Ecological site PX136X00X850
Acidic High Hills and Isolated Ridges, Dry-moist

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 136X–Southern Piedmont

This MLRA is on a large piedmont underlain by metamorphic and igneous bedrock. It stretches from north-central Virginia to east-central Alabama, running parallel to the Appalachian highlands to the northwest and the Atlantic coast to the southeast.

MLRA 136 has only subtle climatic differences with MLRA 148 (Northern Piedmont), with which it shares a common geologic origin. This adjacent MLRA sits to the north. Along the fall line, it shares a boundary with MLRA 133A (Southern Coastal Plain), MLRA 137 (Carolina and Georgia Sand Hills), and 133C (Gulf Coastal Plain). Here, unconsolidated Coastal Plain sediments intersect the much older Piedmont bedrock. Along it's northwestern boundary, it sits adjacent to MLRAs 130B (Southern Blue Ridge), 130A (Northern Blue Ridge), and 128 (Southern Appalachian Ridges and Valleys). These MLRAs are distinguished from the Southern Piedmont by topographic and elevational differences, as well as differences in the age, origin, and degree of metamorphism of the underlying bedrock.

Five states are intersected by the MLRA, including North Carolina (29 percent), Georgia (27 percent), Virginia (20 percent), South Carolina (17 percent), and Alabama (7 percent). The MLRA extent makes up about 63,720 square miles (165,034 square kilometers).

MLRA PHYSIOGRAPHY
The landscape is generally rolling to hilly, with a well-defined drainage pattern. Streams have dissected the original Piedmont plateau, forming narrow ridgetops, somewhat broad interfluves, and short, steep side slopes adjacent to the streams and drainageways. With some exceptions, the valley floors are generally narrow and make up about 10 percent or

less of the land area. The associated stream terraces are generally small and of minor extent.

The landscape is moderately dissected overall, with isolated erosional remnants (monadnocks) and other areas of high topographic relief interspersed. Over most of the MLRA, elevation ranges from approximately 325 to 1,315 feet (100 to 400 meters), with elevations generally increasing toward the Appalachian Highlands, in the upper Piedmont, and decreasing toward the Coastal Plain, in the lower Piedmont.

The major rivers that cross this area en route to the ocean include, from north to south, the James, Roanoke, Cape Fear, Savannah, Altamaha, Chattahoochee, and Alabama Rivers. These rivers typically originate within the Piedmont or in the Blue Ridge. They flow east and south across the Coastal Plain and empty into the Atlantic Ocean or the Gulf of America.

MLRA GEOLOGY
Precambrian and Paleozoic metamorphic and igneous rocks underlie almost all of this MLRA. The dominant metamorphic rock types include gneiss, schist, slate, argillite, and phyllite, among others. Dominant igneous rock types include granite and other related felsic crystalline rocks. Mafic intrusive rocks, including gabbro, diabase, amphibolite, and other dark colored rocks, underlie a minority of the upland landscape. These mafic intrusions crop out in the form of dikes and sills, and often weather to produce soils high in base cations.

The Carolina Slate Belt runs lengthwise through the east-central part of the MLRA, in southern Virginia, North Carolina, South Carolina, and the eastern-most part of the Georgia Piedmont. This region is underlain by fine-grained metasedimentary and metavolcanic rock, which generally weathers to produce soils high in silt.

From Virginia to North Carolina, and in a single county in South Carolina, fault-bounded Triassic Basins are scattered amongst the igneous and metamorphic uplands. These basins are underlain by Triassic and Jurassic siltstone, shale, sandstone, and mudstone, which were laid down in response to continental rifting and subsequent erosion during the Mesozoic era.

MLRA SOILS
The dominant soil orders of the MLRA are Ultisols, Inceptisols, and Alfisols. Ultisols and Alfisols are typically found on more stable landforms, such as interfluves, gentle hillslopes, broad ridgetops, and stream terraces, while Inceptisols are typically found on less stable landforms, including flood plains, steep hillslopes, and narrow ridgetops.

Soils of the region predominantly have a thermic temperature regime, a udic moisture regime, and generally have kaolinitic or mixed mineralogy. In the upper Piedmont of Virginia and North Carolina however, soils have a mesic soil temperature regime, as depicted in figure 2. The mesic soil temperature regime portion of the MLRA is oriented from northeast to southwest and occupies approximately 18 percent of the MLRA extent, or 11,729 square miles (30,377 square kilometers).

Broadly speaking, soils of the Southern Piedmont uplands are shallow to very deep, well drained, and loamy or clayey. Soils of the river valleys are generally very deep, well to poorly drained, and loamy. Soils tend to be finer-textured than in Coastal Plain regions.

MLRA CLIMATE
In general, precipitation is evenly distributed throughout the year in this MLRA, with occasional drought-like conditions extending from late summer into autumn. During the growing season, most of the rainfall comes from high-intensity, convective thunderstorms. Significant moisture also comes from the movement of warm and cold fronts across the MLRA from November to April. High amounts of rain can also occur during hurricanes, usually during the months of August through October.

Over most of the MLRA, snowfall is typically light, though overall, the mesic soil temperature regime portion of the MLRA features colder temperatures, more snowfall, and a shorter growing season than in the thermic portion. The cooler climate in this region supports an increase in species with northern or Blue Ridge affinities. Both the mean annual temperature and the length of the freeze-free period increase from north to south and with decreasing elevation from the upper to the lower Piedmont.

MLRA LAND USE AND RESOURCES
Once largely cultivated, much of this region is now planted to loblolly pine or has reverted to successional pine and hardwood forests. The more productive lands support small to medium-size family farms that produce crops and livestock, while the less productive lands have been in forest for some time. Most of the open areas are used for grazing beef cattle, though in years past, dairy cattle were also important to the local economy. The principal crops of the region include corn, soybeans, and small grains. Burley tobacco remains a crop of local importance. Cotton is grown in the thermic soil temperature regime portion of the MLRA.

Several major land cover transformations have occurred in the Southern Piedmont over the past several centuries; from open woodlands sculpted by fire, to farmland, to closed forests and planted pine, past land uses have played an outsized role in shaping present-day soils and vegetation patterns in the region. Land-use intensity peaked with the arrival of the industrial revolution, which gradually increased demand for textiles. Cotton became the dominant crop over much of the region.

In spite of early successes, two centuries of poor management practices accelerated soil erosion, stripping away the fertility and moisture-supplying capacity of soils. In addition to soil losses in the uplands, legacy sediments derived from the eroded land rapidly accumulated in the river valleys below, often leading to changes in hydrology and flooding frequency.

After being stripped of it's loamy topsoil, many areas of the Piedmont had been so badly eroded as to render the land unsuitable or economically impractical for agriculture. The effects of erosion were widespread, with cumulative soil loss estimates ranging from 5 to 10 inches on average. The steeper slopes, which had often been cleared and farmed at the height of the Cotton era, generally suffered greater losses. By the 1930's, crop production was in rapid decline in the Southern Piedmont. The loss of soil productivity due to erosion, losses to the cotton boll weevil, development of synthetic fibers, and the onset of the Great Depression all contributed to rapid abandonment of cropland. By 1960, cropland acres had decreased by more than 50 percent in nearly every county in the Southern Piedmont.

While crop production is still important today on the more productive lands, those of lower productivity, or those that were subject to severe erosion, were often abandoned some time ago. Typically, they have either reverted to forest, or have been converted to other uses. Although the productivity of soils was greatly reduced through erosion, less intensive land uses such as grazing and forestry were still feasible. These land uses gained popularity as patterns of urban migration, low commodity prices, and other factors gradually made crop production less economical on the marginal lands.

In recent years, large-scale adoption of soil conservation practices have led to better outcomes with respect to erosion in much of MLRA, increasing the economic viability and long-term sustainability of Piedmont farms. Despite some success, water erosion remains one of the most important soil resource concerns in the MLRA.

Other major resource concerns include increasing conversion of prime farmland and farmland of statewide importance to urban uses. Throughout the MLRA, metropolitan areas are expanding into lands that have historically been used for timber or agriculture. This change in land use is occurring rapidly in the corridor called the Piedmont Crescent, which extends from Atlanta, Georgia, to Raleigh, North Carolina.

HISTORIC VEGETATION COVER

Over most of the Southern Piedmont uplands, the historic oak-hickory, or oak-hickory-pine forest, once covered large portions of the landscape. It was dominated by upland oaks, such as white oak (*Quercus alba*), northern red oak (Quercus rubra), and southern red oak (*Quercus falcata*), with a smaller contribution from hickories (Carya spp.) and pines. The principal pine species are shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), and to the north and west, Virginia pine (*Pinus virginiana*). In the southernmost and easternmost portions of the MLRA, the historic montane longleaf pine forest, dominated by longleaf pine (*Pinus palustris*), shortleaf pine (*P. echinata*), and dry-site oaks, was found on ridgetops and steep south or west-facing slopes.

According to historic accounts, forests and woodlands of the past were generally more open and park-like, having been exposed to a more frequent fire regime. Piedmont prairies, likely maintained by Native Americans, were also reportedly common across the landscape, as were fire-maintained canebrakes along the streams (Trimble 1974; Daniels

1987; Griffith et al. 2002; Van Lear et al. 2004; Dearman and James 2019; Schomberg et al. 2020; USDA-NRCS 2022).

LRU notes

MLRA 136 is one of the largest MLRAs in the United States. It has a broad north-south and east-west extent and covers a wide range of elevations. The MLRA is partitioned by the mesic-thermic line, which divides the MLRA into mesic and thermic soil temperature regimes (figure 2.). The mesic soil temperature regime was delineated based on estimates of the native range of loblolly pine, which was historically absent in this part of the MLRA. In addition, this region is said to represent the northern and western limits of cotton production, an important crop to the south and east.

ESDs developed for this MLRA were split geographically into mesic and thermic ecological site concepts. Climate variation across the MLRA extent warrants the development of Land Resource Unit (LRU) classifications, to further subdivide the MLRA and support more precise Ecological Site Descriptions.

Classification relationships

APPLICABLE USNVC ASSOCIATIONS
CEGL006281 *Quercus montana* - *Quercus alba* / *Oxydendrum arboreum* / *Vitis rotundifolia*; CEGL004415 *Quercus montana* - *Quercus alba* / *Oxydendrum arboreum* / *Kalmia latifolia*; CEGL004148 *Quercus montana* - *Pinus echinata* / *Vaccinium pallidum*; CEGL008437 *Pinus palustris* - *Pinus echinata* / *Quercus marilandica* - (*Quercus montana*) / *Vaccinium pallidum*

APPLICABLE EPA ECOREGIONS
Level III: 45. Piedmont
Level IV: 45a. Southern Inner Piedmont; 45c. Carolina Slate Belt; 45i. Kings Mountain; 45d. Talladega Upland; 45h. Pine Mountain Ridges

APPLICABLE USFS ECOLOGICAL UNITS
Domain: Humid Temperate
Division: Subtropical
Ecological province: 231. Southeastern Mixed Forest
Ecological sections: 231I.Central Appalachian Piedmont; 231A. Southern Appalachian Piedmont (Cleland et al. 2007).

Based on the USGS physiographic classification system (Fenneman and Johnson 1946), most of MLRA 136 is in the Piedmont Upland section of the Piedmont province, in the Appalachian Highlands division.

Ecological site concept

This ecological site includes dry-moist acidic uplands, found in highly dissected and higher elevation parts of the MLRA, or on isolated erosional remnants known as monadnocks. It is geographically restricted to the thermic soil temperature regime portion of the MLRA. This ecological site is typically found in upper landscape positions, on summits and shoulders of high hills, prominent ridges, or monadnocks. On stable side slopes, it can also be found in the backslope position. Soils are generally rocky and acidic, but deeper and better developed than in PX136X00X880, a similar and associated ecological site which tends to be found on slightly less stable surfaces with shallower soils.

This ecological site is exposed to the elements, including sun, wind, and historically fire. It generally occupies some of the driest topographic positions in the region and has a drier character than might be expected based on the influence of edaphic conditions alone. The vegetation and relative moisture status vary with aspect, being driest on south or west-facing exposures and moister on those that face north. Overall, species-richness is low.

Soils on this ecological site are typically very deep to moderately deep, well drained Ultisols. At the surface and throughout, these soils typically have an abundance of rock fragments. Parent materials are residuum derived from acidic igneous or metamorphic rocks.

The reference state typically has a somewhat open tree canopy dominated by dry-site oaks, or a mixture of dry-site oaks and pines. Typical species include chestnut oak (*Quercus montana*), white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), black oak (*Quercus velutina*), and pine (*Pinus virginiana*, *P. echinata*, *P. taeda*, and in parts of the extent, *P. palustris*). Dominant land uses include wildlife habitat, pasture, and planted pine.

ES CHARACTERISTICS SUMMARY
• Thermic soil temperature regime
• Occurs on Piedmont uplands, on summits, shoulders, and stable backslopes of high hills, prominent ridges, and isolated monadnocks, in highly dissected and higher elevation parts of the MLRA
• Base saturation: < 35 percent in the subsoil
• Seasonal high water table: absent within 72 inches of the soil surface
• Depth to bedrock is ≥ 40 inches, OR the available water storage capacity of the profile (from the soil surface to 80 inches, or to paralithic or lithic bedrock, whichever is shallower) is greater than or equal to 4 inches
• Parent materials: residuum derived from felsic igneous or metamorphic rock
• Soils: very deep to moderately deep, well drained Ultisols

Associated sites

PX136X00X840	**Acidic Upland Colluvial Forest** Found in lower landscape positions, in sheltered colluvial areas that receive water from upslope. Moisture-loving plant species, such as American beech (Fagus grandifolia), northern red oak (Quercus rubra), and tuliptree (Liriodendron tulipifera) are dominant in the canopy.
PX136X00X880	**Acidic High Hills and Isolated Ridges, Depth Restriction, Dry** Found on nearby surfaces of lower geomorphic stability, including steep backslopes and narrow ridgetops. Soils are shallower to bedrock (< 40 inches) and less developed, with a lower available water storage capacity (< 4 inches). Species composition is similar but primary productivity is presumably lower.
PX136X00X900	**Talladega Upland and Pine Mountain Acidic High Hills and Ridges, Dry, Metasedimentary** Found on nearby surfaces of lower geomorphic stability, including steep backslopes and narrow ridgetops in the Talladega Uplands and in the Pine Mountain region of Georgia and Alabama. Soils are shallower to bedrock (< 40 inches) and less developed, with a lower available water storage capacity (< 4 inches). Species composition is similar but primary productivity is presumably lower.

Similar sites

PX136X00X830	**Acidic Upland Forest, Depth Restriction, Dry-moist** Found on moderately dissected landscapes with typical, rolling to hilly Piedmont topography. Aspect plays a much smaller role in shaping environmental conditions at any given location. Species with Blue Ridge affinities, such as chestnut oak (Quercus montana), are usually scarce.
PX136X00X880	**Acidic High Hills and Isolated Ridges, Depth Restriction, Dry** Found on nearby surfaces of lower geomorphic stability, including steep backslopes and narrow ridgetops. Soils are shallower to bedrock (< 40 inches) and less developed, with a lower available water storage capacity (< 4 inches). Species composition is similar but primary productivity is presumably lower.
PX136X00X900	**Talladega Upland and Pine Mountain Acidic High Hills and Ridges, Dry, Metasedimentary** Found on nearby surfaces of lower geomorphic stability, including steep backslopes and narrow ridgetops in the Talladega Uplands and in the Pine Mountain region of Georgia and Alabama. Soils are shallower to bedrock (< 40 inches) and less developed, with a lower available water storage capacity (< 4 inches). Species composition is similar but primary productivity is presumably lower.

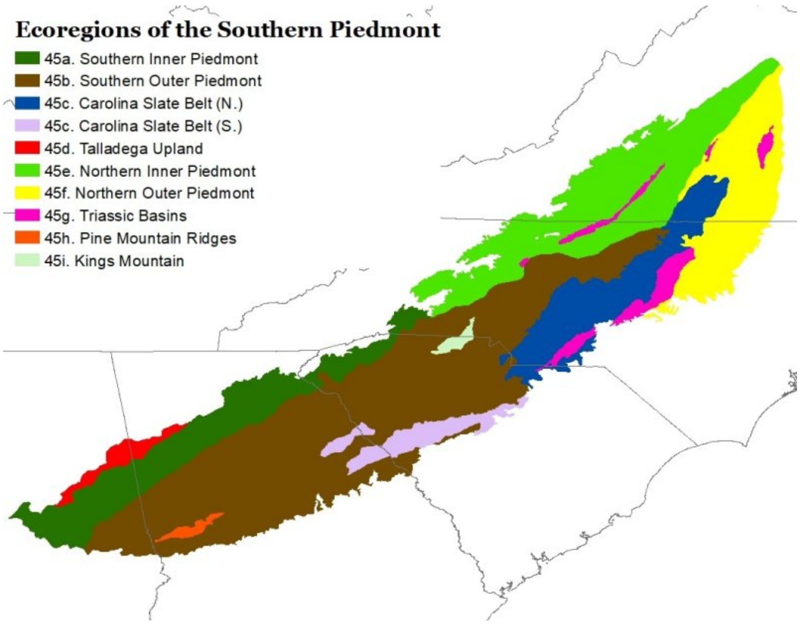


Figure 1. EPA level IV ecoregions of the Southern Piedmont (45).

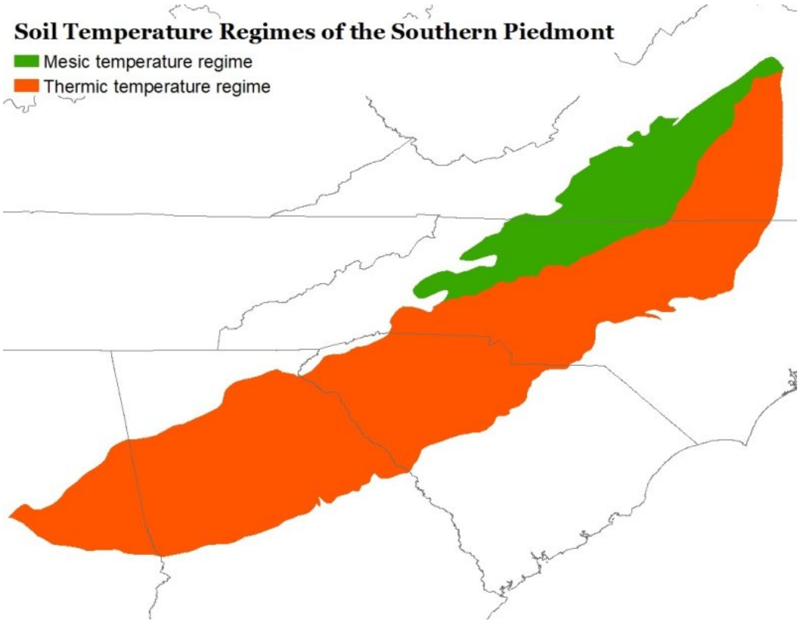


Figure 2. Spatial illustration of soil temperature regimes of the Southern Piedmont.

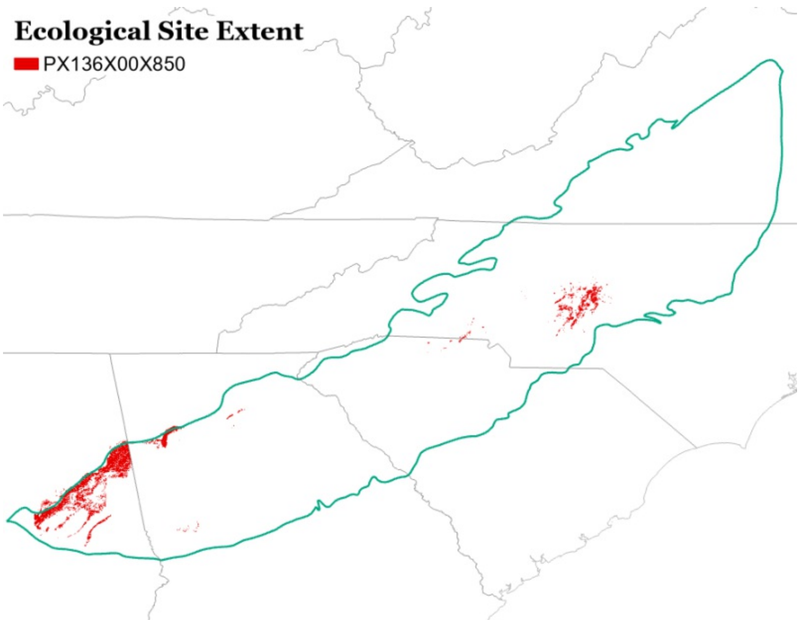


Figure 3. Spatial extent of this ecological site representing the major areas where this site is important on the landscape.

Table 1. Dominant plant species

Tree	(1) *Quercus montana* (2) *Quercus alba*
Shrub	(1) *Vaccinium pallidum* (2) *Vaccinium stamineum*
Herbaceous	(1) *Danthonia* (2) *Schizachyrium scoparium*

Legacy ID

F136XY850AL

Physiographic features

This ecological site includes dry-moist acidic uplands, which sit in upper landscape positions, in highly dissected and higher elevation parts of the MLRA, or on isolated erosional remnants known as monadnocks. It is found in summit and shoulder positions, on high hills, prominent ridges, or monadnocks of the thermic soil temperature regime portion of the MLRA. On stable side slopes, it can also be found in the backslope position. These landscape settings are most common in EPA ecoregions 45a, 45i, 45h, 45d, and portions of ecoregion 45c (Southern Inner Piedmont, Kings Mountain, Pine Mountain Ridges, the Talladega Uplands, and the Carolina Slate Belt respectively).

Representative locations are gently sloping on ridgetops, to steeply sloping on backslopes, with a representative slope of 2 to 35 percent and a maximum slope of 45 percent. The geologic substrate is typically low in ferromagnesian minerals and high in silica. Parent materials include fine-grained metasedimentary and metavolcanic rock, or felsic crystalline rock. Examples include gneiss, quartzite, schist, phyllite, dacite, rhyolite, and other weathering-resistant rocks.

Figure 4. A typical landscape in highly dissected portions of the upper Piedmont, EPA ecoregion 45a. High hill in foreground is a complex of Wateree and Louisburg soils, with outcrops of granite and gneiss. Louisburg soils are associated with this ecological site.

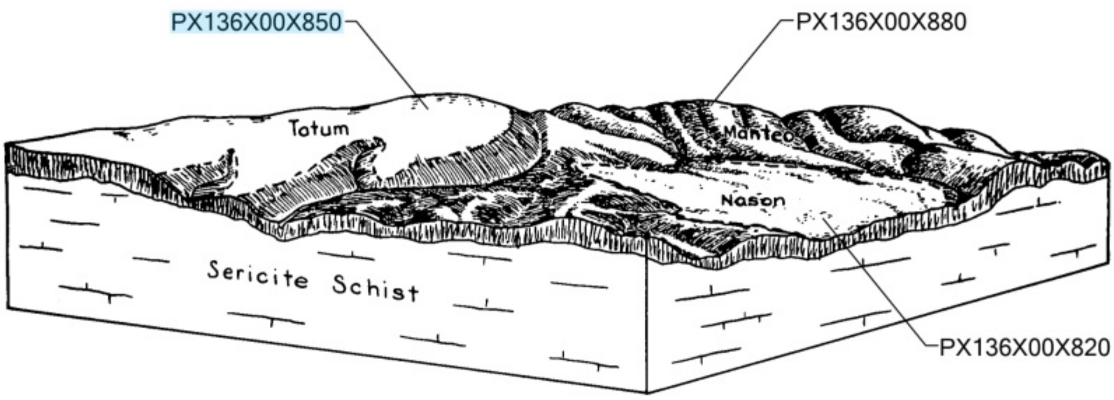


Figure 5. Typical soil-landscape relationships in EPA ecoregion 45i, Kings Mountain. Tatum soils are associated with this ecological site, depicted here on a prominent ridge.

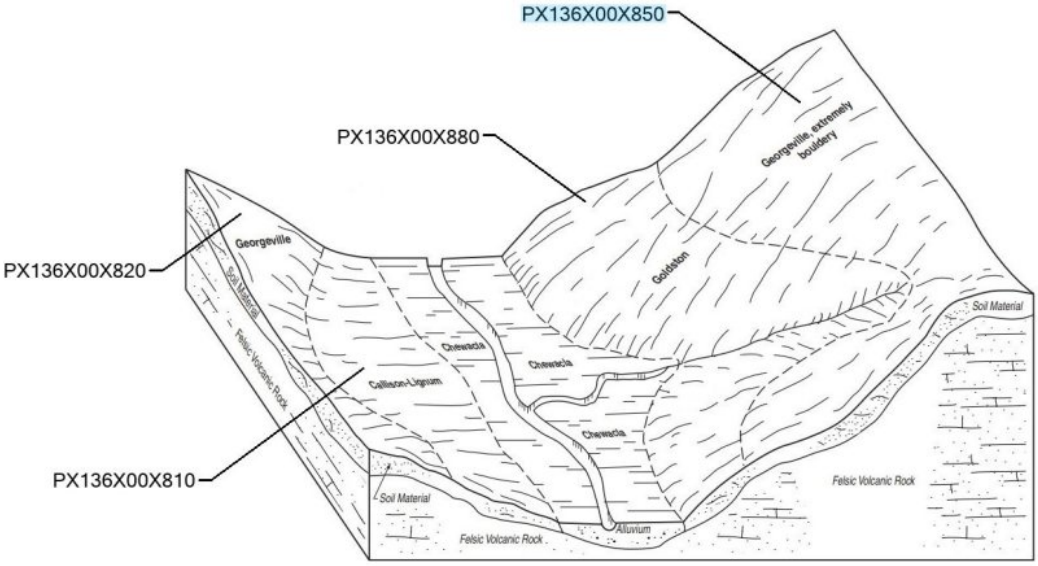


Figure 6. Typical soil-landscape relationships in the Uwharrie Mountains of the Carolina Slate Belt, EPA ecoregion 45c. Georgeville, extremely bouldery soils are associated with this ecological site, depicted here in summit and shoulder positions on a high hill.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Summit (3) Shoulder
Landforms	(1) Piedmont > Ridge (2) Piedmont > Hill
Runoff class	Medium to high
Flooding frequency	None
Ponding frequency	None
Elevation	720–1,610 ft
Slope	2–35%
Water table depth	72–999 in
Aspect	W, NW, N, NE, E, SE, S, SW

Table 3. Representative physiographic features (actual ranges)

Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None
Elevation	410–1,950 ft
Slope	2–45%
Water table depth	72–999 in

Climatic features

On this ecological site, the average mean annual precipitation is 52 inches. On average, the rainiest months occur in July and August, as well as in March. The driest months occur in April, May, and October.

Table 4. Representative climatic features

Frost-free period (characteristic range)	169-187 days
Freeze-free period (characteristic range)	198-218 days
Precipitation total (characteristic range)	46-57 in
Frost-free period (actual range)	160-196 days
Freeze-free period (actual range)	192-236 days
Precipitation total (actual range)	43-59 in
Frost-free period (average)	177 days
Freeze-free period (average)	210 days
Precipitation total (average)	52 in

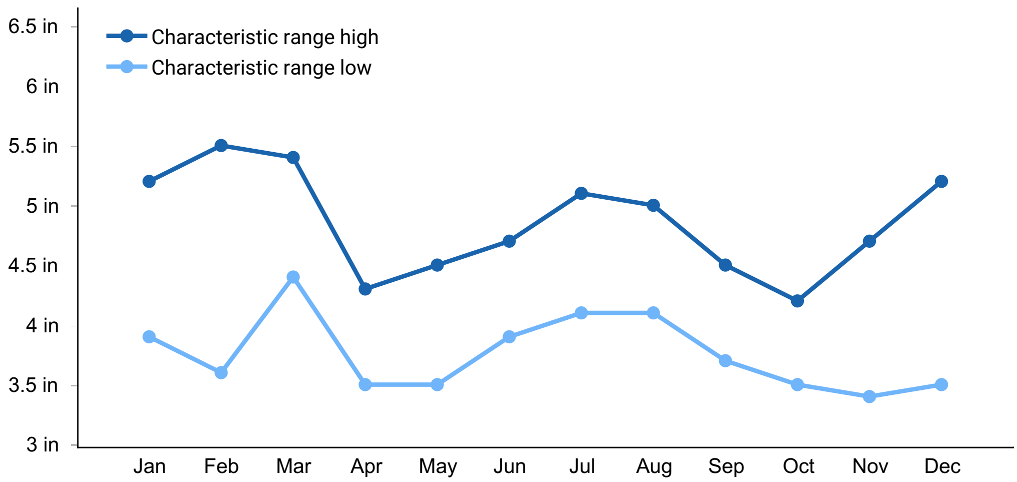


Figure 7. Monthly precipitation range

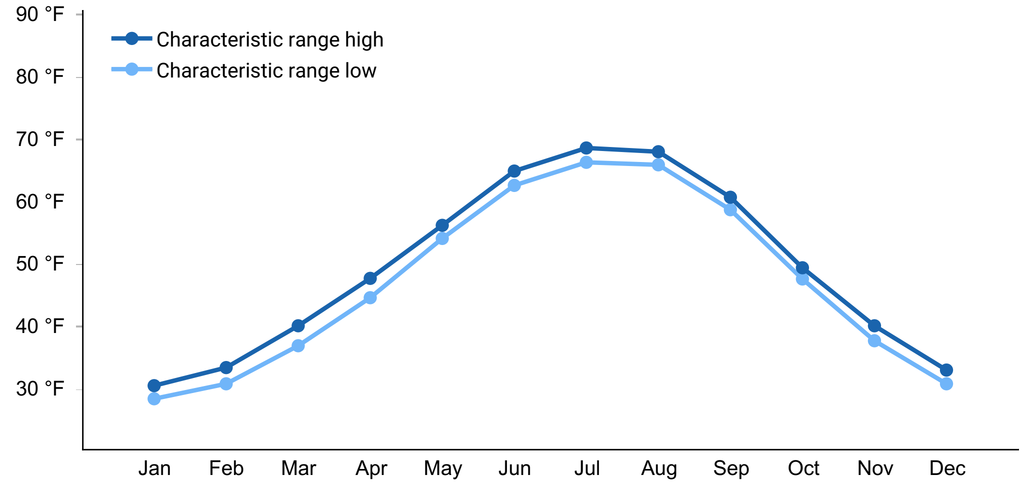


Figure 8. Monthly minimum temperature range

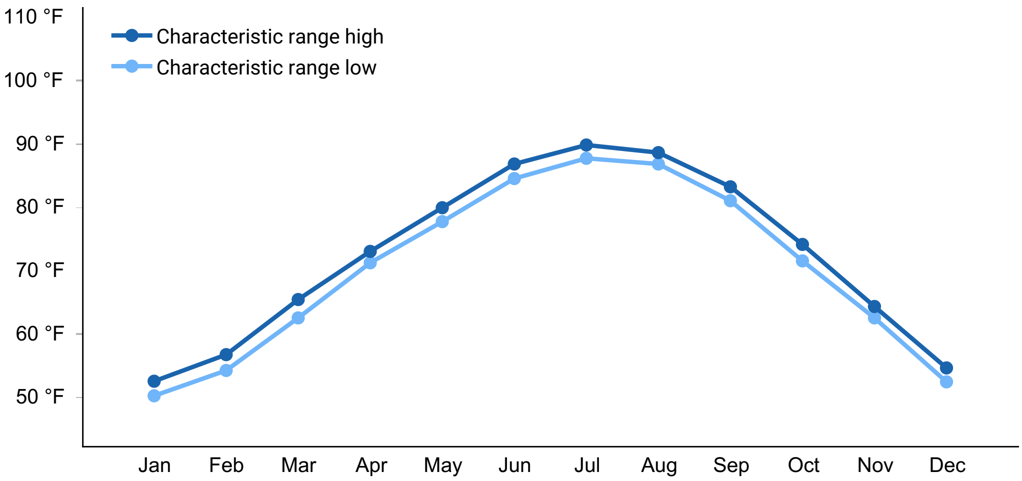


Figure 9. Monthly maximum temperature range

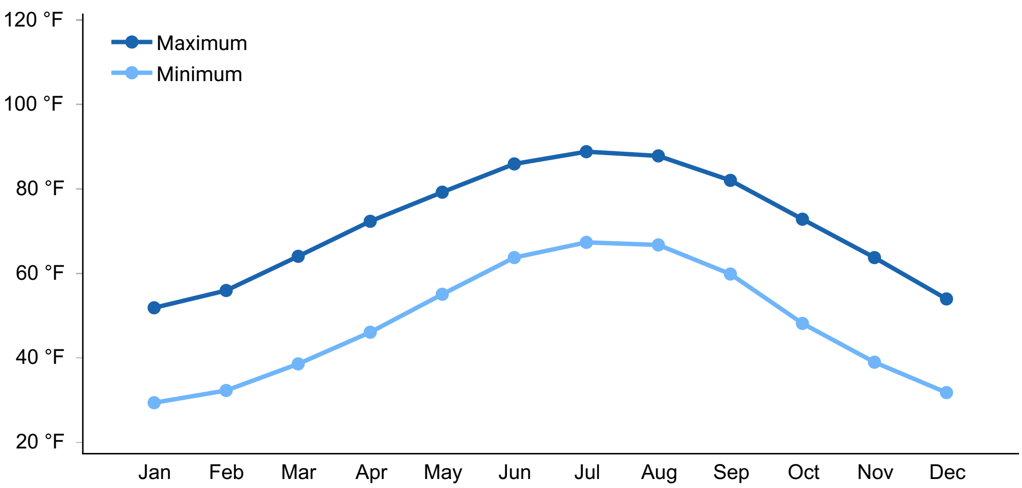


Figure 10. Monthly average minimum and maximum temperature

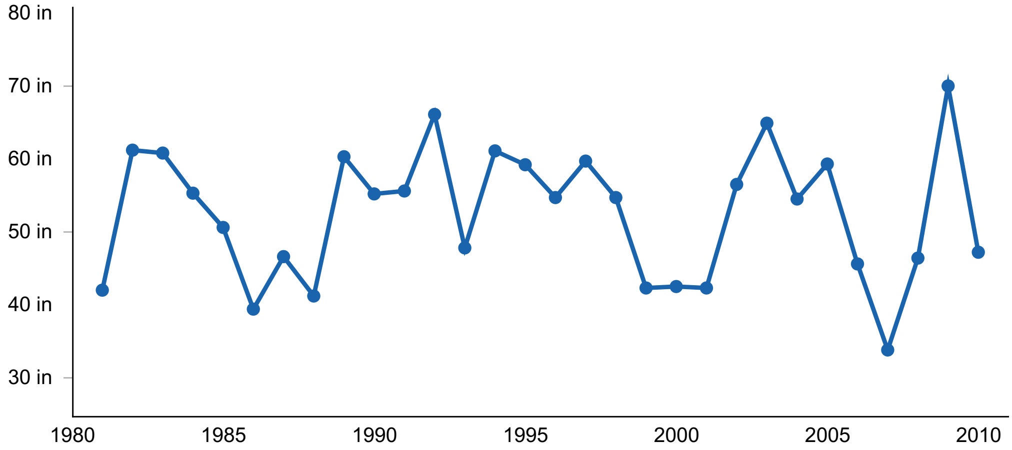


Figure 11. Annual precipitation pattern

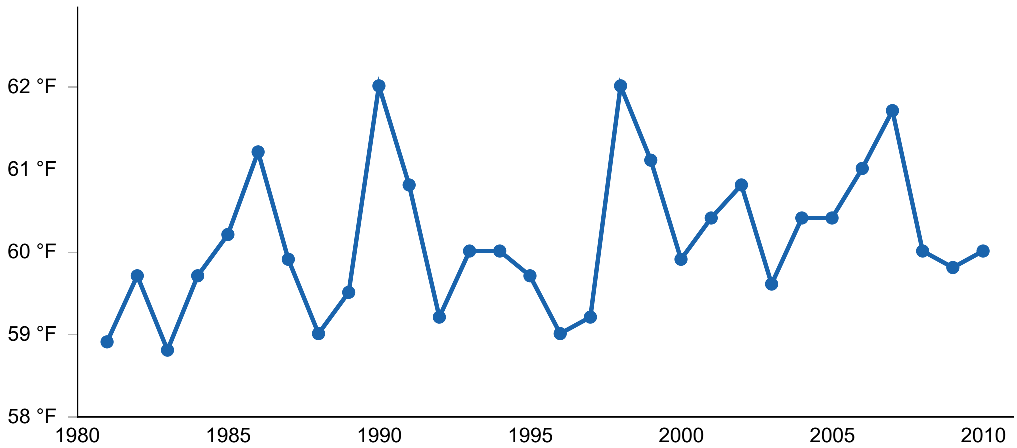


Figure 12. Annual average temperature pattern

Climate stations used

- (1) HEFLIN [USC00013775], Heflin, AL
- (2) SYLACAUGA 4 NE [USC00017999], Sylacauga, AL
- (3) TOCCOA [USC00098740], Toccoa, GA
- (4) CLEVELAND [USC00092006], Cleveland, GA
- (5) THOMASTON [USC00098661], Thomaston, GA
- (6) ASHLAND 3 ENE [USC00010369], Ashland, AL
- (7) CUMMING 2N [USC00092408], Cumming, GA
- (8) PICKENS [USC00386831], Pickens, SC
- (9) WALHALLA [USC00388887], Walhalla, SC
- (10) GASTONIA MUNI AP [USW00053870], Gastonia, NC
- (11) NINETY NINE ISLANDS [USC00386293], Blacksburg, SC
- (12) ALBEMARLE [USC00310090], Albemarle, NC
- (13) ASHEBORO 2 W [USC00310286], Asheboro, NC
- (14) CORNELIA [USC00092283], Cornelia, GA
- (15) GASTONIA [USC00313356], Gastonia, NC
- (16) SHELBY 2 NNE [USC00317845], Shelby, NC

Influencing water features

This ecological site is not influenced by surface or ground water features.

Soil features

Soils on this ecological site are typically very deep to moderately deep, well drained Ultisols. Parent materials are residuum derived from acidic igneous or metamorphic rock, such as phyllite, schist, gneiss, dacite, rhyolite, quartzite, and other weathering-resistant rocks. The available water storage capacity of the profile is 4 inches or greater and the depth to unweathered or partially weathered bedrock is usually greater than 40 inches.

Soils on this ecological site are typically rocky or gravelly. Areas of exposed rock, or large boulders, may sit at the surface in places. Representative particle size families include fine-loamy and fine families. Reaction is typically strongly acid to very strongly acid throughout (pH 4.5 to 5.5). Base saturation is less than 35 percent in the subsoil.

Soils on this ecological site have a thermic soil temperature regime, which is characterized by a mean annual soil temperature of 15°C to 22°C and a winter to summer temperature differential of 6°C or more in the subsoil.

Modal taxa include: Typic Hapludults
Soils attributed to this ecological site include Uwharrie, Montonia, Edgemont, Habersham, Tatum, Fruithurst, Braswell, Georgeville, and Herndon

Table 5. Representative soil features

Parent material	(1) Residuum–metasedimentary rock (2) Residuum–metavolcanics (3) Residuum–igneous and metamorphic rock
Surface texture	(1) Silt loam (2) Loam (3) Channery fine sandy loam (4) Gravelly sandy loam (5) Sandy loam (6) Gravelly loam (7) Channery loam
Family particle size	(1) Fine-loamy (2) Fine
Drainage class	Well drained
Permeability class	Moderately rapid
Depth to restrictive layer	40–999 in
Soil depth	40–80 in

Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–5%
Available water capacity (0-80in)	9–11 in
Soil reaction (1:1 water) (0-10in)	4.5–5.5
Subsurface fragment volume <=3" (0-80in)	0–7%
Subsurface fragment volume >3" (0-80in)	0–4%

Table 6. Representative soil features (actual values)

Drainage class	Well drained
Permeability class	Moderately slow to moderately rapid
Depth to restrictive layer	30–999 in
Soil depth	30–80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–14%
Available water capacity (0-80in)	4–12 in
Soil reaction (1:1 water) (0-10in)	4.5–6.5
Subsurface fragment volume <=3" (0-80in)	0–13%
Subsurface fragment volume >3" (0-80in)	0–10%

Ecological dynamics

U.S. National Vegetation Classification (USNVC) associations that are consistent with reference conditions on this ecological site include CEGL006281 *Quercus montana - Quercus alba / Oxydendrum arboreum / Vitis rotundifolia*, which is typical of ridgetops and east-facing slopes. North-facing slopes are often represented by the very similar CEGL004415 *Quercus montana - Quercus alba / Oxydendrum arboreum / Kalmia latifolia*. On west-facing or south-facing slopes, pines generally become more abundant. Here, CEGL004148 *Quercus montana - Pinus echinata / Vaccinium pallidum*, or other similar associations may apply. Within the range of the montane longleaf pine ecosystem, CEGL008437 *Pinus palustris - Pinus echinata / Quercus marilandica* - (*Quercus montana*) / *Vaccinium pallidum* may apply to restored, fire-maintained examples and to some degraded, fire-suppressed stands. These and other similar associations, are part of the vegetation complex typical of high hills of the Southern Piedmont (USNVC 2022).

The reference community on this ecological site overlaps that of Wharton (1978) 'Pine-Hardwood Xeric Ridge and Slope Forest' and 'Pine-Broadleaf Deciduous Subcanopy Xeric Forest; Barry (1980) 'Ridgetop Forest' and 'Chestnut Oak-Heath Forest'; and Schafale (2012) 'Piedmont Monadnock Forest.'

Note: at this time there is not enough data to support a geographic split between soils mapped within the historic range of the montane longleaf pine ecosystem and those that are outside of the range. In the southern-most portions of the MLRA, in Alabama and western Georgia, and in portions of the Carolina Slate Belt as far north as North Carolina, longleaf pine once dominated the pine component in highly dissected areas of the Piedmont. Forests of this type were best-developed on dry, south and west-facing slopes and on prominent ridges. Somewhat degraded remnant examples, as well as those that have been restored to mimic historic conditions, are not uncommon in these regions. Future ecological site work should consider targeting soils in these areas to determine whether a distinct ecological site is warranted and to ascertain whether delineating these two concepts across the MLRA would be feasible. This ecological site also includes deep soils that formed in quartzite or Talladega slate, in the Talladega Uplands and on Pine Mountain in Georgia and Alabama. These areas often support an unusual mixture of species which can include Blue Ridge and Coastal Plain elements, along with several important endemic plant species. Future ecological site work should examine regional differences such as these.

MATURE FORESTS
The reference state typically has a somewhat open tree canopy dominated by dry-site oaks, or a mixture of dry-site oaks and pines. Though the natural vegetation often includes species with Blue Ridge affinities, such as chestnut oak (*Quercus montana*), these elements are very seldom as abundant as they are in the Blue Ridge proper.

On account of the shallow effective rootzone and nutrient-poor substrate, trees grow slowly and generally have a stunted appearance. Species diversity tends to be very low in the canopy layer. Typical species include chestnut oak (*Quercus montana*), white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), and black oak (*Quercus velutina*). Pines (*Pinus virginiana*, *P. echinata*, *P. taeda*, and in parts of the extent, *P. palustris*) are consistent in the canopy but their importance varies depending on aspect.

On south-facing exposures, the canopy tends to be more open. Here, blackjack oak (*Quercus marilandica*) or post oak (*Quercus stellata*) often become more important, along with pines (*P. echinata*, *P. virginiana*). On west-facing exposures, pines are typically even more numerous, and on some of the driest sites, they may be codominant or even dominant in the canopy. Over portions of the extent, in Alabama, western Georgia, and in portions of the Carolina Slate Belt as far north as North Carolina, longleaf pine (*Pinus palustris*) was once an import canopy species (along with aforementioned species) on highly dissected, dry landscapes of the Piedmont. Montane longleaf pine woodlands, as they are known, were particularly prevalent on south and west-facing exposures, and on narrow ridgetops. Longleaf pine has become less prevalent in these areas due mainly to fire suppression.

On the whole, the subcanopy layer tends to be poorly developed. It is dominated by acid-tolerant understory trees, including sourwood (*Oxydendrum arboreum*), flowering dogwood (*Cornus florida*), blackgum (*Nyssa sylvatica*), sassafras (*Sassafras albidum*), and red maple (*Acer rubrum*), several of which often take on a shrub-like appearance. Also consistent, though generally of low cover are hickories, including mockernut hickory (*Carya tomentosa*), pignut hickory (*C. glabra*), and sand hickory (*C. pallida*).

The shrub layer is of variable cover, depending largely on aspect. Typical shrubs include members of the heath family, notably Vaccinium spp., Gaylussacia spp., along with stunted subcanopy species. Blue Ridge blueberry (*Vaccinium pallidum*) and deerberry (*Vaccinium stamineum*) are most consistent in the shrub layer, with farkleberry (*Vaccinium arboreum*) increasing in abundance toward the southern part of the MLRA. On protected north-facing slopes, mountain laurel (*Kalmia latifolia*) often dominates in places and can form dense colonies.

As a result of decades of fire suppression, the herb layer is generally sparse and species-poor, with true herbaceous species usually being poorly represented in most contemporary stands. Typically, the herb layer is dominated by scattered ericaceous subshrubs (semi-woody members of the heath family). Representative species include striped prince's pine (*Chimaphila maculata*) and trailing arbutus (*Epigaea repens*). Other species that appear frequently in plot data include western brackenfern (*Pteridium aquilinum*) and little heartleaf (*Hexastylis minor*). Muscadine (*Vitis rotundifolia*) may form a fairly dense ground cover in places, but unlike moister sites, it seldom climbs into trees.

Grasses common to this ecological site, especially where fire has been reintroduced, include species such as little bluestem (*Schizachyrium scoparium*), poverty oatgrass (*Danthonia spicata*), and blackseed speargrass (*Piptochaetium avenaceum*), among others. Forbs that are more abundant in fire-maintained examples include various species of ticktrefoil (Desmodium spp.), lespedeza (Lespedeza spp.), Virginia tephrosia (*Tephrosia virginiana*), anisescented goldenrod (*Solidago odora*), and various other composites (Asteraceae) and leguminous forbs.

DYNAMICS OF NATURAL SUCCESSION AND FIRE ECOLOGY
The exposure of prominent ridges and high hills to the elements makes them particularly susceptible to lightning and wind. They are also subject to the uphill spread of fire, which produces burns of increased speed and intensity.

Historically, oak and oak-pine forests of the Southeast were maintained through recurring fire, either naturally-occurring or introduced by humans. Beginning in the early 20th century, a widespread fire suppression campaign resulted in a dramatic decrease in the frequency of fires across the Southeast. These changes gradually altered the vegetation structure and species composition of ecosystems that were dependent on fire for seedling recruitment, reproduction, and maintenance

On Piedmont uplands, the historical influence of fire on successional dynamics was likely expressed on a continuum, from dry to moist, where moist or sheltered sites were shaped more by gap-driven dynamics and dry or exposed sites more by fire. On intermediate sites, their respective influence on successional dynamics probably fell somewhere in between.

In contemporary upland forests of the Southern Piedmont, an overall shift towards gap-driven successional dynamics (driven largely by windthrow, drought, disease, etc.) has had a homogenizing effect on the upland vegetation of the region, making moist, intermediate, and dry sites more similar to one another than they were in the past.

In most contemporary examples associated with this ecological site, a thick layer of leaf litter and duff has accumulated on the forest floor, suppressing the growth of understory grasses and forbs. Shrubs, vines, and small trees have often grown up in the understory, further constraining herb growth. Over years of fire exclusion, these characteristics have often progressed to such a degree that conditions are no longer conducive to the spread of fire, a phenomenon known as mesophication. In this scenario, when fire is removed for long periods of time, positive feedbacks result in succession toward forest systems that are less apt to burn.

In the past, the routine use of fire by Native Americans, coupled with periodic lightning-induced fires, constrained the growth of understory shrubs and fire-intolerant trees. These fires maintained a more open canopy and promoted a dense herbaceous layer that could efficiently carry fire in future burns. While the historic fire return interval is thought to be relatively similar across most of the Southern Piedmont uplands, drier sites were more prone to fire and hence burned more completely and at higher intensities than moister sites.

Vegetation structure was historically more open throughout the Southern Piedmont uplands, but particularly on drier or more exposed sites. Given the more frequent fire regime of the past, canopy cover was likely more open and more heterogeneous than it is presently, and herb cover higher overall, as per historical accounts and witness tree records.

The reduction in the frequency of fires over the past century has allowed shade-tolerant, fire-sensitive trees such as red maple (*Acer rubrum*), American beech (*Fagus grandifolia*), and American holly (*Ilex opaca*) to become more abundant in many upland forests in the Southeast, but they are particularly out of place on dry or exposed sites. Except for in sheltered areas, these thin-barked species would have been largely excluded from the understory of dry upland forests under a more frequent fire regime.

A combination of prescribed burns and selective removals can open up the understory and constrain the growth of fire-intolerant opportunistic species, thereby restoring the health and vigor of forests that evolved under a more regular fire regime (Oosting 1942; Wells 1974; Barry 1980; Peet and Christensen 1980; Nelson 1986; Schafale and Weakley 1990; Cowell 1998; White and Govus 2005; Schwartz et al. 2007; Guyette et al. 2012; Spira 2011; Schafale 2012a, 2012b; Kressuk et al. 2020; Vander Yacht et al. 2020; Greenberg et al. 2021; Spooner et al. 2021).

Note: variability in species composition and vegetation structure on this ecological site are largely ascribed to environmental factors (i.e., aspect, elevation, local relief, degree of exposure, etc.). Due to the overwhelming influence of rugged topographic conditions, the vegetation of high hills with deeper soils is expected to have much in common with those that have shallower soils (as represented by the similar and associated ecological site PX136X00X880). Both typically support a canopy with a large contribution from chestnut oak, along with other dry-site oaks and pines, and both vary significantly with aspect, elevation, and other environmental factors. Field investigations will be needed to quantify expected differences in primary productivity, as well as tree stature and physiognomy, which are a likely outgrowth of edaphic variability. Field investigations will also examine finer scale differences in species composition, vegetation structure, and the impact of natural disturbances, which will likely vary between these similar ecological site concepts.

SPECIES LIST
Canopy layer: *Quercus montana*, *Quercus alba*, *Quercus coccinea*, *Quercus velutina*, *Quercus falcata*, *Quercus marilandica*, *Quercus stellata*, *Pinus echinata*, *Pinus virginiana*, *Pinus taeda*, *Pinus palustris*

Subcanopy layer: *Oxydendrum arboreum*, *Cornus florida*, *Nyssa sylvatica*, *Sassafras albidum*, *Acer rubrum*, *Diospyros virginiana*, *Carya tomentosa*, *Carya glabra*, *Carya pallida*, *Prunus serotina*, *Robinia hispida*, *Robinia pseudoacacia*, *Castanea pumila*

Vines/lianas: *Vitis rotundifolia*, *Smilax rotundifolia*, *Smilax glauca*, *Gelsemium sempervirens*

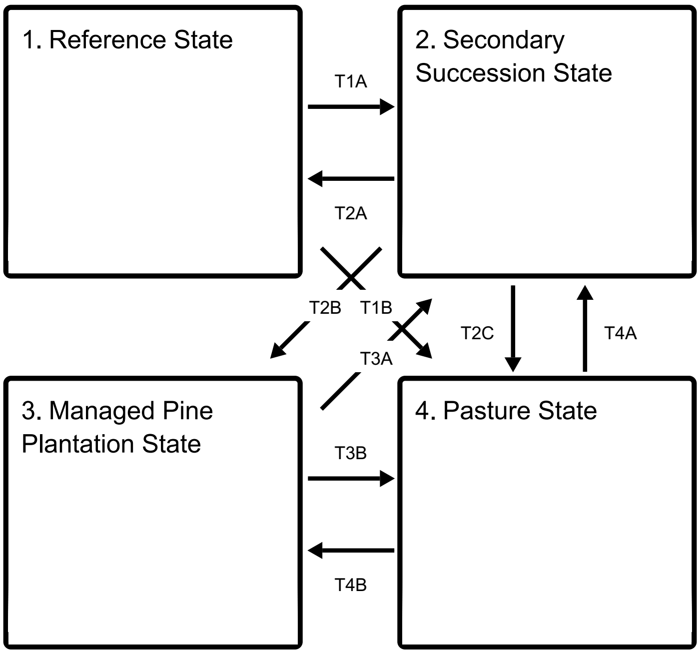
Shrub layer: *Vaccinium pallidum*, *Vaccinium stamineum*, *Vaccinium arboreum*, *Gaylussacia dumosa*, *Viburnum acerifolium*, *Hypericum hypericoides* ssp. multicaule, *Symplocos tinctoria*, *Kalmia latifolia*, *Gaylussacia baccata*, *Rhododendron canescens*, *Rhododendron periclymenoides*, *Rhododendron minus*, *Rhus glabra*, *Rhus copallinum*, *Amorpha schwerinii*

Herb layer - forbs: *Chimaphila maculata*, *Epigaea repens*, *Tephrosia virginiana*, *Pteridium aquilinum*, *Solidago odora*, *Hexastylis minor*, *Desmodium laevigatum*, Desmodium spp., *Lespedeza virginica*, *Lespedeza hirta*, *Clitoria mariana*, *Baptisia tinctoria*, *Coreopsis verticillata*, *Coreopsis major*, *Pityopsis aspera*, *Pityopsis graminifolia*, *Ionactis linariifolius*, *Chrysopsis mariana*, *Antennaria plantaginifolia*, *Cunila origanoides*, *Mimosa microphylla*, *Eupatorium album*, *Euphorbia corollata*, *Hieracium venosum*, *Hieracium gronovii*, *Goodyera pubescens*, *Sericocarpus asteroides*, *Symphyotrichum undulatum*, *Uvularia puberula*, *Hypoxis hirsuta*, *Liatris pilosa*, *Iris verna*, *Lilium michauxii*, *Aureolaria virginica*

Herb layer - graminoids: *Danthonia spicata*, *Danthonia sericea*, *Schizachyrium scoparium*, *Piptochaetium avenaceum*, *Scleria oligantha*, *Dichanthelium commutatum*, *Dichanthelium depauperatum*, *Andropogon ternarius*, *Carex nigromarginata*,

State and transition model

Ecosystem states



T1A - Clearcut logging or other large-scale disturbances that cause canopy removal.

T1B - Mechanical tree/brush/stump/debris removal, seedbed preparation, and planting of perennial grasses and forbs.

T2A - Long-term natural succession.

T2B - Site preparation and tree planting.

T2C - Mechanical tree/brush/stump/debris removal, seedbed preparation, and planting of perennial grasses and forbs.

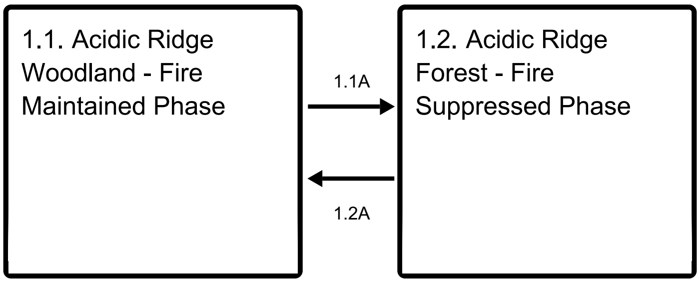
T3A - Abandonment of forestry practices.

T3B - Timber harvest, mechanical stump and debris removal, seedbed preparation, and planting of perennial grasses and forbs.

T4A - Long-term cessation of grazing.

T4B - Site preparation and tree planting.

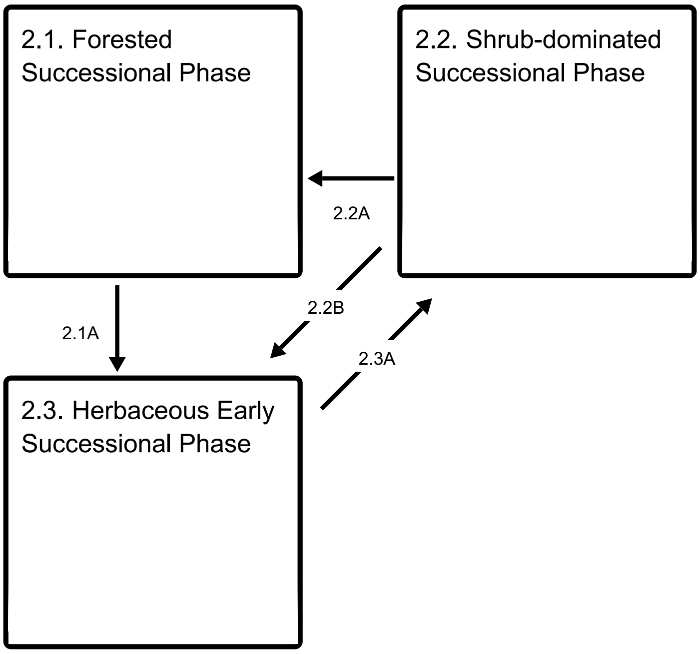
State 1 submodel, plant communities



1.1A - Long-term exclusion of fire.

1.2A - Prescribed burns and selective removals.

State 2 submodel, plant communities



2.1A - Clearcut logging.

2.2A - Natural succession.

2.2B - Brush management.

2.3A - Natural succession.

State 1
Reference State

This mature forest state is generally dominated by dry-site oaks, or a mixture of dry-site oaks and pines, with acid-tolerant flora in the understory.

Characteristics and indicators. Stands are uneven-aged with at least some old trees present.

Community 1.1

Acidic Ridge Woodland - Fire Maintained Phase

This is an open canopy mature forest community/phase. Regular low-intensity fires have been reintroduced, keeping the understory somewhat open, increasing the cover and diversity of herbaceous species and limiting the importance of fire-intolerant woody species.

Resilience management. This community/phase is maintained through regular prescribed burns. The recruitment of fire-adapted oaks and pines benefits from regular low-intensity ground fires, as these forests evolved under a more regular fire regime. Tree ring data suggests that the mean fire return interval of the past in the Southern Piedmont is approximately 6 years, though the actual return interval varied from 3 to 16 years. To approximate the pre-colonial fire regime, prescribed burns should be carried out every 4 to 8 years.

Forest overstory. The overstory is dominated by dry-site oaks, or a mixture of dry-site oaks and pines. Species diversity is very low. Characteristic species include chestnut oak (Quercus montana), white oak (Quercus alba), scarlet oak (Quercus coccinea), black oak (Quercus velutina), Virginia pine (Pinus virginiana), shortleaf pine (Pinus echinata), and in parts of the extent, longleaf pine (Pinus palustris). Canopy cover is lower than in the fire suppressed phase.

Forest understory. Generally, sourwood (Oxydendrum arboreum) is the most commonly seen understory tree species. Other characteristic species include flowering dogwood (Cornus florida), blackgum (Nyssa sylvatica), sassafras (Sassafras albidum), and common persimmon (Diospyros virginiana), several of which often take on a shrub-like appearance.

Representative understory shrub species include Blue Ridge blueberry (Vaccinium pallidum) and deerberry (Vaccinium stamineum). On protected north-facing slopes, mountain laurel (Kalmia latifolia) often dominates the shrub layer and can form dense colonies.

The herb layer is denser, grassier, and more diverse than in the fire suppressed phase.

Dominant plant species

- chestnut oak (*Quercus montana*), tree
- white oak (*Quercus alba*), tree
- scarlet oak (*Quercus coccinea*), tree
- black oak (*Quercus velutina*), tree
- shortleaf pine (*Pinus echinata*), tree
- longleaf pine (*Pinus palustris*), tree
- sourwood (*Oxydendrum arboreum*), tree
- blackgum (*Nyssa sylvatica*), tree
- flowering dogwood (*Cornus florida*), shrub
- sassafras (*Sassafras albidum*), shrub

- Blue Ridge blueberry (*Vaccinium pallidum*), shrub
- deerberry (*Vaccinium stamineum*), shrub
- farkleberry (*Vaccinium arboreum*), shrub
- muscadine (*Vitis rotundifolia*), shrub
- evening trumpetflower (*Gelsemium sempervirens*), shrub
- mapleleaf viburnum (*Viburnum acerifolium*), shrub
- St. Andrew's cross (*Hypericum hypericoides ssp. multicaule*), shrub
- roundleaf greenbrier (*Smilax rotundifolia*), shrub
- blackberry (*Rubus*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- poverty oatgrass (*Danthonia spicata*), grass
- downy danthonia (*Danthonia sericea*), grass
- blackseed speargrass (*Piptochaetium avenaceum*), grass
- littlehead nutrush (*Scleria oligantha*), grass
- variable panicgrass (*Dichanthelium commutatum*), grass
- starved panicgrass (*Dichanthelium depauperatum*), grass
- splitbeard bluestem (*Andropogon ternarius*), grass
- black edge sedge (*Carex nigromarginata*), grass
- Virginia tephrosia (*Tephrosia virginiana*), other herbaceous
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- anisescented goldenrod (*Solidago odora*), other herbaceous
- ticktrefoil (*Desmodium*), other herbaceous
- lespedeza (*Lespedeza*), other herbaceous
- Atlantic pigeonwings (*Clitoria mariana*), other herbaceous
- horseflyweed (*Baptisia tinctoria*), other herbaceous
- tickseed (*Coreopsis*), other herbaceous
- silkgrass (*Pityopsis*), other herbaceous
- flaxleaf whitetop aster (*Ionactis linariifolius*), other herbaceous
- Maryland goldenaster (*Chrysopsis mariana*), other herbaceous

Community 1.2
Acidic Ridge Forest - Fire Suppressed Phase

This is a partially open to closed canopy mature forest community/phase. This phase accounts for the majority of contemporary examples. Canopy cover is higher than in stands in which fire has been reintroduced and the herb layer is typically sparser. The understory usually contains a greater proportion of fire-intolerant species.

Forest overstory. The overstory is dominated by dry-site oaks, or a mixture of dry-site oaks and pines. Species diversity is very low. Characteristic species include chestnut oak (Quercus montana), scarlet oak (Quercus coccinea), white oak (Quercus alba), Virginia pine (Pinus virginiana), shortleaf pine (Pinus echinata), loblolly pine (Pinus taeda), and in parts of the extent, longleaf pine (Pinus palustris). Canopy cover is higher than in the fire maintained phase.

Forest understory. Generally, sourwood (Oxydendrum arboreum) is the most commonly seen understory tree species. Other characteristic species include flowering dogwood (Cornus florida), blackgum (Nyssa sylvatica), sassafras (Sassafras albidum), and common persimmon (Diospyros virginiana), several of which often take on a shrub-like appearance. In the absence of fire, red maple (Acer rubrum) commonly invades the understory of stands associated with this ecological site.

Representative understory shrub species include Blue Ridge blueberry (Vaccinium pallidum) and deerberry (Vaccinium stamineum). On protected north-facing slopes, mountain laurel (Kalmia latifolia) often dominates the shrub layer and can form dense colonies.

The herb layer is sparser, less grassy, and less diverse than in the fire maintained phase.

Dominant plant species

- chestnut oak (*Quercus montana*), tree
- white oak (*Quercus alba*), tree
- scarlet oak (*Quercus coccinea*), tree
- black oak (*Quercus velutina*), tree
- Virginia pine (*Pinus virginiana*), tree
- loblolly pine (*Pinus taeda*), tree
- shortleaf pine (*Pinus echinata*), tree
- sourwood (*Oxydendrum arboreum*), tree
- blackgum (*Nyssa sylvatica*), tree
- red maple (*Acer rubrum*), tree
- flowering dogwood (*Cornus florida*), shrub
- Blue Ridge blueberry (*Vaccinium pallidum*), shrub
- deerberry (*Vaccinium stamineum*), shrub
- muscadine (*Vitis rotundifolia*), shrub
- farkleberry (*Vaccinium arboreum*), shrub
- roundleaf greenbrier (*Smilax rotundifolia*), shrub
- mapleleaf viburnum (*Viburnum acerifolium*), shrub
- mountain laurel (*Kalmia latifolia*), shrub
- poverty oatgrass (*Danthonia spicata*), grass
- downy danthonia (*Danthonia sericea*), grass
- variable panicgrass (*Dichanthelium commutatum*), grass
- starved panicgrass (*Dichanthelium depauperatum*), grass
- black edge sedge (*Carex nigromarginata*), grass
- striped prince's pine (*Chimaphila maculata*), other herbaceous
- trailing arbutus (*Epigaea repens*), other herbaceous
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- little heartleaf (*Hexastylis minor*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Long-term exclusion of fire causes an increase in fire-intolerant understory species and a deterioration of the abundance and diversity of herbaceous species.

Pathway 1.2A
Community 1.2 to 1.1

The fire suppressed phase can be managed towards the fire maintained phase through a combination of prescribed burns and selective removals. To approximate the pre-colonial fire regime, prescribed burns should be carried out every 4 to 8 years.

Context dependence. After decades of fire suppression, most upland forests of the Southeast have undergone mesophication, or succession toward forest systems that are less apt to burn. If prescribed fire is to be used as a management tool in fire suppressed ecosystems of the Piedmont, planning will be needed in some forest systems to overcome the effects of mesophication in the early stages of fire reintroduction.

State 2
Secondary Succession State

This successional phase develops in the wake of clearcut logging, storm-related catastrophic tree mortality, or other large-scale disturbances that have led to canopy removal in the recent past. Which species colonize a particular location in the wake of a disturbance does involve a considerable degree of chance. It also depends a great deal on the type, duration, and magnitude of the disturbance event.

Characteristics and indicators. Plant age distribution is even. Plants exhibit pioneering traits such as rapid growth, early reproduction, and shade-intolerance.

Community 2.1
Forested Successional Phase

This successional phase develops in the wake of recent, large-scale disturbances which have resulted in canopy removal. Stands are even-aged and species diversity is low. The canopy is usually dominated by pines, with hardwoods confined mostly to the understory. Species that exhibit pioneering traits are usually most abundant.

Forest overstory. The overstory is dominated by pines, including Virginia pine (Pinus virginiana), shortleaf pine (P. echinata), and loblolly pine (P. taeda).

Forest understory. Common understory tree species include sassafras (Sassafras albidum), blackgum (Nyssa sylvatica), red maple (Acer rubrum), flowering dogwood (Cornus florida), and sweetgum (Liquidambar styraciflua). Seedlings of dry-site oaks are usually present in the understory. These seedlings are released gradually as the forest matures and some of the pines begin to die off.

In the shrub layer, representative species include various blueberries (Vaccinium spp.), along with stunted subcanopy species, and several vines.

Dominant plant species

- Virginia pine (*Pinus virginiana*), tree
- shortleaf pine (*Pinus echinata*), tree
- loblolly pine (*Pinus taeda*), tree
- sassafras (*Sassafras albidum*), tree
- blackgum (*Nyssa sylvatica*), tree
- red maple (*Acer rubrum*), tree
- flowering dogwood (*Cornus florida*), tree
- sweetgum (*Liquidambar styraciflua*), tree
- oak (*Quercus*), tree
- blueberry (*Vaccinium*), shrub
- muscadine (*Vitis rotundifolia*), shrub
- sassafras (*Sassafras albidum*), shrub
- greenbrier (*Smilax*), shrub
- evening trumpetflower (*Gelsemium sempervirens*), shrub
- rosette grass (*Dichanthelium*), grass
- poverty oatgrass (*Danthonia spicata*), grass
- downy danthonia (*Danthonia sericea*), grass
- striped prince's pine (*Chimaphila maculata*), other herbaceous
- trailing arbutus (*Epigaea repens*), other herbaceous

Community 2.2
Shrub-dominated Successional Phase

This successional phase is dominated by shrubs and vines, along with seedlings of opportunistic hardwoods and pines. It grades into the forested successional phase as tree seedlings become saplings and begin to occupy more of the canopy cover.

Forest overstory. Species composition varies considerably from location to location.

Dominant plant species

- Virginia pine (*Pinus virginiana*), tree
- loblolly pine (*Pinus taeda*), tree
- blackgum (*Nyssa sylvatica*), tree
- sweetgum (*Liquidambar styraciflua*), tree
- winged sumac (*Rhus copallinum*), shrub
- muscadine (*Vitis rotundifolia*), shrub
- sassafras (*Sassafras albidum*), shrub

- smooth sumac (*Rhus glabra*), shrub
- St. Johnswort (*Hypericum*), shrub
- greenbrier (*Smilax*), shrub
- blackberry (*Rubus*), shrub
- evening trumpetflower (*Gelsemium sempervirens*), shrub
- broomsedge bluestem (*Andropogon virginicus*), grass
- lespedeza (*Lespedeza*), other herbaceous
- thoroughwort (*Eupatorium*), other herbaceous
- goldenrod (*Solidago*), other herbaceous
- ticktrefoil (*Desmodium*), other herbaceous

Community 2.3
Herbaceous Early Successional Phase

This transient community is composed of the first herbaceous invaders in the aftermath of clearcut logging or other large-scale natural disturbances that lead to canopy removal.

Resilience management. If the user wishes to maintain this community/phase for wildlife or pollinator habitat, a prescribed burn, mowing, or prescribed grazing will be needed at least once annually to prevent community pathway 2.3A. To that end, as part of long-term maintenance, periodic overseeding of wildlife or pollinator seed mixtures can be helpful in ensuring the viability of certain desired species and maintaining the desired composition of species for user goals.

Dominant plant species

- grape (*Vitis*), shrub
- greenbrier (*Smilax*), shrub
- broomsedge bluestem (*Andropogon virginicus*), grass
- hairy crabgrass (*Digitaria sanguinalis*), grass
- smooth crabgrass (*Digitaria ischaemum*), grass
- southern crabgrass (*Digitaria ciliaris*), grass
- rosette grass (*Dichanthelium*), grass
- goldenrod (*Solidago*), other herbaceous
- thoroughwort (*Eupatorium*), other herbaceous
- lespedeza (*Lespedeza*), other herbaceous
- ticktrefoil (*Desmodium*), other herbaceous
- Canadian horseweed (*Conyza canadensis*), other herbaceous
- Virginia dwarfdandelion (*Krigia virginica*), other herbaceous
- dwarf cinquefoil (*Potentilla canadensis*), other herbaceous
- aster (*Symphyotrichum*), other herbaceous
- common mullein (*Verbascum thapsus*), other herbaceous
- cudweed (*Pseudognaphalium*), other herbaceous

Pathway 2.1A

Community 2.1 to 2.3

The forested successional phase can return to the herbaceous early successional phase through clearcut logging or other large-scale disturbances that cause canopy removal.

Context dependence. Note: if the user wishes to use this community pathway to create wildlife or pollinator habitat, please contact a local NRCS office for a species list specific to the area of interest and user needs.

Pathway 2.2A
Community 2.2 to 2.1

The shrub-dominated successional phase naturally moves towards the forested successional phase through natural succession.

Pathway 2.2B
Community 2.2 to 2.3

The shrub-dominated successional phase can return to the herbaceous early successional phase through brush management, including herbicide application, mechanical removal, prescribed grazing, or fire.

Context dependence. Note: if the user wishes to use this community pathway to create wildlife or pollinator habitat, please contact a local NRCS office for a species list specific to the area of interest and user needs. If the user wishes to maintain the shrub-dominated successional phase long term, for wildlife habitat or other uses, periodic use of this community pathway is necessary to prevent community pathway 2.2A, which happens inevitably unless natural succession is set back through disturbance.

Pathway 2.3A
Community 2.3 to 2.2

The herbaceous early successional phase naturally moves towards the shrub-dominated successional phase through natural succession. The process takes approximately 3 years on average, barring any major disturbances capable of inhibiting natural succession.

State 3
Managed Pine Plantation State

This transient community is composed of the first herbaceous invaders in the aftermath of clearcut logging or other large-scale natural disturbances that lead to canopy removal. Note: if the user wishes to convert stands dominated by hardwoods to planted pine, clearcutting will usually be necessary first, allowing herbaceous pioneers to establish on the site in the weeks or months prior to planting. Users should utilize measures described in transition T2B under these circumstances.

Resilience management. Hardwood Encroachment: Hardwood encroachment can be problematic in managed pine plantations. Good site preparation, proper stocking, and periodic thinning are advisable to reduce hardwood competition. Overstocking: The overstocked condition commonly occurs in naturally regenerated stands. When competition from other pines begins to impact the health and productivity of the stand, precommercial thinning should be considered. At this point, the benefit of thinning usually outweighs the potential for invasion and competition from non-pine species. As the target window for thinning passes, the condition of the stand can slowly deteriorate if no action is taken. Under long-term overstocked conditions, trees are more prone to stresses, including pine bark beetle infestation and damage from wind or ice. High-grading: In subsequent commercial thinnings, care should be taken in tree selection. High quality specimens should be left to reach maturity, while slower growing trees or those with defects should be removed sooner. If high quality specimens are harvested first, trees left behind are often structurally unsound, diseased, genetically inferior, or of poor form. This can have long-term implications for tree genetics and for the condition of the stand (Felix III 1983; Miller et al. 1995, 2003; Megalos 2019).

Dominant plant species

- loblolly pine (*Pinus taeda*), tree
- blackgum (*Nyssa sylvatica*), tree
- sassafras (*Sassafras albidum*), tree
- red maple (*Acer rubrum*), tree
- oak (*Quercus*), tree
- blueberry (*Vaccinium*), shrub
- muscadine (*Vitis rotundifolia*), shrub
- Japanese honeysuckle (*Lonicera japonica*), shrub
- greenbrier (*Smilax*), shrub
- blackberry (*Rubus*), shrub
- St. Johnswort (*Hypericum*), shrub
- rosette grass (*Dichanthelium*), grass
- poverty oatgrass (*Danthonia spicata*), grass
- downy danthonia (*Danthonia sericea*), grass
- striped prince's pine (*Chimaphila maculata*), other herbaceous

State 4
Pasture State

This converted state is dominated by herbaceous forage species.

Dominant plant species

- Bermudagrass (*Cynodon dactylon*), grass
- dallisgrass (*Paspalum dilatatum*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- purpletop tridens (*Tridens flavus*), grass

- Indiangrass (*Sorghastrum nutans*), grass
- hairy crabgrass (*Digitaria sanguinalis*), grass
- broomsedge bluestem (*Andropogon virginicus*), grass
- smooth crabgrass (*Digitaria ischaemum*), grass
- white clover (*Trifolium repens*), other herbaceous
- sericea lespedeza (*Lespedeza cuneata*), other herbaceous
- Japanese clover (*Kummerowia striata*), other herbaceous
- field clover (*Trifolium campestre*), other herbaceous
- dogfennel (*Eupatorium capillifolium*), other herbaceous
- narrowleaf plantain (*Plantago lanceolata*), other herbaceous

Transition T1A
State 1 to 2

The reference state can transition to the secondary succession state through clearcut logging or other large-scale disturbances that cause canopy removal.

Transition T1B
State 1 to 4

The reference state can transition to the pasture/hayland state through 1) mechanical tree/brush/stump/debris removal, 2) seedbed preparation, and 3) planting of perennial grasses and forbs.

Context dependence. Herbicide applications, fire, and/or root-raking can be helpful in transitioning treed land to pasture. This is done in part to limit coppicing, as many woody plants are capable of sprouting from residual plant structures left behind after clearing. Judicious use of root-raking is recommended, as this practice can have long-term repercussions with regard to soil structure. Applications of fertilizer and lime can also be helpful in establishing perennial forage species. Grazing should be deferred until grasses and forbs are well established.

Transition T2A
State 2 to 1

The secondary succession state can transition to the reference state through long-term natural succession. This process can be accelerated to some degree by a combination of prescribed burns and selective harvesting of pines and opportunistic hardwoods.

Transition T2B
State 2 to 3

The secondary succession state can transition to the managed pine plantation state through site preparation and planting of timber trees. Thinning alone may be sufficient for portions of the forest if pines have already established, though it is rarely sufficient for an entire forest patch.

Transition T2C
State 2 to 4

The secondary succession state can transition to the pasture/hayland state through through 1) mechanical tree/brush/stump/debris removal, 2) seedbed preparation, and 3) planting of perennial grasses and forbs.

Context dependence. A broad spectrum herbicide, fire, and/or root-raking can be helpful in transitioning wooded or semi-wooded land to pasture. This is done in part to limit coppicing, as many woody pioneers are capable of sprouting from residual plant structures left behind after clearing. Judicious use of root-raking is recommended, as this practice can have long-term repercussions with regard to soil structure. Applications of fertilizer and lime can also be helpful in establishing perennial forage species. Grazing should be deferred until grasses and forbs are well established.

Transition T3A
State 3 to 2

The managed pine plantation state can transition to the secondary succession state through abandonment of forestry practices (with or without timber tree harvest).

Transition T3B
State 3 to 4

The managed pine plantation state can transition to the pasture/hayland state through 1) timber harvest, 2) mechanical stump and debris removal, 3) seedbed preparation, 4) planting of perennial grasses and forbs.

Context dependence. Applications of fertilizer and lime can be helpful in establishing perennial forage species. Grazing should be deferred until grasses and forbs are well established.

Transition T4A
State 4 to 2

The pasture/hayland state can transition to the secondary succession state through long-term cessation of grazing.

Transition T4B
State 4 to 3

The pasture/hayland state can transition to the managed pine plantation state through site preparation and tree planting.

Additional community tables

Inventory data references

Data collection and analysis of field data will be performed during the Verification Stage of ESD development.

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Approval

Charles Stemmans, 5/02/2025

Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	05/21/2025
Approved by	Charles Stemmans
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most**

sites will show a range of values):

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

17. **Perennial plant reproductive capability:**