USDA Natural Resources
Conservation Service

Ecological site PX136X00X730
Basic Upland Forest, Depth Restriction, Dry

Last updated: 5/02/2025
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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
CEGL007773 *Quercus alba* - *Quercus stellata* - *Carya carolinae-septentrionalis* / *Acer leucoderme* - *Cercis canadensis*; CEGL004416 *Quercus montana* - *Quercus stellata* - *Carya glabra* / *Vaccinium arboreum* - *Viburnum rufidulum*; CEGL004443 *Juniperus virginiana* - *Ulmus alata* / *Schizachyrium scoparium*

APPLICABLE EPA ECOREGIONS
Level III: 45. Piedmont
Level IV: 45a. Southern Inner Piedmont; 45b. Southern Outer Piedmont; 45c. Carolina Slate Belt; 45f. Northern Outer Piedmont; 45g. Triassic Basins; 45i. Kings Mountain; 45d. Talladega Upland; 45h. Pine Mountain Ridges (EPA 2013).

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 uplands that are rich in base cations, on narrow ridges and side slopes, and along short, steep-sided drainageways. It is geographically restricted to the thermic soil temperature regime portion of the MLRA.

Soils on this ecological site are weathered from mafic intrusive rock. They are typically shallow to moderately deep, well drained Alfisols, which formed in residuum from dark colored rocks high in ferromagnesian minerals. Base saturation is greater than or equal to 35 percent in the subsoil. Unweathered or partially weathered bedrock is typically found within 40 inches of the surface.

The reference state supports a partially open to closed canopy oak-hickory forest with a higher proportion of hickories, elms, and ashes, and greater species diversity than is typical of similar acidic forest types. Important canopy species include white oak (*Quercus alba*), post oak (*Quercus stellata*), black oak (*Quercus velutina*), southern red oak (*Quercus falcata*), and several species of hickory (Carya spp.). Dominant land uses include pasture and hayland, planted pine, wildlife habitat, cropland, and various urban or suburban uses.

ES CHARACTERISTICS SUMMARY
• Thermic soil temperature regime
• Occurs on Piedmont uplands, on on narrow ridges and side slopes, and along short, steep-sided drainageways
• Parent materials: mafic intrusive rock
• Base saturation: ≥ 35 percent in the subsoil
• Seasonal high water table: usually absent within 72 inches of the soil surface
• Depth to bedrock: < 40 inches
• 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 less than 6 inches
• Soils: shallow to moderately deep, well drained Alfisols

Associated sites

PX136X00X720	**Basic Upland Forest, Moist** Generally found in similar or slightly lower landscape positions, on more stable and less steeply sloping parts of the landscape where soils are deeper to bedrock (≥ 40 inches, usually deeper). Moisture-loving plant species generally increase in abundance, of which northern red oak (Quercus rubra) is most notable.
PX136X00X710	**Basic Upland Woodland, Expansive Clay, Seasonally Wet and Dry** Found in lower landscape positions with low topographic relief. The seasonal high water table is shallower (12-40 inches from the soil surface). Species tolerant of short-lived anaerobic conditions usually occupy some portion of the canopy, of which willow oak (Quercus phellos) is most notable.

PX136X00X820	**Acidic Upland Forest, Moist** Widespread on the surrounding acidic uplands. It is underlain either by acidic igneous or metamorphic rock, or by highly weathered mafic materials that have been leached of base cations. Base saturation is less than 35 percent and soils are deeper to bedrock (≥ 40 inches, usually deeper). Moisture-loving plant species, such as northern red oak (Quercus rubra), generally increase in the canopy, but basic indicator species are usually scarce or absent in the understory.

Similar sites

PX136X00X230	**Mesic Temperature Regime, Basic Upland Forest, Depth Restriction, Dry** The soil temperature regime is mesic, occurring outside of the native range of loblolly pine (Pinus taeda).
PX136X00X830	**Acidic Upland Forest, Depth Restriction, Dry-moist** The relative soil moisture status is similar, but soils are more thoroughly leached of base cations. Base saturation is less than 35 percent. This ecological site supports similar species in the canopy, but basic indicator species are generally scarce or absent in the understory.

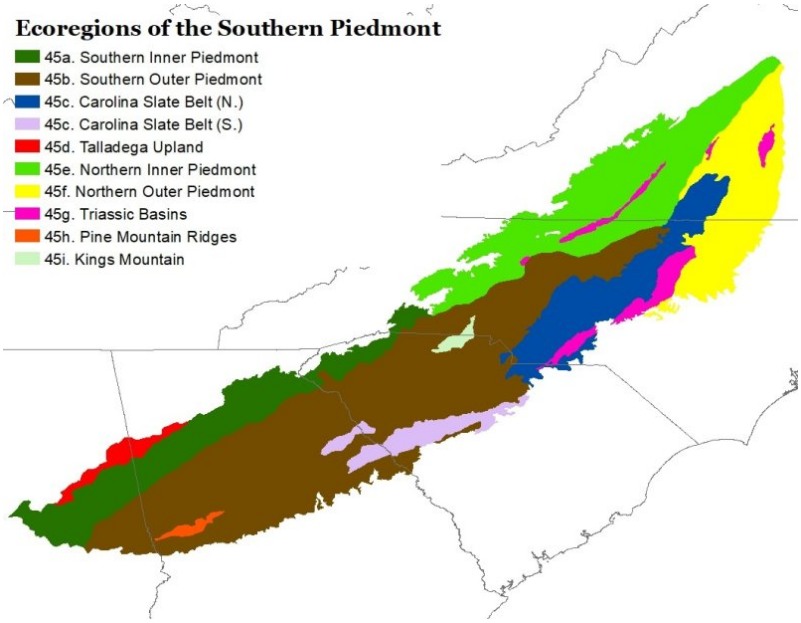


Figure 1. EPA level IV ecoregions of the Southern Piedmont (45).

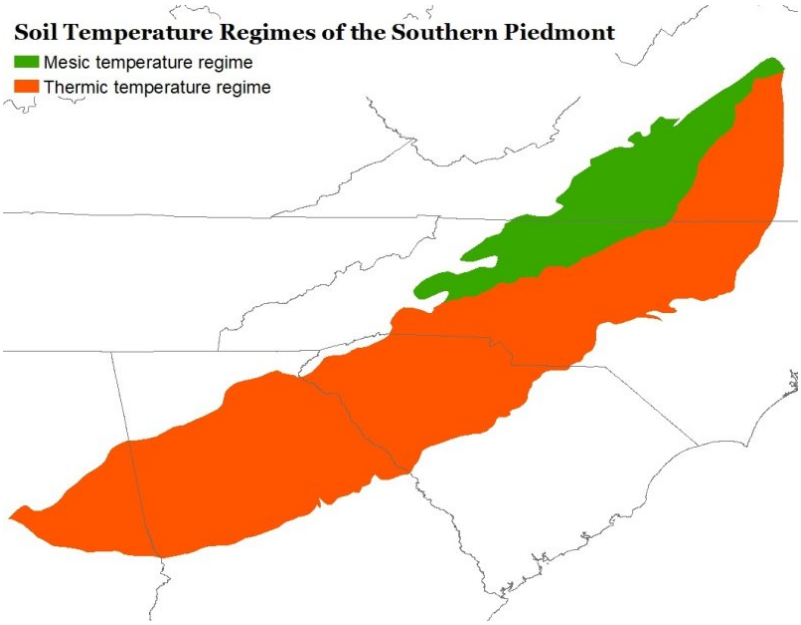


Figure 2. Spatial illustration of soil temperature regimes of the Southern Piedmont.

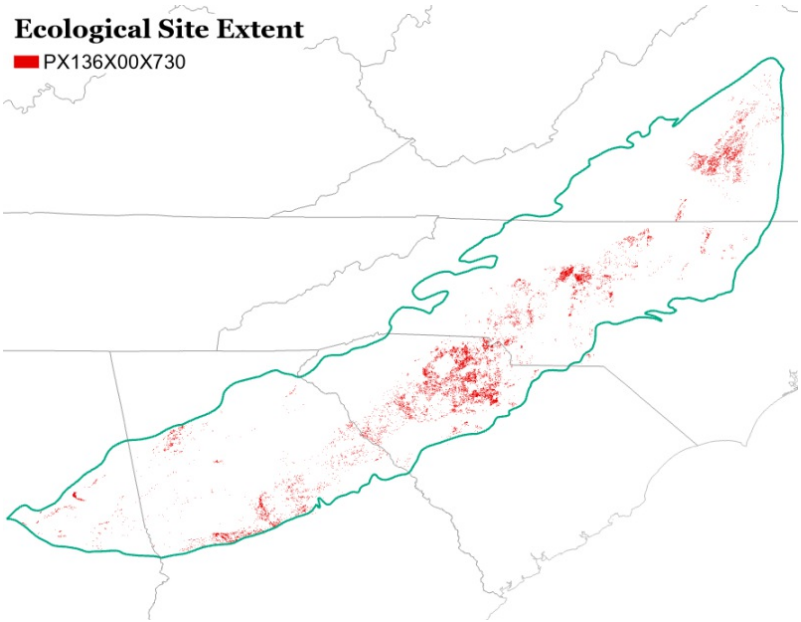


Figure 3. Spatial extent of this ecological site representing the major areas where this site is important on the landscape.

Table 1. Dominant plant species

Tree	(1) *Quercus alba* (2) *Quercus stellata*
Shrub	(1) *Cercis canadensis* (2) *Viburnum rufidulum*
Herbaceous	(1) *Danthonia* (2) *Schizachyrium scoparium*

Legacy ID

F136XY730SC

Physiographic features

This ecological site includes dry uplands on narrow ridges and side slopes, and along short, steep-sided drainageways. Representative locations are gently sloping on ridgetops, to steeply sloping on backslopes, with a representative slope of 8 to 25 percent and a maximum slope of 45 percent.

The geologic substrate is mafic intrusive rock, such as diabase, gabbro, and other related dark colored rocks high in ferromagnesian minerals. The material was transported upward through fissures in the earth's crust in the form of mafic dikes and sills. These structures cut through the surrounding country rock. As a result, this ecological site often occurs in small patches, and is often adjacent to or intermingled with acidic uplands, or basic uplands with dissimilar soil moisture conditions.

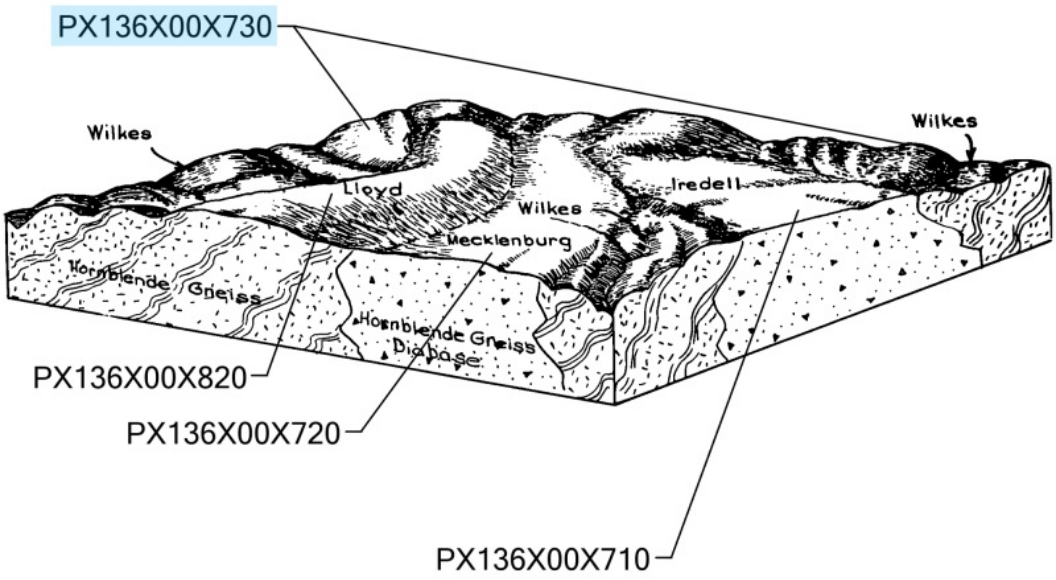


Figure 4. Typical soil-landscape relationships of the Southern Piedmont Mixed Felsic and Mafic Soil System. Wilkes soils are associated with this ecological site, depicted here narrow ridgetops and along steep-sided drainageways.

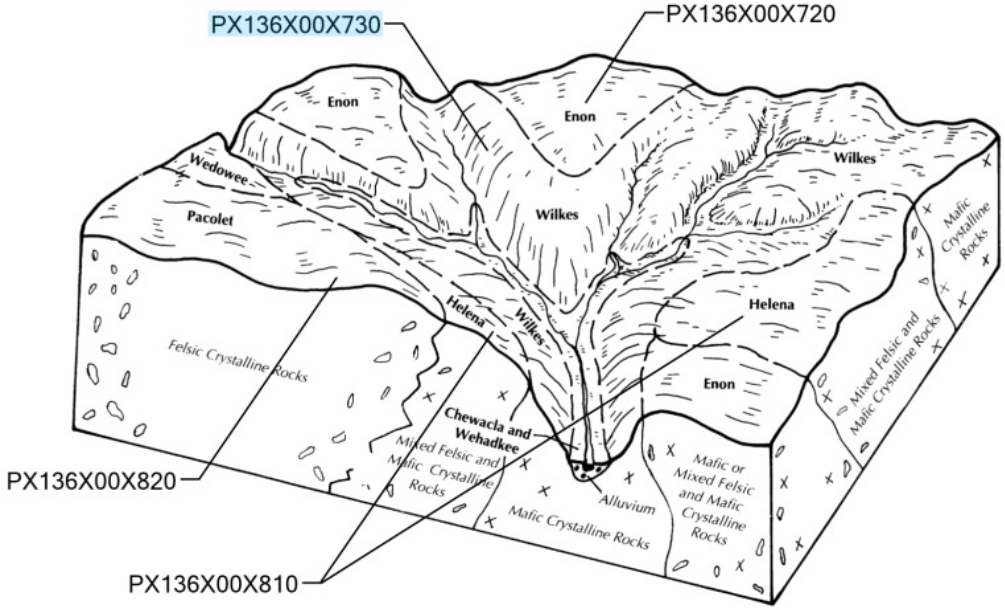


Figure 5. Typical soil-landscape relationships of the Southern Piedmont Mixed Felsic and Mafic Soil System. Wilkes soils are associated with this ecological site, depicted here on backslopes and along steep-sided drainageways.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Shoulder (3) Summit
Landforms	(1) Piedmont > Hillslope (2) Piedmont > Ridge
Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None
Elevation	110–299 m
Slope	8–25%
Water table depth	183–2,537 cm
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Low to very high
Flooding frequency	None
Ponding frequency	None
Elevation	55–411 m
Slope	2–45%
Water table depth	183–2,537 cm

Climatic features

On this ecological site, the average mean annual precipitation is 48 inches. On average, the rainiest months occur from July through August, as well as in March. The driest months occur from April through May, along with October.

Table 4. Representative climatic features

Frost-free period (characteristic range)	163-191 days
Freeze-free period (characteristic range)	194-224 days
Precipitation total (characteristic range)	1,143-1,295 mm

Frost-free period (actual range)	156-197 days
Freeze-free period (actual range)	183-235 days
Precipitation total (actual range)	1,092-1,422 mm
Frost-free period (average)	176 days
Freeze-free period (average)	209 days
Precipitation total (average)	1,219 mm

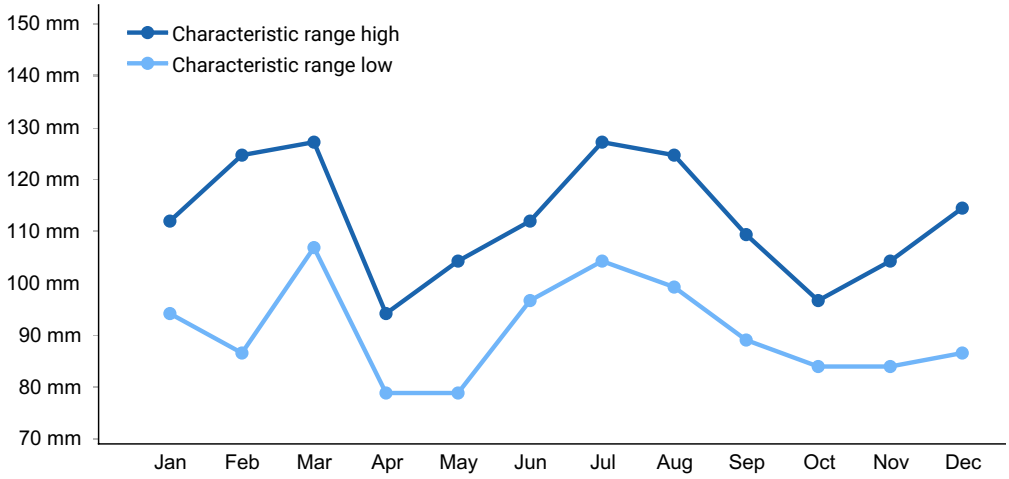


Figure 6. Monthly precipitation range

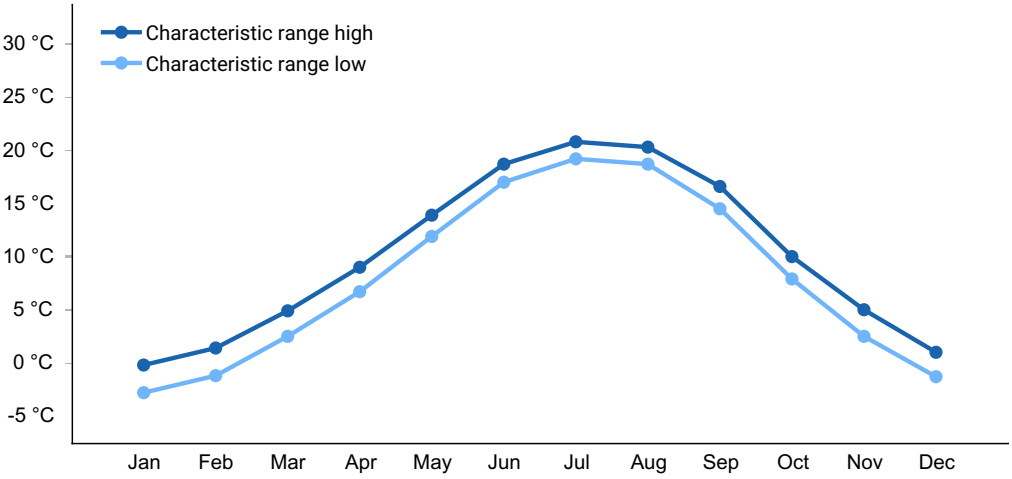


Figure 7. Monthly minimum temperature range

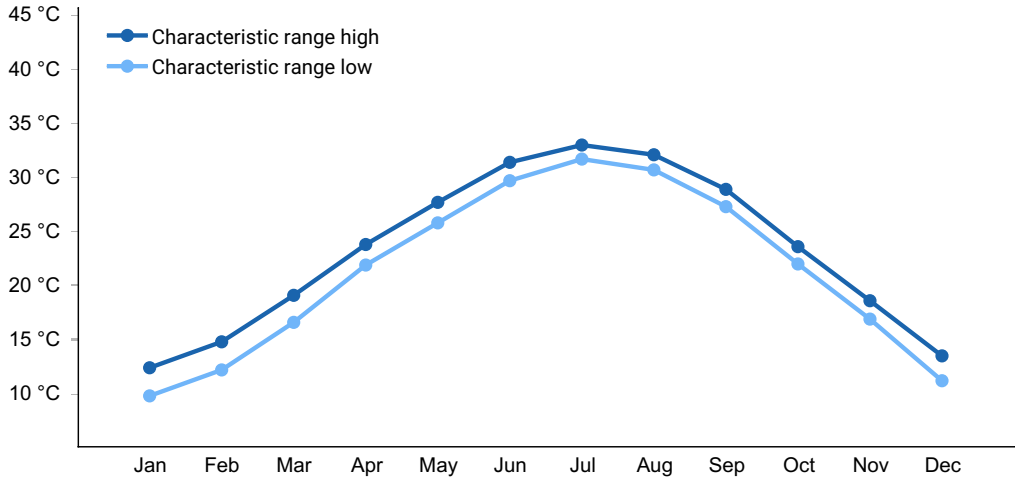


Figure 8. Monthly maximum temperature range

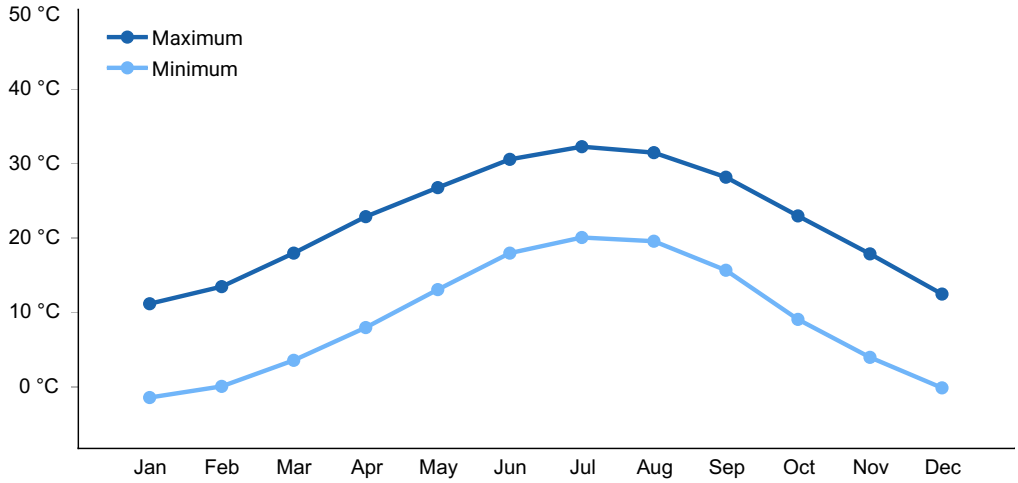


Figure 9. Monthly average minimum and maximum temperature

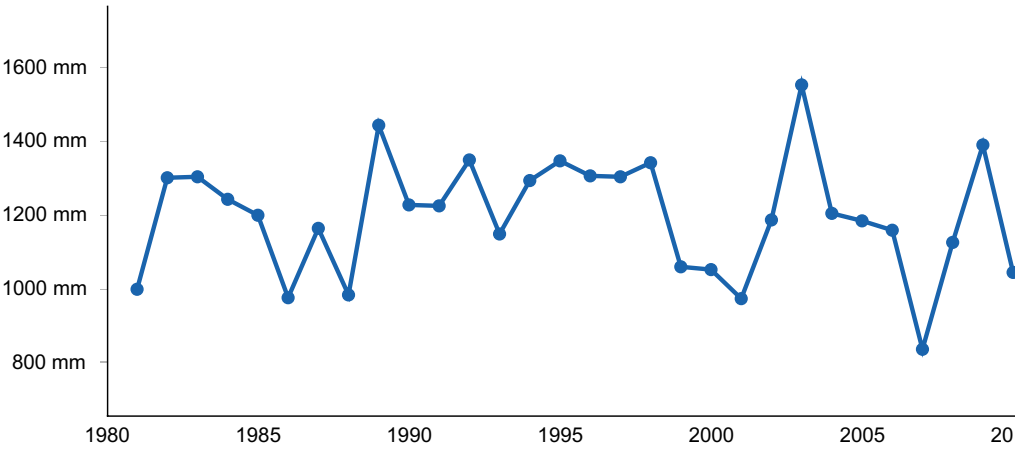


Figure 10. Annual precipitation pattern

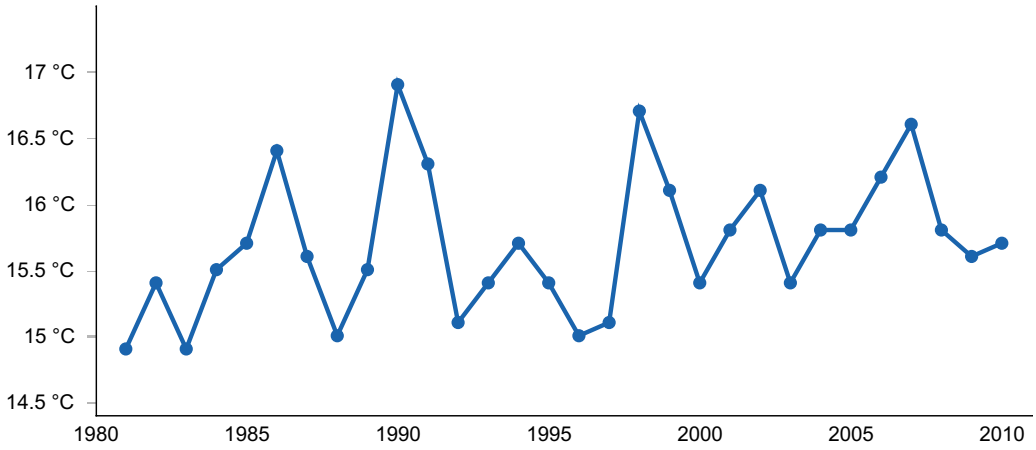


Figure 11. Annual average temperature pattern

Climate stations used

- (1) ROCKFORD 3 ESE [USC00017020], Rockford, AL
- (2) LAFAYETTE 2W [USC00014502], Lafayette, AL
- (3) ASHLAND 3 ENE [USC00010369], Ashland, AL
- (4) ROCK MILLS [USC00017025], Roanoke, AL
- (5) CARROLLTON [USC00091640], Carrollton, GA
- (6) TALBOTTON [USC00098535], Talbotton, GA
- (7) NEWNAN 5N [USC00096335], Newnan, GA
- (8) EXPERIMENT [USC00093271], Griffin, GA
- (9) MABLETON 1 N [USC00095404], Smyrna, GA
- (10) ALPHARETTA 4 SSW [USC00090219], Alpharetta, GA
- (11) MONTICELLO [USC00095988], Monticello, GA
- (12) SILOAM 3N [USC00098064], Greensboro, GA
- (13) CUMMING 2N [USC00092408], Cumming, GA
- (14) CORNELIA [USC00092283], Cornelia, GA
- (15) WASHINGTON 2 ESE [USC00099157], Washington, GA
- (16) ELBERTON 2 N [USC00093060], Elberton, GA
- (17) CALHOUN FALLS [USC00381277], Calhoun Falls, SC
- (18) CLEMSON OCONEE CO AP [USW00053850], Seneca, SC
- (19) WEST PELZER 2 W [USC00389122], Pelzer, SC
- (20) PICKENS [USC00386831], Pickens, SC
- (21) MC CORMICK 9 E [USC00385658], Mc Cormick, SC
- (22) CLARKS HILL 1 W [USC00381726], Modoc, SC
- (23) GREENVILLE DWTN AP [USW00013886], Greenville, SC
- (24) GREER [USW00003870], Greer, SC
- (25) LAURENS [USC00385017], Laurens, SC
- (26) NEWBERRY [USC00386209], Newberry, SC
- (27) LITTLE MTN [USC00385200], Little Mountain, SC
- (28) CEDAR CREEK 2E [USC00381479], Blythewood, SC
- (29) PARR [USC00386688], Jenkinsville, SC

- (30) WINNSBORO [USC00389327], Winnsboro, SC
- (31) UNION 8 S [USC00388786], Union, SC
- (32) SPARTANBURG 3 SSE [USC00388188], Spartanburg, SC
- (33) SIMMS WTP [USC00387885], Chesnee, SC
- (34) CHESNEE 7 WSW [USC00381625], Chesnee, SC
- (35) NINETY NINE ISLANDS [USC00386293], Blacksburg, SC
- (36) YORK 4 S [USC00389625], York, SC
- (37) ROCK HILL YORK CO AP [USW00053871], Rock Hill, SC
- (38) WINTHROP UNIV [USC00389350], Rock Hill, SC
- (39) KERSHAW 1SW [USC00384690], Kershaw, SC
- (40) SALEM 5 NNE [USC00387589], Salem, SC
- (41) WADESBORO [USC00318964], Wadesboro, NC
- (42) MONROE 2 SE [USC00315771], Monroe, NC
- (43) MONROE AP [USW00053872], Monroe, NC
- (44) SHELBY 2 NNE [USC00317845], Shelby, NC
- (45) FOREST CITY 8 W [USC00313152], Rutherfordton, NC
- (46) ASHEBORO 2 W [USC00310286], Asheboro, NC
- (47) SALISBURY [USC00317615], Salisbury, NC
- (48) HIGH POINT [USC00314063], High Point, NC
- (49) BURLINGTON ALAMANCE AP [USW00093783], Burlington, NC
- (50) YANCEYVILLE 4 SE [USC00319704], Yanceyville, NC
- (51) ROXBORO 7 ESE [USC00317516], Roxboro, NC
- (52) ARCOLA [USC00310241], Macon, NC
- (53) CLAYTON WTP [USC00311820], Clayton, NC
- (54) SANFORD 8 NE [USC00317656], Sanford, NC
- (55) OXFORD AG [USC00316510], Oxford, NC
- (56) CLARKSVILLE [USC00441746], Clarksville, VA
- (57) LAWRENCEVILLE 3 E [USC00444768], Freeman, VA
- (58) JOHN H KERR DAM [USC00444414], Boydton, VA
- (59) CHARLOTTE COURT HOUSE [USC00441585], Keysville, VA
- (60) CAMP PICKETT [USC00441322], Blackstone, VA
- (61) AMELIA COURTHOUSE 1 [USC00440187], Amelia Court House, VA
- (62) CROZIER [USC00442142], Maidens, VA

Influencing water features

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

Soil features

Soils on this ecological site are shallow to moderately deep, well drained Alfisols, which formed in mafic residuum. Base saturation is greater than or equal to 35 percent in the subsoil. Unweathered or partially weathered bedrock is typically found within 40 inches of the soil surface. The available water storage capacity of the profile is generally less than 6 inches.

Reaction in the subsoil is typically moderately acid to slightly alkaline (pH 5.6 to 7.8). In the surface layers, reaction varies with land use and management. Under low input or forested conditions, it generally falls somewhere between pH 5.1 and 7.3. These soils are typically in a loamy, fine-loamy, or fine particle sized family.

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 soil taxa include: Typic Hapludalfs
Modal soil series include: Wilkes
Other soils attributed to this ecological site include Poindexter, Wynott, and Sekil.

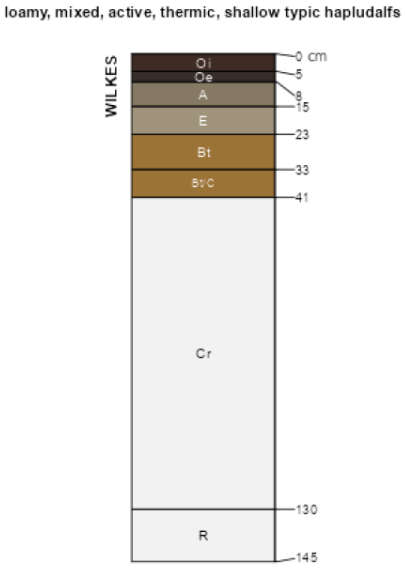


Figure 12. An illustration of a soil profile belonging to the Wilkes series, a representative soil series associated with this ecological site.

Figure 13. A soil profile of the Wilkes series.

Table 5. Representative soil features

Parent material	(1) Residuum–amphibolite (2) Residuum–diabase (3) Residuum–diorite (4) Residuum–hornblende gneiss (5) Residuum–gabbro (6) Residuum–schist
Surface texture	(1) Sandy loam (2) Loam (3) Fine sandy loam (4) Gravelly sandy loam (5) Gravelly loam (6) Sandy clay loam
Family particle size	(1) Fine-loamy (2) Loamy (3) Fine
Drainage class	Well drained
Permeability class	Moderately slow to moderately rapid
Depth to restrictive layer	33–51 cm
Soil depth	33–51 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-203.2cm)	5.08–7.62 cm
Soil reaction (1:1 water) (0-25.4cm)	5.1–7.3
Subsurface fragment volume <=3" (0-203.2cm)	0–12%
Subsurface fragment volume >3" (0-203.2cm)	0–3%

Table 6. Representative soil features (actual values)

Drainage class	Well drained to somewhat excessively drained
Permeability class	Very slow to moderately rapid
Depth to restrictive layer	28–99 cm
Soil depth	28–99 cm
Surface fragment cover <=3"	0–1%
Surface fragment cover >3"	0–1%

Available water capacity (0-203.2cm)	5.08–15.24 cm
Soil reaction (1:1 water) (0-25.4cm)	4.5–7.8
Subsurface fragment volume <=3" (0-203.2cm)	0–17%
Subsurface fragment volume >3" (0-203.2cm)	0–4%

Ecological dynamics

U.S. National Vegetation Classification (USNVC) associations that are consistent with reference conditions on this ecological site include CEGL007773 *Quercus alba* - *Quercus stellata* - *Carya carolinae-septentrionalis* / *Acer leucoderme* - *Cercis canadensis*. On high hills of the upper Piedmont and Carolina Slate Belt, CEGL004416 *Quercus montana* - *Quercus stellata* - *Carya glabra* / *Vaccinium arboreum* - *Viburnum rufidulum* may apply in some stands. Where the substrate thins and rock outcrops become more abundant, usually on steep slopes, CEGL004443 *Juniperus virginiana* - *Ulmus alata* / *Schizachyrium scoparium*, or other associations dominated by eastern redcedar may apply to small patches (USNVC 2022).

MATURE FORESTS
The reference state supports a partially open to closed canopy oak-hickory forest, with a higher proportion of hickories, elms, and ashes, and greater species diversity than is typical of similar acidic forest types. Acid-loving flora are usually scarce or absent in the understory and basic indicator species are typically present in greater numbers.

In the canopy layer, the oak component includes a higher proportion of dry-site oaks than is typical of moister sites, including post oak (*Quercus stellata*), black oak (*Quercus velutina*), and southern red oak (*Quercus falcata*), along with somewhat more mesophytic species such as white oak (*Quercus alba*), and several species of hickory (*Carya carolinae-septentrionalis*, *C. tomentosa*, *C. glabra*, *C. ovalis*). Mesophytic oaks less drought-tolerant than white oak (*Q. alba*) (e.g., northern red oak (*Quercus rubra*)), are generally absent or scarce.

In mature stands, pines are typically scattered throughout the forest. Loblolly pine (*Pinus taeda*) and shortleaf pine (*P. echinata*) are the principle species in most of the thermic soil temperature regime portion of the MLRA. According to historical accounts and witness tree records, the importance of the pine component naturally increases, though very gradually, from north to south. Shortleaf pine likely dominated the pine component in the past, though loblolly is of equal or greater importance in contemporary stands. Prior to the European settlement, loblolly pine was largely confined to drainageways and adjacent lower slopes in the uplands of the Southern Piedmont.

In the reference state, the subcanopy layer includes basic indicator species such as eastern redbud (*Cercis canadensis*), eastern redcedar (*Juniperus virginiana*), chalk maple (*Acer leucoderme*), white fringetree (*Chionanthus virginicus*), white ash (*Fraxinus americana*), and dwarf hackberry (*Celtis pumila*). Subcanopy generalists include flowering dogwood (*Cornus florida*), red maple (*Acer rubrum*), and American persimmon (*Diospyros virginiana*), along with saplings of canopy species.

Species typical of the shrub layer include rusty blackhaw (*Viburnum rufidulum*), mapleleaf viburnum (*Viburnum acerifolium*), downy arrowwood (*Viburnum rafinesqueanum*), and coralberry (*Symphoricarpos orbiculatus*). Other shrub species which are characteristic, but generally of low cover include Fragrant sumac (*Rhus aromatica*), hog plum (*Prunus umbellata*), and smallflower pawpaw (*Asimina parviflora*). Several species of blueberry (Vaccinium spp.) may be present, but they typically are of low cover. Of the Vaccinium species, farkleberry (*Vaccinium arboreum*) is most common on this ecological site, as it is tolerant of both acidic and circumneutral conditions.

In the herb layer, characteristic grasses and grass-like plants include blackseed speargrass (*Piptochaetium avenaceum*), little bluestem (*Schizachyrium scoparium*), poverty oatgrass (*Danthonia spicata*), and littlehead nutrush (*Scleria oligantha*). Common forbs include anisescented goldenrod (*Solidago odora*), wreath goldenrod (*Solidago caesia*), wild quinine (*Parthenium integrifolium*), and rattlesnakeweed (*Hieracium venosum*). Basic indicator species typical of the herb layer including nettleleaf sage (*Salvia urticifolia*), nettleleaf noseburn (*Tragia urticifolia*), whorled milkweed (*Asclepias verticillata*), and many others.

DYNAMICS OF NATURAL SUCCESSION AND FIRE ECOLOGY

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, such as those associated with this ecological site, their respective influence on successional dynamics probably fell somewhere in between. 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.

Like other oak-hickory forests in the region, small-scale natural disturbances such as windthrow, drought, and disease, are important drivers of natural succession in contemporary stands. Presumably these localized events made a rather large contribution to the disturbance regime in the past, though fire likely had shared influence in shaping the competitive environment for plants on this ecological site.

In the past, regular low-intensity fires would have kept the understory somewhat more open than at present and constrained the growth of fire-intolerant woody species. Periodic severe fires would have likely occurred during unusually dry and windy conditions, presumably resulting in catastrophic tree mortality and stand replacing changes. 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.

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.

YOUNG SECONDARY FORESTS
On relatively undisturbed sites, stands are uneven-aged, with at least some old trees present. In areas that were cultivated in the recent past, even-aged pine stands dominate the landscape, being replaced by oaks and hickories only as the pines die.

In general, young secondary forests on this ecological site are dominated by loblolly and shortleaf pines, along with opportunistic hardwoods such as sweetgum (*Liquidambar styraciflua*) and red maple (*Acer rubrum*). Oaks and hickories, including white oak (*Q. alba*), post oak (*Q. stellata*), and black oak (*Q. velutina*), along with hickories (Carya spp.), are usually confined to the understory of young secondary stands. Their growth is temporarily suppressed by the cover of faster growing tree species.

In the central Piedmont of North Carolina and Virginia, Virginia pine (*P. virginiana*) becomes increasingly important in young secondary stands, particularly in the Carolina Slate Belt and even more so in regions to the west or north. In regions further south, loblolly pine is typically the more competitive pioneer under most site conditions, apart from higher elevation areas of the upper Piedmont where Virginia pine becomes more abundant (Wharton 1978; Barry 1980; Peet and Christensen 1980, 1987; Nelson 1986; Schafale and Weakley 1990; Cowell 1998; Spira 2011; Fleming 2012; Guyette et al. 2012; Schafale 2012a, 2012b; Edwards et al. 2013; Vander Yacht et al. 2020; Fleming et al. 2021; Greenberg et al. 2021; Spooner et al. 2021).
.
SPECIES LIST
Canopy layer: *Quercus alba*, *Quercus stellata*, *Quercus velutina*, *Quercus falcata*, *Carya carolinae-septentrionalis*, *Carya tomentosa*, *Carya glabra*, *Carya ovalis*, *Quercus marilandica*, *Quercus montana*, *Carya pallida*, *Pinus echinata*, *Pinus virginiana*, *Ulmus alata*, *Quercus muehlenbergii*,

Subcanopy layer: *Acer leucoderme*, *Cercis canadensis*, *Juniperus virginiana*, *Cornus florida*, *Acer rubrum*, *Chionanthus virginicus*, *Fraxinus americana*, Carya spp., *Celtis pumila*, *Acer floridanum*, *Diospyros virginiana*, *Ulmus alata*,

Vines/lianas: *Vitis rotundifolia*, *Smilax glauca*, *Smilax bona-nox*, *Matelea decipiens*, *Cocculus carolinus*, *Lonicera japonica* (I)

Shrub layer: *Viburnum rufidulum*, *Viburnum acerifolium*, *Viburnum rafinesqueanum*,

Vaccinium arboreum, *Symphoricarpos orbiculatus*, *Hypericum hypericoides* ssp. multicaule, *Crataegus uniflora*, *Ceanothus americanus*, *Rhus aromatica*, *Prunus umbellata*, *Asimina parviflora*, *Styrax grandifolius*, *Physocarpus opulifolius*, *Ptelea trifoliata*

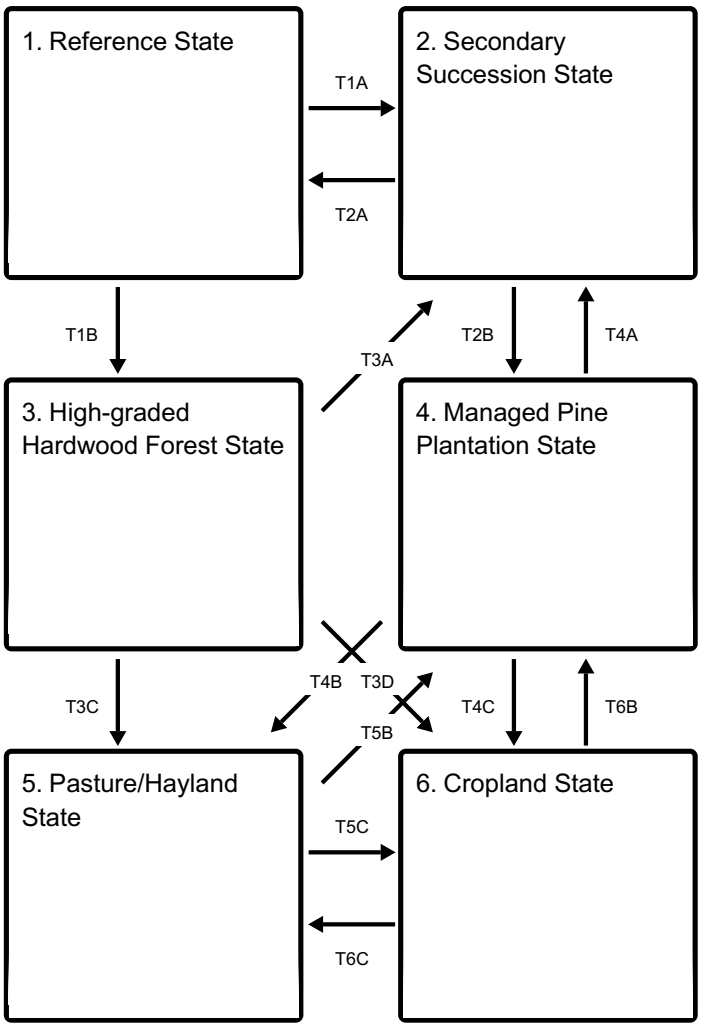
Herb layer - forbs: Desmodium spp., *Solidago odora*, *Solidago caesia*, *Parthenium integrifolium*, *Hieracium venosum*, *Coreopsis major*, *Clitoria mariana*, *Asplenium platyneuron*, *Salvia urticifolia*, *Tragia urticifolia*, *Asclepias verticillata*, *Eryngium yuccifolium* var. yuccifolium, *Hieracium gronovii*, *Helianthus divaricatus*, *Hypoxis hirsuta*, *Silphium compositum*, *Liatris squarrosa*, *Asclepias viridiflora*, *Coreopsis verticillata*, *Saxifraga virginiensis*, *Euphorbia pubentissima*, *Euphorbia corollata*, Delphinium spp., *Trifolium reflexum*, Myriopteris tomentosa, Myriopteris lanosa, *Pleopeltis polypodioides* ssp. michauxiana, *Uvularia perfoliata*, *Ionactis linariifolius*, *Commelina erecta*, *Oligoneuron album*, *Ruellia purshiana*, *Antennaria plantaginifolia*, *Hypericum gentianoides*, *Agrimonia pubescens*, *Taenidia integerrima*, *Aquilegia canadensis*, *Angelica venenosa*, *Arabis canadensis*, *Triosteum angustifolium*

Herb layer - graminoids: *Danthonia spicata*, *Danthonia sericea*, *Schizachyrium scoparium*, *Piptochaetium avenaceum*, *Scleria oligantha*, *Dichanthelium depauperatum*, *Dichanthelium dichotomum* var. dichotomum, *Dichanthelium boscii*, Carex spp. (rosea, striatula, retroflexa), *Andropogon ternarius*, Panicum spp., *Melica mutica*, *Muhlenbergia capillaris*, *Sporobolus junceus*

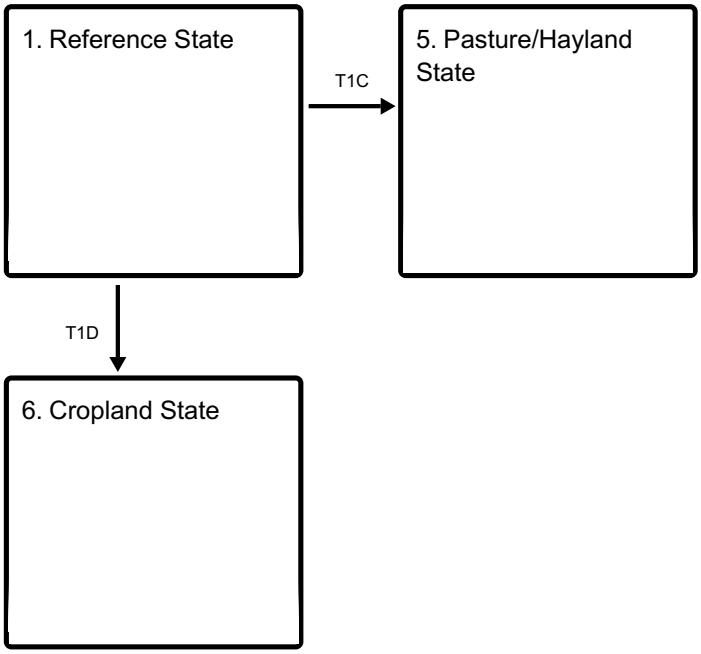
(I) = introduced

State and transition model

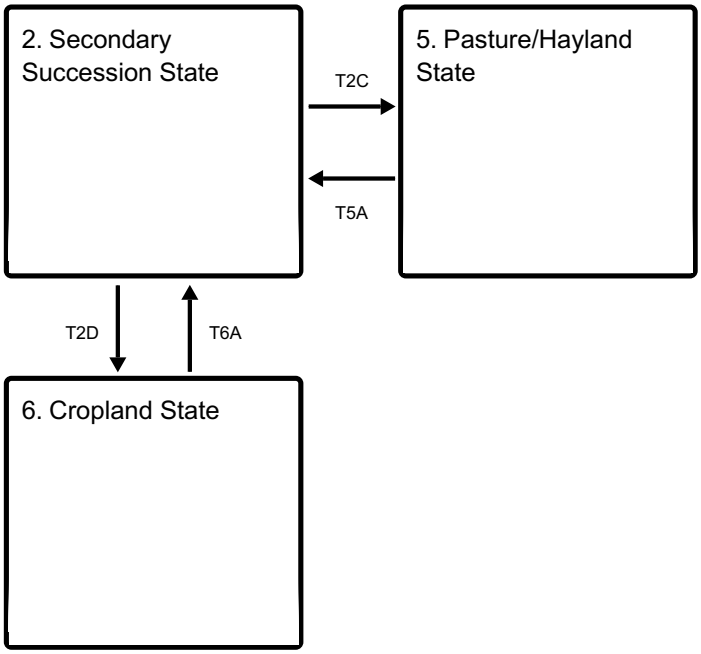
Ecosystem states



States 1, 5 and 6 (additional transitions)



States 2, 5 and 6 (additional transitions)



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

T1B - Selective removals of the most valuable timber specimens, leaving inferior trees behind.

T1C - Mechanical tree/brush/stump/debris removal, seedbed preparation, and planting of perennial grasses and forbs.

T1D - Mechanical tree/brush/stump/debris removal, seedbed preparation, applications of fertilizer/lime, and planting of crop or cover crop seed.

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.

T2D - Mechanical tree/brush/stump/debris removal, seedbed preparation, applications of fertilizer/lime, weed control, planting of crop or cover crop seed.

T3A - Clearcut logging or other large-scale disturbances that cause canopy removal.

T3C - Mechanical tree/brush/stump/debris removal, seedbed preparation, applications of fertilizer/lime, weed control, and planting of perennial grasses and forbs.

T3D - Mechanical tree/brush/stump/debris removal, seedbed preparation, applications of fertilizer/lime, weed control, planting of crop or cover crop seed.

T4A - Abandonment of forestry practices.

T4B - Timber harvest, mechanical stump and debris removal, seedbed preparation, and planting of perennial grasses and forbs.

T4C - Timber harvest, mechanical stump and debris removal, seedbed preparation, fertilizer/lime, weed control, planting of crop or cover crop seed.

T5A - Long-term cessation of grazing.

T5B - Site preparation and tree planting.

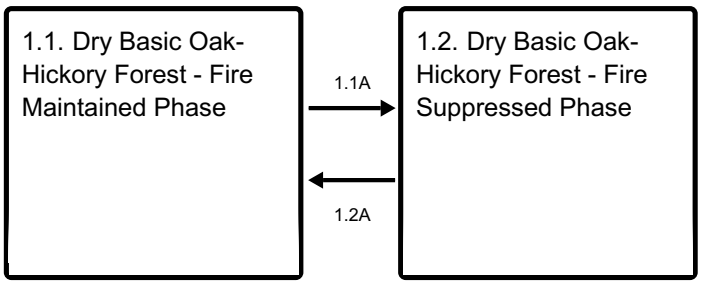
T5C - Seedbed preparation, applications of fertilizer/lime, weed control, and planting of crop or cover crop seed.

T6A - Agricultural abandonment.

T6B - Site preparation and tree planting.

T6C - Seedbed preparation, weed control, and planting of perennial grasses and forbs.

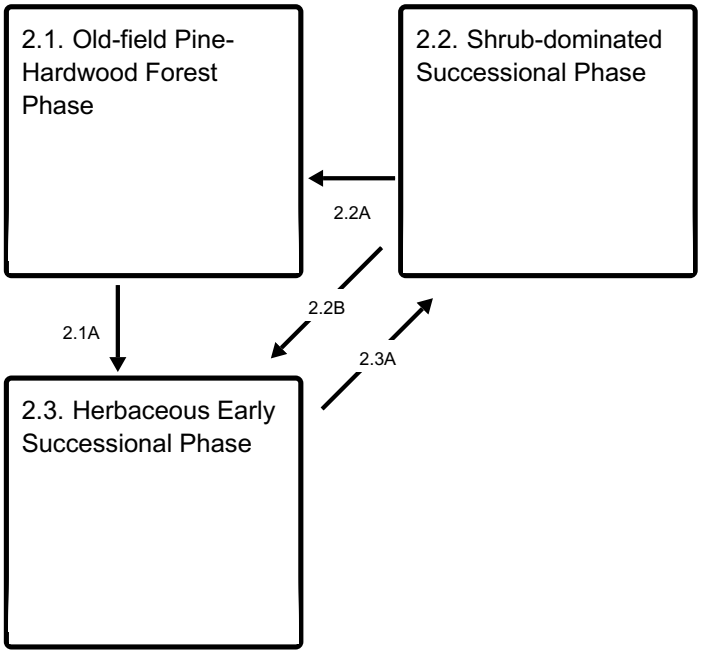
State 1 submodel, plant communities



1.1A - Long-term exclusion of fire.

1.2A - Prescribed burns and selective removals.

State 2 submodel, plant communities



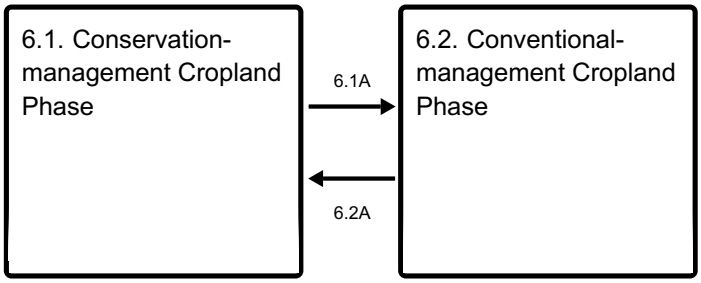
2.1A - Clearcut logging.

2.2A - Natural succession.

2.2B - Brush management.

2.3A - Natural succession.

State 6 submodel, plant communities



6.1A - Conventional tillage is reintroduced.

6.2A - Implementation of conservation tillage and other soil conservation practices

State 1
Reference State

This mature forest state supports an oak-hickory forest with a greater proportion of dry-site oaks than is typical of moister oak-hickory forest types. It usually has a greater proportion of hickories, elms, and ashes than acidic oak-hickory forest types.

Characteristics and indicators. Stands are uneven-aged with at least some old trees present. Pines make up a minority of the canopy cover.

Resilience management. Deer population management is critical to sustaining the diversity of herbaceous understory species.

Community 1.1
Dry Basic Oak-Hickory Forest - Fire Maintained Phase

This is a mature forest community/phase with a partially open canopy. Regular low-intensity fires have been reintroduced, keeping the understory 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 oaks. Representative species include white oak (Quercus alba), post oak (Quercus stellata), and black oak (Quercus velutina), with a smaller but significant contribution from hickories. Pines are typically scattered throughout the forest. Characteristic hickory species include southern shagbark hickory (Carya carolinae-septentrionalis), mockernut hickory (Carya tomentosa), pignut hickory (Carya glabra), and red hickory (C. ovalis). Shortleaf pine (Pinus echinata) is representative of the pine component.

Forest understory. Representative understory tree species include eastern redbud (Cercis canadensis), eastern redcedar (Juniperus virginiana), flowering dogwood (Cornus florida), white fringetree (Chionanthus virginicus), hickory (Carya spp.), dwarf hackberry (Celtis pumila), and chalk maple (Acer leucoderme).

Representative understory shrub species include rusty blackhaw (Viburnum rufidulum), mapleleaf viburnum (Viburnum acerifolium), downy arrowwood (Viburnum rafinesqueanum), several species of blackberry (Rubus spp.), coralberry (Symphoricarpos

orbiculatus), and farkleberry (Vaccinium arboreum), among others.

The herb layer is denser overall and contains more grasses than in the fire suppressed phase.

Dominant plant species

- white oak (*Quercus alba*), tree
- post oak (*Quercus stellata*), tree
- black oak (*Quercus velutina*), tree
- mockernut hickory (*Carya tomentosa*), tree
- shortleaf pine (*Pinus echinata*), tree
- eastern redbud (*Cercis canadensis*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- flowering dogwood (*Cornus florida*), tree
- white fringetree (*Chionanthus virginicus*), tree
- chalk maple (*Acer leucoderme*), tree
- rusty blackhaw (*Viburnum rufidulum*), shrub
- mapleleaf viburnum (*Viburnum acerifolium*), shrub
- downy arrowwood (*Viburnum rafinesqueanum*), shrub
- blackberry (*Rubus*), shrub
- farkleberry (*Vaccinium arboreum*), shrub
- coralberry (*Symphoricarpos orbiculatus*), shrub
- St. Andrew's cross (*Hypericum hypericoides ssp. multicaule*), shrub
- poverty oatgrass (*Danthonia spicata*), grass
- downy danthonia (*Danthonia sericea*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- blackseed speargrass (*Piptochaetium avenaceum*), grass
- littlehead nutrush (*Scleria oligantha*), grass
- starved panicgrass (*Dichanthelium depauperatum*), grass
- cypress panicgrass (*Dichanthelium dichotomum var. dichotomum*), grass
- Bosc's panicgrass (*Dichanthelium boscii*), grass
- rosy sedge (*Carex rosea*), grass
- lined sedge (*Carex striatula*), grass
- anisescented goldenrod (*Solidago odora*), other herbaceous
- wreath goldenrod (*Solidago caesia*), other herbaceous
- rattlesnakeweed (*Hieracium venosum*), other herbaceous
- wild quinine (*Parthenium integrifolium*), other herbaceous
- ticktrefoil (*Desmodium*), other herbaceous
- lespedeza (*Lespedeza*), other herbaceous
- greater tickseed (*Coreopsis major*), other herbaceous
- Atlantic pigeonwings (*Clitoria mariana*), other herbaceous
- nettleleaf sage (*Salvia urticifolia*), other herbaceous
- nettleleaf noseburn (*Tragia urticifolia*), other herbaceous

Community 1.2
Dry Basic Oak-Hickory Forest - Fire Suppressed Phase

This is a 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. The pine component can have a greater proportion of loblolly or Virginia pine and the understory usually contains a greater proportion of fire-intolerant species. The herbaceous understory is typically sparse.

Forest overstory. The overstory is dominated by oaks. Representative species include white oak (Quercus alba), post oak (Quercus stellata), and black oak (Quercus velutina), with a smaller but significant contribution from hickories. Pines, including Virginia pine (Pinus virginiana) and shortleaf pine (Pinus echinata), are typically scattered throughout the forest.Characteristic hickory species include southern shagbark hickory (Carya carolinae-septentrionalis), mockernut hickory (Carya tomentosa), pignut hickory (Carya glabra), and red hickory (Carya ovalis). Loblolly pine (Pinus taeda) and shortleaf pine (Pinus echinata) are most representative of the pine component. In portions of the MLRA, Virginia pine (Pinus virginiana) can be equally important in fire suppressed stands.

Forest understory. Representative understory tree species include chalk maple (Acer leucoderme), eastern redbud (Cercis canadensis), eastern redcedar (Juniperus virginiana), red maple (Acer rubrum), white ash (Fraxinus americana), American beech (Fagus grandifolia), flowering dogwood (Cornus florida), white fringetree (Chionanthus virginicus), and hickory (Carya spp.).

Representative understory shrub species include rusty blackhaw (Viburnum rufidulum), mapleleaf viburnum (Viburnum acerifolium), downy arrowwood (Viburnum rafinesqueanum), farkleberry (Vaccinium arboreum), and coralberry (Symphoricarpos orbiculatus), among others.

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

Dominant plant species

- white oak (*Quercus alba*), tree
- post oak (*Quercus stellata*), tree
- black oak (*Quercus velutina*), tree
- mockernut hickory (*Carya tomentosa*), tree
- loblolly pine (*Pinus taeda*), tree
- chalk maple (*Acer leucoderme*), tree
- eastern redbud (*Cercis canadensis*), tree
- red maple (*Acer rubrum*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- white ash (*Fraxinus americana*), tree
- American beech (*Fagus grandifolia*), tree
- rusty blackhaw (*Viburnum rufidulum*), shrub

- mapleleaf viburnum (*Viburnum acerifolium*), shrub
- downy arrowwood (*Viburnum rafinesqueanum*), shrub
- farkleberry (*Vaccinium arboreum*), shrub
- muscadine (*Vitis rotundifolia*), shrub
- cat greenbrier (*Smilax glauca*), shrub
- coralberry (*Symphoricarpos orbiculatus*), shrub
- rosette grass (*Dichanthelium*), grass
- poverty oatgrass (*Danthonia spicata*), grass
- downy danthonia (*Danthonia sericea*), grass
- littlehead nutrush (*Scleria oligantha*), grass
- ebony spleenwort (*Asplenium platyneuron*), other herbaceous
- rattlesnakeweed (*Hieracium venosum*), other herbaceous
- wreath goldenrod (*Solidago caesia*), 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 hardwood 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 state develops in the immediate aftermath of agricultural abandonment, clearcut logging, or other large-scale disturbances that lead to canopy removal. 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
Old-field Pine-Hardwood Forest Phase

This forested successional phase develops in the wake of long-term agricultural abandonment or other large-scale disturbances that have led to canopy removal in the recent past. Stands are even-aged and species diversity is low. The canopy is usually dominated by pines, though opportunistic hardwoods can also be important, particularly in the early stages of tree establishment. Species that exhibit pioneering traits are usually most abundant.

Forest overstory. The overstory is dominated by pines. Loblolly pine (Pinus taeda) is the most characteristic species, followed by shortleaf pine (P. echinata), and to the north and west Virginia pine (P. virginiana).

Forest understory. Common understory tree species include eastern redcedar (Juniperus virginiana), red maple (Acer rubrum), sweetgum (Liquidambar styraciflua), and Sassafras (Sassafras albidum). Seedlings of oaks and hickories are usually present in the understory. These seedlings are released gradually as the forest matures and the pines begin to die off.

Dominant plant species

- loblolly pine (*Pinus taeda*), tree
- Virginia pine (*Pinus virginiana*), tree
- shortleaf pine (*Pinus echinata*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- sweetgum (*Liquidambar styraciflua*), tree
- red maple (*Acer rubrum*), tree
- flowering dogwood (*Cornus florida*), tree
- sassafras (*Sassafras albidum*), tree
- southern red oak (*Quercus falcata*), tree
- mockernut hickory (*Carya tomentosa*), tree
- muscadine (*Vitis rotundifolia*), shrub
- Japanese honeysuckle (*Lonicera japonica*), shrub
- greenbrier (*Smilax*), shrub
- blueberry (*Vaccinium*), shrub
- rosette grass (*Dichanthelium*), grass
- littlehead nutrush (*Scleria oligantha*), grass
- poverty oatgrass (*Danthonia spicata*), grass
- ebony spleenwort (*Asplenium platyneuron*), 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 typically develops beginning in the third year after

agricultural abandonment or clearcut logging. 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

- loblolly pine (*Pinus taeda*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- winged elm (*Ulmus alata*), tree
- Callery pear (*Pyrus calleryana*), tree
- silktree (*Albizia julibrissin*), tree
- Chinaberrytree (*Melia azedarach*), tree
- blackberry (*Rubus*), shrub
- rose (*Rosa*), shrub
- Japanese honeysuckle (*Lonicera japonica*), shrub
- greenbrier (*Smilax*), shrub
- winged sumac (*Rhus copallinum*), shrub
- coralberry (*Symphoricarpos orbiculatus*), shrub
- sassafras (*Sassafras albidum*), shrub
- smooth sumac (*Rhus glabra*), shrub
- broomsedge bluestem (*Andropogon virginicus*), grass
- dogfennel (*Eupatorium capillifolium*), other herbaceous
- goldenrod (*Solidago*), other herbaceous
- aster (*Symphyotrichum*), other herbaceous
- sericea lespedeza (*Lespedeza cuneata*), other herbaceous
- Indianhemp (*Apocynum cannabinum*), other herbaceous

Community 2.3
Herbaceous Early Successional Phase

This transient community is composed of the first herbaceous invaders in the aftermath of agricultural abandonment, 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

- Japanese honeysuckle (*Lonicera japonica*), tree
- evening trumpetflower (*Gelsemium sempervirens*), tree

- greenbrier (*Smilax*), tree
- broomsedge bluestem (*Andropogon virginicus*), grass
- crabgrass (*Digitaria*), grass
- dogfennel (*Eupatorium capillifolium*), other herbaceous
- Canadian horseweed (*Conyza canadensis*), other herbaceous
- goldenrod (*Solidago*), other herbaceous
- Virginia dwarfdandelion (*Krigia virginica*), other herbaceous
- Indianhemp (*Apocynum cannabinum*), other herbaceous
- fleabane (*Erigeron*), other herbaceous
- dwarf cinquefoil (*Potentilla canadensis*), other herbaceous
- sericea lespedeza (*Lespedeza cuneata*), other herbaceous
- cudweed (*Pseudognaphalium*), other herbaceous
- Virginia threeseed mercury (*Acalypha virginica*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.3

The old-field pine-hardwood forest 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 old-field pine-hardwood forest 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
High-graded Hardwood Forest State

This state develops as a consequence of high-grading, where the most valuable trees are removed, leaving less desirable timber specimens behind. Trees left behind include undesirable timber species, trees of poor form, diseased trees, or genetically inferior trees.

Characteristics and indicators. Typically, high-graded stands consist of a combination of residual stems from the previous stand, a high proportion of undesirable shade-tolerant species, along with some regrowth from desirable timber species. In some cases, large-diameter trees of desirable timber species may be present, but upon closer inspection, these trees usually have serious defects that resulted in their being left behind in earlier cuts.

Resilience management. Landowners with high-graded stands have two options for improving timber production: 1) rehabilitate, or 2) regenerate. To rehabilitate a stand, the landowner must evaluate existing trees to determine if rehabilitation is justified. If the proportion of high-quality specimens present in the stand is low, then the stand should be regenerated. In many cases, poor quality of the existing stand is the result of decades of mismanagement. Drastic measures are often required to get the stand back into good timber production.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- maple (*Acer*), tree
- elm (*Ulmus*), tree
- common persimmon (*Diospyros virginiana*), tree
- eastern redbud (*Cercis canadensis*), tree
- oak (*Quercus*), tree
- hybrid hickory (*Carya*), tree
- pine (*Pinus*), tree

State 4
Managed Pine Plantation State

This converted state is dominated by planted timber trees. Loblolly pine (*Pinus taeda*) is the most commonly planted species. Even-aged management is the most common timber management system. 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
- sweetgum (*Liquidambar styraciflua*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- red maple (*Acer rubrum*), tree
- eastern redbud (*Cercis canadensis*), tree
- sassafras (*Sassafras albidum*), tree
- oak (*Quercus*), tree
- hybrid hickory (*Carya*), tree
- grape (*Vitis*), shrub
- Japanese honeysuckle (*Lonicera japonica*), shrub
- greenbrier (*Smilax*), shrub
- blackberry (*Rubus*), shrub
- St. Johnswort (*Hypericum*), shrub
- blueberry (*Vaccinium*), shrub
- rosette grass (*Dichanthelium*), grass
- littlehead nutrush (*Scleria oligantha*), grass
- poverty oatgrass (*Danthonia spicata*), grass
- broomsedge bluestem (*Andropogon virginicus*), grass
- silver plumegrass (*Saccharum alopecuroides*), grass
- ebony spleenwort (*Asplenium platyneuron*), other herbaceous
- aster (*Symphyotrichum*), other herbaceous
- thoroughwort (*Eupatorium*), other herbaceous
- dwarf cinquefoil (*Potentilla canadensis*), other herbaceous

State 5
Pasture/Hayland State

This converted state is dominated by herbaceous forage species.

Resilience management. Overgrazing and High Foot Traffic: In areas that are subject to high foot traffic from livestock and equipment, and/or long-term overgrazing, unpalatable weedy species tend to invade, as most desirable forage species are less competitive under these conditions. High risk areas include locations where livestock congregate for water, shade, or feed, and in travel lanes, gates, and other areas of heavy use. Plant species that are indicative of overgrazing or excessive foot traffic on this ecological site include buttercup (Ranunculus spp.), plantain (Plantago spp.), curly dock (*Rumex crispus*), sneezeweed (*Helenium amarum*), cudweed (Pseudognaphalium spp.), slender yellow woodsorrel (*Oxalis dillenii*), Carolina horsenettle (*Solanum carolinense*), Virginia pepperweed (*Lepidium virginicum*), black medick (*Medicago lupulina*), Japanese clover (*Kummerowia striata*), annual bluegrass (*Poa annua*), poverty rush (*Juncus tenuis*), rattail fescue (*Vulpia myuros*), and Indian goosegrass (*Eleusine indica*), among others. A handful of desirable forage species are also tolerant of heavy grazing and high foot traffic, including white clover (*Trifolium repens*), dallisgrass (*Paspalum dilatatum*), and bermudagrass (*Cynodon dactylon*). An overabundance of these species, along with poor plant vigor and areas of bare soil, may imply that excessive foot traffic and/or overgrazing is a concern, either in the present or in the recent past. Brush Encroachment: Brush encroachment can be problematic in some pastures, particularly near fence lines where there is often a ready seed source. Pastures subject to low stocking density and long-duration grazing rotations can also be susceptible to encroachment from woody plants. Shorter grazing rotations of higher stocking density can help alleviate pressure from shrubs and vines with low palatability or thorny stems. Clipping behind grazing rotations, annual brush hogging, and multispecies grazing systems (cattle with or followed by goats) can also be helpful. Common woody invaders of pasture on this ecological site include rose (Rosa spp.), blackberry (Rubus spp.), saw greenbrier (*Smilax bona-nox*), Japanese honeysuckle (*Lonicera japonica*), common persimmon (*Diospyros virginiana*), eastern redcedar (*Juniperus virginiana*), and black cherry (*Prunus serotina*).

Dominant plant species

- Bermudagrass (*Cynodon dactylon*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- dallisgrass (*Paspalum dilatatum*), grass
- hairy crabgrass (*Digitaria sanguinalis*), grass
- purpletop tridens (*Tridens flavus*), grass
- Johnsongrass (*Sorghum halepense*), grass
- bahiagrass (*Paspalum notatum*), grass
- broomsedge bluestem (*Andropogon virginicus*), grass
- white clover (*Trifolium repens*), other herbaceous
- vetch (*Vicia*), other herbaceous

- narrowleaf plantain (*Plantago lanceolata*), other herbaceous
- dogfennel (*Eupatorium capillifolium*), other herbaceous
- black medick (*Medicago lupulina*), other herbaceous
- field clover (*Trifolium campestre*), other herbaceous
- common dandelion (*Taraxacum officinale*), other herbaceous

State 6
Cropland State

This converted state produces food or fiber for human uses. It is dominated by domesticated crop species, along with typical weedy invaders of cropland.

Community 6.1
Conservation-management Cropland Phase

This cropland phase is characterized by the practice of no-tillage or strip-tillage, and other soil conservation practices. Though no-till systems offer many benefits, several weedy species tend to be more problematic under this type of management system. In contrast with conventional tillage systems, problematic species in no-till systems include biennial or perennial weeds, owing to the fact that tillage is no longer used in weed management.

Dominant plant species

- corn (*Zea mays*), grass
- common wheat (*Triticum aestivum*), grass
- grain sorghum (*Sorghum bicolor ssp. bicolor*), grass
- soybean (*Glycine max*), other herbaceous
- upland cotton (*Gossypium hirsutum*), other herbaceous
- cultivated tobacco (*Nicotiana tabacum*), other herbaceous

Community 6.2
Conventional-management Cropland Phase

This cropland phase is characterized by the recurrent use of tillage as a management tool. Due to the frequent disturbance regime, weedy invaders tend to be annual herbaceous species that reproduce quickly and are prolific seed producers.

Resilience management. The potential for soil loss is high under this management system. Measures should be put in place to limit erosion.

Dominant plant species

- corn (*Zea mays*), grass
- common wheat (*Triticum aestivum*), grass
- grain sorghum (*Sorghum bicolor ssp. bicolor*), grass
- soybean (*Glycine max*), other herbaceous

- upland cotton (*Gossypium hirsutum*), other herbaceous
- cultivated tobacco (*Nicotiana tabacum*), other herbaceous

Pathway 6.1A
Community 6.1 to 6.2

The conservation-management cropland phase can shift to the conventional-management cropland phase through cessation of conservation tillage practices and the reintroduction of conventional tillage practices.

Context dependence. Soil and vegetation changes associated with this community pathway typically occur several years after reintroduction of conventional tillage practices. These changes continue to manifest as conventional tillage is continued, before reaching a steady state.

Pathway 6.2A
Community 6.2 to 6.1

The conventional-management cropland phase can be brought into the conservation-management cropland phase through the implementation of one of several conservation tillage options, including no-tillage or strip-tillage, along with implementation of other soil conservation practices.

Context dependence. Soil and vegetation changes associated with this community pathway typically occur several years after implementation of conservation tillage. These changes continue to manifest as conservation tillage is continued, before reaching a steady state.

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 3

The reference state can transition to the high-graded hardwood forest state through selective removal of the most valuable trees, leaving undesirable timber specimens behind. This may occur through multiple cutting cycles over the course of decades or longer, each cut progressively worsening the condition of the stand.

Transition T1C
State 1 to 5

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 T1D
State 1 to 6

The reference state can transition to the cropland state through 1) mechanical tree/brush/stump/debris removal, 2) seedbed preparation, 3) applications of fertilizer/lime, and 4) planting of crop or cover crop seed.

Context dependence. A broad spectrum herbicide, fire, and/or root-raking can be helpful in transitioning treed land to cropland. 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. Weedy grasses and forbs can also be problematic on these lands.

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 4

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 5

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 T2D
State 2 to 6

The secondary succession state can transition to the cropland state through 1) mechanical tree/brush/stump/debris removal, 2) seedbed preparation, 3) applications of fertilizer/lime, 4) weed control, 5) planting of crop or cover crop seed.

Context dependence. A broad spectrum herbicide, fire, and/or root-raking may be needed to successfully transition land that has been fallow for some time back to cropland. 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. Weedy grasses and forbs can also be problematic on these lands.

Transition T3A
State 3 to 2

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

Transition T3C
State 3 to 5

The high-graded hardwood forest 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 T3D
State 3 to 6

The high-graded hardwood forest state can transition to the cropland state through 1) mechanical tree/brush/stump/debris removal, 2) seedbed preparation, 3) applications of fertilizer/lime, 4) weed control, 5) planting of crop or cover crop seed.

Context dependence. A broad spectrum herbicide, fire, and/or root-raking can be helpful in transitioning treed land to cropland. 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. Weedy grasses and forbs can also be problematic on these lands.

Transition T4A
State 4 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 T4B
State 4 to 5

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 T4C
State 4 to 6

The managed pine plantation state can transition to the cropland state through 1) timber harvest, 2) mechanical stump and debris removal, 3) seedbed preparation, 4) applications of fertilizer/lime, 5) weed control, 6) planting of crop or cover crop seed.

Transition T5A
State 5 to 2

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

Transition T5B
State 5 to 4

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

Transition T5C
State 5 to 6

The pasture/hayland state can transition to the cropland state through 1) seedbed preparation, 2) applications of fertilizer/lime, 3) weed control, and 4) planting of crop or cover crop seed.

Transition T6A
State 6 to 2

The cropland state can transition to the secondary succession state through agricultural abandonment.

Transition T6B
State 6 to 4

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

Transition T6C
State 6 to 5

The cropland state can transition to the pasture/hayland state through 1) seedbed preparation, 2) weed control, and 3) planting of perennial forage grasses and forbs.

Context dependence. To convert cropland to pasture or hayland, weed control and good seed-soil contact are important. It is also critical to review the labels of herbicides used for weed control and on the previous crop. Many herbicides have plant-back restrictions, which if not followed could carryover and kill forage seedlings as they germinate. Grazing should be deferred until grasses and forbs are well established.

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):**

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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:**

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17. **Perennial plant reproductive capability:**
