LOW ELEVATION CLIFFS AND ROCK OUTCROPS

Contents

LOW ELEVATION CLIFFS AND ROCK OUTCROPS THEME

Concept: Low Elevation Cliffs and Rock Outcrops are sparsely vegetated communities of bedrock or occasionally of talus. They have less vegetation, less continuous soil, and more bare rock than Piedmont and Mountain Glades and Barrens. They lack the distinctive characteristics of Granitic Flatrocks, Coastal Plain Marl Outcrops, and the bedrock wetlands of Spray Cliff and Low Elevation Seep (Bedrock Subtype). They occur in the Piedmont, Coastal Plain, and low-to-moderate elevations in the Mountains. The rock may be fractured bedrock, loose talus, or sloping smooth exfoliated granitic rock, but flat-lying exfoliated granitic rock is contained in the Granitic Flatrocks theme instead. Cover of all vegetation is low in the community as a whole. It may consist wholly of herbs, bryophytes, and lichens, or may include limited patches or individual stems of shrubs and stunted trees.

Distinguishing Features: Low Elevation Cliffs and Rock Outcrops communities are distinguished from High Elevation Rock Outcrops by the floristic differences associated with lower elevation. They lack the distinctive species confined to higher elevations, such as *Sibbaldiopsis tridentata, Carex brunnescens, Rhododendron (Menziesia) pilosum, Picea rubens*, and the suite of rare species such as *Houstonia montana*. They are less likely to have some additional species such as *Bryodesma tortipilum, Danthonia compressa, Mononeuria groenlandica*, and *Rhododendron catawbiense*. Other species such as *Toxicodendron radicans, Gelsemium sempervirens, Rhododendron minus, Vaccinium arboreum, Vaccinium stamineum, Pinus virginiana, Juniperus virginiana*, and most *Quercus* species are more likely to occur on low elevation outcrops.

Low Elevation Cliffs and Rock Outcrops are distinguished from Piedmont and Mountain Glades and Barrens, as well as from all forest and woodland themes, by their sparse vegetation and limited soil. The predominance of bare rock distinguishes them from other naturally nonforested communities such as those of beaches, river bars, and excessively drained sands.

Within the theme, communities are primarily divided into rocky summit, granitic dome, cliff, and talus communities. As in the High Elevation Rock Outcrops theme, rocky summits are distinguished by an exposed topographic position and by fractured rock rather than smooth exfoliation surfaces. They generally occur on ridge tops or upper slopes but may occur on mid slopes where there is no topographic sheltering. They may be steep and cliff-like or more gently sloping. Fractures provide deep rooting sites for plants. Granitic domes generally are in a similarly exposed topographic situations, but the rock is a smooth exfoliation surface. Without deep crevices, plants are confined to shallow soil mats that are not well anchored to the rock surface. Cliffs are distinguished by a sheltered topographic position, generally lower slope, but potentially mid or, rarely, upper slope where adjacent landforms shelter them. They generally are steep, often vertical or overhanging, but may have a flatter top and may have ledges and other horizontal surfaces. The rock is generally fractured, offering at least some rooting sites. Talus consists of a deep surface cover of boulders, with little or no soil accumulation. Open, sparsely vegetated talus is extremely rare in North Carolina, where most accumulations of boulders support forest communities.

Sites: Low Elevation Cliffs and Rock Outcrop communities occur on outcrops of rock that have very little soil cover, because of steepness, high topographic position, and resistance to weathering.

Outcrops on higher topography tend to be more weathering-resistant kinds of rock, such as quartzite, granite, gneiss, rhyolite, or related rocks. Cliffs may be of a broader range of rock types, with the outcrop created or maintained by undercutting and collapse. Outcrops tend to be extremely heterogeneous at a fine scale, with cliffs and rocky summits often broken by ledges, chutes, overhangs, deep crevices, soil pockets, and aisles between slumped slabs of rock. Small accumulations of fallen boulders are common at the base of steeper outcrops, but larger areas of open talus are extremely rare.

Soils: Soil is limited to shallow mats or accumulations on smooth surfaces or in local small depressions and to occasional deeper accumulations in crevices. It presumably consists of a combination of marginally weathered rock and organic matter, perhaps with the addition of dust trapped by the vegetation.

Hydrology: Rock outcrop communities tend to be xeric overall, due to the lack of soil. Most rainfall runs off immediately, leaving the rock dry shortly afterward. However, moisture availability is extremely heterogeneous on a fine scale. Cliffs often have small, sometimes larger, zones of seepage emerging from fractures in the rock or from the edge of the soil cover above. Granitic domes too can have seepage areas on the edge of the soil of the adjacent forest. Even rocky summits may have microsites that concentrate or store water running off the bare rock, and deep crevices may provide substantial moisture for plants rooted in them. Slope aspect is also very important in determining moisture status of plants, as is the presence of overhangs. Overhangs and grottos can result from differential strength of rock layers but also often appear to be formed by sapping by ground water discharge.

Vegetation: All rock outcrop communities have limited cover of vascular plants, but their vegetation structure and composition tends to be extremely heterogeneous within occurrences as well as variable among the different communities and among the examples of them. Moister outcrops may have substantial cover of bryophytes, while drier outcrops may have substantial cover of crustose lichens, umbilicate lichens, or more xerophytic mosses. On the bare rock, vascular plants tend to be sparse. A suite of species that can grow on bare rock occurs across many of the communities. It includes several species of *Heuchera, Micranthes (Saxifraga), Asplenium, Bryodesma (Selaginella)*, and *Polypodium*. A further suite of herbs capable of surviving in shallow soil occurs on many outcrops, including drought-tolerant grasses such as *Danthonia* spp. and *Schizachyrium scoparium*, and forbs such as several *Houstonia* species, *Krigia* spp., *Hypericum gentianoides,* and *Phemeranthus teretifolius*, while additional more specialized rock outcrop species occur in particular communities. Individuals of any other species may occur in small numbers where there are favorable microsites. Trees or shrubs often take root in crevices. They may be of any species, but more often are drought-tolerant species such as *Juniperus virginiana, Pinus echinata, Pinus rigida, Pinus pungens, Quercus stellata, Quercus montana, Ulmus alata, Kalmia latifolia,* or *Vaccinium arboreum*. On ledges or flatter tops, patches of vegetation similar to glades may occur, with grasses or xerophytic sedges dominant. Granitic domes have distinctive vegetation representing stages of primary succession from *Grimmia laevigata* and *Bryodesma (Selaginella) rupeste* to small herbs to larger grassy patches and eventually shrubs and small trees.

Dynamics: Most rock outcrop communities appear stable for long time periods, but they are undergoing a slow primary succession as rock weathers, soil accumulates, and plants establish.

They tend to occur where these processes are particularly difficult and slow, due to resistant rock and steepness. Nevertheless, the continued long-term existence of rock outcrops clearly depends on primary succession being interrupted or reset. Where succession is not checked, they presumably develop into glades and ultimately into forests. Resetting may occur as rare collapse, breaking, or spalling of rock, which produces a fresh bare rock surface. Sapping by groundwater, undercutting by streams, or undermining by slope creep, as well as exfoliation or parallel jointing, may promote this. On granitic domes, where soil/vegetation mats are not well anchored, they eventually simply fall when they become too large and heavy. Maintenance of open rock may also be aided by droughts, which can kill established plants in the harsh environment. The author has observed many cases of well-established trees on outcrop dying during droughts. Heavy rains may also wash accumulated soil from some parts of outcrops and promote the falling of unanchored soil mats.

Comments: Site reports include many descriptions of most of the rock outcrop communities, varying in thoroughness. However, steeper outcrops such as cliffs and many granitic domes are extremely difficult to study quantitatively. Many of the intensive local vegetation analysis studies focused on forest vegetation and did not address rock outcrops at all. Where they were sampled in local studies, such as Newell (1997), the number of plots is few. Wiser, et al. (1996) was a comprehensive study of High Elevation Rocky Summits. Elsewhere, what plot data exist may be biased or misleading, as sampling often must be confined to the flatter portions or edges, which may not characterize the community as a whole. Several early studies with a floristic focus have provided published descriptions of various other rock outcrop communities (e.g., Taggart 1973, Dumond 1970, Cooper and Hardin 1970, and the particularly thorough focused study of Oosting and Anderson 1937).

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KEY TO LOW ELEVATION CLIFFS AND ROCK OUTCROPS

1. Community in an exposed topographic position, on an upper to mid slope without sheltering topography; if facing north, nevertheless exposed to drying winds; in the Mountains or mountainous foothills.
   2. Community on exfoliated granitic gneiss, granite, or related massive rocks; surface smooth, often curving from gentle to steep, with few or no deep fractures or crevices; vegetation, other than lichens and mosses on bare rock, consisting largely of plants in shallow soil mats, with *Bryodesma (Selaginella) rupestre* usually dominant. Larger plants, where present, also rooted in shallow soil mats; in the Mountains or mountain-like foothills. (Consider also High Elevation Granitic Dome if near 3000 feet elevation). ..... **Low Elevation Granitic Dome**
   2. Community not on exfoliated granite-like rocks; rock generally substantially fractured and offering some deep crevices or soil pockets; smoother only where bedding planes or edges of massive beds are exposed.
      3. Community on bedding planes of quartzite; vegetation dominated by mats of *Bryodesma (Selaginella) tortipilum, Carex umbellata, Kalmia (Leiophyllum) buxifolia*, and *Rhododendron carolinianum*, often with *Hudsonia montana*; extremely rare community possibly confined to the east rim of Linville Gorge..... **Low Elevation Rocky Summit (Quartzite Ledge Subtype)**
      3. Community not both on bedding planes of quartzite and dominated by the above species, though some of these species may be present and it may occur on quartzite with other configurations.
         4. Community containing multiple species indicative of higher pH and high base saturation, such as *Myriopteris (Cheilanthes) lanosa, Myriopteris tomentosa, Hylotelephium (Sedum) telephioides, Aquilegia canadensis*, *Pycnanthemum incanum*, *Philadelphus inodorus*, *Philadelphus hirsutus, Celtis tenuifolia*, and *Ptelea trifoliata*..... **Low Elevation Rocky Summit (Basic Subtype)**
         4. Community containing few or no species indicative of higher pH and high base saturation; flora largely or exclusively of acid-tolerant plants; *Kalmia latifolia, Vaccinium* spp., and other members of the Ericaceae often prominent..... **Low Elevation Rocky Summit (Acidic Subtype)**

1. Community in a topographically sheltered setting, on a lower slope, or if higher upslope, in a narrow gorge or facing north; in any region.
   5. Community in the Coastal Plain; substrate of unconsolidated or marginally consolidated sediments. ..... **Coastal Plain Cliff**
   5. Community not in the Coastal Plain; substrate igneous, metamorphic, or consolidated sedimentary rock.
      6. Community on talus or loose piles of boulders with extensive open space between and beneath them; in the Mountains..... **Talus Vineland**
      6. Community not on talus or loose boulders; in either the Mountains or Piedmont.
         7. Community in the Piedmont outside of the mountainous foothills; containing little or no montane flora (though occasional disjunct populations of montane species may be present); species not characteristic of the Mountains, such as *Quercus stellata, Ulmus alata, Vaccinium arboreum, Piptochaetium avenaceum*, and *Gelsemium sempervirens,* present and usually abundant and diverse; associated with Piedmont communities.
            8. Community containing indicators of high base saturation and higher pH, such as *Aquilegia canadensis, Myriopteris (Cheilanthes) lanosa, Asplenium trichomanes, Asplenium rhizophyllum, Adiantum pedatum, Asarum canadense*, and species shared with basic forests or floodplain forests ..... **Piedmont Cliff (Basic Subtype)**
            8. Community containing few or no species suggesting high base saturation; flora almost exclusively of acid-tolerant species. ..... **Piedmont Cliff (Acidic Subtype)**

7. Community in the Mountains or mountain-like foothills area; montane flora such as *Micranthes petiolaris, Heuchera villosa, Polypodium appalachianum, Carex biltmoreana, Rhododendron maximum, Tsuga canadensis,* and *Betula lenta* relatively abundant and diverse; associated with Mountain communities.

9. Community containing multiple species indicative of higher pH and high base saturation, such as *Aquilegia canadensis, Asplenium rhizophyllum, Asplenium resiliens, Micranthes careyana, Cystopteris* spp., *Philadelphus* spp., and *Hydrangea arborescens*; substrate mafic or calcareous rock or apparently influenced by base-rich rock.

10. Substrate of calcareous rock such as limestone, dolomite, marble, or occasionally calc-silicate; species of strongly calcareous conditions present, such as *Asplenium resiliens, Cystopteris bulbifera, Asplenium ruta-muraria,* and *Pellaea atropurpurea*, and *Sedum glaucophyllum* present; other species indicative of high base saturation more numerous. ....**Montane Cliff (Calcareous Subtype)**

10. Substrate of mafic rock such as amphibolite, hornblende gneiss, or possibly calc-silicate, or apparently influenced by such rocks; species indicative of higher pH and high base saturation abundant but less so, species of strongly calcareous conditions absent. .... **Montane Cliff (Mafic Subtype)**

9. Community containing few or no species indicative of higher pH and high base saturation; flora consisting largely or exclusively of acid-tolerant species; substrate felsic or other acidic rock. .....**Montane Cliff (Acidic Subtype)**

LOW ELEVATION ROCKY SUMMIT (ACIDIC SUBTYPE)

Concept: Low Elevation Rocky Summits are flat-to-vertical outcrops of fractured rock on ridge tops, upper to mid slopes, or other topographically exposed settings at low to mid elevations, general below 4000 feet. Vegetation of Low Elevation Rocky Summit communities is sparse or patchy in density and is generally characterized by a mix of growth forms, including forbs, granimoids, shrubs, and trees. The Acidic Subtype is the widespread community of felsic rocks, quartzite, or other acidic rocks, lacking plants that indicate higher pH conditions and also lacking the distinctive characteristics of the Quartzite Ledge Subtype.

Distinguishing Features: Low Elevation Rocky Summits are distinguished from High Elevation Rocky Summits, which have similar site configuration and vegetation structure, by an elevation generally below 4000 feet. Near the transition zone, they are distinguished by flora. Characteristic low elevation species include *Bryodesma (Selaginella) rupestre, Danthonia spicata, Danthonia sericea, Chimaphila maculata, Rhododendron minus, Quercus montana, Pinus virginiana,* and *Pinus echinata*. Characteristic high elevation species that seldom occur in Low Elevation Rocky Summit include *Bryodesma tortipilum, Carex brunnescens, Sibbaldiopsis tridentata, Rhododendron (Menziesia) pilosum, Picea rubens, Sorbus americana*, and a number of rarer plant species such as *Liatris helleri*. However, a few species more typical of higher elevations are found in Low Elevation Rocky Summits, including *Rhododendron catawbiense*, *Danthonia compressa*, and *Mononeuria (Arenaria, Minuartia) groenlandica*.

Low Elevation Rocky Summits are distinguished from Montane Cliffs by occurring in topographically exposed situations. Both may be steep to vertical, though Rocky Summits may be less steep. Cliffs are confined to lower slopes, gorges, or other topographically sheltered environments. Low Elevation Rocky Summits are distinguished from Low Elevation Granitic Domes by rock structure and vegetation. Rocky Summits have fractured rock which offers some deeper rooting sites and greater stability to at least some plants. Granitic Domes have smooth exfoliated rock surfaces where vegetation is confined to shallow soil mats.

Low Elevation Rocky Summits are distinguished from various Piedmont and Mountain Glades and Barrens, as well as from forests, by having less continuous vegetation and soil. Though shrub and tree patches may be present, the predominant ground cover in Low Elevation Rocky Summit is bare rock or lichen. Small Low Elevation Rocky Summits can be difficult to distinguish from small, shaded rock outcrops that are regarded as part of a forest. To be classified as a Low Elevation Rocky Summit, an outcrop should be large enough to create a persistent gap in the canopy, and it should have multiple species typical of bare rock or open sunny conditions.

The Acidic Subtype is distinguished from the Basic Subtype by the lack or near lack of plants preferring higher pH conditions, such as *Myriopteris (Cheilanthes) lanosa, Hylotelephium (Sedum) telephioides, Sedum glaucum, Aquilegia canadensis*, and *Pycnanthemum incanum*. Given the typically sparse vegetation of Rocky Summits, these species may be limited in abundance even in the Basic Subtype. The Quartzite Ledge Subtype is distinguished from Low Elevation Rocky Summit by a distinctive configuration of flat-lying quartzite beds with vegetation intermediate between Rocky Summit and Granitic Dome, as well as intermediate between low and higher elevation communities. *Bryodesma (Selaginella) tortipilum* is abundant in it, and *Kalmia*

(Leiophyllum) buxifolia, Hypericum densiflorum, Xerophyllum asphodeloides, and *Tsuga caroliniana* are characteristic.

Synonyms: *Saxifraga michauxii* Herbaceous Vegetation (CEGL004524).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Sites: Low Elevation Rocky Summits occur on ridge tops or on upper to mid slopes exposed to sun and wind. The rock tends to be somewhat fractured, offering at least a few deeper crevices and soil pockets. The rock may be relatively flat-lying or may include cliffs that are vertical or even overhanging. The rock structure may be very heterogeneous, with a flat top, jagged crags, vertical faces, ledges, chutes, overhanging faces, and grottos potentially present. The rock in the Acidic Subtype tends to be quartzite, granite, gneiss, or other acidic rocks.

Soils: Soil is limited to local small depressions and to occasional deeper accumulations in crevices. It presumably consists mainly of marginally weathered rock and accumulated organic matter but may locally include soil washed in from above.

Hydrology: Low Elevation Rocky Summits tend to be xeric overall. With little soil, rainfall runs off immediately, leaving the rock dry most of the time. Seeps are rare in Rocky Summits, but small ones may occur. Local microsites may concentrate or trap rainwater and runoff, creating moist conditions.

Vegetation: The vegetation on Low Elevation Rocky Summits is sparse but with a patchy structure that may include small denser areas. Large areas are bare rock with only crustose lichens. Other lichens, including *Umbilicaria* spp. or *Lasallia papulosa* may be present in patches of steep rock, while *Cladonia* spp., *Grimmia laevigata*, *Polytrichum* spp., and other mosses may dominate patches on flatter surfaces. Herbs of bare rock or extremely shallow soil, such as *Heuchera villosa, Bryodesma rupestre, Micranthes (Saxifraga, Hydatica) petiolaris* var. *petiolaris, Campanula divaricata*, and *Hypericum gentianoides* occur with moderate frequency. Less frequent such species in site descriptions include *Asplenium montanum*, *Asplenium bradleyi*, *Polypodium virginianum, Polypodium appalachianum, Mononeuria groenlandica,* and *Corydalis sempervirens*. More widespread herbs of open areas are fairly diverse, though they occupy a limited area. *Schizachyrium scoparium*, *Danthonia spicata, Danthonia compressa*, and *Coreopsis major* have high constancy in site descriptions. Other such species with fairly high frequency include *Andropogon virginicus, Danthonia sericea,* and *Packera anonyma*. A number of species shared with forest communities are generally also present, though only a few, such as *Dryopteris marginalis, Chimaphila maculata* and *Goodyera pubescens,* have even moderate frequency. Woody species may dominate patches that have as much or more cover than the herbs. *Kalmia latifolia* is nearly constant, while *Rhododendron minus, Rhododendron maximum*, *Vaccinium pallidum, Gaylussacia baccata, Rubus* spp., and, somewhat surprisingly, *Rhododendron catawbiense* and *Hydrangea arborescens,* are at least somewhat frequent. Vines are not usually prominent, but *Smilax rotundifolia* and *Toxicodendron radicans* occur with some moderate frequency. Among the trees that may occur on the edges or in crevices and deeper soil pockets, *Quercus montana* is highly constant, and *Acer rubrum, Quercus rubra, Pinus pungens, Pinus virginiana, Amelanchier arborea, Oxydendrum arboreum, Nyssa sylvatica, Pinus echinata,* and *Quercus alba* are at least fairly frequent.

Range and Abundance: Ranked G3? North Carolina examples are scattered throughout the Mountain region and mountainous foothills. Fewer than 50 occurrences are known. This community also occurs in Georgia, South Carolina, Tennessee, and Virginia.

Associations and Patterns: Low Elevation Rocky Summit (Acidic Subtype) is a small patch community. Most patches are one or a few acres, though some occur in clusters that add up to ten acres or more. Extent is often difficult to assess because rock patches may be interspersed with forest shrub vegetation and because important surfaces may be near vertical. Low Elevation Rocky Summits are generally surrounded by dry forest or woodland vegetation, usually a community in the Mountain Oak Forests or Mountain Dry Coniferous Woodland theme. They may also be associated with Piedmont and Mountain Glades and Barrens. The transition to the adjacent forest or woodland can sometimes be gradual and ambiguous, with woody vegetation patches becoming larger but not continuous in the peripheral areas and small open rocks continuing into the forest.

Variation: Examples vary with degree of development and with the nature of the surrounding vegetation. They may potentially vary with elevation, slope aspect, configuration of the rocks, and type of rock, but patterns of variation have not been identified.

Dynamics: Low Elevation Rocky Summits are generally among the most stable of rocky outcrop communities. They are less likely to experience undercutting and collapse than cliffs. With their deep rooting sites in crevices and deeper soil pockets, they are less likely to have vegetation mats slough off than are granitic domes. However, they are subject to stress and mortality of established vegetation caused by drought. Their high topographic position and occurrence in a landscape of dry communities exposes them to fire. Heat may stress or kill plants even where the sparse vegetation itself will not carry fire, vegetation patches on the edge may burn, and fire may jump to some isolated vegetation patches. The importance of fire in this community has received limited study or discussion, but Barden (2000) argued that it was important in at least one site (Crowders Mountain) and was responsible for maintaining a disjunct population of *Quercus ilicifolia*. While this may be one of the most fire-prone Low Elevation Rocky Summit sites, it is possible fire is more generally important. The stressful environment may allow fire to have more dramatic effects on woody vegetation in Low Elevation Rocky Summits than in typical forest communities. The prominence of woody plants in comparison to herbaceous plants in many site descriptions may be partly a result of lack of fire.

Comments: This community is frequently described in unpublished site reports, and there was an early published description in Williams and Oosting (1944), but it otherwise has little published material. Only a couple of CVS plots appear to represent it. The comprehensive study of Wiser (1993) for higher elevation rock outcrops did not include it.

The concept of Low Elevation Rocky Summit has been narrowed from the 3rd Approximation by the creation of the Low Elevation Acidic Glade and other glade communities. Low Elevation Rocky Summit (Acidic Subtype) appears to be more abundant than Low Elevation Acidic Glade, but the number of apparent occurrences has been reduced.

Rare species:

Vascular plants: *Asplenium bradleyi, Chenopodium simplex, Heuchera hispida, Heuchera pubescens, Liatris aspera, Lysimachia tonsa, Mononeuria groenlandica, Quercus ilicifolia, Sisyrinchium dichotomum, Spiraea corymbosa,* and *Woodsia appalachiana*.
Nonvascular plants: *Coscinodon cribrosa.*
Vertebrate animals: *Falco peregrinus, Neotoma magister,* and *Plethodon yonahlossee* pop. 1.
Invertebrate animals: *Hypochilus coylei.*

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LOW ELEVATION ROCKY SUMMIT (BASIC SUBTYPE)

Concept: Low Elevation Rocky Summits are flat-to-vertical outcrops of fractured rock on ridge tops, upper-to-mid slopes, or other topographically exposed settings at low to mid elevations, general below 4000 feet. Vegetation of Low Elevation Rocky Summit communities is sparse or patchy in density and is generally characterized by a mix of growth forms, including forbs, granimoids, shrubs, and trees. The Basic Subtype is a rare community that shows evidence of more base-rich, higher pH conditions, generally occurring on mafic rock or basic sedimentary rocks, occasionally on acidic rocks influenced by base-rich seepage.

Distinguishing Features: Low Elevation Rocky Summits are distinguished from High Elevation Rocky Summits, which have similar site configuration and vegetation structure, by an elevation generally below 4000 feet. See the Acidic Subtype for species that indicate high elevation and low elevation.

The Basic Subtype is distinguished from the Acidic Subtype by the presence of plants preferring higher pH conditions, such as *Myriopteris (Cheilanthes) lanosa, Myriopteris tomentosa, Hylotelephium (Sedum) telephioides, Aquilegia canadensis*, *Pycnanthemum incanum*, *Philadelphus inodorus*, *Philadelphus hirsutus, Celtis tenuifolia*, and *Ptelea trifoliata*. Species that indicate base-rich conditions in forest communities, such as *Fraxinus biltmoreana* or *Ulmus rubra*, may also be present. Most species of the Acidic Subtype, such as *Micranthes petiolaris* var. *petiolaris, Danthonia spicata, Heuchera villosa*, and *Campanula divaricata* are also present in the Basic Subtype. Rocky summits are extremely heterogeneous environments, with moisture and nutrient levels varying greatly among small microsites. All vascular plants, including the indicator species of basic conditions, may be sparse.

Synonyms: *Saxifraga michauxii - Cheilanthes lanosa - Hylotelephium telephioides* Herbaceous Vegetation (CEGL004989).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Sites: Low Elevation Rocky Summits occur on ridge tops or on upper-to-mid slopes exposed to sun and wind. The rock tends to be somewhat fractured, offering at least a few deeper crevices and soil pockets. The rock may be relatively flat-lying or may include cliffs that are vertical or even overhanging. The rock structure may be very heterogeneous, with a flat top, jagged crags, vertical faces, ledges, chutes, overhanging faces, and grottos potentially present. The rock in the Basic Subtype is usually amphibolite or hornblende gneiss, but it may be calc-silicate or, less often, felsic rock that presumably is influenced by adjacent mafic rock.

Soils: Soil is limited to local small depressions and to occasional deeper accumulations in crevices. It presumably consists mainly of marginally weathered rock and accumulated organic matter but may locally include soil washed in from above. Vegetation suggests that the chemistry of this limited soil is strongly influenced by the mafic rock; presumably it has high base saturation and circumneutral pH.

Hydrology: Low Elevation Rocky Summits tend to be xeric overall. With little soil, rainfall runs off immediately, leave the rock dry most of the time. Seeps are rare in Rocky Summits, but small

ones may occur. Local microsites may concentrate or trap rainwater and runoff, creating moist conditions.

Vegetation: The vegetation on Low Elevation Rocky Summits is sparse but with a patchy structure that may include small denser areas. Large areas are bare rock with only crustose lichens. Larger lichens such as *Umbilicaria* spp., *Lasallia papulosa*, or *Cladonia* spp. may be present in places, as may a variety of mosses. Some herbs of bare rock or minimal soil, such as *Myriopteris tomentosa, Myriopteris lanosa, Heuchera villosa, Heuchera americana, Heuchera caroliniana, Polypodium virginianum, Hylotelephium telephioides*, *Micranthes careyana, Micranthes caroliniana,* and *Micranthes petiolaris*, are generally present, but only the *Myriopteris* have even moderate frequency in site descriptions. A diverse collection of herbs shared with the Acidic Subtype and species indicative of richer conditions is present. *Aquilegia canadensis, Helianthus divaricatus, Packera anonyma*, and *Coreopsis major* are moderately frequent in site reports. Other species include *Penstemon canescens, Penstemon smallii, Schizachyrium scoparium, Rudbeckia hirta, Liatris aspera, Andropogon gerardii, Micranthes careyana, Micranthes caroliniana, Tradescantia* spp., *Pycnanthemum incanum, Scleria oligantha, Solidago* spp., *Eupatorium godfreyanum, Danthonia spicata, Actaea racemosa*, *Chasmanthium latifolium, Asclepias verticillata*, and a great many others. Shrubs that may dominate small patches include both species indicative of the rich conditions, such as *Celtis tenuifolia, Lonicera flava, Ptelea trifoliata, Philadelphus hirsutus,* and *Physocarpus opulifolius*, and species shared with the Acidic Subtype, such as *Kalmia latifolia, Vaccinium pallidum*, and *Vaccinium stamineum*. Among trees, *Quercus montana* and *Pinus virginiana* are the most frequent species, but *Crataegus* spp., *Juniperus virginiana*, *Chionanthus virginicus*, *Ulmus rubra*, *Fraxinus biltmoreana*, and less frequently, *Carya cordiformis, Ostrya virginiana,* and *Cercis canadensis* suggest high base status. Shrubs and trees may be diverse in individual examples, often representing more species than the herbs reported.

Range and Abundance: Ranked G1 but probably G2. In North Carolina, about a dozen occurrences are known. The majority are in the foothills or Blue Ridge escarpment, with only a few examples in the Blue Ridge itself. The synonymized association is attributed definitively only to North Carolina but may occur South Carolina or Georgia.

Associations and Patterns: Low Elevation Rocky Summit (Basic Subtype) is a small patch community. Most patches are one or a few acres, though some occur in clusters that add up to ten acres or more. Extent is often difficult to assess because rock patches may be interspersed with forest shrub vegetation and because important surfaces may be near vertical. Low Elevation Rocky Summits are generally surrounded by dry forest or woodland vegetation. Often the surrounding forest is a basic community such as Montane Oak–Hickory Forest (Basic Subtype), but it can be a more common acidic community. Occasionally the Basic Subtype is associated with a glade or woodland community such as Low Elevation Basic Glade or Montane Red Cedar–Hardwood Woodland.

Variation: Occurrences of the Basic Subtype are extremely variable, but patterns of variation have not been recognized. The small number of occurrences will make elucidation of patterns difficult. Examples can be expected to vary with elevation, configuration of the rocks, slope aspect, and degree of basic influence.

Dynamics: Low Elevation Rocky Summits are generally the most stable of rocky outcrop communities. They are less likely to experience undercutting and collapse than cliffs. With their deep rooting sites in crevices and deeper soil pockets, they are less likely to have vegetation mats slough off than are granitic domes. However, they are subject to stress and mortality of established vegetation caused by drought. Their high topographic position and occurrence in a landscape of dry communities exposes them to fire. Heat may stress or kill plants even though the sparse vegetation itself will not carry fire, and vegetation patches on the edge may burn.

Comments: This community is very little studied. No CVS plots appear to have been sampled in it and no published literature has been identified.

The concept of Low Elevation Rocky Summit has been narrowed from the 3rd Approximation by the creation of the Low Elevation Basic Glade and other glade communities. Low Elevation Basic Glade occurrences seem to be substantially more abundant than Low Elevation Rocky Summit (Basic Subtype) occurrences.

Rare species:
Vascular plants: *Berberis canadensis, Liatris aspera, Micranthes caroliniana, Mononeuria groenlandica, Packera millefolium, Spiranthes ochroleuca, Tradescantia virginiana,* and *Woodsia appalachiana*.
Invertebrate animals: *Papilio cresphontes*.

References:

LOW ELEVATION ROCKY SUMMIT (QUARTZITE LEDGE SUBTYPE)

Concept: The Quartzite Ledge Subtype is a distinctive community of the flat-lying quartzite outcrops around Linville Gorge. It is intermediate between Low Elevation Rocky Summit and High Elevation Rocky Summit, with characteristics of both; it also shares characteristics with High Elevation Granitic Dome and Low Elevation Acidic Glade. It has additional unique characteristics related to extreme acidity, bedding plane exposure with limited fracturing, and exposure to fire. It is characterized by the narrow endemic species *Hudsonia montana* and by abundant *Kalmia* (*Leiophyllum*) *buxifolia* and *Rhododendron carolinianum*, along with herbaceous mats dominated by *Bryodesma (Selaginella) tortipilum*.

Distinguishing Features: The Quartzite Ledge Subtype occurs around 4000 feet, the transition elevation between Low Elevation Rocky Summit and High Elevation Rocky Summit. It can be distinguished from all subtypes of both by the combination of flat-lying quartzite with limited fracturing, along with sparse patchy vegetation dominated by *Bryodesma tortipilum*, *Kalmia buxifolia*, *Rhododendron carolinianum*, and *Hudsonia montana*. Not all quartzite outcrops support this subtype. It is presently known only on the southeast rim of Linville Gorge where *Hudsonia montana* occurs, but it may be recognized outside of the range of *Hudsonia* if flat-lying quartzite ledges are found to support an otherwise-similar community.

While the Quartzite Ledge Subtype resembles High Elevation Granitic Dome in having *Bryodesma tortipilum* as a near-constant patch dominant, and in sharing a number of species, including *Carex umbellata, Danthonia sericea*, and several shrubs, there are substantial floristic as well as environmental differences. In roughly 15 plots in the Carolina Vegetation Survey database for the Quartzite Ledge Subtype and 40 for Granitic Domes, plant species frequent in the Quartzite Ledge Subtype and seldom or never in Granitic Domes include *Hypericum densiflorum, Xerophyllum asphodeloides, Coreopsis major*, and *Tsuga caroliniana*. Species of High Elevation Granitic Domes and scarce or absent in this subtype include *Hypericum gentianoides, Houstonia longifolia, Hypericum buckleyi, Krigia montana*, and *Diervilla sessilifolia*.

Synonyms: *Leiophyllum buxifolium - (Hudsonia montana) / Selaginella tortipila - Carex umbellata* Quartzite Outcrop Dwarf-shrubland (CEGL007010).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Sites: The Quartzite Ledge Subtype occurs on level exposed beds of quartzite with limited fracturing. Examples are at around 4000 feet elevation.

Soils: Soil is largely limited to shallow mats on the rock surface. Given the limited weathering residue left by quartzite, they may consist largely of windblown material and organic matter accumulated by plants.

Hydrology: The Quartzite Ledge Subtype, as with other rock outcrop communities, is xeric overall because of the limited soil. However, rainfall may run off more slowly from the horizontal surface than it does in most rock outcrops.

Vegetation: The Quartzite Ledge Subtype vegetation is patchy, with areas of herbs and shrubs interspersed with areas of bare or lichen-covered rock. *Bryodesma tortipilum* dominates the herbaceous areas, and *Carex umbellata* and *Xerophyllum asphodeloides* are frequent species in Newell (1997) and Newell and Peet (1998) plot data. Other herbs typical of Low Elevation Rocky Summits or shared with adjacent forests are present at low frequency in plot data but may be more frequent in sites as a whole, including *Danthonia sericea, Coreopsis major, Paronychia argyrocoma*, *Chasmanthium laxum, Iris verna, Lysimachia quadrifolia, Liatris virgata*, and *Pteridium latiusculum*. Several rare herbaceous species also occur, including *Liatris helleri* and *Mononeuria groenlandica*. Shrubs that frequently dominate woody patches include *Rhododendron carolinianum, Kalmia buxifolia, Rhododendron catawbiense, Kalmia latifolia, Eubotrys recurva, Gaylussacia baccata*, and *Fothergilla major*, while *Hudsonia montana, Lyonia ligustrina, Clethra acuminata, Ilex montana*, and other species may also occur. The NVC description also noted *Hypericum densiflorum*. *Smilax rotundifolia* and *Smilax glauca* are fairly frequent. Frequent trees include *Pinus pungens, Pinus rigida, Acer rubrum*, *Tsuga caroliniana, Pinus strobus, Pinus virginiana, Nyssa sylvatica*, and *Quercus montana.*

Range and Abundance: Ranked G1. This is a narrow endemic community, known only from the eastern rim of Linville Gorge in Burke County and unlikely to be found in other states.

Associations and Patterns: The Quartzite Ledge Subtype is a small patch community, with occurrences of up to a few acres in aggregate. It may be surrounded by a variety of dry forest communities such as Chestnut Oak Forest or Pine–Oak/Heath.

Variation: This is a narrowly defined community. Variation is primarily in the transition to other communities.

Dynamics: Much attention has been paid to the dynamics of the Quartzite Ledge Subtype, because of concern for the federally listed *Hudsonia montana*. Unpublished work by Cecil Frost and observations by botanists working with this species have described the importance of fire. This community is highly dependent on burning to maintain its open character. In the absence of fire, woody cover increases at the expense of herbaceous vegetation and perhaps open rock as well. The small-statured *Hudsonia montana* is eventually eliminated from soil mats by taller *Rhododendron, Kalmia*, and other shrubs, or becomes confined to shallower soils that are marginal for its survival. The NVC description describes the presumed natural structure as essentially extinct, though noting that it is being restored in places by prescribed burning. The dilemma is illustrated by the absence of *Hudsonia montana* from most of the plot data.

Other than fire, dynamics of this subtype are probably intermediated between those of other subtypes and those of granitic domes. The soil mats are shallow, and it is likely that drought may cause mortality of shrubs and trees, and that mats are easily destroyed to restart primary succession.

Comments: This community has been difficult to place in classifications, as it shares characteristics with multiple different rock outcrop types. It was treated as a variant of High Elevation Rocky Summit in the 3rd Approximation. Its elevational range is near the 4000 foot elevation that is the general division between High Elevation and Low Elevation Rocky Summit. However, most examples fall below 4000 feet, and the xeric nature of the vegetation, importance

of fire, and absence of most of the characteristic high elevation plant species tie it more closely to other Low Elevation Rocky Summits. Newell (1997) initially synonymized her equivalent vegetation type with the association that represents High Elevation Granitic Dome, because of the dominance of *Bryodesma tortipilum* and the presence of *Carex umbellata*. The transition from low elevation to high elevation types of granitic domes is lower than for rocky summits, and its 4000 foot elevation is within the range of High Elevation Granitic Dome. The smooth, unfractured bedding planes support similar shallow, minimally anchored soil mats. However, ad hoc analysis of plot data by NatureServe in 1997 for the two community types illustrated the differences. The importance of fire and the tendency of woody vegetation to increase in cover in its absence gives the Quartzite Ledge Subtype affinity with various glade communities. Finally, the patchiness of the vegetation makes it difficult to characterize the vegetation structure. This is the case with several rock outcrop communities, but it is made more difficult because of the presumed change in vegetation structure with lack of fire.

Rare species:
Vascular plants: *Hudsonia montana, Liatris aspera, Liatris helleri, Mononeuria groenlandica, Packera millefolium,* and *Trichophorum cespitosum*.

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

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

LOW ELEVATION GRANITIC DOME

Concept: Low Elevation Granitic Domes are communities of large, smooth, exfoliation surfaces of granitic rock, occurring at lower elevations than High Elevation Granitic Domes, generally below 3000 feet. The exfoliated surfaces have few cracks or crevices that allow deep rooting of plants. Vegetation consists primarily of lichens on bare rock or of shallow mats generally dominated by *Bryodesma (Selaginella) rupestre*.

Distinguishing Features: Low Elevation Granitic Domes are distinguished from High Elevation Granitic Domes by elevation and vegetation. The elevational boundary is around 3000 feet, but the types may overlap somewhat. Species that occur in High Elevation Granitic Domes but seldom in Low Elevation Granitic Domes include *Carex misera, Carex biltmoreana, Trichophorum cespitosum, Danthonia compressa, Hypericum buckleyi, Packera millefolium,* and *Robinia hartwigii*. Species that occur in Low Elevation Granitic Domes but seldom or less often in High Elevation include *Bryodesma rupestre, Danthonia spicata, Hypericum gentianoides, Hexasepalum (Diodia) teres, Phemeranthus teretifolius, Phlox nivalis ssp. hentzii, Rhododendron minus, Chionanthus virginicus, Juniperus virginiana*, *Pinus virginiana*, and *Carya* spp.

Granitic Domes are distinguished from most other rock outcrop communities by a near absence of crevices and deep soil pockets, so that what vascular vegetation there is tends to be strongly dominated by shallow mats. In contrast, glades have undulating rock with more extensive areas of better-developed shallow soil where graminoids and low shrubs may predominate. Rocky summits may have local areas of shallow soil mats, but also support substantial plant cover rooted in crevices or deeper pockets. Cliffs are located in more topographically sheltered situations, generally on lower slopes or gorge walls, and generally also are more fractured. Smooth, exfoliated rock faces which extend onto lower slopes or gorge walls should be treated as Low Elevation Granitic Domes if the rock is largely free of fractures and the vegetation is similar to that described above.

Another community that may occur on the same rock outcrops as Low Elevation Granitic Domes is Low Elevation Seep (Bedrock Subtype). It is a wetland community that occurs where seepage areas are extensive and have well-developed bryophyte mats or distinctive wetland flora. It should be recognized only for large, well-developed patches, while small seeps should be treated as part of the Low Elevation Granitic Dome community.

Low Elevation Granitic Domes sometimes have zones along their edges with vegetation that resembles Pine–Oak/Heath. These areas should be considered part of the Granitic Dome community unless they cover a substantial area or extend far from the rock outcrop.

Low Elevation Granitic Domes grade conceptually into Low Elevation Basic Glades. The Brushy Mountains Subtype especially may resemble it. Glades are distinguished by more continuous soils and vegetation, though their soils are still shallow and their vegetation of low stature and often of similar composition. Often glades are on rocks that appear to be exfoliation surfaces that are more irregular, with undulating surfaces and more weathering pits. Both communities can contain patches that resemble the other, and in such cases, classification may need to be decided by the

preponderance of cover. Only if there are substantial contiguous areas of both should both types be recognized on a single outcrop.

Low Elevation Granitic Domes share many characteristics with Granitic Flatrocks but are distinguished by geographic location and associated floristic differences. The most characteristic Granitic Flatrock species are largely or completely absent in Low Elevation Granitic Domes.

Synonyms: *Selaginella rupestris - Schizachyrium scoparium - Hypericum gentianoides - Bulbostylis capillaris* Herbaceous Vegetation (CEGL007690).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Sites: Low Elevation Granitic Domes occur on outcrops of exfoliated massive rocky, usually granite or related rocks or granitic gneiss. Slopes may be gentle or steep, but large examples often curve gradually from nearly flat to nearly vertical. Domes are usually in upper slope positions and most often face south. Examples are known from 1700 feet to 3300 feet in elevation.

Soils: Soils are generally absent, except for patchy mats of shallow organic or mineral matter, usually of a sandy texture. Shallow continuous soils occur at the periphery.

Hydrology: Low Elevation Granitic Domes tend to be xeric overall. With little soil, rainfall runs off immediately, leaving the rock dry most of the time. It is notable that some examples occur in areas with twice the rainfall of other examples, with no noticeable difference in vegetation.

Small seeps are common on the edges of domes, where moisture percolating through forest soil meets the bare rock. Occasionally a more persistent small stream may flow down the rock. Where domes have flatter tops, they may have small weathering pits that can trap water for a while after rains.

Vegetation: Low Elevation Granitic Domes include large areas of rock that is bare or covered with crustose lichens. Areas of *Umbilicaria* sp. or *Lasallia papulosa* may be present. Nonvascular plants that may colonize bare rock include *Grimmia laevigata, Racomitrium heterostichum, Polytrichum juniperinum, Polytrichum commune*, and in wet areas, *Sphagnum* spp., *Andraea rupestris*, and *Hedwigia ciliata*. Clumps of *Cladonia* spp. are common. Vegetation mats of *Bryodesma rupestre* dominate the portions with vascular vegetation. Deeper mats are usually dominated by *Schizachyrium scoparium* or *Danthonia spicata*, both of which are highly constant in occurrences. Other frequent herbs which may dominate patches include *Danthonia sericea, Andropogon virginicus, Hypericum gentianoides, Corydalis sempervirens, Coreopsis major*, *Phemeranthus teretifolius*, and *Micranthes petiolaris* var. *petiolaris*. Other species at least fairly frequent in occurrences or the few CVS plots include *Campanula divaricata, Hexasepalum (Diodia) teres, Polygala curtisii, Hylotelephium telephioides, Heuchera villosa, Heuchera americana, Heuchera parviflora, Bulbostylis capillaris, Carex biltmoreana, Houstonia longifolia* var. *glabra, Houstonia purpurea, Dryopteris marginalis, Mononeuria groenlandica, Packera anonyma, Packera millefolium, Pycnanthemum incanum*, and *Scleria triglomerata*. A great variety of herbs occurs in one or two examples, including species shared with other rock outcrops, species shared with glades, and species typical of burned woodlands. Where soil accumulations are deep enough to support shrubs, *Kalmia latifolia* is highly constant and *Rhododendron minus, Vaccinium*

pallidum, Vaccinium stamineum, and *Rhododendron maximum* are frequent. *Pinus rigida, Quercus montana*, and *Juniperus virginiana* are the most frequent trees. Also, fairly frequent are *Amelanchier arborea/laevis, Chionanthus virginicus, Pinus pungens, Quercus coccinea*. A few occurrences have *Pinus echinata* or *Quercus stellata*. A few occurrences have small rich portions that may contain species such as *Ptelea trifoliata*, *Physocarpus opulifolius*, or *Phildelphus hirsutus*.

Range and Abundance: Ranked G2 but perhaps G3. In North Carolina, this community is scattered through the Blue Ridge, including the escarpment area, and in the foothills. There is a concentration in the southern mountains of Henderson, Transylvania, and Macon counties. This community also ranges southward to Georgia and Alabama.

Associations and Patterns: Low Elevation Granitic Domes are best considered small patch communities. Many examples are a few acres in size, but larger ones may be tens of acres and a few complexes exceed 100 acres. Low Elevation Granitic Domes are usually bordered by Pine–Oak/Heath or various oak forests. Lower edges may grade to Acidic Cove Forest. Patches of the rare Low Elevation Seep (Bedrock Subtype) or Low Elevation Acidic Glade (Biltmore Sedge Subtype) may be associated with them.

Variation: Examples vary with configuration of the rock. Relative amounts of bare rock and vegetation mats may vary with rock configuration but also with time and with amount of visitation.

Dynamics: Granitic Dome communities are primary successional communities like other rock outcrops, but they display a distinctive kind of successional dynamics as described by Oosting and Anderson (1937) for High Elevation Granitic Domes. Bare rock is colonized by mosses, particularly *Grimmia laevigata*, and by *Bryodesma tortipilum*. These pioneer mats trap sand grains and wind-blown dust, and accumulate organic matter, forming shallow soil that eventually can be colonized by other plants. As mats expand at their edges and become thicker, larger herbs and eventually shrubs and trees can root in them. Because the mats are not well anchored to the smooth rock beneath, most mats slough off under their own weight before they become very old. This tendency is greater on the steeper slopes and is exacerbated both by the death of the shallowly rooted trees and shrubs and by saturation of the mats during heavy rains. This cyclic succession maintains a predominance of bare rock and early successional mats despite the occurrence of many examples in areas with very high rainfall. Spalling of the rock surface may also occasionally renew the unweathered rock surface. The overall complex of vegetation zones appears relatively stable over time. However, flatter upper edges of domes are less susceptible to sloughing, and a more continuous zone of shallow soil shrubland can develop there. Most of the sparse vegetation of the community would not carry fire and probably is little affected by fire in surrounding communities. However, it is possible that the upper edge may shift in response to fire dynamics or climatic cycles.

Comments: The 4th Approximation treatment of Low Elevation Granitic Dome has been narrowed from earlier classifications. The 3rd Approximation included a Basic Variant of Low Elevation Granitic Dome, which was treated as a subtype in early drafts of the 4th Approximation. It has been removed to be treated as the Brushy Mountains subtype of Low Elevation Basic Glade, because examples appear to be more heavily vegetated than typical Low Elevation Granitic Dome.

Nevertheless, it more resembles Low Elevation Granitic Dome than the other subtype of Low Elevation Glade does. Some outcrops in the Brushy Mountains remain classified as Low Elevation Granitic Dome but share some of the distinctive species of Low Elevation Basic Glade (Brushy Mountain Subtype).

Low Elevation Granitic Domes share many characteristics with Granitic Flatrocks, including the distinctive cyclic succession of unanchored soil mats, but their steepness causes differences. Vegetation mats are slower to start and are sooner destroyed by sloughing off. Few mats reach the stage of dominance by woody vegetation. Also, the distinctive pools of flatrocks are absent on the steep slopes of domes.

Granitic domes are easier environments to study than cliffs, but quantitative study has been limited. Only a few CVS plots have been sampled. Numerous examples are described in site reports. Some floristic studies have described them (e.g., Cooper and Hardin 1970, Dumond 1970, Taggart 1973).

Rare species:
Vascular plants: *Allium keeverae, Danthonia epilis, Dicentra eximia, Fleischmannia incarnata, Hackelia virginiana, Hexalectris spicata, Huperzia porophila, Matelea decipiens, Mononeuria groenlandica, Packera millefolium, Pellaea atropurpurea, Rhynchospora alba, Solidago simulans, Spiraea corymbosa, Trichophorum cespitosum,* and *Trichostema setaceum*.
Nonvascular plants: *Macrocoma sullivantii* and *Orthotrichum keeverae*.
Invertebrate animals: *Hypochilus coylei*

References:
Cooper, A.W., and J.W. Hardin. 1970. Floristics of the gorges on the southern Blue Ridge escarpment. In: The distributional history of the biota of the Southern Appalachians, Part II: Flora. Virginia Polytechnic Institute and State University Research Division Monograph 2.

Dumond, D.M. 1970. Floristic and vegetational survey of the Chattooga River gorge. Castanea 35:201-44.

Oosting, H.J., and L.E. Anderson. 1937. The vegetation of a bare-faced cliff in western North Carolina. Ecology 8:280-292.

Taggart, J.B. 1973. Floristic survey and vegetational analysis of Stone Mountain State Park in North Carolina. M.S. Thesis, N.C. State University.

MONTANE CLIFF (ACIDIC SUBTYPE)

Concept: Montane Cliffs are steep-to-vertical, sparsely vegetated rock outcrops on river bluffs, lower slopes, and other topographically sheltered locations. This range of sites is narrower than the features that are commonly called cliffs; vertical outcrops on ridge tops and upper slopes are classified as Rocky Summit communities. Some of the communities called cliffs in the 3rd Approximation have been removed to the new glade types. The Acidic Herb Subtype covers the more common examples where bare rock, crustose lichens, mosses, or sparse herbs and woody vegetation predominate and where species of mafic or calcareous rock are absent.

Distinguishing Features: Montane Cliffs are distinguished from forest and shrubland communities by having contiguous rock outcroppings large enough to form a canopy break. In general, the minimum size is about 10 meters in height. Smaller rock outcrops that are completely shaded by the adjacent forest and that have few or no herbs typical of rock outcrops should not be treated as occurrences. Montane Cliffs are distinguished from Rocky Summit communities by occurring in more topographically sheltered locations, generally below mid slope. The plant species that are incidentally present are more likely to include mesophytic species such as *Tsuga canadensis, Quercus rubra, Betula* spp., or *Rhododendron maximum*, and to lack plants of more exposed sites. However, cliffs are heterogeneous environments, and xerophytic, mesophytic, and even hydrophytic species are often present in different microsites in close proximity. In addition, cliffs can vary with slope aspect and degree of topographic sheltering.

Montane Cliffs are distinguished from Low Elevation Acidic Glades and Low Elevation Basic Glades by having vertical rock more prominent and by having only limited areas of soil mats with herbaceous vegetation. The herbaceous and woody vegetation that is present on Montane Cliffs is primarily rooted on bare rock or in crevices or deep pockets rather than in soil mats.

The Acidic Herb Subtype is distinguished from the Carolina Rocktripe Subtype by having cover dominated by bare rock, crustose lichens, or plants other than umbilicate lichens, though umbilicate lichens may be a component. The Acidic Herb Subtype is distinguished from the Mafic and Calcareous Subtypes by the absence of plant species indicative of higher pH conditions. These indicator plants are sometimes present only in small numbers, as all plants are usually sparse on cliffs.

Synonyms: Synonyms: *Asplenium montanum - Heuchera villosa* Felsic Cliff Sparse Vegetation (CEGL004980).
Ecological Systems: Southern Appalachian Montane Cliff and Talus (CES202.330).

Sites: Montane Cliff communities occur on steep, often vertical or even overhanging rock outcrops in lower topographic positions. They may be adjacent to streams, on the edges of flat bottoms, on lower side slopes, or occasionally on higher slopes that face north or are in narrow gorges. Besides vertical rock faces, they may also include ledges, grottos, a flatter area at the top, and open areas of fallen rock at the base, was well as crevices, chutes, and soil pockets. They generally don't include significant expanses of smooth exfoliated rock. The rock in the Acidic Herb Subtype may be felsic gneiss, schist, granitic rocks, quartzite, or other acidic rock types. They may occur over a broad range of elevations. Examples are known from 1000-5200 feet and rarely higher.

Soils: Soil is limited to small patches and occasional deeper accumulations on ledges or in crevices or chutes. Soil may be either marginally weathered rock and accumulated organic matter or deposits of soil washed in from above. Soils are acidic and low in nutrients.

Hydrology: Cliffs are extremely heterogeneous in moisture levels and behavior of water. Most portions are dry to xeric because rainfall runs off rapidly from the bare rock. However, they may have areas where runoff accumulates or even scours the surface locally. Cliffs usually include some seepage areas, where water emerges from fractures in the rock or flows across the rock face from above. The conditions on dry parts are less extreme than on Rocky Summits or Granitic Domes because of their more sheltered position.

Vegetation: Montane Cliff vegetation is sparse overall, but patches of dense vegetation may be present on flat cliff tops, on ledges, amid broken rock at the base, and in larger soil-filled crevices or pockets. Rock faces have sparse cover of specialist herbs, while shallow soil areas have some additional species shared with other rock outcrop communities. In the Acidic Herb Subtype, the highly constant species in site descriptions include *Heuchera villosa, Micranthes petiolaris* ssp. *petiolaris, Asplenium montanum, Dryopteris marginalis*, *Krigia montana, Campanula divaricata*, and *Heuchera parviflora*. Other outcrop species that occur less frequently include *Polypodium virginianum, Polypodium appalachianum, Danthonia spicata, Danthonia compressa, Coreopsis major, Carex pensylvanica, Carex biltmoreana*, other *Carex* species, *Corydalis sempervirens, Micranthes careyana,* and *Schizachyrium scoparium*, while species such as *Bryodesma rupeste, Asplenium trichomanes, Asplenium platyneuron*, *Houstonia longifolia* var. *glabra*, *Eurybia surculosa*, *Solidago* spp., and many others may occur occasionally. Very moist sheltered cliffs in gorges may have *Hymenophyllum tayloriae, Crepidomanes (Trichomanes) intricatum, Vittaria appalachiana*, or *Huperzia porophila*. Mesophytic species shared with nearby forests often occur in small numbers; *Eurybia divaricata, Mitchella repens*, *Galax urceolata*, and *Polystichum acrostichoides* are fairly frequent. Small seepage areas may support additional species, such as *Chelone glabra, Chelone lyonii, Parnassia asarifolia,* and *Thalictrum clavatum*, as well as *Sphagnum* spp. and other bryophytes. Nonvascular plants are sometimes abundant on the bare rock. *Umbilicaria mamulata* and other species are frequent. Not enough reports name nonvascular plants to tell what are common, but other species noted include *Lasallia papulosa, Bartramia pomiformis, Atrichum* spp. *Andreaea* sp., *Bryoxiphium norvegicum, Radula sullivantii, Ephebe solida*, and *Gymnoderma lineare*. Woody species are present on the edges and rooted in deeper crevices and soil pockets, and often have more cover than herbs. *Kalmia latifolia* and *Rhododendron maximum* are highly constant, and *Rhododendron minus* is frequent. The only other shrubs with a moderate frequency are *Clethra acuminata* and *Rubus alleghaniensis*, but a variety of other species occur occasionally. A few vine species, *Smilax rotundifolia, Smilax glauca, Toxicodendron radicans* and *Isotrema macrophyllum* occur in multiple examples. Trees are extremely variable, including both mesophytic species such as *Tsuga canadensis* and *Quercus rubra* and drier site species such as *Quercus montana, Tsuga caroliniana, Pinus virginiana, Juniperus virginiana*, and *Robinia pseudo-acacia*.

Range and Abundance: Ranked G3G4. Examples are present throughout the Mountain region and scattered in the foothills. More than 100 examples are known in North Carolina, but overall extent is limited, with less than 1000 acres in existence. The equivalent association ranges southward to Georgia and may occur in Virginia.

Associations and Patterns: Montane Cliffs are small patch communities. Many examples are one acre or less, though some complexes are believed to be several acres. They are sometimes bordered by a river or creek below, but otherwise are surrounded by forests that are most often Mountain Cove Forests or Mountain Oak Forests. Floodplain forests may border them at the base.

Variation: This subtype is fairly diverse. Variants may be able to be distinguished with more study, possibly including examples on quartzite, examples on felsic gneisses and schists, and very moist, moss-covered examples transitional to Spray Cliff.

Dynamics: Montane Cliff communities generally are stable, though they are undergoing slow primary succession. There may be occasional local natural disturbances by rocks breaking or by trees falling from the top. Because most of the larger plants are rooted in crevices or deep soil pockets, they are better buffered from both windthrow and drought than are the shallow soil mats of granitic domes and most glades. Plants on bare rock or in shallower soil may be stressed or killed during drought but represent less of the community. Because cliffs usually have forest above and below, most examples are at least partly shaded by adjacent trees. Light levels may occasionally change as a result of canopy gaps in the adjacent forest, which sometimes result in an influx of weedy species. Examples surrounded by oak forests presumably were exposed to fire, but since fire would not carry through the sparse vegetation, its effects might be limited to the edges and to scorching by radiant heat. Many examples are surrounded by mesic forest or are next to streams, where they probably had limited exposure to fire.

Comments: The acidic, mafic, and calcareous cliff communities, treated as full types in the 3rd Approximation, have been reduced to subtypes here. In general, the variation in these communities due to chemical influences, while real, appears to be more limited than previously believed.

Cliffs are very difficult to study quantitatively because steep terrain limits access. Plots are generally almost impossible to sample on them. When plots are done, they often present a biased or unrepresentative picture, because only the flatter, most accessible portions are sampled. Newell (1997) had a few rock outcrop samples at Linville Gorge, some of which were Montane Cliff edges or ledges, others of which were Low Elevation Rocky Summit. Montane Cliffs are described in many unpublished site descriptions, with varying thoroughness. Few published studies specifically address them, though some, such as Cooper and Hardin (1970) mention them.

Much descriptive literature differentiates cliffs by slope aspect. These differences can be striking when extreme, but variable occurrence of seepage and extremely variable microsites usually make the distinction nearly meaningless. The most sheltered cliffs can be very dry, and even south-facing cliffs can have moist crevices or wet seeps. Slope aspect is potentially increasingly important in the more exposed vertical portions of some Rocky Summit communities.

Rare species:
Vascular plants: *Asplenium bradleyi, Asplenium pinnatifidum, Chelone obliqua, Chenopodium simplex, Didymoglossum petersii, Diervilla rivularis, Hackelia virginiana, Heuchera pubescens, Huperzia porophila, Hymenophyllum tayloriae,* and *Silphium perfoliatum.*

Nonvascular plants: *Bryoxiphium norvegicum, Bryum limbatum*, *Gymnoderma lineare, Homaliadelphus sharpie,* and *Plagiochila sullivantii*.
Vertebrate animals: *Aneides aeneus, Neotoma magister*, *Plethodon wehleri,* and *Sylvilagus obscurus.*

References:

Cooper, A.W., and J.W. Hardin. 1970. Floristics of the gorges on the southern Blue Ridge escarpment. In: The distributional history of the biota of the Southern Appalachians, Part II: Flora. Virginia Polytechnic Institute and State University Research Division Monograph 2.

Newell, C.L. 1997. Local and regional variation in the vegetation of the Southern Appalachian Mountains. PhD. Dissertation, University of North Carolina, Chapel Hill.

MONTANE CLIFF (MAFIC SUBTYPE)

Concept: Montane Cliffs are steep to vertical, sparsely vegetated rock outcrops on river bluffs, lower slopes, and other topographically sheltered locations. This range of sites is narrower than the features that are commonly called cliffs; vertical outcrops on ridge tops and upper slopes are classified as Rocky Summit communities. Some of the communities called cliffs in the 3rd Approximation have been removed to the new glade types. The Mafic Subtype covers examples occurring on mafic rock substrates or mixed substrates containing plant species characteristic of higher base status conditions.

Distinguishing Features: Montane Cliffs are distinguished from forest and shrubland communities by having contiguous rock outcroppings large enough to form a canopy break. They are distinguished from Low Elevation Acidic Glades and Low Elevation Basic Glades by having vertical rock more prominent and by having only limited area of soil mats with herbaceous vegetation. The herbaceous and woody vegetation that is present on Montane Cliffs is primarily rooted on bare rock or in crevices or deep pockets rather than in thin soil mats. See the Montane Cliff (Acidic Herb Subtype) for more details on distinguishing Montane Cliffs from other rock outcrop communities.

The Mafic Subtype is distinguished by the presence of plants that indicate basic soil conditions but without those indicative of stronger calcareous conditions. *Cystopteris protrusa, Micranthes (Saxifraga) careyana, Micranthes (Saxifraga) caroliniana, Asplenium trichomanes, Asplenium rhizophyllum, Aquilegia canadensis, Hydrangea arborescens, Philadelphus inodorus, Ulmus rubra*, or species of Rich Cove Forests indicate high base status. Indicator plants are often low in abundance, with more widespread species of rock outcrops or of surrounding forests more common. *Toxicodendron radicans* is sometimes abundant. Species typical of the Calcareous Subtype but not to the Mafic Subtype include *Pellaea atropurpurea, Asplenium ruta-muraria, Asplenium resiliens, Aquilegia canadensis, Cystopteris bulbifera*, and a variety of mosses. The Mafic Subtype generally occurs directly on mafic rock such as amphibolite or hornblende gneiss but may occur on felsic or other acidic rocks that are influenced by base-rich seepage.

Synonyms: (*Hydrangea arborescens, Toxicodendron radicans) / Heuchera americana - (Dichanthelium depauperatum, Woodsia obtusa)* Shrubland (CEGL004395).
Ecological Systems: Southern Appalachian Montane Cliff and Talus (CES202.330).

Sites: Montane Cliff communities occur on steep, often vertical or even overhanging rock outcrops in lower topographic positions. They may be adjacent to streams, on the edges of flat bottoms, on lower side slopes, or occasionally on higher slopes that face north or are in narrow gorges. Besides vertical rock faces, they may also include ledges, grottos, a flatter area at the top, and open areas of fallen rock at the base, was well as crevices, chutes, and soil pockets. The rock in the Mafic Subtype is generally amphibolite or hornblende gneiss, or related rocks such as metabasalt or greenstone. This community may occasionally occur on felsic or acidic rocks that underlie mafic rocks and are influenced by seepage from them. It may possibly occur on ultramafic rocks where their extreme chemistry is mitigated by alteration or mixture with other kinds of rock. Examples are known from 1400-4700 feet elevation.

Soils: Soil is limited to small patches and occasional deeper accumulations on ledges or in crevices or chutes. Soil may be either marginally weathered rock and accumulated organic matter or deposits of soil washed in from above. Soils may be acidic or circumneutral but are generally higher in pH and base saturation than those in the Acidic Herb Subtype.

Hydrology: Cliffs are extremely heterogeneous in moisture levels and behavior of water. Most portions are dry to xeric because rainfall runs off rapidly from the bare rock. However, they may have areas where runoff accumulates or even scours the surface locally. Cliffs usually include some seepage areas, where water emerges from fractures in the rock or flows across the rock face from above. The conditions on dry parts are less extreme than on Rocky Summits or Granitic Domes because of their more sheltered position.

Vegetation: Vegetation in the Mafic Subtype is sparse overall, but patches of dense vegetation may be present on flat cliff tops, on ledges, amid broken rock at the base, and in larger soil-filled crevices or pockets. Rock faces have sparse cover of specialist herbs, while shallow soil areas have some additional species shared with other rock outcrop communities, specialized species of high pH outcrops, more generalist species of open areas, and weedy species. No species have high constancy in site descriptions, but the most frequent herbaceous species are *Heuchera villosa, Heuchera americana, Tradescantia subaspera*, and *Dryopteris marginalis*, followed by *Micranthes careyana, Carex biltmoreana, Coreopsis major,* and *Micranthes petiolaris* var. *petiolaris.* A great diversity of herbs is less frequent but occurs in several sites, including *Cystopteris protrusa, Woodsia obtusa, Krigia montana, Asplenium montanum, Asplenium trichomanes* var. *trichomanes, Myriopteris lanosa, Heuchera parviflora, Micranthes caroliniana, Primula (Dodecatheon) meadia, Houstonia tenuifolia, Campanula divaricata, Andropogon gerardii, Eupatorium sessilifolium* var. *sessilifolium*, *Schizachyrium scoparium, Sorghastrum nutans, Panicum gattingeri, Solidago simulans, Helianthus divaricatus, Lespedeza hirta, Ambrosia artemisiifolia,* and *Pseudognaphalium obtusifolium*. Additional species seem to occur with lower frequency but serve to indicate base-rich conditions when they are present, including *Asplenium rhizophyllum* and *Aquilegia canadensis*. Most occurrences also have some species shared with mesic or rich forests. *Polygonatum biflorum* and *Eurybia divaricata* occur with frequency as high as most of the outcrop species, while *Polystichum acrostichoides, Sedum ternatum, Laportea canadensis, Pycnanthemum beadlei, Adiantum pedatum,* and *Silene virginica* are fairly frequent, and a large number of additional species, such as *Prosartes lanuginosa, Hydrophyllum virginianum, Osmorhiza claytoniana, Phacelia bipinnatifida*, and *Geranium maculatum* indicate base-rich conditions. Small seepage areas may have a variety of wetland species, such as *Osmundastrum cinnamomeum, Calamagrostis coarctata*, and *Thalictrum clavatum*. Nonvascular plants are thought to be an important component in the Mafic Subtype, where they may be more abundant and diverse than in the Acidic Herb Subtype and may include specialist species but are seldom listed in site descriptions. Woody species are confined to microsites with deeper soil, which may be very limited or fairly abundant in different occurrences. A great variety of shrubs may occur, none with high frequency. They include ones indicating base-rich conditions, such as *Hydrangea arborea, Rosa carolina, Amelanchier sanguinea, Philadelphus hirsutus, Philadelphus inodorus, Ptelea trifoliata*, and *Symphoricarpos orbiculatus*, and ones shared with acidic cliffs, such as *Kalmia latifolia, Rhododendron maximum, Clethra acuminata*, and *Amorpha glabra*. The latter occur with much lower frequency than in the Acidic Subtype. Vines are often present, with *Toxicodendron radicans* and *Parthenocissus quinquefolia*

particularly frequent. The trees that are present are similarly quite variable. The only species with high frequency are *Quercus montana* and *Fraxinus americana/biltmoreana*, though *Crataegus* spp. and *Juniperus virginiana* occur in several examples. The range of other tree species includes ones suggestive of basic conditions, such as *Ulmus rubra, Juniperus virginiana*, and *Juglans nigra*, and widespread species such as *Pinus strobus, Quercus rubra*, and *Pinus* spp.

Range and Abundance: Ranked G3. In North Carolina, there are fewer than 40 examples known. Examples are scattered over most of the Blue Ridge, with a higher density in the Amphibolite Mountains area of Ashe County and in the Craggy Mountains. Virtually no examples are known in the foothills area but a few may be found. The equivalent NVC association is attributed to Alabama and potentially to Georgia and Tennessee.

Associations and Patterns: The Mafic Subtype, like other subtypes, is a small patch community. Many examples are one acre or less, though some complexes are believed to be several acres. As with other cliffs, defining extent is complex because they may have more vertical surface than area of map projection. They may be bordered by a river or creek below, but otherwise are surrounded by forests that are most often Mountain Cove Forests or Mountain Oak Forests. Surrounding forests are usually base-rich communities such as Rich Cove Forest, Montane Oak–Hickory Forest (Basic Subtype), or High Elevation Red Oak Forest (Rich Subtype).

Variation: The Mafic Subtype is very heterogeneous, and variants may be recognized in the future. Examples may vary with degree of development (openness versus shading and degree of weathering of the rock), amount of seepage, amount of sheltering by topography, and elevation, as well as showing biogeographic differences.

Dynamics: Montane Cliff communities generally are stable, though they are undergoing slow primary succession. There may be occasional local natural disturbances by rocks breaking or by trees falling from the top. Because most of the larger plants are rooted in crevices or deep soil pockets, they are better buffered from both windthrow and drought than are the shallow soil mats of granitic domes and most glades. Plants on bare rock or in shallower soil may be stressed or killed during drought but represent less of the community. Because cliffs usually have forest above and below, most examples are at least partly shaded by adjacent trees. Light levels may occasionally change as a result of canopy gaps in the adjacent forest, which sometimes result in an influx of weedy species. Examples surrounded by oak forests presumably were exposed to fire, but since fire would not carry through the sparse vegetation, its effects might be limited to the edges and to scorching by radiant heat. Many examples are surrounded by mesic forest or are next to streams, where they probably had limited exposure to fire.

Comments: The acidic, mafic, and calcareous cliff communities, treated as full types in the 3rd Approximation, have been reduced to subtypes here. In general, the variation in these communities due to chemical influences, while real, appears to be more limited than previously believed. The distinction between the Mafic Subtype and Calcareous Subtype needs further investigation. Cliffs are very difficult to study because steep terrain limits access. Plots are generally almost impossible to sample on them. No CVS plot data exist. They are described in many unpublished site descriptions, with varying thoroughness.

Rare species:
Vascular plants: *Adlumia fungosa, Arabis pycnocarpa* var. *adpressilis*, *Berberis canadensis, Celastrus scandens, Dicentra eximia, Draba ramosissima, Hydrophyllum macrophyllum, Meehania cordata, Micranthes caroliniana, Packera millefolium, Sedum glaucophyllum, Sisyrinchium dichotomum, Smilax hugeri, Solidago simulans, Trichophorum cespitosum,* and *Woodsia appalachiana*
Nonvascular plants: *Gymnoderma lineare*.
Vertebrate animals: *Certhia americana, Crotalus horridus, Falco peregrinus,* and *Neotoma magister*.
Invertebrate animals: *Hypochilus coylei*.

References:

MONTANE CLIFF (CALCAREOUS SUBTYPE)

Concept: Montane Cliffs are steep-to-vertical, sparsely vegetated rock outcrops on river bluffs, lower slopes, and other topographically sheltered locations. This range of sites is narrower than the features that are commonly called cliffs; vertical outcrops on ridge tops and upper slopes are classified as Rocky Summit communities. Some of the communities called cliffs in the 3rd Approximation have been removed to the new glade types. The Calcareous Subtype covers examples on dry to moist calcareous rock, characterized by a more strongly calciphilic flora, with species such as *Pellaea atropurpurea, Asplenium ruta-muraria, Asplenium resiliens, Aquilegia canadensis, Cystopteris bulbifera*, and a variety of mosses.

Distinguishing Features: Montane Cliffs are distinguished from forest and shrubland communities by having contiguous rock outcroppings large enough to form a canopy break. They are distinguished from Low Elevation Acidic Glades and Low Elevation Basic Glades by having vertical rock more prominent and by having only limited areas of soil mats with herbaceous vegetation. The herbaceous and woody vegetation that is present on Montane Cliffs is primarily rooted on bare rock or in crevices or deep pockets rather than in thin soil mats. See the Montane Cliff (Acidic Herb Subtype) for more details on distinguishing Montane Cliffs from other rock outcrop communities.

The Calcareous Subtype is distinguished from other subtypes by the presence of strong calciphilic plants such as *Pellaea atropurpurea, Cystopteris bulbifera, Asplenium ruta-muraria* var. *cryptolepis,* and *Asplenium resiliens*. It also has an overall flora that contains more base-loving species such as *Aquilegia canadensis* and *Asplenium rhizophyllum* than the Mafic Subtype.

Synonyms: *Asplenium ruta-muraria - Pellaea atropurpurea* Sparse Vegetation (CEGL004476). Ecological Systems: Southern Interior Calcareous Cliff (CES202.356).

Sites: Montane Cliff communities occur on steep, often vertical or even overhanging rock outcrops in lower topographic positions. They may be adjacent to streams, on the edges of flat bottoms, on lower side slopes, or occasionally on higher slopes that face north or are in narrow gorges. Besides vertical rock faces, they may also include ledges, grottos, vertical or horizontal solution cavities, a flatter area at the top, and open areas of fallen rock at the base, was well as crevices, chutes, and soil pockets. The rock in the Calcareous Subtype may be limestone, dolomite, marble, or occasionally calc-silicate rock, or potentially a mix that includes some of these calcium-rich rocks.

Soils: Soil is limited to small patches and occasional deeper accumulations on ledges or in crevices or chutes. Soil may be either marginally weathered rock and accumulated organic matter or deposits of soil washed in from above. Soils probably are circumneutral or slightly basic and are high in base saturation and calcium content.

Hydrology: Cliffs are extremely heterogeneous in moisture levels and behavior of water. Most portions are dry to xeric because rainfall runs off rapidly from the bare rock. However, they may have areas where runoff accumulates or even scours the surface locally. Cliffs usually include some seepage areas, where water emerges from fractures in the rock or flows across the rock face from above. Because of the solubility of calcareous rock, solution cavities may conduct water or

provide microsites for water to pool. Conversely, solution cavities may provide greater potential for internal drainage of water out of the reach of plants. In extreme cases, larger caves may be present. The conditions on dry parts are less extreme than on Rocky Summits or Granitic Domes because of their more sheltered position.

Vegetation: Vegetation in the Calcareous Subtype is sparse overall, but patches of dense vegetation may be present on flat cliff tops, on ledges, amid broken rock at the base, and in larger soil-filled crevices or pockets. Rock faces have sparse cover of specialist herbs, while shallow soil areas have some additional species shared with other rock outcrop communities, specialized species of high pH outcrops, more generalist species of open areas, and weedy species. Though examples are very variable in composition, the overall vegetation is more strongly of base-loving plants than in the Mafic Subtype, with the addition of some specialist species and with much lower abundance of the widespread acid-tolerant species. Species with the highest frequency in site descriptions are *Dryopteris marginalis, Asplenium trichomanes* var. *trichomanes*, *Asplenium resiliens, Asplenium rhizophyllum, Pellaea atropurpurea, Polystichum acrostichoides, Aquilegia canadensis,* and *Sedum ternatum*. Oosting (1941) also found *Adiantum pedatum* and *Sedum ternatum* frequent. Other species that are fairly frequent include *Asarum canadense, Heuchera* spp., *Campanula divaricata, Coreopsis major, Impatiens capensis*, *Asplenium platyneuron, Arisaema triphyllum, Pleopeltis michauxiana (Polypodium polypodioides*)*, Botrypus virginianus*, *Lycopodioides (Selaginella) apodum*, and *Mitella diphylla*. A number of other species occur with low frequency but indicate the calcium-rich conditions, including *Cystopteris protrusa, Cystopteris bulbifera, Cystopteris fragilis, Myriopteris tomentosa, Myriopteris alabamensis, Solidago flexicaulis, Asplenium ruta-muraria* var. *cryptolepis, Cubelium concolor, Arabidopsis lyrata, Carex manhartii, Borodinia burkii (Arabis laevigata* var. *burkii*), *Utrica dioica*, *Anticlea (Zigadenus) glauca*, *Carex plantaginea,* and *Polygala senega*. Nonvascular plants are thought to be an important component in the Calcareous Subtype, where they may be more abundant and diverse than in the Acidic Herb Subtype and may include specialist species, but they are seldom listed in site descriptions.

Among woody plants that inhabit the microsites with deeper soil, the only highly constant species is *Hydrangea arborescens*, though *Philadelphus hirsutus* is also fairly frequent. Vines, particularly *Toxicodendron radicans* and *Parthenocissus quinquefolia*, are usually present. Other shrubs indicative of rich conditions are present at lower frequency, including *Lindera benzoin, Ptelea trifoliata, Euonymus atropurpureus*, and *Dirca palustris*. No tree species have high constancy, but a number of species indicative of calcareous conditions may occur, including *Fraxinus americana, Fraxinus biltmoreana, Celtis occidentalis, Ulmus rubra, Acer saccharum, Acer nigrum, Quercus muhlenbergii,* and *Cercis canadensis*, along with *Juniperus virginiana, Ostrya virginiana, Chionanthus virginicus*, and more widespread species.

Range and Abundance: Ranked G3G4. This subtype is extremely rare in North Carolina, since it depends on the coincidence of rare calcareous rock types with topographic processes that form cliffs. Most examples are confined to geologic areas known to have calcareous rocks, such as the Hot Springs window, Grandfather Mountain window, and Murphy syncline geologic areas, but a couple of apparent examples occur elsewhere. The equivalent NVC association is more abundant in states that have extensive limestone such as Tennessee and Virginia. It is defined very broadly, extending to Pennsylvania and Alabama as well as Kentucky, and may warrant subdivision.

Associations and Patterns: The Calcareous Subtype is a small patch community, with even the largest complexes no more than a few acres. As with other cliffs, defining extent may be complex because they may have more vertical surface than area of map projection. The community may potentially be bordered by a river or creek, but otherwise is generally surrounded by rich mesophytic communities such as Rich Cove Forest (Foothills Rich or Montane Rich Subtype).

Variation: The Calcareous Subtype is very heterogeneous even among its few examples. Variants may be recognized in the future. Examples may vary with type of rock (limestone, dolomite, or calc-silicate), degree of development (openness versus shading and degree of weathering of the rock), amount of seepage, amount of sheltering by topography, and elevation, as well as showing biogeographic differences.

Dynamics: Montane Cliff communities generally are stable, though they are undergoing slow primary succession. The solubility of calcareous rocks may speed the physical breakdown of cliffs, but the often-limited amount of residual material might slow soil accumulation. There may be occasional local natural disturbances by rocks breaking or by trees falling from the top. Because most of the larger plants are rooted in crevices or deep soil pockets, they are better buffered from both windthrow and drought than are the shallow soil mats of granitic domes and most glades. Plants on bare rock or in shallower soil may be stressed or killed during drought but represent less of the community. Because cliffs usually have forest above and below, most examples are at least partly shaded by adjacent trees. Light levels may occasionally change as a result of canopy gaps in the adjacent forest, which sometimes result in an influx of weedy species. Examples surrounded by oak forests presumably were exposed to fire, but since fire would not carry through the sparse vegetation, its effects might be limited to the edges and to scorching by radiant heat. Many examples are surrounded by mesic forest or are next to streams, where they probably had limited exposure to fire.

Comments: The acidic, mafic, and calcareous cliff communities, treated as full types in the 3rd Approximation, have been reduced to subtypes here. In general, the variation in these communities due to chemical influences, while real, appears to be more limited than previously believed. The distinction between the Mafic Subtype and Calcareous Subtype needs further investigation.

Cliffs are very difficult to study because steep terrain limits access. No CVS plot data exist for this subtype. However, Oosting (1941) represents and early thorough study of their flora. Examples are described in many unpublished site descriptions, with varying thoroughness.

Cystopteris bulbifera - (Asplenium rhizophyllum) Sparse Vegetation (CEGL004394) is another calcareous cliff association of sinkhole walls, occurring in adjacent states. North Carolina has no known sinkholes in the Mountains, but it is possible that some of our Calcareous Subtype vegetation would fit this association better.

Rare species:
Vascular plants: *Adlumia fungosa, Anticlea glauca, Arabis patens, Asplenium ruta-muraria* var. *cryptolepis*, *Buckleya distichophylla, Carex eburnea, Dicentra eximia, Myrioteris alabamensis,* and *Polygala senega*.

Nonvascular plants: *Encalypta procera, Entodon compressus, Entodon concinnus, Eucladium verticillatum, Homaliadelphus sharpii, Neckera complanata, Orthodontium pelluscens, Orthotrichum strangulatum, Palamocladium leskeodies, Plagiochasma wrightii, Platydictya confervoides,* and *Tortula plinthobia*.

References:

Oosting, H.J. 1941. Plants occurring on calcareous rock outcrops in North Carolina. Torreya 41:76-81.

TALUS VINELAND

Concept: Talus Vineland is a community of open boulderfields or expanses of loose large rocks. Vegetation is either sparse or, if denser, is dominated by woody vines which may cover the rocks from a limited number of rooting sites.

Distinguishing Features: Talus Vinelands are distinguished from all forest communities, including those of boulderfields, by lack of a well-developed tree canopy. They are distinguished from rock outcrop communities by consisting largely of loose boulders. Talus Vineland is defined conceptually as any community on open talus. It may have an extensive cover of vines but vegetation is often sparse.

Synonyms: *Parthenocissus quinquefolia / (Dicentra eximia)* Sparse Vegetation (CEGL004454). Ecological Systems: Southern Appalachian Montane Cliff and Talus (CES202.330).

Sites: Talus Vineland occurs on steep slopes at the base of cliffs or on the walls of gorges. The ground is covered with loose rocks, usually of boulder size, and has extensive void space beneath the rock. The rock may potentially be of any type that occurs in massive beds but is most often of highly resistant types such as quartzite or quartz-rich metasedimentary rocks.

Soils: No developed soil is present. Small accumulations of organic matter, dust, and rock fragments occur in patches between the boulders.

Hydrology: The boulderfields or talus slopes are generally xeric due to the lack of soil. Rainfall runs off the surface to deeper levels very quickly.

Vegetation: The Talus Vineland community is not well known. Its vegetation generally is sparse, but it may have more extensive cover of vines, especially *Parthenocissus quinquefolia, Toxicodendron radicans*, or *Muscadinia rotundifolia*, or potentially of herbs. Bryophytes or lichens may be abundant if the talus is moist. Herbs noted as occurring in examples include *Polymnia canadensis, Dryopteris marginalis, Dioscorea villosa, Dicentra eximia*, and *Adlumia fungosa*. Trees and shrubs may be absent, but some individuals, potentially large ones, may be present on the edges or in less extreme microsites.

Range and Abundance: Ranked G2G3Q, but likely rarer and without need for an indication of taxonomic question. The communities are very poorly known in North Carolina, but no more than a handful of examples are likely to exist. The NVC association is attributed only to North Carolina and Tennessee. Related associations are present in Virginia.

Associations and Patterns: Talus Vinelands are small patch communities. The size of the few examples is not well known. They may potentially be a few acres in size.

Variation: Nothing is known of variation.

Dynamics: Little is known of the dynamics of Talus Vinelands. Addition of falling rock from above may constitute a chronic natural disturbance, though the frequency is not known. The

openness is due to inhospitable site conditions rather than chronic disturbance. Shallowly rooted vegetation may be particularly prone to stress or mortality during drought, but vines or trees that become large and have extensive root systems may be well buffered from drought.

Comments: This community was not known at the time of the 3rd Approximation. It remains poorly known and very little documented.

Rare species:
Vascular plants: *Adlumia fungosa,* and *Dicentra eximia*.

References:

PIEDMONT CLIFF (ACIDIC SUBTYPE)

Concept: Piedmont Cliffs are steep to vertical, sparsely vegetated rock outcrops on river bluffs, lower slopes, and other topographically sheltered locations. The vegetation often includes some woody plants rooted in deeper soil pockets or crevices, but the overall woody cover is low. The Acidic Subtype encompasses the more common examples occurring on felsic igneous and metamorphic rocks and other acidic rocks and lacking flora indicative of base-rich conditions.

Distinguishing Features: Piedmont Cliffs are distinguished from forest and shrubland communities by having contiguous rock outcroppings large enough to form a canopy break. In general, the minimum size is about 10 meters in height. Smaller rock outcrops that are completely shaded by the adjacent forest and that have few or no herbs typical of rock outcrops should not be treated as occurrences.

Piedmont Cliffs are distinguished from various Piedmont and Mountain Glades and Barrens communities by having lower vegetation cover, with much bare rock present, herbaceous cover persistently less than 25 percent, and woody plants restricted to more favorable microsites. Cliffs generally have substantial vertical or very steep surfaces. Flat ledges on cliff faces and related vegetation on flatter tops of outcrops are included in the cliff occurrence. Piedmont Cliffs are distinguished from Granitic Flatrocks, which also have substantial bare rock, by having more fractured rock rather than a smooth exfoliated surface, and by having larger plants rooted in deeper soil microsites rather than primarily in shallow soil mats. Characteristic herbs such as *Diamorpha smallii* and *Mononeuria (Minuartia) uniflora* are present in Granitic Flatrocks and not on Piedmont Cliffs. Cliffs are generally very steep and Granitic Flatrocks horizontal or gently sloping, but portions may overlap in steepness.

Lower parts of cliffs may extend near rivers or streams. They are distinguished from Rocky Bar and Shore communities, which may be bedrock outcrops, by the lack of flooding, with its associated transport of seeds and scouring of soil.

Piedmont Cliffs are distinguished from Montane Cliffs by having flora indicative of warmer lowland conditions. They largely lack characteristic mountain species such as *Micranthes petiolaris (= Saxifraga michauxii)*, *Asplenium montanum*, and *Heuchera villosa*, but some examples support notable disjunct populations of them. As with other communities of the Mountain Region, Montane Cliffs with characteristic montane flora occur in the foothills of the upper Piedmont. Piedmont Cliffs are distinguished from Coastal Plain Cliffs by occurring on hard rock substrates rather than unconsolidated or marginally consolidated Coastal Plain sediments.

The Acidic Subtype is distinguished from the Basic Subtype by scarcity of species largely or completely lacking plant species that indicate base-rich conditions, such as *Aquilegia canadensis, Myriopteris (Cheilanthes) lanosa, Asplenium trichomanes, Asplenium rhizophyllum, Adiantum pedatum*, and *Asarum canadense*.

A few species that indicate base-rich conditions in forests are sometimes present in the Acidic Subtype, including *Rhus aromatica*, *Myriopteris lanosa*, and *Myriopteris tomentosa*. Intermediate rocks such as diorite and andesite, and some metasedimentary rocks such as metamudstone and

argillite, may support either the Acidic Subtype or Basic Subtype, or may represent intermediate examples. They will need to be assigned based on the flora.

Synonyms: Synonyms: Piedmont Acidic Cliff Sparse Vegetation (CEGL003979).
Ecological Systems: Southern Piedmont Cliff (CES202.386).

Sites: Piedmont Cliff communities occur on steep, often vertical or even overhanging rock outcrops in lower topographic positions. They may be adjacent to streams, on the edges of flat bottoms, on lower side slopes, or occasionally on higher slopes that face north or are in narrow gorges. Besides vertical rock faces, they may also include ledges, grottos, a flatter area at the top, and open areas of fallen rock at the base, was well as crevices, chutes, and soil pockets. They generally don't include significant expanses of smooth exfoliated rock. Rocks may be any felsic igneous or metamorphic rock or acidic metasedimentary rock, and sometimes may be intermediate rock such as diorite.

Soils: Soil is limited to small patches and occasional deeper accumulations on ledges or in crevices or chutes. Soil may be either marginally weathered rock and accumulated organic matter or deposits of soil washed in from above. Soils are acidic and low in nutrients.

Hydrology: Cliffs are extremely heterogeneous in moisture levels and behavior of water. Most portions are dry to xeric because rainfall runs off rapidly from the bare rock. However, there may be areas where runoff accumulates or even scours the surface locally. Cliffs often include some seepage areas, where water emerges from fractures in the rock or flows across the rock face from above.

Vegetation: Piedmont Cliff vegetation is sparse or patchy. Rock faces have only sparse vascular plants, but edges, soil pockets, and ledges may have dense herbaceous or woody plants or may have large individual trees or shrubs. Bryophytes and lichens may be extensive on moist or north-facing cliffs. Fewer vascular plants grow on the rock faces than in Montane Cliff, with more of the flora confined to the top or to ledges. In the Acidic Subtype, *Danthonia spicata* is the only herb with high constancy in site descriptions. Fairly frequent herbs include *Polypodium virginianum, Asplenium platyneuron, Dryopteris marginalis, Bryodesma rupestre, Hieracium venosum,* and *Antennaria plantaginifolia*. Less frequent species shared with other rock outcrop communities or open areas include *Schizachyrium scoparium, Hypericum gentianoides, Phemeranthus teretifolius, Potentilla* spp., *Sedum ternatum, Tephrosia virginiana, Micranthes virginiensis, Solidago caesia*, *Pleopeltis michauxiana (polypodioides)*, and *Dichanthelium* spp. Though a well-developed montane flora is not present, occasional species from farther west can occur as disjunct populations, including *Galax urceolata* and even rare species such as *Asplenium bradleyi* or *Asplenium montanum*. The most frequent shrubs are *Kalmia latifolia* and *Vaccinium arboreum*, while *Vaccinium stamineum* and other species of *Vaccinium* are fairly frequent. Several vines may be present, most frequently *Toxicodendron radicans* and *Gelsemium sempervirens*. The most frequent trees are *Juniperus virginiana* and *Quercus stellata*, but *Quercus alba, Pinus echinata, Pinus virginiana*, and *Chionanthus virginicus* are moderately frequent. Species typical of more base-rich sites, such as *Rhus aromatica, Hydrangea arborescens*, *Myriopteris lanosa,* or *Myriopteris tomentosa,* may be present in small numbers.

Range and Abundance: Ranked G2? but probably less rare. There are about two dozen occurrences in North Carolina, though the total area is well under 100 acres. The association is attributed to South Carolina and Georgia, and questionably to Alabama and Virginia.

Associations and Patterns: Piedmont Cliffs are small patch communities, with most patches a handful of acres at most and many less than one acre. As with other cliffs, assessing extent is complex because they may have more vertical area than area in map projections. Cliffs are usually bordered by oak forest above and may be bordered by oak forest, Mesic Mixed Hardwood Forest, or various floodplain communities below.

Variation: Examples vary in rock structure and its effect on vegetation structure, as well as varying geographically.

Dynamics: Piedmont Cliff communities generally are stable, though they are undergoing slow primary succession. There may be occasional local natural disturbances by rocks breaking or by trees falling from the top. Because most of the larger plants are rooted in crevices or deep soil pockets, they are better buffered from both windthrow and drought than are the shallow soil mats of Granitic Flatrocks and various glades. Plants on bare rock or in shallower soil may be stressed or killed during drought. Because cliffs usually have forest above and below, most examples are at least partly shaded by adjacent trees. Light levels may occasionally change as a result of canopy gaps in the adjacent forest, which sometimes result in an influx of weedy species. Examples surrounded by oak forests presumably were exposed to fire, but since fire would not carry through the sparse vegetation, its effects might be limited to the edges and to scorching by radiant heat. Many examples are surrounded by mesic forest or are next to streams, where they probably had limited exposure to fire.

Comments: The structure of Piedmont Acidic Cliff classification in the 3rd Approximation has been changed for the 4th Approximation. It has been narrowed by the creation of the Piedmont Acidic Glade community type, which encompasses sites with more cover of soil and vegetation, which generally are less steep. At the same time, it is now treated as a subtype rather than a type. Though the floristic differences that distinguish the two subtypes are real, they are not as pronounced as initially believed. Montane Cliffs are divided into three subtypes while Piedmont Cliffs are divided only into two. No well-developed calcareous cliffs are known in the Piedmont, though some examples of the Basic Subtype are on apparently calcium-rich metasedimentary rocks. As with other Mountain communities, Montane Cliffs may replace Piedmont cliffs in the foothills zone of the upper Piedmont. The lichen-covered cliffs at Hanging Rock in the Sauratown Mountains, previously called Piedmont Cliff (Acidic Lichen Subtype) are one of these disjunct communities; they are now treated as Montane Cliff (Acidic Lichen Subtype).

Rare species:
Vascular plants: *Asplenium bradleyi, Clinopodium georgiananum, Cirsium carolianum, Euphorbia mercurialina, Eurybia mirabilis, Fothergilla major,* and *Liatris squarrulosa.*

References:

PIEDMONT CLIFF (BASIC SUBTYPE)

Concept: Piedmont Cliffs are steep-to-vertical, sparsely vegetated rock outcrops on river bluffs, lower slopes, and other topographically sheltered locations. The vegetation often includes some woody plants rooted in deeper soil pockets or crevices, but the overall woody cover is low. The Basic Subtype encompasses examples with flora indicative of base-rich conditions, occurring on mafic or somewhat calcareous rocks.

Distinguishing Features: Piedmont Cliffs are distinguished from forest and shrubland communities by having contiguous rock outcroppings large enough to form a canopy break. In general, the minimum size is about 10 meters in height. Smaller rock outcrops that are completely shaded by the adjacent forest and that have few or no herbs typical of rock outcrops should not be treated as occurrences. Piedmont Cliffs are distinguished from various Piedmont and Mountain Glades and Barrens communities by having lower vegetation cover, with much bare rock present, herbaceous cover persistently less than 25 percent, and woody plants restricted to more favorable microsites. The Basic Subtype often has more plant cover than the Acidic Subtype and thus appears transitional to Piedmont Basic Glade. Cliffs generally have substantial vertical or very steep surfaces but some examples of the Basic Subtype are less steep. Flat ledges on cliff faces and related vegetation on flatter tops of outcrops are included in the cliff occurrence.

Piedmont Cliffs are distinguished from Montane Cliffs by having flora indicative of warmer lowland conditions. They largely lack characteristic mountain species such as *Micranthes petiolaris (= Saxifraga michauxii)*, *Asplenium montanum*, and *Heuchera villosa*, but some examples support notable disjunct populations of them. As with other communities of the Mountain Region, Montane Cliffs with characteristic montane flora occur in the foothills of the upper Piedmont.

The Basic Subtype is distinguished from the Acidic Herb Subtype by the presence of base-loving flora in more than token numbers. This includes *Aquilegia canadensis, Cheilanthes lanosa, Asplenium trichomanes, Asplenium rhizophyllum, Adiantum pedatum, Asarum canadense*, and a variety of species shared with Basic Mesic Forest, Dry-Mesic Basic Oak–Hickory Forest, and Dry Basic Oak–Hickory Forest, or with floodplain communities. Acid-tolerant flora typical of the Acidic Subtype is usually present as well. In the absence of full floristic information, substrate chemistry may provisionally be used to distinguish this subtype; however, some mafic rock outcrops have vegetation indistinguishable from felsic rock outcrops. Cliffs of metamudstone and andesitic igneous and metamorphic rocks, which have intermediate chemistry, should be classified as the Basic Subtype only if base-loving flora is present.

Synonyms: Piedmont Mafic Cliff Sparse Vegetation (CEGL003982).
Ecological Systems: Southern Piedmont Cliff (CES202.386).

Sites: Piedmont Cliff communities generally occur on steep, often vertical or even overhanging rock outcrops in lower topographic positions, but some of the Basic Subtype are less steep. Cliffs may be adjacent to streams, on the edges of flat bottoms, on lower side slopes, or occasionally on higher slopes that face north or are in narrow gorges. Besides vertical rock faces, they may also include ledges, grottos, a flatter area at the top, and open areas of fallen rock at the base, was well

as crevices, chutes, and soil pockets. Some examples are on fine-bedded rock that forms sloping areas covered with flat rock fragments. There generally is not a sizeable expanse of exfoliated rock surface. Rocks generally are either mafic rocks such as diabase or gabbro, or are base-rich metamudstone or argillite, which may be massive or finely foliated and like slate. Intermediate rocks such as diorite or andesite sometimes support Basic Subtype vegetation.

Soils: Soil is limited to small patches and occasional deeper accumulations on ledges or in crevices or chutes. Soil may be either marginally weathered rock and accumulated organic matter or deposits of soil washed in from above. Soils may be low in nutrients but are higher in pH and base saturation than those of the Acidic Subtype. They likely are finer-textured and richer in clay than the Acidic Subtype.

Hydrology: Cliffs are extremely heterogeneous in moisture levels and behavior of water. Most portions are dry to xeric because rainfall runs off rapidly from the bare rock. However, there may be areas where runoff accumulates or even scours the surface locally. Cliffs often include some seepage areas, where water emerges from fractures in the rock or flows across the rock face from above.

Vegetation: Piedmont Cliff vegetation is sparse or patchy. Rock faces have only sparse vascular plants, but edges, soil pockets, and ledges may have dense herbaceous or woody plants or may have large individual trees or shrubs. Bryophytes and lichens may be extensive on moist or north-facing cliffs. In the Basic Subtype, the most constant herbs are *Myriopteris lanosa*, *Piptochaetium avenaceum*, *Aquilegia canadensis*, and *Carex nigromarginata*. Also frequent are *Danthonia spicata, Schizachyrium scoparium, Antennaria plantaginifolia, Cunila origanoides, Pleopeltis michauxiana (polypodioides), Solidago arguta, Commelina erecta, Danthonia sericea, Myriopteris tomentosa, Campanula divaricata, Micranthes virginiensis, Sedum glaucophyllum, Melica mutica, Hieracium venosum, Borodinia (Arabis) missouriensis, Dichanthelium depauperatum*, and *Eurybia divaricata*. Less frequent species that indicate the base-rich conditions include *Asplenium rhizophyllum, Asplenium trichomanes, Cystopteris protrusa, Elymus virginicus, Elymus hystrix, Brachyelytrum erectum, Deparia acrostichoides, Adiantum pedatum*, and *Asarum canadense*. A variety of herbs of open dry sites, such as *Yucca filamentosa* and *Opuntia* spp., are also present at low frequency. Shrubs include species of richer sites, such as *Hydrangea arborescens, Celtis pumila (tenuifolia),* and *Rhus aromatica*, as well as more widespread species such as *Vaccinium arboreum* and *Vaccinium stamineum*, none with more than moderate frequency. Several vines are frequently present, including *Bignonia capreolata, Toxicodendron radicans*, *Lonicera sempervirens*, and the exotic *Lonicera japonica*. Among tree species, *Juniperus virginiana* is almost universally present, and *Ostrya virginiana, Ulmus alata*, *Carya glabra*, and *Pinus virginiana* occur with high frequency. Other fairly frequent species include *Cercis canadensis, Quercus montana, Acer leucoderme*, *Fraxinus americana/biltmoreana*, and *Quercus stellata*, while less frequent species such as *Tilia americana* var. *caroliniana* and *Juglans nigra* indicate base-rich conditions.

Range and Abundance: Ranked G2?. There are well under 20 occurrences in North Carolina, with a cluster of the Slate Variant in Stanley, Anson, and Union counties and other examples scattered across the Piedmont. The association is attributed to South Carolina and Georgia, and questionably to Alabama and Virginia.

Associations and Patterns: Piedmont Cliffs are small patch communities, with most patches a handful of acres at most and many less than one acre. As with other cliffs, assessing extent is complex because they may have more vertical area than in map projection. Cliffs are usually bordered by oak forest above and may be bordered by oak forest, Mesic Mixed Hardwood Forest, or various floodplain communities below.

Variation: While the Basic Subtype examples are as variable as any rock outcrop communities, a distinctive cluster is recognized as a variant.
1. Typic Variant fits most examples, on a variety of rock types.
2. Slate Variant occurs on a narrow-ranging cluster of bluffs of, apparently, calcium-rich slate in Stanley and Union counties. The fine-bedded rock forms some hard outcrops and some areas of loose flat fragments making the site physically transitional to those of Acidic Shale Slope Woodland and Piedmont Basic Glade (Falls Dam Slope Subtype). Its flora and vegetation structure are similar to other cliffs of the Basic Subtype, but several species, including *Acer leucoderme* and *Borodinia missouriensis*, occur primarily or exclusively in it. After further study, the Slate Variant may warrant recognition as a subtype.

Dynamics: Piedmont Cliff communities generally are stable, though they are undergoing slow primary succession. Because mafic and many metasedimentary rocks are less resistant to weathering than many felsic rocks, primary succession probably is faster in the Basic Subtype. If succession is not reset, they may develop to Piedmont Basic Glades. There may be occasional local natural disturbances by rocks breaking or by trees falling from the top. Because most of the larger plants are rooted in crevices or deep soil pockets, they are better buffered from both windthrow and drought than are the shallow soil mats of Granitic Flatrocks and various glades. Plants on bare rock or in shallower soil may be stressed or killed during drought. Examples occurring on slate and similar rocks has some natural disturbance from shifting of unstable fragments, though less so than other shale communities.

Light levels may occasionally change as a result of canopy gaps in the adjacent forest, which sometimes result in an influx of weedy species. Examples surrounded by oak forests presumably were exposed to fire, but since fire would not carry through the sparse vegetation, its effects might be limited to the edges and to scorching by radiant heat. Many examples are surrounded by mesic forest or are next to streams, where they probably had limited exposure to fire.

The Basic Subtype is susceptible to invasion by exotic plants to a greater degree than most rock outcrop communities. *Lonicera japonica* is fairly frequent in it, and several other exotic species occur in examples.

Comments: The structure of Piedmont cliff classification has been changed from the 3rd Approximation. It has been narrowed by the creation of the Piedmont Basic Glade community type, which encompasses sites with more cover of soil and vegetation, which generally are less steep. At the same time, the formerly separate mafic and calcareous communities have been combined. While somewhat calcareous rocks are present in parts of the Piedmont, they are less distinctive than those that support different communities in the Mountains. Because of the ambiguous classification of some substrates, the more general term “basic” has been used for their

name. The cliff communities have been changed from types into subtypes, suggesting what appears to be a closer relationship among their biota.

Rare species:
Vascular plants: *Anemone berlandieri, Bododinia missouriensis, Euphorbia mercurialina, Eurybia mirabilis, Pellaea wrightiana,* and *Sedum glaucophyllum,*

References:

COASTAL PLAIN CLIFF

Concept: Coastal Plain Cliffs are sparsely vegetated, largely dry communities of steep-to-vertical exposures of bare sedimentary substrates.

Distinguishing Features: Coastal Plain Cliffs are distinguished from most communities of the Coastal Plain by sparse vegetation on steep-to-vertical exposures. Piedmont/Coastal Plain Heath Bluff and Cape Fear Valley Mixed Bluff Forest occur on steep bluffs but have dense vegetation. Coastal Plain Cliffs are distinguished from Coastal Plain Seepage Bank communities by having only local saturated seepage zones and having a flora consisting primarily of upland plants. They are distinguished from Piedmont Cliffs by occurring on unconsolidated Coastal Plain sediments rather than crystalline rock, and by the more dynamic environment this creates. There are substantial floristic differences between Piedmont and Coastal Plain cliff communities. Many of the most characteristic species, such as *Morella cerifera* and *Pinus taeda,* are scarce and infrequent on Piedmont cliffs. Characteristic Piedmont cliff species that don't typically occur on Coastal Plain Cliffs include *Pinus virginiana*, *Chionanthus virginicus, Rhododendron* spp., *Vaccinium pallidum, Danthonia spicata, Myriopteris (Cheilanthes) lanosa, Solidago caesia*, *Pleopeltis polypodioides,* and *Hieracium venosum*. Distinctive species of Coastal Plain Cliffs are less well known, but *Morella cerifera, Vaccinium arboreum*, and *Pinus taeda* are often common. *Mikania scandens*, *Andropogon tenuispatheus*, and a variety of weedy herbaceous species are often present.

Synonyms: Coastal Plain Acidic Cliff Sparse Vegetation (CEGL004388). Piedmont/Coastal Plain Acidic Cliff (3rd approximation).
Ecological Systems: Definitive placement in an ecological system has not been determined.

Sites: Coastal Plain Cliffs occur on bluffs of large rivers, or rarely in ravines of tributary creeks. Most are very steep to nearly vertical, but ledges and sloping areas may occur. An accumulation of fallen material at the base may be less steep. The substrate is unconsolidated or semi-consolidated clayey and sandy sediment, generally of Cretaceous age formations.

Soils: Coastal Plain Cliffs have soft or firm clay, loamy, or sandy material, but surfaces are young and soil development is limited. The rooting medium may be relatively fertile or infertile.

Hydrology: Coastal Plain Cliffs may be very heterogeneous in moisture levels. Large parts are dry, but significant zones may be moist and local areas may be saturated by seepage.

Vegetation: Coastal Plain Cliff vegetation is sparse overall, often completely absent over the central part of the cliff face. The top, the base, and ledges or areas with seepage may have locally dense vegetation. Vegetation is extremely variable among the few examples. The only frequent species is *Morella cerifera*, which is universally present on the edges. Trees on the edges may be either species of Mesic Mixed Hardwood Forest, such as *Fagus grandifolia* or *Acer floridanum*, species of floodplains such as *Platanus occidentalis*, or widely dispersed species such as *Pinus taeda, Acer rubrum*, *Liquidambar styraciflua*, or *Quercus nigra*. Shrubs noted in different examples include *Hydrangea arborescens, Vaccinium arboreum, Ilex decidua*, *Clethra alnifolia, Cyrilla racemiflora, Symplocos tinctoria, Alnus serrulata, Vaccinium elliottii*, and many others.

Herbs may include disjunct or regionally uncommon species such as *Galax urceolata* or *Epigaea repens*, or weedy species such as *Eupatorium capillifolium*. The greatest diversity of herbs comes in the seepage zones. They may have widespread wetland species such as *Osmundastrum cinnamomeum, Osmunda spectabilis*, *Lorinseria areolata*, *Impatiens capensis, Hydrocotyle verticillata/umbellata, Ptilimnium capillaceum, Persicaria* spp., or *Viola lanceolata*. They may have fewer usual wetland species such as *Kellochloa (Panicum) verrucosa* or *Equisetum hyemale*. A couple of examples have zones influenced by calcareous seepage and contain *Parnassia grandifolia*.

Range and Abundance: Ranked G2? In North Carolina examples are widely scattered, with the six known examples occurring along four different rivers. The overall range is very poorly known. The NVC association is attributed definitively only to North Carolina but conceptually similar vegetation could occur in any Coastal Plain state.

Associations and Patterns: Coastal Plain Cliffs are small patch communities. As with other cliff communities, they may have more area in vertical orientation than in map projection. Cliffs are generally bordered by a river or by floodplain communities below. Otherwise, they may be bordered by Mesic Mixed Hardwood Forest, Piedmont/Coastal Plain Heath Bluff, or Dry-Mesic Oak–Hickory Forest. They could be bordered by longleaf pine communities above.

Variation: Coastal Plain Cliffs are extremely variable. The six occurrences could represent five different variants.

Dynamics: Coastal Plain Cliffs are less stable than other cliff communities. Undercutting or sapping and slumping remove vegetation and developing soil and create new bare surfaces fairly frequently. Without undercutting or sapping, the steep slopes would quickly break down in the soft sediment and succession would be rapid. Although the frequency of slumping is not well known, most examples appear to have fresh scars. The sparse vegetation and location on steep slopes along rivers make fire unlikely to be an influence anywhere other than at the top of the cliff. Seepage zones may be affected by drought or alteration of ground water recharge areas.

Comments:

Rare species:
Vascular plants: *Carex socialis* and *Parnassia grandifolia*.

References: