GRANITIC FLATROCKS

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GRANITIC FLATROCKS THEME

Concept: Granitic Flatrocks are communities occurring on nearly level outcrops of exfoliating granitic rock in the eastern and central Piedmont. The pavement-like surfaces largely lack crevices or other sites for deep rooting by plants. The individual communities represent different major stages of primary succession: barely vegetated bedrock, shallow soil with herbaceous vegetation, and continuous shallow soil capable of supporting xerophytic woodland trees.

Distinguishing Features: The Granitic Flatrock theme is distinguished by naturally sparse, herbaceous, or stunted woodland vegetation associated with flat-lying exfoliated granitic rock at or near the surface. The gentle slope, which changes soil development, as well as differing climate and regional flora, separate Granitic Flatrocks from the Low Elevation Granitic Dome communities of the foothills and Mountain Region. The edge of the Granitic Flatrocks theme occurs where the distinctive xerophytic vegetation gives way to more typical forest communities.

Synonyms: Granite flatrock, granite outcrop, pavement (general usage).

Sites: Sites are unfractured outcrops of exfoliating granite, adamellite, syenite, or related igneous rocks, level or gently sloping, at about the same elevation as the surrounding land. Rock may be extensive at the surface or may be covered with a shallow layer of soil. Rock surfaces may have shallow weathering pits, large or small loose rock fragments, and occasionally larger loose slabs of rock but have extensive pavement-like surfaces. Flatrocks may be on upland ridges or may be exposed on gentle slopes above streams. In a few examples, they extend to the banks of streams that flow over the bedrock.

Soils: Soils consist of sandy-textured partially weathered rock and accumulated organic matter. They range from barely present to continuous shallow layers. The more continuous soil areas are often treated as Wake (Lithic Udispamment), Louisburg (Ruptic-Ultic Dystrochrept), or, farther west, Ashlar (Typic Dystrudept).

Hydrology: Moisture conditions may have extreme fluctuations. The limited soil depth creates extremely dry conditions much of the year but the limited water penetration allows soils to be saturated during wet periods. Local areas of seepage may be present on edges of open rock, and water may pool seasonally in weathering depressions.

Vegetation: Vegetation varies greatly among the three communities in this theme, but all are more open than the surrounding forest. Thorough vegetation descriptions were published early (Oosting and Anderson 1939, McVaugh 1943), and interest has continued to lead to publications ((Palmer 1970, Wyatt and Fowler 1977, Phillips 1982). The Annual Herb Subtype often has sparse vegetation or may consist of a mosaic of lichens, mosses, spikemosses (*Bryodesma (Selaginella) rupestre*), and small herbs that include habitat specialist species such as *Diamorpha smallii*, *Mononeuria (Minuartia Arenaria) uniflora* and *Cyperus granitophilus*, as well as more widespread rock outcrop species such as *Phemeranthus (Talinum) teretifolius* and *Hypericum gentianoides*. The Perennial Herb Subtype has more continuous vegetation of larger herbaceous plants such as *Andropogon virginicus* and *Packera tomentosa,* along with some shrubs. Granitic Flatrock Border

Woodland has a tree canopy dominated by species characteristic of xeric sites, such as *Juniperus virginiana, Quercus stellata,* and *Pinus virginiana*.

Dynamics: The successional dynamics of Granitic Flatrocks were a theme of interest to early ecologists. Oosting and Anderson (1939), McVaugh (1943), Palmer (1970), and other authors interpreted the concentric zonation of soil mats as representing successional time, and fit the finely described vegetation patch types into successional sequences that remain generally accepted. They noted that lichens are the first pioneers to establish on bare rock, but that they don't seem to contribute to soil development. Mat-forming mosses and spikemoss (*Bryodesma (Selaginella*) *rupestre*) also establish on bare rock and are more capable of trapping sand and clay and depositing organic matter to begin building soil. A small number of specialized herbs, mostly annuals, take hold in the extremely shallow soil accumulations in depressions or in the moss mats. As soil mats thicken, perennial herbs and then larger herbs can establish. Shrubs and tree seedlings are able to survive as the mats thicken. Succession may ultimately lead to the somewhat deeper soil and continuous woody vegetation of the Granitic Flatrock Border Woodland community. Oosting and Anderson (1939) and McVaugh (1943) also noted different successional pathways in different microsites, including seepages and small depressions that hold water long enough to exclude many species.

Most authors also noted that flatrocks are "self-perpetuating," tending to support a cyclic succession pattern, where rock repeatedly becomes bare and primary succession begins anew. They noted wind, drought, and fire as causes of the disturbance that regenerates bare rock. The shallow soil leaves trees vulnerable to wind throw and drought. When live or dead trees fall, they can pull up soil mats and destroy the accumulated soil. This effect has been observed by the author in recent years after droughts and major storms. Fire presumably once was an additional source of natural disturbance, at least on the edges of flatrocks adjacent to surrounding forests. Given the high organic content of the shallow soil, fire during drought might destroy more than just the woody plants. However, the sparse vegetation of the open rock would not carry fire.

The presence of a number of weedy species in undisturbed flatrocks has been noted and discussed (Burbanck and Platt 1964, Wyatt and Fowler 1977). It appears that the open environment, with limited competition, allows them to persist.

Though similar primary and cyclic succession patterns occur in Low Elevation Granitic Dome and High Elevation Granitic Dome communities, the lack of slope in Granitic Flatrocks suggests some differences. Soil mats are likely to persist longer in Granitic Flatrocks, weathering debris would be removed more slowly, water and soil are more likely to pool in weathering depressions, and erosion by flowing water is likely to be less vigorous.

It is unclear how much the cyclic succession involves the larger surrounding zone of Granitic Flatrock Border Woodland. Soil pulled up by falling trees there is more readily replaced from the surroundings. However, the susceptibility to natural disturbance because of the shallow soil is presumed to be the cause of the distinctive xerophytic flora and abundance of successional species in these woodlands. It may be that a longer-term cyclic dynamic occurs, with woodlands and open rock alternately expanding and contracting in response to climatic cycles on the scale of decades.

Palmer (1970) noted that the border woodland at one site appeared to have expanded from 1949 to 1966, but also believed it might expand and contract over longer time periods.

The open Granitic Flatrocks are extremely sensitive to mechanical disturbance, including even moderate foot traffic, while the unique environment attracts such traffic. The hard level surface and open vegetation also attract vehicle traffic and dumping of trash, while the unweathered rock without overburden makes flatrocks attractive for quarrying. Traffic destroys the vegetation of both the Annual Herb and Perennial Herb Subtype, and it is possible that the relative proportions of these communities seen at present reflects this as well as the configuration of the rock.

Like the other glade, barren, and rock outcrop communities, Granitic Flatrocks are an anomaly in the Piedmont climate, which supports the development of thick saprolite, deep soils, and forest vegetation. While many of the plant species are weedy species or are shared with other kinds of rock outcrop or open communities, McVaugh (1943) argued that the existence of a distinctive flora of species with no other habitat, along with the amount of time it would take for them to disperse to the small sites over distances of unsuitable habitat, suggest great antiquity. Oosting and Anderson (1939) appear to have thought flatrocks originated recently as a result of human actions. Burbanck and Platt (1964) suggested a shifting pattern of flatrocks disappearing and appearing across the landscape, and this view was favored by Wyatt and Fowler (1977). However, no new flatrocks have been reported. The most characteristic plants do not seem to appear at artificially created bare rock exposures. Wyatt and Fowler (1977) noted reduction in characteristic and community-endemic species as one travels away from the center of flatrock distribution in northcentral Georgia. A shifting mosaic would be expected to produce a more random pattern of richness in these species, as individual rocks would be of differing age. In the end, the existence of multiple specialized endemic species that don't occur in other rock outcrop communities suggests many millennia of evolutionary time in this habitat.

Comments: Granitic Flatrocks are clearly closely related to glade and barren communities on other rock types, sharing features of ecology, vegetation structure, and species composition. Thus, this community type could as easily be termed "Granitic Glade." The flatrock name has been retained because of its long and well-established usage. It was modified slightly from the often-used "Granite Flatrock," changing it to "Granitic Flatrock," since several kinds of rock that are not strictly granite can also support them.

The structure of the classification of the Granitic Flatrocks theme and its component communities is different from other parts of the 4th Approximation. The somewhat analogous Granitic Dome Basic Woodland is separated from the associated Low Elevation Granitic Dome and instead placed with other communities having similar vegetation structure, while the Granitic Flatrock Border Woodland is included in the Granitic Flatrocks theme despite the very different vegetation structure. While a different decision could have been made, and a more parallel treatment used, it appears that the granitic flatrock environment is more distinct from other rock outcrops than that of granitic dome, and that the border woodland is more closely tied to it ecologically.

References:

Burbanck, M.P., and R.B. Platt. 1964. Granite outcrop communities of the Piedmont plateau in Georgia. Ecology 45:292-305.

McVaugh, R. 1943. The vegetation of the granitic flatrocks of the southeastern United States. Ecol. Monogr. 13:119.

Oosting, H.J., and L.E. Anderson. 1939. Plant succession on granite rock in eastern North Carolina. Bot. Gaz. 100:750-768.

Palmer, P.G. 1970. The vegetation of Overton Rock Outcrop, Franklin Co., N.C. J. Elisha Mitchell Sci. Soc. 86:80-87.

Phillips, D.L. 1982. Life-forms of granite outcrop plants. American Midland Naturalist 107:206-208.

Wyatt, R., and N. Fowler. 1977. The vascular flora and vegetation of the North Carolina granite outcrops. Bull. Torrey Bot. Club 104:245-253.

KEY TO GRANITIC FLATROCKS

1. Vegetation with substantial tree cover, more than 50% cover when not recently disturbed. Xerophytic composition, usually with abundant *Pinus* spp. or *Juniperus virginiana* distinguish it from adjacent forests ..... **Granitic Flatrock Border Woodland**

1. Vegetation without substantial tree cover; only sparse trees or young trees are present; vegetation generally sparse or dense herbaceous cover, with limited shrub patches.

   2. Vegetation dominated by combinations of small annual herbs, small mosses such as *Grimmia laevigata*, and lichens, often with substantial bare rock ..... **Granitic Flatrock (Annual Herb Subtype)**

   2. Vegetation dominated by combinations of predominantly long-lived and larger herbs, including grasses such as *Andropogon virginicus* and *Schizachyrium scoparium*, forbs such as *Packera tomentosa*, and large mosses such as *Polytrichum* spp. and *Sphagnum* spp.; bare rock and smaller herbs are present in smaller amounts and in small patches. **Granitic Flatrock (Perennial Herb Subtype)**

GRANITIC FLATROCK (ANNUAL HERB SUBTYPE)

Concept: Granitic Flatrock communities are sparsely vegetated or herbaceous communities of flatrock outcrops. The Annual Herb Subtype represents the zones in the vegetation mosaic that occur on the shallowest soil accumulations or on bare rock, where plants are primarily annual herbs, small bryophytes, or lichens. This subtype represents the earliest stages of primary succession. Characteristic flatrock endemic species such as *Diamorpha smallii, Sedum pusillum, Portulaca smallii, Mononeuria uniflora,* and *Cyperus granitophilus* occur primarily in this subtype.

Distinguishing Features: Granitic Flatrocks are distinguished from Granitic Domes by floristic differences such as the presence of *Diamorpha smallii, Sedum pusillum, Mononeuria glabra, Packera tomentosa, Croton willdenowii*, and the absence of plants more characteristic of the Blue Ridge, as well as by their location in the central and eastern Piedmont. They are generally distinguished by gentler topography and the associated presence of small weathering depressions, but the range of slopes can overlap with that of Granitic Domes. Granitic Flatrocks are distinguished from all other rock outcrop communities by the characteristic physical structure produced by exfoliation, with shallow depressions but few crevices, fractures, or deeper soil pockets.

The Annual Herb Subtype is distinguished from other zones by the dominance of smaller mosses, lichens, or annual herbs, usually *Diamorpha, Mononeuria, Sedum,* or *Portulaca*, but also including *Hexasepalum (Diodia) teres, Cyperus granitophilus, Hypericum gentianoides*, and others. Mats of *Grimmia laevigata* are included, but beds of *Polytrichum* spp., *Sphagnum* spp. beds in seeps, and other larger mosses are included with the Perennial Herb Subtype.

Synonyms: *Diamorpha smallii - Minuartia glabra - Minuartia uniflora - Cyperus granitophilus* Herbaceous Vegetation (CEGL004344).
Ecological Systems: Southern Piedmont Granitic Flatrock and Outcrop (CES202.329).

Sites: The Annual Herb Subtype occurs on open flatrock outcrops of granitic rocks. It may include flat areas, gentle slopes, and shallow weathering depressions.

Soils: Soil is absent or consists solely of very shallow accumulations of organic matter and sandy partially weathered granite.

Hydrology: The Annual Herb Subtype generally is very dry, due to lack of soil and water-holding capacity. However, it may be seasonally wet, especially in weathering depressions.

Vegetation: The vegetation of the Annual Herb Subtype is generally a fine-scale mosaic of several zones or patch types of short-lived or small-stature plants. Most distinctive, though not always most extensive, are areas dominated by *Diamorpha smallii, Portulaca smallii, Mononeuria (Minuartia) glabra*, *Mononeuria (Minuartia) uniflora*, or *Cyperus granitophilus*, species which occur exclusively, or nearly so, in Granitic Flatrocks and in this subtype. Other herbs of extremely shallow soils, such as *Hypericum gentianoides, Hexasepalum (Diodia) teres*, *Bulbostylis capillaris*, or *Croton willdenowii* (*Crotonopsis elliptica*) may also dominate patches. Patches dominated by *Bryodesma (Selaginella) rupestre* are also included in this subtype; though

perennial, they represent early stages of primary succession. Large patches of this subtype may be dominated by mats of *Grimmia laevigata* or other small mosses, other substantial areas by crustose lichens or unvegetated bedrock. Any of the larger plants characteristic of the Perennial Herb Subtype may occur with limited cover; vegetation plots often capture portions of that community and suggest greater presence of them. Though this is inherently a sparsely vegetated community, trees rooted on the edge may provide substantial cover.

Granitic Flatrock vegetation was described in early thorough studies by Oosting and Anderson (1939) and McVaugh (1943), who described multiple zones. Later authors (e.g. Palmer 1970, Wyatt and Fowler 1977) focused on specific sites or concentrated in other states. Only a few CVS plots exists for this community.

Range and Abundance: Ranked G3. The approximately 30 examples are scattered in the eastern and central Piedmont, with a denser cluster in eastern Wake and adjacent Franklin County. This community ranges from North Carolina to Alabama. One of the best developed examples is a few miles into South Carolina. A closely related flatrock community, regarded as more floristically depauperate, occurs in Virginia.

Associations and Patterns: The Annual Herb Subtype usually is closely intermixed with the Perennial Herb Subtype, but the proportions of the communities vary. Some flatrocks are predominantly one or the other. Oosting and Anderson (1939) and McVaugh (1943) emphasized concentric patterns in vegetation mats, with the Annual Herb Subtype vegetation occurring on the outside of patches and the Perennial Herb Subtype in the presumably older centers. The Perennial Herb Subtype often also occurs as a broad zone on the edge of the open rock, with the Annual Herb Zone making up more of the center. Granitic Flatrocks probably once were usually surrounded by Granitic Flatrock Border Woodland, though not all examples retain them now.

Variation: This community represents several distinctive kinds of patches, which may vary in extent with undulations of the rock surface and with disturbance history.

Dynamics: General flatrock dynamics are described more fully in the theme description. The Annual Herb Subtype represents the earliest stages of the primary succession characteristic of flatrocks. Crustose lichens may be the first colonists on bare rock, but Oosting and Anderson (1939) noted that they do not contribute to soil accumulation. *Grimmia laevigata* moss beds and the annual herb patches may accumulate shallow soil by depositing organic matter and trapping dust or sand. Soil eventually builds up enough to support the vegetation of the Perennial Herb Zone. McVaugh noted that the larger mosses *Polytrichum ohioense* and *Polytrichum commune* invade soil mats and eliminate the lichens and smaller mosses, and that they greatly increase the extent and thickness of the mats. Because of the limited vegetation cover in the Annual Herb Subtype, fire presumably plays little or no role. However, both authors mention the role of wind, drought, and fire in destroying the later successional stages and regenerating the early stages of the Annual Herb Subtype.

Comments: It is not entirely clear if it is useful to have the two subtypes distinguished, when they are so closely intermixed and each is still heterogeneous. It is not practical to recognize even finer subtypes for all the different fine-scale vegetation zones that have been described. However, the

subtypes do occur in differing proportions on different outcrops, and they may respond differently to threats such as trampling and climate change.

Rare species:
Vascular plants: *Cyperus granitophilus, Isoetes piedmontana, Isolepis carinata, Mononeuria (Minuartia, Arenaria) uniflora, Panicum philadelphicum* ssp. *lithophilum, Portulaca smallii,* and *Sedum pusillum.*
Nonvascular plants: *Campylopus oerstedianus*

References:
McVaugh, R. 1943. The vegetation of the granitic flatrocks of the southeastern United States. Ecol. Monographs 13:119.

Oosting, H.J. and L.E. Anderson. 1939. Plant succession on granite rock in eastern North Carolina. Bot. Gaz. 100:750-768.

Palmer, P.G. 1970. The vegetation of Overton Rock Outcrop, Franklin Co., N.C. J. Elisha Mitchell Sci. Soc. 86:80-87.

Wyatt, R., and N. Fowler. 1977. The vascular flora and vegetation of the North Carolina granite outcrops. Bull. Torrey Bot. Club 104:245-253.

GRANITIC FLATROCK (PERENNIAL HERB SUBTYPE)

Concept: Granitic Flatrock communities are sparsely vegetated or herbaceous communities of flatrock outcrops. The Perennial Herb Subtype represents the zones that occur on thicker soil accumulations, where larger perennial herbs predominate and some shrub cover may be present.

Distinguishing Features: Granitic Flatrocks are distinguished from Granitic Domes by floristic differences such as the presence of *Diamorpha smallii, Sedum pusillum, Mononeuria glabra, Packera tomentosa, Croton willdenowii*, and the absence of plants more characteristic of the Blue Ridge, as well as by their location in the central and eastern Piedmont. They are generally distinguished by gentler topography and the associated presence of small weathering depressions, but the range of slopes can overlap with that of Granitic Domes. Granitic Flatrocks are distinguished from all other rock outcrop communities by the characteristic physical structure produced by exfoliation, with shallow depressions but few crevices, fractures, or deeper soil pockets.

The Perennial Herb Subtype is distinguished from the Annual Herb Subtype by the dominance of larger and longer-lived species, which may include grasses such as *Andropogon virginicus* or *Schizachyrium scoparium*, forbs such as *Packera tomentosa,* or large mosses such as *Polytrichum commune* or *Sphagnum* spp. Species of the Annual Herb Subtype may also be present.

Synonyms: Synonyms: *Packera tomentosa - Croton willdenowii - Schizachyrium scoparium - (Selaginella rupestris)* Herbaceous Vegetation (CEGL004298).
Ecological Systems: Southern Piedmont Granitic Flatrock and Outcrop (CES202.329).

Sites: The Perennial Herb Subtype occurs on open flatrock outcrops of granitic rocks. It may include flat areas, gentle slopes, shallow weathering depressions, and local seepage areas.

Soils: Soils are shallow accumulations of organic matter and sandy partially weathered granite, a few inches to a foot in depth. Soil mapping often includes these areas with Wake (Lithic Udipsamment), Louisburg (Ruptic-Ultic Dystrochrept) or Ashlar (Typic Dystrochrept), or simply as rock outcrop.

Hydrology: The Perennial Herb Subtype generally is very dry, due to lack of soil and water-holding capacity. However, it may be seasonally wet, especially in weathering depressions. Locally areas may be saturated with seepage for extended periods.

Vegetation: The Perennial Herb Subtype often includes patches or zones with very different dominant species, though they may occur in many mixtures. *Andropogon virginicus* is the most constant species and most often the dominant grass, but *Andropogon ternarius, Schizachyrium scoparium, Danthonia sericea, Danthonia spicata, Chasmanthium laxum*, or other grasses may be abundant. *Packera tomentosa* or *Packera anonyma* are the most constant forbs. *Asplenium platyneuron, Opuntia mesacantha* ssp. *mesacantha*, and *Yucca* spp. are also frequent. A number of other species are frequent enough to be considered characteristic, including *Aristida dichotoma, Tridens flavus, Manfreda virginica, Krigia virginica, Geranium carolinianum, Micranthes virginica, Commelina erecta* var. *erecta*, *Juncus dichotomus, Panicum philadelphicum* ssp.

lithophilum, *Eupatorium hyssopifolium, Eupatorium rotundifolium, Salvia lyrata,* several *Cyperus* species, and larger mosses such as *Polytrichum commune* and *Polytrichum ohioense*,. Various species shared with the Annual Herb Subtype are also present, such as *Hexasepalum (Diodia) teres, Croton wildenowii (Crotonopsis elliptica*), and *Hypericum gentianoides*. In the deeper, older soil mats, some woody species may be established. *Smilax rotundifolia, Gelsemium sempervirens*, *Rhus copallinum*, and *Vaccinium arboreum* are frequent. Small *Juniperus virginiana* and other trees may be present; they may be short-lived or may be the beginning of succession to woody dominance. In seepage areas, *Sphagnum lescurii*, *Lindernia monticola, Eupatorium perfoliatum, Greeneochloa coarctata (Calamagrostis cinnoides*), *Utricularia juncea*, the moss *Philonotus fontana*, and other wetland species may predominate, though some of the above species may also be present.

Granitic Flatrock vegetation was described in early thorough studies by Oosting and Anderson (1939) and McVaugh (1943), who described multiple zones. Later authors (e.g. Palmer 1970, Wyatt and Fowler 1977) focused on specific sites or concentrated in other states. Only a few CVS plots exists for this community.

Range and Abundance: Ranked G3. The approximately 30 examples are scattered in the eastern and central Piedmont, with a denser cluster in eastern Wake and adjacent Franklin County. This community ranges from North Carolina to Alabama.

Associations and Patterns: The Perennial Herb Subtype usually is closely intermixed with the Annual Herb Subtype, but the proportions of the communities vary. Some flatrocks are predominantly one or the other. Most authors emphasize concentric patterns in vegetation mats, with the Annual Herb Subtype vegetation occurring on the outside of patches and the Perennial Herb Subtype in the presumably older centers with thicker soil. The Perennial Herb Subtype often also occurs as a broad zone on the edge of the open rock, with the Annual Herb Zone making up more of the center. Granitic Flatrocks probably once were usually surrounded by Granitic Flatrock Border Woodland, though not all examples retain them now.

Variation: This community represents several distinctive kinds of patches, which may vary in extent with undulations of the rock surface, presence of seepage, and disturbance history. Rare flatrocks have extensive and relatively long-term seepage; these need further investigation but may require division into a separate type.

Dynamics: General flatrock dynamics are described more fully in the theme description. The Perennial Herb Subtype represents the middle stages of the primary succession characteristic of flatrocks. If undisturbed, its patches will continue to trap mineral particles and accrete organic matter until shrubs and trees are able to invade. Once trees have grown fairly large, they are susceptible to wind throw as well as drought mortality because of the shallow soils. Patches in the interior of the open flatrock probably are destroyed and returned to bare rock fairly quickly at this stage, but patches on the edge may merge into the adjacent Granitic Flatrock Border Woodland until a more severe disturbance affects them. Fire may spread into patches on the edge of the open rock but probably has no effect on isolated patches surrounded by the Annual Herb Subtype.

The conditions that allow many native weed species to persist in this community also make it susceptible to invasion by exotic plants. *Lonicera japonica* and *Lespedeza cuneata* can be particularly abundant.

Comments: It is not entirely clear if it is useful to have the two subtypes distinguished, when they are so closely intermixed and each is still heterogeneous. It is not practical to recognize even finer subtypes for all the different fine-scale vegetation zones that have been described. However, the subtypes do occur in differing proportions on different outcrops, and they may respond differently to threats such as trampling and climate change.

Rare species:
Vascular plants: *Cyperus granitophilus, Isoetes piedmontana, Isolepis carinata, Mononeuria (Minuartia, Arenaria) uniflora, Panicum philadelphicum* ssp. *lithophilum, Portulaca smallii,* and *Sedum pusillum.*
Nonvascular plants: *Campylopus oerstedianus*

References:
McVaugh, R. 1943. The vegetation of the granitic flatrocks of the southeastern United States. Ecol. Monographs. 13:119.

Oosting, H.J., and L.E. Anderson. 1939. Plant succession on granite rock in eastern North Carolina. Bot. Gaz. 100:750-768.

Palmer, P.G. 1970. The vegetation of Overton Rock Outcrop, Franklin Co., N.C. J. Elisha Mitchell Sci. Soc. 86:80-87.

Wyatt, R., and N. Fowler. 1977. The vascular flora and vegetation of the North Carolina granite outcrops. Bull. Torrey Bot. Club 104:245-253.

GRANITIC FLATROCK BORDER WOODLAND

Concept: Granitic Flatrock Border Woodlands are open xerophytic forests or woodlands on shallow soils around Granitic Flatrocks, more xerophytic than the surrounding upland forests. They are generally dominated by pines, with abundant *Juniperus virginiana* and a varying mix of drought-tolerant hardwoods such as *Quercus stellata, Quercus marilandica, Ulmus alata, Carya glabra*, and *Carya tomentosa*. Some mesophytic and even a few wetland species may be present in minor amounts. *Quercus phellos* occurs in a number of examples but is not a major component.

Distinguishing Features: The Granitic Flatrock Border Woodland is distinguished from all other upland forests and woodlands in its location on shallow soil over exfoliated granitic rock in the eastern or central Piedmont. Granitic Dome Basic Woodland is associated with exfoliated rock but is steeper and occurs in the foothills or Blue Ridge. It lacks the eastern Piedmont flora and has distinct montane components. The most closely related community, Piedmont Acidic Glade, is the only other Piedmont community that may be naturally dominated by *Pinus virginiana* or *Pinus taeda*. It also has a similarly xerophytic and acid-tolerant composition. However, it has a more open canopy, generally has *Quercus montana* as an important canopy component, and tends to have a well-developed shrub or herb layer. Piedmont Basic Glade also shares an open structure created by shallow soil and bedrock. It has a larger component of base-loving flora, though a few members (*Rhus aromatica, Chionanthus virginicus*) are sometimes shared with this type. Granitic Flatrock Border Woodlands should be recognized where substantial natural woodland occurs around or between open Granitic Flatrock communities. Small islands of woody vegetation on open rocks should be treated as part of the Perennial Herb Subtype, but large patches may be viewed as Granitic Flatrock Border Woodland.

Granitic Flatrock Border Woodlands can be particularly hard to distinguish from anthropogenic successional communities, which may also be dominated by pines, especially because they may often share an abundance of invasive nonnative plants. Granitic Flatrock Border Woodlands are most easily distinguished by their site characteristics, including soils too shallow to plow, absence of evidence of cultivation, and association with rock outcrops. Their vegetation is less likely to be even-aged, more likely to have an abundance of *Juniperus*, and more likely to have a mix of pines and hardwoods of the same age.

Synonyms: *Pinus (virginiana, taeda) / Juniperus virginiana - Chionanthus virginicus - Ulmus alata* Granitic Flatrock Border Forest (CEGL003993).
Ecological Systems: Southern Piedmont Granitic Flatrock and Outcrop (CES202.329).

Sites: Granitic Flatrock Border Woodlands occur on shallow soils with exfoliated granitic rock beneath, generally adjacent to open rock outcrops. They may be uphill or downhill from surrounding forest sites.

Soils: Soils are continuous but are shallow and sandy, yet they may be relatively fertile. The abundance of unweathered minerals may give them higher abundance of base cations than the typical Piedmont soils formed in saprolite. On detailed soil maps they are treated as Wake (Lithic Udispamment), Louisburg (Ruptic-Ultic Dystrochrept), or, farther west, Ashlar (Typic

Dystrudept). These are often mapped as complexes with rock outcrop or with Typic Kanhapludults or Typic Hapludults, especially Saw, Wedowee, and Pacolet.

Hydrology: Granitic Flatrock Border Woodlands are dry for much of the year because of the shallow soil; the environment can be extremely stressful during droughts. However, because of the limited infiltration of water, they can be saturated during wet periods.

Vegetation: Granitic Flatrock Border Woodland has a somewhat open canopy, though it may occasionally be as dense as a typical forest. The canopy is a mix of xerophytic tree species. *Juniperus virginiana* is the most constant species, and some species of pine, most often *Pinus taeda* or *Pinus virginiana*, is usually dominant or codominant. *Pinus echinata* sometimes is also a component and may have been more so in the past. *Quercus stellata, Carya glabra, Carya tomentosa,* and *Ulmus alata* may be codominant or dominant in some examples. Less frequent tree species include *Quercus marilandica, Carya pallida, Quercus phellos*, *Quercus nigra*, and *Quercus alba*. The understory is not well developed beneath the short canopy, but *Prunus serotina, Nyssa sylvatica, Acer rubrum, Cornus florida, Ilex opaca,* or *Chionanthus virginicus* may occur, along with most of the canopy species. The shrub layer may be sparse to fairly dense. *Rhus copallinum* is the most frequent species in the few CVS plots and among qualitative reports, but *Vaccinium arboreum* may dominate. The exotic *Ligustrum sinense* can also become dense. Occasional shrubs include *Vaccinium fuscatum, Toxicodendron pubescens, Rosa carolina, Viburnum prunifolium, Castanea pumila,* and *Ilex decidua*, as well as any of the species typical of Piedmont Oak Forests. Woody vines are often extensive in cover. *Lonicera sempervirens, Smilax rotundifolia, Toxicodendron radicans*, *Parthenocissus quinquefolia*, or *Muscadinia rotundifolia*, as well as the exotic *Lonicera japonica*, may dominate the ground cover in large portions. Herbs are generally sparse, but local patches may have denser stands of *Chasmanthium laxum, Danthonia spicata,* or *Piptochaetium avenaceum*. Grasses of more open areas, including *Schizachyrium scoparium* and *Andropogon ternarius* may be present in small numbers. These grasses likely would have been more abundant when fires occurred regularly. *Asplenium platyneuron* and *Chimaphila maculata* are the most frequent herbs, but *Yucca flaccida, Yucca filamentosa,* and *Opuntia mesacantha* ssp. *mesacantha* are fairly frequent. Other herb species that occur with low frequency include *Penstemon canescens, Pycnanthemum tenuifolium, Melica mutica, Lespedeza* spp., *Cunila origanoides, Athyrium asplenioides, Dichanthelium* spp., *Endodeca serpentaria, Commelina erecta* var. *erecta*, *Aristida purpurascens*, and a large number of others.

Range and Abundance: Ranked G3? This community was distinguished only relatively recently, and it was often not described in qualitative reports, making it difficult to know how many examples remain. It presumably was present around most or all Granitic Flatrocks in the past but occurrences are more likely to have been destroyed. It is believed to range from North Carolina to Georgia and possibly to Alabama.

Associations and Patterns: Granitic Flatrock Border Woodland occurs with Granitic Flatrock communities, sometimes occurring as small patches within the mosaic and usually forming a broad ring around them. Though most examples are now surrounded by fields, developed areas, or successional forests, they naturally graded to typical Piedmont Oak Forests.

Variation: Examples vary in canopy composition, but patterns of variation are not well known.

Dynamics: General flatrock dynamics are described more fully in the theme description. The open canopy, small stature of trees, abundance of pines, and frequency of weedy species in all strata suggest a greater frequency of natural disturbance and tree mortality than in typical Piedmont forests. Impacts of drought and greater susceptibility to windthrow because of the shallow soils is presumably the reason. The continuous litter would allow them to burn at the same frequency as the surrounding forests. As in various glade and barren communities, fire may have had more effect in creating open vegetation on the extreme sites. While examples now have high cover of vines and sometimes shrubs, with limited herb cover, with regular fire they likely would be grassy.

While Granitic Flatrock Border Woodland on the edges and in small patches adjacent to open rock is part of the cyclic succession, restarting it by falling trees pulling up soil mats, the broader ring surrounding the open rock appears to be more stable. Windthrow pits in its interior are more readily refilled by soil from adjacent areas, and trees quickly regenerate. However, it may be that the ring widens and narrows in response to climatic cycles.

Comments: Granitic Flatrock Border Woodland was not initially recognized as a distinctive natural community. Though many of the published papers (Oosting and Anderson 1939, McVaugh 1943, Palmer 1970, Wyatt and Fowler 1977) described the woody vegetation, at least as the end stage of succession, it is generally not always clear how much it contrasts with more typical forests. The small stature, abundance of successional tree species in the canopy, abundance of weedy species, and sometimes heavy invasion by exotic species, make them resemble more altered Piedmont forests that are not usually the target of conservation. However, they appear to be naturally distinct and to retain these characteristics even in the absence of recent alteration.

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

References:

McVaugh, R. 1943. The vegetation of the granitic flatrocks of the southeastern United States. Ecol. Monogr. 13:119.

Oosting, H.J. and L.E. Anderson. 1939. Plant succession on granite rock in eastern North Carolina. Bot. Gaz. 100:750-768.

Palmer, P.G. 1970. The vegetation of Overton Rock Outcrop, Franklin Co., N.C. J. Elisha Mitchell Sci. Soc. 86:80-87.

Wyatt, R., and N. Fowler. 1977. The vascular flora and vegetation of the North Carolina granite outcrops. Bull. Torrey Bot. Club 104:245-253.