked G2?, but presumably G1. Only one example is known in North Carolina, and the synonymized association is not attributed to any other state.

Associations and Patterns: The Piedmont Subtype occurs as a small patch. It is bordered by Mesic Mixed Hardwood Forest and Dry-Mesic Oak–Hickory Forest on different rock types.

Variation: The one known example shows some evidence of a moisture gradient from the uphill to downhill side.

Dynamics: Ultramafic Outcrop Barrens in general remain open in the absence of natural disturbance, due to the extreme soil conditions. This may be less true for the Piedmont Subtype than for the other subtypes, due to greater weathering of the rock. The Piedmont Subtype may thus be more dependent on fire to maintain its natural structure, with woody cover increasing and herbs being reduced in the absence of burning. The specific history of the one example is not well known. The lack of rare plant species contained there may suggest it was not able to remain open in past climates, but this dearth may also be due to its small size or to greater alteration. Related Piedmont ultramafic communities of states to the north also seem to suffer increases of woody vegetation (Tyndall 2005). As with many barrens and woodland communities, extreme site conditions are expected to allow fire to have a greater effect on vegetation structure than it does in adjacent forests with the same fire regime.

Comments: This subtype appears to be distinct from the more diverse Piedmont serpentine barrens of Maryland and from the examples in Georgia and Alabama. A single CVS plot represents it. The one known example is small. Its flora is depauperate compared to other subtypes, and this may be partly because of its small size and partly because it is more heavily altered.

Rare species:
Vascular plants: *Polygala senega*.

References: No references specific to this community have been identified.

ACIDIC SHALE SLOPE WOODLAND

Concept: Acidic Shale Slope Woodlands are rare open woodlands of steep slopes on shale or similar acidic, fine-bedded, crumbly rock which form an unstable surface of small rock fragments. *Pinus virginiana* is dominant or codominant. There is generally only sparse cover in the herb layer, but more stable patches may have a well-developed grassy ground cover. Weedy species are usually present, presumably because of periodic disturbance by movement of the unstable substrate.

Distinguishing Features: Acidic Shale Slope Woodlands are distinguished from all other communities by the combination of pine dominance or codominance, open canopy, unstable, crumbled rock surface, and lack of substantial flora suggestive of calcareous conditions. *Pinus virginiana* dominates in all examples known, but other species are possible.

Synonyms: *Pinus virginiana / Vaccinium pallidum / Schizachyrium scoparium - Carex pensylvanica* Woodland (CEGL003624); Dry Rocky Slope; Montane Acidic Cliff (in part) (Third Approximation).
Ecological Systems: Appalachian Shale Barrens (CES202.598).

Sites: Acidic Shale Slope Woodlands occur on steep river bluffs where shale or fine-bedded siltstone is fragmented into a thick, unstable cover of flat rock fragments. The fine-bedded rock and steep slope are both necessary to create the distinctive site conditions. Most known examples occur on dry slope aspects, and dry conditions may be necessary to limit soil development.

Soils: Soils are poorly developed and are channery. The substrate consists of a thick layer of small, flat rock fragments with little finer-texture material. Most known examples are mapped as complexes involving the Cataska series (Typic Dystrudept), some as rock outcrops.

Hydrology: Examples are probably excessively drained because of the coarse texture of the rock fragments and lack of well-developed soil.

Vegetation: Acidic Shale Slope Woodlands have a somewhat open to very open canopy of small trees. *Pinus virginiana* generally dominates, sometimes strongly, sometimes with a large minority of *Quercus montana*. Other trees present in most examples are *Carya glabra* and *Quercus rubra*. There is no well-developed understory, and the canopy may be little taller than a typical forest understory, but *Amelanchier* sp. is often present and *Nyssa sylvatica, Ulmus alata, Carya pallida,* or *Juniperus virginiana* sometimes occur. The sparse shrub layer includes *Vaccinium pallidum, Vaccinium stamineum, Rhus copallinum*, with occasional *Kalmia latifolia* and a little *Philadelphus hirsutus*. The herb layer is patchy and is sparse overall. *Andropogon virginicus* usually dominates; *Andropogon gerardii* or *Schizachyrium scoparium* may have almost as much cover, and one plot has *Carex pensylvanica* as the most abundant species. Other herbs with high constancy in CVS plots include *Danthonia spicata, Hieracium venosum, Campanula divaricata, Coreopsis major, Asclepias tuberosa, Asplenium platyneuron, Chimaphila maculata, Houstonia longifolia*, and *Solidago* spp. Other herbs sometimes present include *Antennaria parlinii* ssp. *fallax, Clitoria mariana, Dichanthelium acuminatum, Dichanthelium dichotomum, Euphorbia corollata,*

Houstonia purpurea, Lespedeza virginica, Potentilla canadensis, Ambrosia artemisiifolia, and *Helianthus* sp.

Range and Abundance: Ranked G2?. Only a few examples are known in North Carolina. The largest number is in the Hot Springs Window geologic area, a few in other parts of the Unaka Mountains or western Blue Ridge. This community occurs in adjacent Tennessee.

Associations and Patterns: Acidic Shale Slope Woodlands occur as small patches, sometimes associated with rock outcrop communities or Calcareous Shale Slope Woodland. Otherwise, they are surrounded by Mountain Oak Forests on more stable parts of the slope; they may border Montane Alluvial Forest or Mountain Cove Forests at their downhill edge.

Variation: No variants have been recognized. Individual occurrences are heterogeneous in vegetation density in response to slope stability and recentness of movement. *Pinus virginiana - Quercus prinus - Quercus rubra / Vaccinium pallidum - Kalmia latifolia* Forest (CEGL007539) was an association in the NVC formerly defined as a closely related community in the Hot Springs area. It has been lumped with the association above and is viewed as marginal or poorly developed Acidic Shale Slope Woodland.

Dynamics: The dynamics of Acidic Shale Slope Woodlands have not been studied. While dryness and limited soil development likely contribute to the openness and small stature of their woody vegetation, the lack of herb and shrub cover despite the open canopy appears to be due to the unique soil environment. The flat shale fragments shift readily with the passage of animals, and perhaps to some degree in response to weather, making an unstable substrate that must make seedling establishment and survival difficult. Moisture conditions are not well known, but the coarse substrate may lead to excessive drainage of rainfall, leading to xeric conditions. However, the softness of the rock and its tendency to yield clay may offset this. While soils are apparently acidic, cation exchange capacity and fertility probably are not extremely low.

Given the sparseness of vegetation and discontinuous litter, fire could not spread through these communities and probably is of little ecological significance in them.

Comments: Though the distinctive vegetation of the Hot Springs geologic window have been recognized by the North Carolina botanical community for many decades, the shale slope woodlands have not had substantial study. Three CVS plots have been sampled in them. Given the possible role of slope instability, they would be particularly interesting for long term study. However, the same instability would make it difficult to study them without altering the community.

Acidic Shale Slope Woodlands are related to the shale barrens of Virginia and West Virginia. While recognizable as distinct communities, the name shale barren has not been used for them because their vegetation and environment appear not to be as extreme. No endemic species have been recognized in them.

Rare species:
Vascular plants: *Adlumia fungosa, Buckleya distichophylla, Draba ramosissima.*

Nonvascular plants: *Hydrotheria venosa*.

References: No references specific to this community have been identified.

CALCAREOUS SHALE SLOPE WOODLAND

Concept: Calcareous Shale Slope Woodlands are very rare open woodlands of steep slopes on calcareous shale or similar fine-bedded, crumbly rock that forms an unstable surface of small rock fragments. They are comparable to Acidic Shale Slope Woodland but show influence of higher pH and higher calcium levels in the flora.

Distinguishing Features: Calcareous Shale Slope Woodlands are distinguished from all other North Carolina communities by the combination of unstable, crumbled rock surface, presence of plants characteristic of circumneutral or basic soils, open canopy, hardwood and *Juniperus* dominance, and occurrence in the Blue Ridge.

Synonyms: *Quercus prinus - Juniperus virginiana - (Pinus virginiana) / Philadelphus hirsutus - Celtis occidentalis* Woodland (CEGL007720); Dry Rocky Slope, Montane Acidic Cliff (in part?) (Third Approximation).
Ecological Systems: Appalachian Shale Barrens (CES202.598).

Sites: Calcareous Shale Slope Woodlands occur on steep river bluffs where shale or fine-bedded siltstone is fragmented into a thick, unstable cover of flat rock fragments. The fine-bedded rock and steep slope are both necessary to create the distinctive site conditions. Examples occur on dry slope aspects, and dry conditions may be necessary to limit soil development.

Soils: Soils are poorly developed and are channery. The substrate consists of a thick layer of small, flat rock fragments with little finer-texture material. The known examples are mapped as complexes involving the Cataska series (Typic Dystrudept), some as rock outcrops.

Hydrology: Examples are probably excessively drained because of the coarse texture of the rock fragments and lack of well-developed soil.

Vegetation: Calcareous Shale Slope Woodlands have a somewhat open to very open canopy of small trees. *Juniperus virginiana* is abundant and may dominate. *Carya glabra, Pinus virginiana, Quercus montana*, *Quercus rubra*, *Ulmus alata*, and *Fraxinus biltmoreana* or *americana* may be abundant. In one example, *Pinus strobus* and *Tsuga canadensis* are abundant. *Cercis canadensis, Celtis tenuifolia*, *Amelanchier* sp., *Crataegus* sp., and *Ostrya virginiana* may be abundant as small stems. Shrubs tend to be sparse. *Philadelphus hirsutus* may be the most abundant species, and *Rhus copallinum, Rosa carolina*, and sometimes *Vaccinium pallidum* or *Vaccinium stamineum* may be present. The herb layer is patchy, ranging from nearly absent in the most unstable areas to dense in some areas. Where dense, *Piptochaetium avenaceum, Carex pensylvanica, Andropogon gerardii*, or *Danthonia spicata* may dominate. Other herbs that can be locally abundant or widely present include *Myriopteris lanosa, Myriopteris tomentosa, Campanula americana, Clitoria mariana, Commelina erecta, Helianthus microcephalus, Helianthus divaricatus, Danthonia spicata, Coreopsis major, Draba ramosissima, Euphorbia corollata, Houstonia longifolia* var. *compacta, Lespedeza intermedia, Lespedeza stuevei, Danthonia sericea, Melica nitens, Opuntia mesacantha* ssp. *mesacantha, Paronychia canadensis, Solidago sphacelata, Tradescantia ohioensis, Verbesina occidentalis*, *Woodsia obtusa*, *Ambrosia artemisiifolia,* and *Dichanthelium depauperatum*. Other herbs that may be characteristic include *Elymus virginicus, Ruellia*

purshiana, Asplenium platyneuron, Asclepias tuberosa, Andropogon virginicus, Andropogon ternarius, Liatris squarrosa var. *gracilenta*, *Fleischmannia incarnata, Taenidia integerrima, Sedum ternatum, Penstemon canescens, Parietaria pensylvanica, Erigeron strigosus, Galactia volubilis, Cyperus retrorsus, Eurybia undulata*, *Acalypha gracilens,* and *Ionactis linariifolia*.

Range and Abundance: Ranked G2. Only two examples are known in North Carolina. Initially defined only from North Carolina, the equivalent NVC association was later merged with related types in Virginia and Tennessee. The expanded concept of the association may now be broader than conceived in North Carolina, and it may be more broadly defined than the parallel Acidic Shale Slope Woodland.

Associations and Patterns: Calcareous Shale Slope Woodlands occur as small patches, sometimes associated with rock outcrop communities or Acidic Shale Slope Woodland. Otherwise, they are surrounded by Mountain Oak Forests on more stable parts of the slope; they may border Montane Alluvial Forest or Mountain Cove Forests at their downhill edge.

Variation: No variants have been recognized. Individual occurrences are heterogeneous in vegetation density in response to slope stability and recentness of movement.

Dynamics: Dynamics of Calcareous Shale Slope Woodlands can be expected to be similar to those of Acidic Shale Slope Woodland. The instability of the loose rock fragments on steep slopes is important in creating their distinctive character, but excessive drainage in the substrate may also contribute. Fire is unlikely to be important because of the sparse and patchy vegetation.

Comments: This community appears to have high species richness but may be very heterogeneous. Two CVS plots and several site descriptions for the two known sites report a range of different dominant species and substantial differences in overall flora. The vegetation description above is a composite of them.

Rare species:
Vascular plants: *Adlumia fungosa, Arabis patens, Draba ramosissima, Fleischmannia incarnata, Heuchera longiflora, Melica nitens, Myriopteris alabamensis, Ruellia purshiana, Symphyotrichum oblongifolium, Trichostema brachiatum, Packera paupercula* var. *appalachiana,* and *Thaspium pinnatifidum*.

References:
No references specific to this community have been identified.

PIEDMONT ACIDIC GLADE

Concept: Piedmont Acidic Glades are open, generally grassy, heterogeneous woodlands or savannas of shallow soils over irregular bedrock (not exfoliated granitic rocks), not showing any circumneutral or basic influence in their flora. These are generally moderately to steeply sloping and on dry slope aspects. They have more vegetation cover, especially in the herb layer, than the sparsely vegetated cliff communities but are prevented from forming a closed forest by shallow soil and associated xeric conditions. Vegetation is generally patchy and open but often contains substantial tree cover as well as herb- or low-shrub-dominated areas. Open rock areas are limited.

Distinguishing Features: All the glade communities are distinguished from forest communities by having a persistently open tree canopy, ranging from woodland structure to sparser. The combination of tree species, generally *Quercus montana* along with *Quercus stellata* or xerophytic pines, is distinctive. This community is distinguished from Xeric Piedmont Slope Woodland by having more open canopy, shallow soil, and greater influence of rock.

Piedmont Acidic Glades are distinguished from Piedmont Cliff, Granitic Flatrock, and Low Elevation Rocky Summit by having soil with substantial herbaceous or shrub cover over most of the area and limited areas of bare rock. Plants characteristic of bare rock, such as *Phemeranthus (Talinum) teretifolius, Croton wildenowii (Crotonopsis elliptica), Selaginella rupestris*, and crustose lichens, may be present but are scarce and limited to the small areas of open rock outcrop.

Piedmont Acidic Glades are distinguished from Piedmont Basic Glades by lacking flora characteristic of circumneutral or basic sites. Generally, the undergrowth is dominated either by grasses or by short clonal shrubs such as *Vaccinium pallidum* or *Gaylussacia baccata*. Grassy areas are generally dominated by *Schizachyrium scoparium* but may include *Danthonia spicata, Piptochaetium avenaceum, Andropogon gerardii, Andropogon ternarius, Andropogon gyrans*, and *Sorghastrum nutans*. Species characteristic of less acidic soils, such as *Cercis canadensis, Rhus aromatica, Fraxinus americana, Cheilanthes tomentosa*, or *Aquilegia canadensis* are absent or extremely scarce. Species such as *Vaccinium arboreum, Chionanthus virginicus*, and *Carya* spp. may be present but occur in smaller proportions than in basic glades.

Synonyms: *Quercus prinus - Quercus stellata - (Pinus virginiana, Pinus echinata) / Vaccinium pallidum / Schizachyrium scoparium* Woodland (CEGL004910).
Ecological Systems: Southern Piedmont Glade and Barrens CES202.328).

Sites: Piedmont Acidic Glades usually occur on moderate to steep slopes that face south or west, but they may occur on other aspects or may be flat. Bedrock is near the surface beneath most of the community, but shallow soil covers most of it. The geologic substrate is generally felsic igneous or metamorphic rocks such as rhyolite, dacite, granite, gneiss, phyllite, or schist, but it can potentially be meta-sedimentary rock.

Soils: Glade soils are shallow, with bedrock near the surface. The soil material includes rock fragments and early weathering products along with organic matter and washed-in material. These soils may consist of shallow mats or deep fill in crevices and are often extremely heterogeneous. They generally represent inclusions in soil map units.

Hydrology: The shallow soils dry quickly between rains and are prone to extreme drought stress. There is a possibility of small seepage patches on the edges, but this appears to be rare.

Vegetation: The vegetation of Piedmont Acidic Glades is usually patchy and heterogeneous; it may range from an open woodland or savanna to nearly treeless. The herb layer is generally the dominant stratum, though a few examples may have limited herb cover and most have small openings with bare rock. *Schizachyrium scoparium* is most often dominant, but *Danthonia spicata, Danthonia sericea*, or *Piptochaetium avenaceum* may dominate patches. Other herbs that are at least fairly frequent in the grassy vegetation in CVS plot data or site descriptions include *Dichanthelium depauperatum, Andropogon virginicus, Tephrosia virginiana, Pityopsis graminifolia, Coreopsis verticillata, Dichanthelium dichotomum, Sorghastrum nutans, Dichanthelium commutatum, Cunila origanoides, Oxalis stricta* or *dillenii*, and *Euphorbia pubentissima*. Many other herbs of dry open communities are found at low frequency but may once have been more common, including *Solidago odora, Scleria oligantha, Scleria ciliaris, Ionactis linariifolia, Sericocarpus linifolius, Yucca flaccida, Andropogon gerardii, Pteridium latiusculum, Parthenium integrifolium, Baptisia tinctoria, Iris verna*, and *Helianthus divaricatus*. Species of rock outcrops, such as *Krigia virginica, Phemeranthus teretifolius, Hypericum gentianoides*, and mosses and lichens, are often present with small cover on the embedded open rock. Ruderal species such as *Ambrosia artemisiifolia*, *Conyza canadensis*, and *Andropogon virginicus* are often present, though all but the latter with limited cover.

In the tree canopy, *Quercus montana, Pinus virginiana*, or *Pinus echinata* are most constant and most often dominant in both plot data and site descriptions, but *Quercus stellata* may dominate. Other frequent trees that often have moderate cover include *Quercus marilandica, Carya pallida, Carya glabra*, and *Juniperus virginiana*. Less frequent trees include *Oxydendrum arboreum, Nyssa sylvatica, Ulmus alata, Quercus alba, Diospyros virginiana, Sassafras albidum*, and other species that may not be characteristic, such as *Acer rubrum*. Shrubs may be sparse or moderately dense in different examples or in patches within a community. *Vaccinium arboreum* and *Vaccinium pallidum* are most frequent, but *Gaylussacia baccata* may dominate. Other shrubs may include *Toxicodendron pubescens, Vaccinium stamineum, Gaylussacia frondosa, Hypericum hypericoides,* or *Hypericum stragulum*. Vines, particularly *Muscadinia rotundifolia* or *Smilax glauca* but also occasionally *Gelsemium sempervirens*, may dominate patches.

Range and Abundance: Ranked G2. Examples are scattered in the central Piedmont and could occur in more portions of the Piedmont, but the majority occur in the Uwharrie area and Montgomery, Stanly, and Randolph counties. The equivalent association is uncertainly attributed to South Carolina and Georgia.

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Associations and Patterns: Piedmont Acidic Glades occur as small patches. They are surrounded by forest communities, usually Dry Oak–Hickory Forest or Piedmont Monadnock Forest.

Variation: Variants are not defined. There is usually more heterogeneity within examples than there is among examples.

Dynamics: Drought may be an important part of the dynamics of these communities. Drought is more likely to kill trees with limited rooting depth, and periodic mortality may be an important cause of the open structure of these communities. The author has observed a number of cases of substantial tree mortality in glades during droughts which, while fairly severe, did not kill any trees in the adjacent forest. Though less obvious, mortality of tree seedlings in drought may be an even more important contributor to openness. It may take a series of unusually moist years to allow new trees to mature in these communities. Because of these dynamics, tree stands in these communities may be more even aged than typical natural forests, with most trees limited to one or a few cohorts.

Piedmont Acidic Glades, as small patches, would naturally be subject to fire whenever the surrounding forest burned. The irregular vegetation can be expected to lead to heterogeneous fire behavior, but vegetation is continuous enough that most parts would burn. Fire may be an important factor under natural conditions in structuring the vegetation, but some patches in the interior may rarely, perhaps never, burn. Some glades likely have developed heavier tree cover and perhaps become smaller because of fire suppression, but these communities are capable of staying open in the absence of fire.

As with all shallow-rooted trees, wind may cause more disturbance than in a typical deep forest soil, but trees rooted in crevices may be quite well anchored.

Comments: No published literature pertaining to Piedmont Acidic Glades has been identified, but the community is well documented in both plots and site descriptions. As with other glade and barrens communities, it can be difficult to confidently assign plots to them if the vegetation structure and substrate are not recorded in detail.

Quercus prinus - Quercus stellata - Carya glabra / Vaccinium arboreum - Viburnum rufidulum Forest (CEGL004416) is a xeric forest association that in some parts of its description sound similar to Piedmont Acidic Glade or to Xeric Piedmont Slope Woodland. It was apparently originally defined based on two CVS plots in the area of greatest development of both of these communities, and the data from the two plots suggest they are transitional between the two.

Rare species: Invertebrate animals: *Incisalia angusus.*

References:

PIEDMONT BASIC GLADE (TYPIC SUBTYPE)

Concept: Piedmont Basic Glades are open, generally grassy, heterogeneous woodlands or savannas of shallow soils over irregular bedrock (not exfoliated granitic rocks), showing circumneutral or basic influence in their flora. They are generally moderately to steeply sloping and on dry slope aspects. They have more vegetation cover, especially in the herb layer, than the sparsely vegetated cliff communities but are prevented from forming a closed forest by shallow soil and associated xeric conditions. Vegetation is generally patchy and open but often contains substantial tree cover as well as herb- or low-shrub-dominated areas. Open rock areas are limited.

The Typic Subtype covers all examples not fitting the distinctive characteristics of the Falls Dam Slope Subtype.

Distinguishing Features: All of the glade communities are distinguished from forest communities by having a persistently open tree canopy, ranging from woodland structure to sparser. The abundance of *Juniperus virginiana* in most examples is also not characteristic of forest communities. Glades are distinguished from Xeric Hardpan Forest by having less tree cover and having substantial shallow soil and bedrock. They are distinguished from Piedmont Cliff, Granitic Flatrock, and Low Elevation Rocky Summit communities by having soil with substantial herbaceous or shrub cover over most of the area, and limited area of bare rock. Plants characteristic of bare rock, such as *Phemeranthus (Talinum) teretifolius, Croton wildenowii (Crotonopsis elliptica), Selaginella rupestris*, and crustose lichens, may be present but are scarce and limited to the small areas of open rock outcrop.

Piedmont Basic Glades are distinguished from Piedmont Acidic Glades by having multiple species characteristic of circumneutral or basic sites. Multiple species characteristic of less acidic soils, such as *Fraxinus americana, Cercis canadensis, Rhus aromatica, Myriopteris tomentosa*, and *Myriopteris lanosa* are present. Species such as *Chionanthus virginicus*, and *Carya* spp. are typically more abundant.

The Typic Subtype constitutes all but one of the known examples. The Falls Dam Slope Subtype is distinguished from it by having lower herb cover, extensive ground cover by slate fragments, and evidence of substrate instability. A few examples of the Typic Subtype have slate or shale substrate and have some ground cover by rock fragments but it is less extensive.

Synonyms: Synonyms: *Juniperus virginiana var. virginiana - Ulmus alata / Schizachyrium scoparium* Woodland (CEGL004443). Piedmont Mafic Cliff (in part), Piedmont Calcareous Cliff (in part) (3rd Approximation).
Ecological Systems: Southern Piedmont Glade and Barrens (CES202.328).

Sites: Piedmont Basic Glade (Typic Subtype) communities usually occur on moderate to steep slopes that face south or west, but they may occur on other aspects or may be flat. Bedrock is near the surface beneath most of the community, but shallow soil covers most of it. The geologic substrate is generally mafic igneous or metamorphic rocks such as basalt, meta-basalt, diabase, or gabbro. Less frequently, examples may occur on meta-mudstone or even on falic rocks such as

rhyolite or granite. The source of the basic character in these sites is not clear but may come from intrusions, xenoliths, or leaching of material from adjacent substrates.

Soils: Glade soils are shallow, with bedrock near the surface. The soil material includes rock fragments and early weathering products along with organic matter and washed-in material. These soils may consist of shallow mats or deep fill in crevices and are often extremely heterogeneous. Vegetation suggests relatively high pH and base saturation, but this is not well documented. Soils in glades generally are not distinguished in soil mapping but are treated as inclusions in other map units.

Hydrology: The shallow soils dry quickly between rains and are prone to extreme drought stress. There is a possibility of small seepage patches on the edges but this appears to be uncommon.

Vegetation: The vegetation of Piedmont Basic Glades is usually patchy and heterogeneous; it may range from an open woodland or savanna to nearly treeless. The herb layer is generally the dominant stratum, though a few examples may have limited herb cover and most have small openings with bare rock. *Schizachyrium scoparium* is most often dominant, but *Danthonia spicata, Danthonia sericea*, or less often *Piptochaetium avenaceum, Melica mutica*, or other species may dominate large patches. The most constant herbs in CVS plot data are *Asplenium platyneuron, Hieracium venosum, Dichanthelium dichotomum* var. *dichotomum*, *Dichanthelium depauperatum*, *Pleopeltis michauxiana*, and in rocky areas, *Myriopteris tomentosa* and *Myriopteris lanosa*. Other herbs at least fairly frequent in CVS plot data or in site descriptions include *Commelina erecta, Cunila origanoides, Tephrosia virginiana, Coreopsis verticillata, Micranthes virginiensis, Opuntia mesacantha* var. *mesacantha* (*humifusa*), *Hypericum gentianoides, Antennaria plantaginifolia, Ruellia carolinensis, Oxalis dilleniid, Oxalis stricta, Lespedeza virginica, Linaria (Nuttallanthus) canadensis, Dichanthelium laxiflorum*, and *Andropogon gerardii*. The flora often includes small numbers of both species of rock outcrops, such as *Phemeranthus teretifolius* or *Croton wildenowii*, and ruderal species, such as *Ambrosia artemisiifolia*, *Conyza canadensis*, or *Phytolacca americana*. Other widespread species of open areas, such as *Solidago odora, Ionactis linariifolia, Parthenium integrifolium*, and *Scleria oligantha* may be present and may

The open to sparse tree layer is usually dominated by *Juniperus virginiana. Quercus stellata, Carya glabra, Fraxinus biltmoreana* (*americana*), or *Quercus montana* may be codominant or occasionally dominant. Other frequent trees include *Ulmus alata, Pinus virginiana, Carya glabra, Carya tomentosa, Chionanthus virginicus, Acer leucoderme, Acer rubrum, Pinus echinata*, and *Ostrya virginiana*. Less frequent but characteristic tree species include *Quercus marilandica, Cercis canadensis, Diospyros virginiana, Carya cordiformis*, and *Acer floridanum*. Shrubs are generally sparse but may form denser patches. *Vaccinium arboreum* is the most frequent species, and *Rhus aromatica, Styrax grandifolia, Viburnum rufidulum, Celtis tenuifolia,* and many other species may be present. Vines may be abundant in parts, especially *Muscadinia rotundifolia*, but also *Gelsemium sempervirens, Toxicodendron radicans*, *Parthenocissus quinquefolius, Smilax bona-nox*, *Lonicera sempervirens*, and others.

Range and Abundance: Ranked G2. Examples are scattered through the Piedmont, excepting the foothills, but are most abundant in the Carolina Slate Belt geologic region. This community is also known in Virginia. It has not been reported in South Carolina but should be sought.
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Associations and Patterns: Piedmont Basic Glades occur as small patches. They are surrounded by forest communities, usually Dry Basic Oak—Hickory Forest or Dry-Mesic Basic Oak—Hickory Forest. They may less often be associated with acidic communities such as Dry Oak—Hickory Forest.

Variation: The Typic Subtype appears to be variable among sites as well as very heterogeneous within sites. Variants have not been recognized but are likely with further study. Some of the known occurrences that may warrant distinct variants or even subtypes are those on slate slopes in Stanley and Anson counties and on Cedar Mountain in Rockingham County. Both show some of the slope instability that characterizes the Falls Dam Slope Subtype but do not seem to fit well with it.

Dynamics: Dynamics are likely to be similar to those in the Piedmont Acidic Glade and to glades and barrens in general. This includes potentially an important role for drought in keeping woody vegetation from becoming dense, and also an important role for fire.

Comments: The Typic Subtype is well documented in both plot data and site descriptions. As with other glade and barrens communities, it can be difficult to confidently assign plots to them if the vegetation structure and substrate are not recorded in detail. Though rare, these communities appear to be more numerous than the Piedmont Acidic Glades, despite the much greater abundance of acidic rocks. It is unclear why this is true.

The relationship of the two subtypes and of the variation associated with slate and shale substrates needs further investigation.

Rare species: Vascular Plants: *Anemone berlandieri, Baptisia alba, Borodinia missouriensis, Eurybia mirabilis, Gillenia stipulata, Helianthus laevigatus*, *Sedum glaucophyllum*.

References:

PIEDMONT BASIC GLADE (FALLS DAM SLOPE SUBTYPE)

Concept: Piedmont Basic Glades are open, generally grassy, heterogeneous woodlands or savannas of shallow soils over irregular bedrock (not exfoliated granitic rocks), showing circumneutral or basic influence in their flora. The Falls Dam Slope Subtype is a distinctive occurrence, apparently unique, with substantial *Pinus echinata* and has a high species richness that includes a number of plants of prairie affinities. The cause of the distinctive character of this subtype is believed to be related to a loose substrate of slate fragments as well as to fire.

Distinguishing Features: All the glade communities are distinguished from forest communities by having a persistently open tree canopy, ranging from woodland structure to sparser. Piedmont Basic Glades are distinguished from Piedmont Acidic Glades by having multiple species characteristic of circumneutral or basic sites. Species characteristic of less acidic soils, such as *Cercis canadensis, Rhus aromatica, Fraxinus americana, Myriopteris (Cheilanthes) tomentosa*, or *Aquilegia canadensis,* are present. Species such as *Chionanthus virginicus* and *Carya* spp. are usually abundant. The Falls Dam Slope Subtype is distinguished by having low herb cover, an unstable substrate of rock fragments, and evidence of slope instability. A few examples of the Typic Subtype have slate or shale substrate and have some ground cover by rock fragments but it is less extensive.

Synonyms: *Pinus echinata - Quercus stellata - Quercus marilandica / Andropogon gyrans - Chrysopsis mariana* Woodland (CEGL004447).
Ecological Systems: Southern Piedmont Glade and Barrens (CES202.328).

Sites: The only known example occurs on a steep-to-moderate, west-facing slope with a substrate of thin-bedded slate-like rock.

Soils: The soil is a very channery clay loam, with a large fraction of flat rock fragments. These fragments also cover most of the surface. There are frequent small outcrops of the thin-bedded rock. The soft and fragmented rock leads to an uncertain distinction between soil and bedrock.

Hydrology: This community is dry to xeric, given its west-facing slope aspect. Water likely drains rapidly through the rock fragments, but the high cover of flat rocks on the soil surface must reduce evaporation.

Vegetation: The vegetation is an open woodland or savanna dominated by *Quercus stellata, Pinus virginiana,* and *Pinus echinata,* with abundant *Quercus marilandica*. Other trees include *Carya tomentosa, Carya carolinae-septentrionalis,* and in canopy gaps, *Liquidambar styraciflua* and *Robinia pseudo-acacia*. Smaller numbers of *Cercis canadensis*, *Diospyros virginiana*, *Carya glabra, Fraxinus biltmoreana*, and other species are present. The shrub layer is open to sparse. *Vaccinium arboreum* is the most abundant species, but some *Rhus aromatica* and *Rhus copallinum* are present. The herb layer is patchy. Substantial areas are largely bare slate fragments, but patches of dense grass also occur. *Phaseolus polystachyos* is abundant in parts. A high diversity of other herbs is present, including *Schizachyrium scoparium, Andropogon gyrans, Solidago odora, Antennaria plantaginifolia*, *Clitoria mariana* var. *mariana*, *Dichanthelium depauperatum,*

Cirsium carolinianum, Helianthus divaricatus, Helianthus schweinitzii, Silene virginica, Cynoglossum virginianum, Desmodium rotundifolium, and numerous others.

Range and Abundance: Ranked G1?. Only a single example is known.

Associations and Patterns: This community occurs as a small patch. It is surrounded by Piedmont Monadnock Forest and Dry Oak–Hickory Forest.

Variation: The one known example is quite heterogeneous. It is difficult to tell how much of the variation is enduring and how much was caused by the behavior of recent fires.

Dynamics: Dynamics are not well known. The abundant flat rock fragments create an unstable substrate on the steep slope, and this is believed to be responsible for the distinctive character of the community. The abundance of *Pinus virginiana* is shared with Acidic Shale Slope Woodland, a community of more unstable substrates. The greater abundance of ruderal species, compared to the Typic Subtype, may also be related to this. Besides a tendency to slip, the numerous parallel rock fragments presumably are a barrier to root penetration and may favor some species while excluding others.

The site burned in the 1980s or early 1990s, and this fire created abundant canopy gaps. It is unclear how much the community may depend on fire in the long term. It is also difficult to tell what of its current characteristics are transient responses to the fire.

Comments: This community needs more work to clarify its relationship to other glades. Monitoring over time is also needed to describe its long-term character and dynamics.

Rare species: Vascular plants: *Cirsium carolinianum* and *Helianthus schweinitzii*.

References:

DIABASE GLADE

Diabase Glade is an extremely rare, naturally open, patchy glade communities of shallow soils over Piedmont mafic rock outcrops, containing a diverse herbaceous flora that combines species of granitic flatrocks and of mafic and ultramafic rock communities.

Distinguishing Features: The Diabase Glade type is distinguished from all other open glade and rock outcrop communities by having a flora that combines high abundance of rock outcrop species, including granitic flatrock species such as *Portulaca smallii*, *Cyperus granitophilus*, and *Isoetes piedmontana*, with a large number of obligate base-loving species such as *Ruellia humilis, Berberis canadensis, Symphoricarpos orbiculatus, Matelea decipiens, Lithospermum canescens* and *Clematis ochroleuca*. The prairie-like Xeric Hardpan Forest subtypes and other basic woodlands have little area with open rock and lack this component of the flora.

Synonyms: *Sporobolus vaginiflorus var. ozarkanus - Diodia teres - Croton willdenowii - Ruellia humilis* Herbaceous Vegetation (CEGL004276).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Sites: Diabase Glades occur on flat upland sites with mafic bedrock beneath a shallow soil and with small, patchy, flatrock-like outcrops. The rock in both of North Carolina's examples is diabase but one in South Carolina occurs on gabbro.

Soils: Soils are heterogeneous but generally shallow. Deeper pockets may exist in fractures. The soil contains abundant fine gravel-size nodules of manganese, and these cover the surface of some of the open bedrock patches. The pH is circumneutral and base saturation is high.

Hydrology: Diabase Glades are xeric because of the shallow soil, but water may pool locally for brief periods after rains.

Vegetation: The vegetation is a fine-scale mosaic of scrubby tree-patches, dense herbaceous cover, and moderate to sparse vegetation over rock. Woody patches are dominated by *Juniperus virginiana*, with *Quercus stellata, Ulmus alata,* or *Fraxinus biltmoreana* sometimes codominant. The most abundant shrubs include *Rhus aromatica, Symphoricarpos orbiculatus*, and *Rosa carolina*, but *Berberis canadensis* is sometimes present. Abundant herbs in the open areas include *Hexasepalum (Diodia) teres, Tragia urticifolia, Chamaecrista nictitans* var. *nictitans, Dichanthelium boscii, Dichanthelium sphaerocarpon, Euphorbia corollate, Helianthus divaricatus, Oenothera fruticosa* var. *fruticosa*, *Panicum dichotomiflorum* var. *dichotomiflorum*, *Verbena simplex, Lolium arundinaceum, Carex muhlenbergii* var. *muhlenbergii*, *Croton wildenowii, Galactia volubilis* var. *volubilis, Lespedeza repens, Polypremum procumbens,* and *Scleria pauciflora*. Species shared with Granitic Flatrock also include *Portulaca smallii, Cyperus granitophilus*, and *Isoetes piedmontana*. Species shared with Xeric Hardpan Forest (Northern Prairie Barren Subtype) also include *Liatris squarrulosa, Lithospermum canescens, Matelea decipiens, Packera paupercula* var *paupercula, Parthenium auriculatum, Ruellia humilis, Ruellia purshiana, Scutellaria nervosa, Symphyotrichum depauperatum,* and *Trichostema brachiatum*. Among the high diversity of additional herbaceous species are *Commelina virginica, Asclepias*

verticillata, Eragrostis spectabilis, Erigeron strigosus, Polygala verticillata, Rhynchosia tomentosa, Scleria ciliate, Stylosanthes biflora, Sisyrinchium angustifolium, Symphyotrichum pilosum, *Symphyotrichum undulatum, Scleria oligantha*, *Scutellaria integrifolia*, *Andropogon ternarius*, and *Manfreda virginica*.

Range and Abundance: Ranked G1. North Carolina has only two known examples, both near the town of Butner in Granville County. One occurrence is known in South Carolina, close to Mecklenburg County.

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Associations and Patterns: Diabase Glades are associated with forest communities of mafic rock areas, including Xeric Hardpan Forest and Dry Basic Oak—Hickory Forest.

Variation: The few known occurrences are locally heterogeneous on a fine scale.

Dynamics: Diabase Glades are maintained primarily by shallow soil. As in other glade communities, drought may be important in maintaining the open vegetation in the long term by killing established trees as well as limiting seedling establishment. The importance of fire is uncertain. Some component species are shared with frequently burned communities but at least a few are not. The irregular and heterogeneous vegetation would not carry fire well, but edges and denser vegetation patches could burn. Given the stressful site, even infrequent or mild fire may have significant effects.

Comments: Much of the area of the Diabase Glades is in shrub and tree patches. The NVC write-up for this association suggests that a separate association (*Juniperus virginiana - Ulmus alata - Fraxinus americana - Carya glabra* Forest) was intended for the woody component, but that association was not added to the NVC. Given the close association and complex intermixture of herbaceous and woody patches in the few known examples, no subdivision seems necessary.

Rare species: Vascular plants: *Berberis canadensis, Cyperus granitophilus, Dichanthelium bicknellii, Isoetes piedmontana, Liatris squarrulosa, Lithospermum canescens, Matelea decipiens, Nabalus albus, Packera paupercula* var *paupercula, Parthenium auriculatum, Phemeranthus piedmontanus, Portulaca smallii, Ruellia humilis, Ruellia purshiana, Scutellaria nervosa, Symphyotrichum depauperatum, Trichostema brachiatum*.

References:

LeGrand, H.E. 1988. Cedar glades on diabase outcrops: a newly described community type. Castanea 53: 168-172.

Slapcinsky, J. L. 1994. The vegetation and soils associated with diabase in Granville and Durham counties, North Carolina. M.S. thesis, North Carolina State University, Raleigh. 208 pp

XERIC HARDPAN FOREST (BASIC HARDPAN SUBTYPE)

Concept: Xeric Hardpan Forests are woodlands with open vegetation because of restricted rooting depth caused by dense or shrink-swell clay. Surface or shallow rock may be present but is limited in extent and is not the primary cause of openness. The vegetation is an open woodland or savanna dominated by *Quercus stellata*, with or without *Pinus echinata, Quercus marilandica,* or *Carya carolinae-septentrionalis*. It may contain other drought-tolerant species but has little *Quercus alba* or more mesophytic tree presence. The vegetation flora of these communities indicates a drier environment than that of Dry Oak–Hickory Forest and the trees are often somewhat stunted. Canopy density is less than in dry forests and depends more on fire and disturbance history.

The Basic Hardpan Subtype covers examples on upland flats developed over mafic rocks, where acid-loving flora such as *Vaccinium* is absent or scarce and some basic indicator species are present.

Distinguishing Features: Xeric Hardpan Forests are distinguished from Dry Oak–Hickory Forest and Dry Basic Oak–Hickory Forest by having a canopy of more xerophytic composition, with *Quercus stellata* dominant or codominant. *Pinus echinata, Carya carolinae-septentrionalis*, or *Quercus marilandica* may codominate, but *Quercus alba* and more mesic oaks are uncommon. Fire-suppressed, degraded examples of Piedmont Longleaf Pine Forest may be dominated by *Quercus stellata* and other xerophytic species, but they will not occur on flat hardpan soils or rocky mafic ridges, will generally have evidence of the past presence of *Pinus palustris* and its associates, and will have a flora with more Coastal Plain affinities. Xeric Hardpan Forests are distinguished from Montane Red Cedar–Hardwood Woodland and other rock-outcrop-related woodlands by clayey soils and the absence of characteristic rock outcrop flora. Piedmont Basic Glades may share some species but occur on slopes and are associated with shallow soils and rock.

The Basic Hardpan Subtype is distinguished from the Northern and Southern Prairie Barren Subtypes by a more limited component of the characteristic flora of prairie affinities (see the Prairie Barren Subtype for this flora), though widespread prairie species such as *Schizachyrium scoparium* should be present. Given the pervasive alteration of these communities, geography and flora evident in nearby open areas may need to be used. Both Prairie Barren subtypes have a narrow geographic range and are associated with a large number of rare species in roadsides, corridors, and pastures. The Basic Hardpan Subtype is distinguished from the Basic Rocky Subtype by occurrence on broad upland flats, generally without rock outcrops, rather than on bouldery ridge tops or steep slopes. No plants are known to be exclusive to the Basic Rocky Subtype, but *Carya carolinae-septentrionalis* and *Acer leucoderme* generally are much more abundant there. No frequent species are known to be exclusive to the Basic Hardpan Subtype, though *Clematis ochroleuca* may be primarily in it. *Quercus phellos* or other species typical of wetter conditions are generally present in small numbers in the Basic Hardpan Subtype.

The Basic Hardpan Subtype is distinguished from the Acidic Hardpan Subtype by a flora indicative of mafic substrate influence in the soil. Acid-loving flora such as *Chimaphila maculata, Vaccinium* species (other than *V. arboreum* and some *V. stamineum*), *Gaylussacia* spp., and *Oxydendrum arboreum* are absent or scarce. More base-loving flora such as *Clematis ochroleuca, Viburnum*

spp., *Symphoricarpos orbiculatus, Rhus aromatica, Cercis canadensis, Fraxinus americana*, and *Ulmus alata* are usually common.

Synonyms: *Quercus stellata - Carya (carolinae-septentrionalis, glabra) - (Quercus marilandica) / Ulmus alata / (Schizachyrium scoparium, Piptochaetium avenaceum)* Woodland (CEGL003714). Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Sites: Xeric Hardpan Forest (Basic Hardpan Subtype) occurs on broad upland ridgetops or flats underlain by diabase, gabbro, amphibolite, or other mafic rocks. The sites are often unusually flat, with more subdued topography than typical Piedmont uplands. Such flat areas are commonly associated with mafic rocks.

Soils: Soils of the Basic Hardpan Subtype are generally mapped as Alfisols. Iredell (Vertic Hapludalf) is the most common mapped. Picture (Vertic Argiaquoll), a more recently defined series might be applied to more if sites were reexamined. Some examples are mapped as Enon (Ultic Hapludalf), a few as Helena (Aquic Hapludult) or other Ultisols. These soils have montmorillonite as the primary clay mineral; the vertic properties of these soils, shrinking and swelling in response to changing water content, is an important characteristic even though no true Vertisols have been identified in North Carolina. Damage to fine roots combines with impermeability of the clay pan to restrict rooting depth and create xeric conditions for plants.

Hydrology: Xeric Hardpan Forests are xerohydric but with a predominance of xeric conditions. The soils are drier than is typical in the driest Piedmont sites because of restricted water penetration. However, they may perch water and even pond water locally after heavy rains.

Vegetation: The vegetation in the least altered remaining examples is an open forest or woodland dominated by *Quercus stellata*, often with *Pinus echinata*, *Carya carolinae-septentrionalis, Carya glabra,* or *Ulmus alata* abundant. *Quercus marilandica* may be present. *Quercus alba* and *Carya tomentosa* may be present in small amounts. In more altered examples, *Pinus virginiana, Pinus taeda*, or other species may be abundant. Under more natural conditions, *Quercus stellata*, *Pinus echinata*, and *Quercus marilandica* are likely to be more dominant, the other species less so. The understory often is dominated by *Juniperus virginiana* or *Ulmus alata*, and often contains *Diospyros virginiana, Cercis canadensis, Chionanthus virginicus,* and *Cornus florida*. The shrub layer consists primarily of tree saplings, but may include abundant *Viburnum prunifolium*, *Rhus aromatica, Rosa carolina,* or *Symphoricarpos orbiculatus*. Vines, including *Parthenocissus quinquefolia, Smilax bona-nox, Smilax rotundifolia, Toxicodendron radicans*, and *Muscadinia rotundifolia* are frequent though not usually dense. Under more natural conditions, these lower woody strata would be sparse, though the same species might be present. The herb layer generally is sparse to moderate in density in known examples. *Danthonia spicata* is the most frequent species, and *Piptochaetium avenaceum* or *Scleria oligantha* sometimes dominate patches. Frequent herbs in CVS plot data include *Dichanthelium boscii, Galium circaezans, Asplenium platyneuron, Dichanthelium laxiflorum*, and *Endodeca serpentaria*. Also fairly frequent are *Galium pilosum, Antennaria plantaginea Potentilla canadensis, Polygonatum biflorum, Ruellia carolinensis,* and *Scutellaria integrifolia*. Less frequent but characteristic species in plot data or noted in literature (Batson 1952, Oosting 1942, Peet and Christensen 1980) and site reports include *Clematis ochroleuca, Sericocarpus linifolius, Coreopsis major, Lespedeza virginica, Physalis*

virginiana, Manfreda virginica, Symphyotrichum undulatum, Symphyotrichum dumosum, Stylosanthes biflora, Pycnanthemum tenuifolium, Desmodium paniculatum, Parthenium integrifolium, Oenothera fruticosa, Tragia urticifolia, *Ruellia purshiana*, and a number of species of *Carex*. Under more natural conditions of frequent fire and more open canopy, the herb layer is expected to be dense and more diverse. *Schizachyrium scoparium* is likely to be dominant or codominant. Though rarely found now, many of the suite of fire-tolerant herbs of open woodland might also be present, including *Solidago odora, Tephrosia virginiana, Baptisia tinctoria, Liatris squarrosa, Lespedeza procumbens, Andropogon gerardii, Sorghastrum nutans, Pityopsis graminifolia, Ionactis linariifolia, Sericocarpus asteroides,* and *Hypoxis hirsuta*.

Range and Abundance: Ranked G2G3. This community is scattered throughout the lower and middle Piedmont. This community ranges from Virginia to Georgia.

Associations and Patterns: All remaining occurrences are small patches but some may originally have been large patches. They are usually naturally associated with Dry Basic Oak–Hickory Forest and often with Upland Depression Swamp Forest. Piedmont Headwater Stream Forest (Hardpan Subtype) bands may form or run through them.

Variation: No variants are defined. The formerly recognized variants are now treated as subtypes.

Dynamics: Dynamics are similar to most of the Piedmont barrens. Open canopy structure is maintained by dry soil conditions but the natural fire regime would produce a much more open canopy and understory than is seen at present. Because these communities occur as small to large patches, fires would primarily spread from the surrounding landscape, so fire frequency must largely match that of the prevailing oak forests. However, because of the extreme site conditions, the effects of this fire frequency would be greater and would maintain a more open woodland structure. With a denser grass-dominated herb layer, burning would be more complete and fire somewhat more intense than in the current hardwood litter. Fires would probably not be hot enough to harm mature oak or pine trees but would top-kill seedlings and saplings. Most sensitive plant species would be excluded. The existence of old oaks and pines in some remaining sites suggests that these communities existed as open savannas or woodlands rather than as treeless prairies, though later clearing and increased fire frequency after settlement may have left some treeless. See additional discussion under the Northern and Southern Prairie Barren subtypes.

Under natural conditions of open canopy and frequent fire, tree regeneration would be less dependent on canopy gaps and more on favorable fire intervals than in the present forests or in the surrounding oak-hickory forests.

Historical references (e.g., Logan 1859) describe extensive prairies and open, grassy woodlands in the vicinity of Rock Hill, South Carolina, where Iredell soils are common. They note that such areas had later grown up in blackjack. That area likely represented the Southern Prairie Barren Subtype but some may have been the Basic Hardpan Subtype.

Comments: Though Xeric Hardpan Forests make up only a small portion of the landscape in most parts of the Piedmont, their distinct vegetation and its relationship to dense clay soils, restricted rooting depth, mafic rocks, and the Iredell soil series has long been recognized. Oosting (1942)

called them preclimax forests, maintained indefinitely in less than climax condition by the extreme soils. Peet and Christensen (1980) found what they called montmorillonite forests to be a distinctive vegetation group, separating from oak-hickory forest communities at the highest level of their progressive ordinations. Dayton's (1965) study of vegetation of Iredell soils in Granville County likely included both the Basic Hardpan Subtype and Northern Prairie Barren Subtype. The same vegetation is described as distinctive in Wharton (1977) in Georgia.

While early descriptions are recognizable as the Xeric Hardpan Forests we see today, these descriptions hint at continued change in vegetation with the removal of fire, even in recent decades. *Quercus marilandica* is usually mentioned prominently, often described as abundant and sometimes used in the naming of the vegetation. Present examples often have none and never have much of this species. *Symphyotrichum dumosum* was frequently mentioned, yet only 2 out of 48 plots of this community in three states have any of it. *Oenothera fruticosa, Sericocarpus linifolius*, *Stylosanthes biflora*, and species of *Liatris* are additional species that are mentioned as characteristic by Oosting (1942) and other earlier studies but which have very low frequency in recent plot data and site descriptions alike.

The relationship between the Basic Hardpan Subtype and the Northern and Southern Prairie Barren subtypes needs further clarification. All occur on similar flat montmorillonitic hardpan soils and all can look similar in altered remnants. The two Prairie Barren subtypes are recognized for the two areas where hardpan soils are extensive and where remaining open areas have a much more diverse flora of prairie affinities. The distinction is presumed to be a biogeographic one – the large areas have an extensive pool of species of open woodlands or prairies while naturally small patches have a limited pool. However, it is unclear how many species of open conditions may have been lost in small patches as they became dense. There likely was a difference in dynamic processes as well. Large areas of Xeric Hardpan Forest likely increased fire frequency and intensity to some degree, and this could contribute to the more diverse prairie flora and perhaps to more open vegetation.

Rare species: Vascular Plants: *Acmispon helleri, Berberis canadensis, Echinacea laevigata, Helianthus schweinitzii, Solidago rigida ssp. glabrata,* and *Symphyotrichum georgianum*.

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XERIC HARDPAN FOREST (NORTHERN PRAIRIE BARREN SUBTYPE)

Concept: Xeric Hardpan Forests are woodlands with open vegetation because of restricted rooting depth caused by dense or shrink-swell clay. The Northern Prairie Barren Subtype covers examples on mafic rock-derived soils in the Durham Triassic basin and adjacent areas, which contain a diverse and distinctive herbaceous flora of prairie affinities. They generally have a higher species richness than the Basic Hardpan Subtype. The suite of prairie herbs is different for this region than for the range of the Southern Prairie Barren Subtype, apparently for biogeographic reasons.

Distinguishing Features: The Northern Prairie Barren Subtype is distinguished from the closely related Southern Prairie Barren Subtype by a suite of different species. Species characteristic of the Northern and absent in the Southern include *Echinacea laevigata, Oligoneuron album*, *Lithospermum canescens*, and *Baptisia aberrans*. Species characteristic of the Southern and absent in the Northern include *Symphyotrichum georgianum var. georgianum*, and *Helianthus schweinitzii*. Both subtypes are distinguished from the closely related Basic Hardpan Subtype and from all other subtypes by the presence of a substantial flora of prairie affinities, beyond widespread species such as *Schizachyrium scoparium*. *Silphium terebinthinaceum, Cirsium carolinianum, Elymus canadensis, Eryngium yuccifolium, Liatris squarrosa, Parthenium auriculatum, Parthenium integrifolium, Tragia urticifolia*, and *Sorghastrum nutans* are typical of both Prairie Barren subtypes and not the other subtypes.

Synonyms: *Quercus stellata - (Pinus echinata) / Schizachyrium scoparium - Echinacea laevigata - Oligoneuron album* Woodland (CEGL003558). Diabase Barren (common usage).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Sites: The Northern Prairie Barren Subtype occurs on broad upland ridgetops or flats underlain by the large diabase sills northeast of the city of Durham.

Soils: Most areas of the Northern Prairie Barren Subtype are mapped as Iredell (Vertic Hapludalf). The more recently defined Picture series (Vertic Argiaquoll) might be applied more widely if they reexamined. As in all the Xeric Hardpan Forests, montmorillonite is the primary clay mineral and vertic properties are believed to be important in creating a stressful environment for woody plants.

Hydrology: Xeric Hardpan Forests are xerohydric but with a predominance of xeric conditions. The soils are drier than is typical in the driest Piedmont sites because of restricted water penetration. However, they may perch water and even pond water locally after heavy rains.

Vegetation: All remaining examples are now heavily altered, but the natural vegetation of this subtype presumably was a savanna or open woodland with a dense grassy herb layer. Treeless patches may have been present and possibly were extensive. The canopy likely was dominated by *Quercus stellata*, with *Pinus echinata* and possibly *Quercus marilandica* abundant or codominant. Other trees such as *Carya carolinae-septentrionalis, Carya tomentosa, Carya glabra*, *Ulmus alata*, or *Fraxinus biltmoreana* may have been present in smaller numbers, perhaps in groves. In remnants, these species and others such as *Quercus alba* and *Pinus taeda* may be abundant. The understory presumably was sparse in frequently burned examples but is often fairly dense in remnants. Besides the canopy species, *Juniperus virginiana, Cercis canadensis, Diospyros*

virginiana, or *Acer floridanum* may be abundant, and less characteristic species such as *Prunus serotina* or *Liquidambar styraciflua* may be present. Shrubs in remnants and probably characteristic of natural examples include *Rosa carolina*, *Ceanothus americana*, *Celtis tenuifolia*, and *Rhus aromatica*. The more ruderal *Rhus copallinum* is common in remnants and may also have been present in natural examples. The herb layer is generally dense where tree cover is not heavy. Under a more natural fire regime, it would presumably be very dense and diverse. *Schizachyrium scoparium* probably dominated under such conditions, and *Sorghastrum nutans* may have been abundant. However, these species are not usually strongly dominant in remnants, so this is somewhat uncertain. Herbs found in remnants that likely are characteristic of the natural community include *Danthonia spicata, Scleria oligantha, Silphium terebinthinaceum, Echinacea laevigata, Baptisia aberrans, Parthenium auriculatum, Parthenium integrifolium, Lespedeza virginica, Lespedeza hirta, Ruellia carolinensis, Ruellia humilis, Dichanthelium laxiflorum, Andropogon gyrans, Clematis ochroleuca, Oenothera fruticosa* var. *fruticosa, Scutellaria integrifolia, Scutellaria leonardii, Tragia urticifolia, Silphium asteriscus* var. *asteriscus*, and the additional rare species listed below. Species that appear more ruderal, such as *Apocynum cannabinum* and *Salvia lyrata,* may or may not have been part of the more natural condition.

Range and Abundance: Ranked G1. The subtype appears to be a narrow endemic community confined to the extensive diabase sill area in Durham and Granville counties. No good examples remain, though remnants altered to varying degrees are present in this area. The association may conceivably have occurred in nearby Virginia and a newly discovered large hardpan area there may be related to this subtype.

Associations and Patterns: This subtype once occurred as a large patch community within its range. It grades to Dry Basic Oak–Hickory Forest, possibly to Upland Depression Swamp Forest. Piedmont Headwater Stream Forest (Hardpan Subtype) bands may form or run through it.

Variation: Nothing is known of natural variation, but vegetation may have varied along a moisture gradient.

Dynamics: Dynamics are similar to most of the Piedmont barrens but may be more extreme. Open canopy structure is maintained by dry soil conditions but the natural fire regime would produce a much more open canopy and understory than is seen at present. Because this subtype occurred as larger patches than the Basic or Acidic Hardpan subtypes, with larger area of continuous grass cover, fires may have been more intense and somewhat more frequent. However, most ignitions likely still spread from the surrounding landscape rather than originating within the community. Thus, as with other Xeric Hardpan Forests, fire frequency was presumably similar to that of oak-hickory forests. The open character came primarily from greater fire effects. Fires would probably not be hot enough to harm mature oak or pine trees but would top-kill seedlings and saplings. Most sensitive plant species would be excluded. Most areas of this subtype likely were savannas rather than treeless prairie but trees may have been less dense than in most other subtypes and treeless areas may have been larger under natural conditions.

Lori Sigmon-Chatham's (2015) dendrochronology study at the largest remnant of this subtype shows a dramatic shift in tree regeneration that corresponds with a change in land ownership and can only be due to fire suppression. *Pinus taeda* and *Quercus alba* all date to after this time. The

older *Pinus echinata* and *Quercus stellata* remained but these species almost completely stopped reproducing at the same time.

The warmer, drier Hypsithermal period several thousand years ago may have created more open vegetation across larger parts of the Piedmont. However, the distinctive soils that create Xeric Hardpan Forest were not more widespread. If the characteristic species of the Northern Prairie Barren Subtype once ranged widely, their current rarity and absence in open areas beyond its current range suggest they became restricted long ago. Their survival in the area of this subtype may be due to the larger size of the community patches and their ability to support larger populations. The floristic differences between the Northern Prairie Barren and Southern Prairie Barren subtypes suggests a long separation.

Comments: This subtype is conceived as a richer community than the more widely scattered Basic Hardpan Subtype, probably associated with a center of diversity where hardpans were more extensive. A similar large expanse of habitat on the gabbros of Mecklenburg County and adjacent South Carolina has a diverse but somewhat different flora. It is treated as the Southern Prairie Barren Subtype. This needs further investigation, but study is difficult because of the altered condition of all remnants.

Rare species: Vascular Plants: *Acmispon helleri, Agastache nepetoides, Baptisia aberrans, Baptisia minor, Berberis canadensis, Callitriche terrestris, Carex meadii, Delphinium exaltatum, Dichanthelium annulum, Echinacea laevigata, Fleischmannia incarnata, Liatris squarrulosa, Lithospermum canescens, Marshallia legrandii, Matelea decipiens, Parthenium auriculatum, Pseudognaphalium helleri, Rhus michauxii, Ruellia humilis, Packera paupercula* var. *paupercula, Panicum flexile, Panicum philadelphicum* ssp. *lithophilum, Pseudognaphalium helleri, Ruellia humilis, Scirpus pendulus, Scutellaria parviflora, Scutellaria leonardii, Silphium terebinthinaceum, Solidago ptarmicoides, Solidago rigida* var. *glabra, Symphyotrichum concinnum, Symphyotrichum depauperatum,* and *Trifolium reflexum*.

Nonvascular plants: *Astomum ludovicianum*
Invertebrate Animals: *Neonympha helicta* and *Bombus affinis.*

References:

Sigmon-Chatham, L.L. 2015. Historic forest structure and composition of the Dry-Mesic Basic Oak–Hickory Forest and Xeric Hardpan Forest community types of the Picture Creek Diabase Barrens: Insights from Dendrochronology. M.S. Thesis, N.C. State University, Raleigh, NC.

XERIC HARDPAN FOREST (SOUTHERN PRAIRIE BARREN SUBTYPE)

Concept: Xeric Hardpan Forests are woodlands with open vegetation because of restricted rooting depth caused by dense or shrink-swell clay. The Southern Prairie Barren Subtype covers examples on gabbro-derived soils in the area of Mecklenburg County and adjacent South Carolina, which contain a diverse and distinctive herbaceous flora of prairie affinities. No well-developed remnants are known in North Carolina but flora in the area suggests they were once locally extensive.They generally have a higher species richness than the Basic Hardpan Subtype. The suite of prairie herbs is different for this region than for the range of the Northern Prairie Barren Subtype, apparently for biogeographic reasons.

Distinguishing Features: The Southern Prairie Barren Subtype is distinguished from the closely related Northern Prairie Barren Subtype by a suite of different species. Species characteristic of the Northern and absent in the Southern include *Echinacea laevigata, Oligoneuron album*, *Lithospermum canescens*, and *Baptisia australis var. aberrans*. Species characteristic of the Southern and absent in the Northern include *Symphyotrichum georgianum var. georgianum* and *Helianthus schweinitzii*. Both subtypes are distinguished from the closely related Basic Hardpan Subtype and from all other subtypes by the presence of a substantial flora of prairie affinities, beyond widespread species such as *Schizachyrium scoparium*. *Silphium terebinthinaceum, Cirsium carolinianum, Elymus canadensis, Eryngium yuccifolium, Liatris squarrosa, Parthenium auriculatum, Parthenium integrifolium, Tragia urens*, and *Sorghastrum nutans* are typical of the both Prairie Barren subtypes and not the other subtypes.

Synonyms: *Quercus stellata - (Pinus echinata) / Schizachyrium scoparium - Symphyotrichum georgianum* Woodland (CEGL003711).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Sites: The Southern Prairie Barren Subtype occurs on broad upland ridgetops or flats underlain by large gabbro plutons.

Soils: Soils are generally mapped as Iredell (Vertic Hapludalf). It is unclear if further investigation might recognize the Picture series (Vertic Argiaquoll), more recently defined in the Durham area. As in all the Xeric Hardpan Forests, montmorillonite is the primary clay mineral and vertic properties are believed to be important in creating a stressful environment for woody plants.

Hydrology: As in other Xeric Hardpan Forests, sites are drier than is typical in the driest Piedmont sites because of restricted water penetration.

Vegetation: All remaining examples are now heavily altered, but the natural vegetation of this subtype presumably was a savanna or open woodland with a dense grassy herb layer. Treeless patches may have been present and possibly were extensive. The canopy likely was dominated by *Quercus stellata*, with *Pinus echinata* and *Quercus marilandica* abundant or codominant. Other trees such as *Carya tomentosa, Carya glabra*, *Ulmus alata*, or *Fraxinus biltmoreana* may have been present in smaller numbers, perhaps in groves. In remnants, these species and others such as *Pinus taeda* or *Liquidambar styraciflua* may be abundant. The understory presumably was sparse in frequently burned examples but is often fairly dense in remnants. Besides the canopy species,

Juniperus virginiana, Diospyros virginiana, or *Cercis canadensis* may be abundant, and less characteristic species such as *Prunus serotina* or *Liquidambar styraciflua* may be present. Shrubs in remnants and probably characteristic of natural examples include *Rosa carolina*, *Celtis tenuifolia*, and *Rhus aromatica*. *Rhus copallinum* may also have been characteristic. The herb layer would presumably have been very dense and diverse under a more natural fire regime. *Schizachyrium scoparium* probably dominated under such conditions, and *Sorghastrum nutans* may have been abundant. However, these species are not frequent or dominant in remnants, so this is uncertain. Herbs found in remnants and probably characteristic of natural conditions include *Silphium terebinthinaceum, Oenothera fruticosa* var. *fruticosa*, *Penstemon laevigatus, Ruellia humilis, Asclepias verticillata, Scutellaria integrifolia, Dichanthelium laxiflorum, Danthonia spicata, Piptochaetium avenaceum, Rudbeckia fulgida, Solidago ptarmicoides, Liatris aspera, Manfreda virginica, Pycnanthemum tenuifolium, Scleria oligantha*, and *Symphyotrichum dumosum*. More species with more ruderal ecology, such as *Mecardonia acuminata, Setaria parviflora, Paspalum laeve,* and *Eupatorium hyssopifolium,* may or may not have been part of more natural composition.

Range and Abundance: Ranked G1. This community is believed to be a narrow endemic that ranged through the large gabbro plutons in Mecklenburg County and adjacent South Carolina. Only degraded remnants are known in North Carolina. The altered but more intact Rock Hill Blackjacks Preserve in South Carolina is the only known well-developed example remaining.

Associations and Patterns: This subtype once occurred as a large patch community within its range. It grades to Dry Basic Oak–Hickory Forest, possibly to Upland Depression Swamp Forest. Piedmont Headwater Stream Forest (Hardpan Subtype) bands may form or run through it.

Variation: Nothing is known of natural variation, but vegetation may have varied along a moisture gradient.

Dynamics: As in the Northern Prairie Barren Subtype, dynamics are similar to the other Xeric Hardpan Forests but may be more extreme. Open canopy structure is maintained by dry soil conditions but the natural fire regime would produce a much more open canopy and understory than is seen at present. Because this subtype occurred as larger patches than the Basic or Acidic Hardpan subtypes, with a larger area of continuous grass cover, fires may have been more intense and somewhat more frequent. However, most ignitions likely still spread from the surrounding landscape rather than originating within the community. Thus, as with other Xeric Hardpan Forests, fire frequency was presumably similar to that of oak-hickory forests. The open character came primarily from greater fire effects. Fires would probably not be hot enough to harm mature oak or pine trees but would top-kill seedlings and saplings.

Additional dynamic issues discussed for the Northern Prairie Barren Subtype also apply to this subtype.

Comments: This subtype is analogous to the Northern Prairie Barren Subtype. It is conceived as a richer community than the more widely scattered Basic Hardpan Subtype, probably associated with a center of diversity where hardpans were more extensive. The Northern Prairie Barren Subtype has a diverse but somewhat different flora.

This subtype is probably the largest of the historic prairie areas discussed by Barden (1997), though it is unclear if the reported extensive lack of trees was the natural state or the result of clearing in the recent past. Historical references (e.g., Logan 1859) describe extensive prairies and open, grassy woodlands in the vicinity of Rock Hill, South Carolina, where Iredell soils are extensive. They note that such areas had later grown up in blackjack.

Rare species: Vascular plants: *Acmispon helleri, Anemone berlandieri, Anemone caroliniana, Cirsium carolinianum, Delphinium exaltatum, Desmodium sessilifolium, Dichanthelium annulum, Echinacea laevigata, Echinacea pallida, Helianthus schweinitzii, Matelea decipiens, Parthenium auriculatum, Pseudognaphalium helleri, Rhus michauxii, Silphium terebinthinaceum, Solidago rigida* var. *glabra, Symphyotrichum georgianum,* and *Thermopsis mollis*.

Rare species: Animals: *Bombus affinis*.

References:

Barden, L.S. 1997. Historic prairies of the Piedmont of North and South Carolina, USA. Natural Areas Journal 17: 149-152.

Logan, J.H. 1859. A history of the upper country of South Carolina from the earliest periods to the close of the War of Independence. Vol. 1. Courtnay and Company, Charleston, SC.

XERIC HARDPAN FOREST (ACIDIC HARDPAN SUBTYPE)

Concept: Xeric Hardpan Forests are woodlands with open vegetation because of restricted rooting depth caused by dense or shrink-swell clay. The Acidic Hardpan Subtype covers Xeric Hardpan Forests on acidic clays, having an acid-tolerant flora.

Distinguishing Features: The Acidic Hardpan Subtype can be distinguished from all other subtypes by the substantial presence of acid-tolerant flora, with species such as *Vaccinium tenellum, Vaccinium pallidum, Gaylussacia* spp., *Oxydendrum arboreum*, and *Chimaphila maculata* abundant. The strongest basic indicators, such as *Symphoricarpos orbiculatus, Rhus aromatica, Clematis ochroleuca*, and the prairie species are absent, and weaker indicators such as *Cercis canadensis* and *Ulmus alata* are much less common. *Quercus falcata* may be abundant.

Synonyms: *Quercus stellata - (Quercus marilandica) / Gaylussacia frondosa* Acidic Hardpan Woodland (CEGL004413).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Sites: The Acidic Hardpan Subtype occurs on broad upland ridges or flats underlain by clay-rich shale or slate. The properties of the rock that lead to development of hardpan conditions in a few places and not more widely on similar rocks are not clear.

Soils: The most frequently mapped soils are Misenheimer (Aquic Dystrudept) and Zion (Typic Hapludalf). Lignum (Aquic Hapludult) is mapped less often, and a variety of other series are mapped in single examples. The soils are not characterized as montmorillonitic as those in the previous Xeric Hardpan Forests are. An argillic horizon seems to be responsible for the shallow rooting depth and xeric conditions for plants.

Hydrology: Soils are normally xeric due to limited water penetration; however, they may be poorly drained and even pond some water during wet periods.

Vegetation: The vegetation in the least altered remaining examples is an open forest or woodland dominated by *Quercus stellata*, often with *Quercus marilandica* or *Pinus echinata* codominant. *Quercus falcata, Carya carolinae-septentrionalis*, or other *Carya* species are often present. *Quercus phellos* is often present in small numbers. Other species, such as *Quercus alba, Quercus coccinea, Pinus virginiana*, and *Liquidambar styraciflua,* often are present but probably are not characteristic of natural conditions. The understory likely was sparse under natural conditions but often is dense now. Common species are *Juniperus virginiana, Nyssa sylvatica, Acer rubrum, Diospyros virginiana*, and *Oxydendrum arboreum*. Shrubs are patchy but often abundant. *Vaccinium tenellum* is most frequent but *Vaccinium stamineum, Gaylussacia frondosa, Gaylussacia dumosa*, or *Vaccinium pallidum* may dominate in individual examples. *Vaccinium corymbosum, Vaccinium fuscatum*, or *Vaccinium arboreum* may be present, and *Lyonia ligustrina* or *Lyonia mariana* occasionally is abundant. The herb layer generally is sparse to moderate in density in known examples. *Danthonia spicata* or *Danthonia sericea* usually is one of the most abundant herbs. *Cladonia* sp., *Schizachyrium scoparium, Tephrosia virginiana, Coreopsis major, Dichanthelium* spp., and *Andropogon virginicus* are often noted. Less frequently noted species that likely are characteristic include *Scleria oligantha, Liatris pilosa, Chimaphila maculata,*

Pycnanthemum tenuifolium, Houstonia tenuifolia, Solidago odora, Sorghastrum nutans, and *Symphyotrichum dumosum*. Under a more natural fire regime, that herb layer likely was dense and more diverse. *Schizachyrium scoparium* most likely dominated, but since it is scarce in remnants, this is unclear. Species found on roadsides near remnants give a hint of the diversity that might be present in natural examples. Such species include *Acmispon helleri, Agalinis tenuifolia, Andropogon ternarius, Arnica acaulis, Aristida oligantha, Aristida purpurascens, Carex complanata, Euphorbia curtisii, Helianthus divaricatus, Helianthus schweinitzii, Marshallia obovata, Muhlenbergia capillaris, Oenothera fruticosa* var. *fruticosa, Pityopsis aspera, Sericocarpus linifolius, Sporobolus junceus, Stylosanthes biflora, Symphyotrichum concolor*, *Symphyotrichum patens*, and a number of others.

Range and Abundance: Ranked G2. Examples are scattered through the central Piedmont, largely confined to the Carolina Slate Belt geologic region. They seem to have been rarer than the Basic Hardpan Subtype. The only known large concentration occurred in the vicinity of Gold Hill in Rowan and Stanley counties. This subtype appears to be endemic to North Carolina

Associations and Patterns: Occurrences are usually small patches, with the Gold Hill area having large patches. The Acidic Hardpan Subtype is often associated with Upland Depression Swamp Forest and Dry Oak–Hickory Forest of the Hardpan Variant.

Variation: Variation is not well known. No variants are recognized.

Dynamics: Dynamics are believed to be similar to those in the Basic Hardpan Subtype and other subtypes. Open canopy structure is maintained by dry soil conditions but the natural fire regime would produce a much more open canopy and understory than is seen at present. Because these communities occur as small-to-large patches, fires would primarily spread from the surrounding landscape, so fire frequency must largely match that of the prevailing oak forests. However, because of the extreme site conditions, the effects of this fire frequency would be greater and would maintain a more open woodland structure. With a denser grass-dominated herb layer, burning would be more complete and fire somewhat more intense than in the current hardwood litter. Fires would probably not be hot enough to harm mature oak or pine trees but would top-kill seedlings and saplings. Most sensitive plant species would be excluded. The existence of old oaks and pines in some remaining sites suggests that these communities existed as open savannas or woodlands rather than as treeless prairies, though later clearing and increased fire frequency after settlement may have left some treeless.

Comments:

Rare species: Vascular plants: *Acmispon helleri, Helianthus schweinitzii, Pseudognaphalium helleri,* and *Symphyotrichum georgianum*.

References:

XERIC HARDPAN FOREST (BASIC ROCKY SUBTYPE)

Concept: Xeric Hardpan Forests are woodlands with open vegetation because of restricted rooting depth caused by dense or shrink-swell clay. The Basic Rocky Subtype covers the rare communities with Xeric Hardpan Forest composition on rocky ridge tops and steep slopes over mafic rocks. Soils between the rocks appear to have dense shrink-swell clay layers and to restrict water movement and root penetration. The composition is somewhat different from examples on basic hardpan flats.

Distinguishing Features: Xeric Hardpan Forests are distinguished from Dry Oak–Hickory Forest and Dry Basic Oak–Hickory Forest by having a canopy of more xerophytic composition, with *Quercus stellata* dominant or codominant. The Basic Rocky Subtype is distinguished from the other basic subtypes by its occurrence on steep slopes or ridge tops and the presence of abundant rocks. The species indicative of wetter conditions, such as *Quercus phellos*, which are usually present in small numbers in the hardpan subtypes, are absent. No frequent plants are known to be exclusive to the Basic Rocky Subtype, but *Carya carolinae-septentrionalis, Piptochaetium avenaceum, Acer leucoderme, Muscadinia rotundifolia*, and *Parthenocissus quinquefolia* are generally much more abundant than in the Basic Hardpan Subtype. This subtype may grade conceptually into some of the glade communities. It is distinguished from them by its deep clayey soils between any rocks and by absence of any characteristic rock outcrop flora.

Synonyms: *Quercus stellata - Carya carolinae-septentrionalis / Acer leucoderme / Piptochaetium avenaceum - Danthonia spicata* Woodland (CEGL003713).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Sites: The Basic Rocky Subtype occurs on narrow ridge top and upper-to-middle slopes on substrates of gabbro, meta-basalt, or potentially diabase. The sites may have abundant cover of boulders but most of the ground surface is soil.

Soils: Most examples are mapped as Enon (Ultic Hapludalf) or Wilkes (Typic Hapludalf), a few as Iredell (Vertic Hapludalf) or other series. The soils have a dense clay layer despite their frequent high rock cover and occurrence on steep slopes. The dense clay layer and the xeric vegetation suggest that rooting depth is restricted as it is in other Xeric Hardpan Forests.

Hydrology: Soils appear to be xeric due to limited water penetration, which may be exacerbated by their occurrence on slopes.

Vegetation: The vegetation in the least altered remaining examples is an open forest or woodland dominated by *Quercus stellata* and *Carya carolinae-septentrionalis*, sometimes with *Quercus marilandica* or *Fraxinus biltmoreana* codominant. *Pinus echinata, Pinus virginiana, Carya glabra*, or occasionally other species are abundant. The understory is generally open. Besides canopy species, frequent species include *Cercis canadensis, Ulmus alata, Acer leucoderme, Juniperus virginiana*, *Cornus florida*, and *Diospyros virginiana*. Less frequent are *Prunus umbellata, Vaccinium arboreum, Crataegus uniflora,* and *Ulmus alata*, and a variety of other species. Shrubs generally are sparse. *Rosa carolina, Rhus aromatica, Viburnum rufidulum, Viburnum prunifolium, Ceanothus americana*, and *Symphoricarpos orbiculatus* are characteristic.

Vines may have substantial ground cover, especially in rocky areas. *Muscadinia rotundifolia* is most often dominant, but *Toxicodendron radicans, Parthenocissus quinquefolia, Lonicera sempervirens, Smilax rotundifolia*, and *Smilax bona-nox* may also be extensive. The herb layer generally dense. *Piptochaetium avenaceum, Schizachyrium scoparium*, or *Danthonia spicata* dominate. At least fairly frequent herbs in CVS plot data and site descriptions include *Melica mutica, Scleria oligantha, Tragia urticifolia, Dichanthelium boscii, Dichanthelium laxiflorum, Symphyotrichum patens, Lespedeza procumbens,* and *Lespedeza virginica.* Less frequent but likely characteristic species include *Scutellaria integrifolia, Acalypha gracilescens, Dichanthelium annulum, Coreopsis major, Dichanthelium depauperatum, Lespedeza repens, Lespedeza violacea, Stylosanthes biflora, Ruellia caroliniana, Phlox nivalis, Symphyotrichum undulatum, Symphyotrichum orbiculatus*, *Clematis ochroleuca, Pycnanthemum tenuifolium, Allium canadense, Allium cernuum, Asclepias verticillata, Clitoria mariana, Centrosema virginiana, Cunila origanoides, Andropogon gerardii*, and *Andropogon gyrans*. With a more natural fire regime, the canopy would likely be more open, the understory much sparser, and the herb layer more diverse.

Range and Abundance: Ranked G2. North Carolina examples are almost all in the Carolina Slate Belt geologic region, concentrated in the area of Montgomery and Stanley counties. It is unclear if this subtype occurs in any other states.

Associations and Patterns: The Basic Rocky Subtype occurs as small patches. It usually is surrounded by Dry Basic Oak–Hickory Forest. Upland Depression Swamp Forest patches may be adjacent or nearby.

Variation: No variants are defined. The formerly recognized variants are now treated as subtypes.

Dynamics: Dynamics are similar to those of other Xeric Hardpan Forests, with fire having once maintained a more open canopy and a more diverse herb layer than at present due to greater fire effects rather than much more frequent fire. Fire effects appears to be somewhat less extreme than for other subtypes, perhaps due to topography and small patch sizes. The reason for the greater abundance of *Carya carolinae-septentrionalis* in this subtype is not clear but may be related to fire behavior or rock content.

Remaining examples of this subtype appear to be less altered than other subtypes. Most examples retain a dense grassy herb layer. This may be because the rockiness and steep topography contribute more to keeping woody cover low, or it may be because land use was less intense on the slopes and ridge tops where they occur. Nevertheless, canopies probably have become denser and herb diversity declined due to fire suppression.

Comments: No published literature is known pertaining to this subtype. It is well covered by CVS plots, given its rarity. This description is based both on CVS plot data and site observations.

Rare species: Vascular plants: *Eupatorium saltuense, Parthenium auriculatum, Solidago radula,* and *Symphyotrichum concinnum.*

References:

XERIC PIEDMONT SLOPE WOODLAND

Concept: Xeric Piedmont Slope Woodland is a rare woodland or open forest community of xeric microsites such as steep upper slopes on dry aspects, but with less continuous shallow soil, less bedrock, and denser vegetation than Piedmont Acidic Glade. It is dominated by drought-tolerant species, including *Pinus echinata, Quercus stellata, Quercus marilandica*, and *Quercus montana*, and either a dense shrub layer or an herbaceous layer of drought-tolerant and sun-loving species.

Distinguishing Features: Xeric Piedmont Slope Woodland is recognizable by a canopy composition more xerophytic than Dry Oak–Hickory Forest or Piedmont Monadnock Forest (*Quercus stellata, Pinus echinata*, *Quercus marilandica*, sometimes *Quercus montana*, without *Quercus alba* or more mesophytic species) in environments that don't have the characteristics of Piedmont Acidic Glade or Xeric Hardpan Forest. Sites are usually rocky, but dry slope aspect appears more important than continuous bedrock or shallow soil, and a clay hardpan is not present. Xeric Piedmont Slope Woodland is distinguished from Piedmont Acidic Glade by denser vegetation (open forest or fairly dense woodland if not recently disturbed), deeper soil, and limited role of rock. Xeric Hardpan Forest (Basic Rocky Subtype) has a xerophytic canopy in upper slope settings but occurs on mafic rock, has evidence of a dense or shrink-swell clay subsoil, and generally has abundant *Carya carolinae-septentrionalis*.

Synonyms: *Pinus echinata - Quercus marilandica / Kalmia latifolia - Symplocos tinctoria* Woodland (CEGL004446). This association is a marginal fit for the concept of this community type, which might almost as well be regarded as having no NVC analogue.
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Sites: Xeric Piedmont Slope Woodlands occur on steep or convex upper slopes that face west or south.

Soils: Soils may potentially be any dry acidic upland soil. The known examples are mapped as Georgeville (Typic Kanhapludult).

Hydrology: Sites are very dry due to strong solar heating and rapid drainage of rainfall from the steep convex slopes.

Vegetation: The vegetation is an open forest or woodland dominated by *Quercus stellata, Quercus montana,* and *Pinus echinata*, with *Quercus marilandica* abundant in the understory. Shrubs such as *Kalmia latifolia* or *Vaccinium arboreum* may be abundant. The herb layer, where shrubs are not dense, is dominated by grasses, primarily *Piptochaetium avenaceum* or *Danthonia spicata*. With more frequent fire, additional species such as *Schizachyrium scoparium, Tephrosia virginiana, Solidago odora*, and *Pteridium latiusculum* might be abundant.

Range and Abundance: Ranked G2? but much uncertainty remains about its abundance. It may be G1. It is known in North Carolina only in the most rugged part of the Uwharrie National Forest.

Associations and Patterns: Where it is known, Xeric Piedmont Slope Woodland occurs on the driest slope aspects and grades to Piedmont Monadnock Forest (Pine Subtype) on other dry slope

aspects and to Piedmont Monadnock Forest (Typic Subtype) on ridge tops and east-facing slopes. Piedmont Acidic Glade and potentially Dry Piedmont Longleaf Pine Forest occur as additional small patch communities in this landscape.

Variation: Variation is not well known at present.

Dynamics: Dynamics are not well known. The factors that produce this community where it occurs are presumed to be the very dry microsites, but steep south-facing slopes in other parts of the Piedmont do not appear to support this community. Fire probably is very influential, as it is in the other barrens communities, but occurrence in rugged topography may limit fire spread from surrounding landscapes.

Comments: This community is one of the least well understood in the 4th Approximation, and confusion remains about its true character and ecological affinities. The history of nomenclature illustrates the confusion. It was called Xeric Piedmont Pine Heath in earlier drafts of the 4th approximation. It was also called Piedmont Monadnock Forest (Xeric Subtype) at one stage. The synonymized NVC association is a poor fit for the observed vegetation of places identified as Xeric Piedmont Slope Woodland. It describes a dry or xeric woodland with a dense shrub layer suggestive of sheltering from fire, but the setting suggests an important natural role for fire. Further confusing the picture, *Quercus marilandica* is in the name but is not mentioned in the vegetation description. The vegetation, as described in the NVC, suggests a dry phase of Piedmont/Coastal Plain Heath Bluff. It was based on two rather different CVS plots.

The concept used in the Fourth Approximation is based on field observations of rocky acidic upper south-facing slope positions in the most rugged part of the Uwharrie Mountains, initially suggested by Alan Weakley and Allison Weakley (personal comm. 2011). Their observations, and the author's, are of vegetation that is not densely shrubby and has a fairly diverse herbaceous layer. The dense shrub layer in the xeric plots may be an artifact of fire suppression. At present, this rare community is not known outside of the southeastern Badin unit of Uwharrie National Forest, an area of unusually extensive and diverse development of dry, acidic communities. These communities are likely partially dependent on fire for their natural character. With more frequent burning, comparable to that which occurred in most Piedmont forests, these dry sites would have more open canopies, less shrub cover, and would support diverse herbaceous layers.

The relationship of this community to Dry Piedmont Longleaf Pine Forest also needs further clarification. The Mountain Variant of Dry Piedmont Longleaf Pine Forest occurs in similar topographic and geologic settings in close proximity to the known occurrences.

Quercus prinus - Quercus stellata - Carya glabra / Vaccinium arboreum - Viburnum rufidulum Forest (CEGL004416) is another xeric forest association, initially based on two other plots in the same vicinity. It could fit this type's concept as well but may alternatively fit Piedmont Acidic Glade better.

Rare species: No rare species are known in this community.

References: