Ecological site F136XY420NC
Triassic Basin Upland Forest, 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. This ecological site is associated with EPA ecoregion 45g (Triassic Basins) of the northern part of the MLRA, of which approximately 80 percent of the area is in the thermic soil temperature regime. Fieldwork will be needed to determine if additional ecological site concepts will be needed to cover the remaining soils that fall within the mesic soil temperature regime portion of the MLRA. The Triassic Basins of the southeastern United States are arranged in several discontinuous narrow bands, oriented toward the northeast. They have unusual Piedmont geology of unmetamorphosed shales, sandstones, mudstones, siltstones, and conglomerates. Elevation and topographic relief are considerably lower than in surrounding regions. Stream valleys that cross the Triassic Basins tend to be broad, being underlain by rocks that are more easily eroded. Streams that cross the adjacent Carolina Slate Belt or felsic crystalline terrain have narrower valleys, which widen abruptly upon entering the Triassic Basins. Soils in this region tend to be clayey, with low permeability, though sandier soils weathered from sandstone also occur. The clay fraction in some soils can have a high shrink-swell potential which can hinder construction. Land cover consists of a mosaic of mixed hardwood forests, mixed pine-hardwood woodlands, cutover land, pasture, cropland, and urban land (Daniels et al. 1999; Griffith et al. 2002).

Classification relationships

APPLICABLE USNVC ASSOCIATIONS CEGL008475 Quercus alba - Quercus rubra - Carya tomentosa / Vaccinium stamineum / Desmodium nudiflorum APPLICABLE EPA ECOREGIONS Level III: 45. Piedmont Level IV: 45g. Triassic Basins (EPA 2013). APPLICABLE USFS ECOLOGICAL UNITS Domain: Humid Temperate Division: Subtropical Ecological province: 231. Southeastern Mixed Forest Ecological sections: 231I.Central 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 moist acidic uplands of the Triassic Basins, in the northern part of the MLRA, on broad ridges, interfluves, and gentle hillslopes. Soils are typically deep to very deep, well drained Ultisols, though Alfisols in Ultic subgroups are included in the range of variability. Parent materials are residuum derived from Triassic sedimentary rock. The reference state supports a closed to somewhat open canopy forest dominated by species such as white oak (Quercus alba), northern red oak (Quercus rubra), and other upland oaks, with a much smaller contribution from hickories (Carya spp.) and pines (Pinus spp.). Dominant land uses include cropland, pasture and hayland, planted pine, and various urban or suburban uses. ES CHARACTERISTICS SUMMARY • Occurs on Piedmont uplands, on broad ridges, interfluves, and gentle hillslopes in the Triassic Basins of the northern part of the MLRA • Parent materials: Triassic sedimentary rock • Seasonal high water table: ? 40 inches from the soil surface • Depth to bedrock: ? 40 inches, usually deeper • 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 • Soils: deep to very deep, somewhat poorly to moderately well drained Ultisols or Alfisols.

Associated sites

F136XY400NC	**Triassic Basin Upland Woodland, Expansive Clay, Seasonally Wet and Dry** Found in lower and wetter parts of the landscape. The seasonal high water table is shallower (12-40 inches from the soil surface). Though a perched water table is present during the cooler months, dry edaphic conditions develop during the growing season due to the presence of dense layers of clay in the subsoil dominated by shrink-swell clay minerals. Moisture-loving plant species, such as northern red oak (Quercus rubra), are usually scarce or absent.
F136XY410NC	**Triassic Basin Upland Forest, Seasonally Wet** Found in lower and wetter parts of the landscape. The seasonal high water table is shallower (12-40 inches from the soil surface). It is not subject to acute dryness during the growing season, as the subsoil is not dominated by shrink-swell clay minerals. These conditions support a relative increase in obligate or facultative wetland indicator species.
F136XY430NC	**Triassic Basin Upland Forest, Dry** Found in similar or slightly higher landscape positions, but on the less stable parts of the landscape (e.g., steeper slopes, narrower ridges), where the potential for soil weathering is outpaced by the potential for geologic erosion. Soils are generally shallower, less developed, more droughty, and with lower natural fertility. Dry-site species, such as post oak (Quercus stellata) and black oak (Quercus velutina) occupy a higher proportion of the canopy cover.

Similar sites

F136XY820GA	**Acidic Upland Forest, Moist** Found outside of the Triassic Basins, in the surrounding igneous and metamorphic uplands. Soil properties and environmental conditions are similar, though compared to the Triassic Basins, the landscape typically exhibits an overall increase in elevation and topographic relief.

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

Figure 2. View of the Southern Piedmont Major Land Resource Area with a focus on Triassic Basins, including the Deep River, Dan River-Danville, Richmond, Davie, Farmville, Scottsville, and Taylorsville basins.

Figure 3. Spatial illustration of soil temperature regimes of the Southern Piedmont.

Figure 4. Spatial extent of this ecological site representing the major areas where this site is important on the landscape.

Table 5. Dominant plant species

Tree	(1) *Quercus alba* (2) *Quercus rubra*
Shrub	(1) *Cornus florida* (2) *Vaccinium*
Herbaceous	(1) *Desmodium nudiflorum* (2) *Hexastylis arifolia*

Physiographic features

This ecological site is found on broad ridges, interfluves, and gentle hillslopes, in the Triassic Basins of Virginia, North Carolina, and South Carolina, in EPA ecoregion 45g. The geologic substrate is derived from sedimentary rocks of Triassic age. Representative locations are gently sloping to moderately steep, with a representative slope of 2 to 15 percent and a maximum slope of 25 percent.

GENERAL TRIASSIC BASIN GEOMORPHOLOGY
The landscape of Triassic Basins consists of irregular plains with low rounded hills, gentle ridges, and shallow, but broad river valleys. These sedimentary basins are bounded by faults, formed through continental extension, or rifting. In the Southern Piedmont, these rift basins are scattered throughout the northern part of the MLRA, from the South Carolina-North Carolina state line, to just south of Charlottesville and Richmond, Virginia.

In eastern North America, Triassic Basins formed during continental extension associated with the separation of North America and Africa during the first half of the Mesozoic era. In the process of rifting, the ground between the faults dropped down, later filling with sediments eroded off the Appalachian highlands. The material hardened into various sedimentary rock types, including siltstone, shale, sandstone, mudstone, or conglomerate. These rocks are younger and tend to be softer than the igneous and metamorphic rocks that characterize most of the MLRA.

In the Southern Piedmont, the landscape of Triassic Basins is one of lower overall elevation and topographic relief than the surrounding uplands. Where the easily eroded Triassic sediments meet the surrounding Piedmont uplands, steep escarpments have often been cut as a result of differential erosion. Other than these outlying slopes, only the Dan River-Danville basin contains noteworthy topography, including a system of low ridges that run the length of the basin, rising approximately 200 to 300 feet from the basin floor (Hall and Boyer 1992; Schlische 1993; Daniels et al. 1999; Woods et al. 1999; Griffith et al. 2002; EPA 2011; USDA-NRCS 2022).

Figure 1. Typical soil-landscape relationships in the Triassic Basin soil system of the Southern Piedmont. Mayodan soils are associated with this ecological site, depicted here on a broad ridge.

Figure 2. Typical soil-landscape relationships in the Triassic Basin soil system of the Southern Piedmont. Mayodan and Stoneville soils are associated with this ecological site, depicted here on broad interfluves and ridges.

Table 6. Representative physiographic features

Hillslope profile	(1) Summit (2) Backslope (3) Shoulder
Landforms	(1) Piedmont > Interfluve (2) Piedmont > Hillslope (3) Piedmont > Ridge
Runoff class	Low to high

Flooding frequency	None
Ponding frequency	None
Elevation	90 – 230 m
Slope	0 – 20 %
Water table depth	180 – 2,540 cm
Aspect	Aspect is not a significant factor

Table 7. Representative physiographic features (actual ranges)

Runoff class	Low to very high
Flooding frequency	None
Ponding frequency	None
Elevation	70 – 250 m
Slope	0 – 30 %
Water table depth	180 – 2,540 cm

Climatic features

On this ecological site, the average mean annual precipitation is 46 inches. On average, the rainiest months occur from July through September, as well as in March. The driest months occur from October through February, in addition to April.

Table 8 Representative climatic features

Frost-free period (characteristic range)	180-200 days
Freeze-free period (characteristic range)	210-230 days
Precipitation total (characteristic range)	1,140-1,190 mm
Frost-free period (actual range)	170-200 days

Freeze-free period (actual range)	190-230 days
Precipitation total (actual range)	1,120-1,220 mm
Frost-free period (average)	180 days
Freeze-free period (average)	220 days
Precipitation total (average)	1,170 mm

- (1) WADESBORO [USC00318964], Wadesboro, NC
- (2) SANFORD 8 NE [USC00317656], Sanford, NC
- (3) RALEIGH DURHAM INTL AP [USW00013722], Raleigh, NC
- (4) DURHAM [USC00312515], Durham, NC
- (5) OXFORD 1 E [USC00316507], Oxford, NC
- (6) DANVILLE [USC00442245], Danville, VA
- (7) AMELIA 8 NE [USC00440188], Amelia Court House, VA
- (8) APEX [USC00310212], Apex, NC
- (9) PAGELAND [USC00386616], Pageland, SC
- (10) CARY [USC00311535], Cary, NC
- (11) FALLS LAKE [USC00312993], Raleigh, NC
- (12) OXFORD AG [USC00316510], Oxford, 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 deep to very deep, well drained Ultisols, though Alfisols in Ultic subgroups are also included in the range of variability. The available water storage capacity of the profile is generally greater than or equal to 4 inches. While representative soils associated with this ecological site do not have a root restrictive layer, the range of variability includes soils with unweathered or partially weathered bedrock within the rootzone of woody plants, at depths not less than 40 inches from the soil surface. Parent materials are residuum derived from Triassic sedimentary rock, including sandstone, siltstone, mudstone, shale, or conglomerate.

Reaction in the subsoil is typically strongly acid to very strongly acid (pH 4.5 to 5.5). In the surface layers, reaction varies with land use and management. Under low input or forested conditions, it generally falls somewhere between pH 4.5 and 6.0. These soils are typically in a fine or fine-loamy particle size family.

Modal soil taxa include: Typic Hapludults, Typic Rhodudults
Modal soil series include: Mayodan, Clover
Other soils attributed to this ecological site include Stoneville, Warminster, Totier, Spray, Straightstone, Penn, Wadesboro, Granville, Peakin, Hallison, and Exway.

Note: soils included in this ecological site concept are associated with the Triassic Basins of the northern part of the MLRA, in both the thermic and mesic soil temperature regime portions of the MLRA. A significant majority of the land area (approximately 80 percent) falls within the thermic portion of the MLRA, as the Triassic Basins near the fall line are considerably larger in area. Fieldwork will be needed to quantify expected differences in species composition, or other potential distinctions, to determine if an equivalent ecological site concept exclusive to the mesic soil temperature regime is warranted.

Figure 9. An illustration of a soil profile belonging to the Mayodan series, a representative soil series associated with this ecological site.

Table 9. Representative soil features

Parent material	(1) Residuum – sedimentary rock
Surface texture	(1) Fine sandy loam (2) Sandy loam (3) Silt loam (4) Sandy clay loam (5) Clay loam
Family particle size	(1) Fine (2) Fine-loamy
Drainage class	Well drained
Permeability class	Moderately rapid
Depth to restrictive layer	150 – 2,540 cm
Soil depth	150 – 200 cm
Surface fragment cover <=3"	Not specified
Surface fragment cover >3"	Not specified
Available water capacity (0-203.2cm)	17.78 – 33.02 cm
Soil reaction (1:1 water) (0-25.4cm)	4.5 – 10
Subsurface fragment volume <=3" (0-203.2cm)	0 – 10 %
Subsurface fragment volume >3" (0-203.2cm)	Not specified

Table 10. Representative soil features (actual values)

Drainage class	Well drained
Permeability class	Moderate to moderately rapid
Depth to restrictive layer	130 – 2,540 cm
Soil depth	130 – 200 cm
Surface fragment cover <=3"	0 %
Surface fragment cover >3"	0 %
Available water capacity (0-203.2cm)	10.16 – 33.02 cm
Soil reaction (1:1 water) (0-25.4cm)	3.5 – 10
Subsurface fragment volume <=3" (0-203.2cm)	0 – 10 %
Subsurface fragment volume >3" (0-203.2cm)	0 %

Ecological dynamics

U.S. National Vegetation Classification (USNVC) associations that are consistent with reference conditions on this ecological site include CEGL008475 Quercus alba - Quercus rubra - Carya tomentosa / Vaccinium stamineum / Desmodium nudiflorum. This concept is closely related to the reference community, but is likely broader than the scope of this ecological site, which is limited in extent to the Triassic Basins of the Southern Piedmont (USNVC 2022).

The landscape of the Triassic Basins is one of lower overall elevation and topographic relief than the surrounding uplands. Because of the ease with which the land could be cleared and cultivated, most of the arable land was put into production early on during European settlement of the Piedmont. Cotton and tobacco were the principle crops. By the turn of the twentieth century, very little remained of the original forest cover, though large-scale abandonment of cropland agriculture began a few decades later. Today most of the forest cover in the Triassic Basin uplands is in a state of young secondary growth, consisting of stands dominated by loblolly pine (Pinus taeda), shortleaf pine (P. echinata), or Virginia pine (P. virginiana), with opportunistic hardwoods and seedlings of oaks and hickories in the understory. The remainder is being used for pasture, managed pine plantations, and urban development. The most productive lands are still under cultivation. In young stands, the importance of Virginia pine increases gradually to the north and west, while loblolly pine is favored toward the south and east. Old-growth forests of the Triassic Basin uplands are uncommon on the landscape today.

MATURE FORESTS
The reference state supports a closed to somewhat open canopy forest dominated by mesophytic and dry-mesophytic oaks, with a smaller contribution from hickories and pines. Representative canopy species include white oak (Quercus alba) and northern red oak (Quercus rubra). The hickory component is of much lower cover. Pignut hickory (Carya glabra) and mockernut hickory (Carya tomentosa) are typically most abundant. Hickories tend to be much more abundant in the understory.

According to witness tree records taken in North Carolina Triassic Basins, cover from pines was higher overall in pre-settlement forests compared to neighboring regions with higher elevation and topographic relief. Although loblolly pine (Pinus taeda) is far more abundant today in contemporary stands, witness tree records and field surveys of old trees and stumps suggest that shortleaf pine (Pinus echinata) was the dominant pine species of the Triassic Basins at one time.

Under reference conditions, important species of the subcanopy layer include flowering dogwood (Cornus florida), blackgum (Nyssa sylvatica), and hickory (Carya spp.). Only minor compositional differences are anticipated between this ecological site and PX136X00X820, a similar ecological site concept associated with felsic crystalline or metasedimentary geology. Future ecological site work will quantify compositional and structural differences between the two substrates. Given the history of intensive land uses in the Triassic basins, species composition in mature oak-hickory forests is not well-documented in this region.

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, 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, moister sites were less prone to fire and hence burned less completely and at lower intensities than drier sites.

Like other moist oak-hickory forests in the region, successional dynamics are thought to be primarily gap-driven, with small-scale natural disturbances such as windthrow, drought, and disease, usually affecting only small portions of the forest at a time. Canopy gaps are readily colonized by early successional herbs and shrubs, and later by shade-intolerant pines and opportunistic hardwoods. These localized events are inconspicuous, but cumulatively they help shape the age class distribution, structure, and species composition in these forests.

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 ruderal species, thereby restoring the health and vigor of forests that evolved under a more regular fire regime (Pinchot and Ashe 1897; Oosting 1942; Peet and Christensen 1980; Schafale and Weakley 1990; Schwartz et al. 2007; Guyette et al. 2012; Spira 2011; Guyette et al. 2012; Fleming 2012; Schafale 2012a, 2012b; Vander Yacht et al. 2020; Fleming et al. 2021; Greenberg et al. 2021; Spooner et al. 2021).

SPECIES LIST
Canopy layer: Quercus alba, Quercus rubra, Quercus falcata, Carya glabra, Pinus echinata, Carya tomentosa, Quercus velutina, Liriodendron tulipifera, Pinus taeda, Pinus virginiana

Subcanopy layer: Cornus florida, Nyssa sylvatica, Carya spp., Diospyros virginiana, Acer rubrum, Oxydendrum arboreum, Fagus grandifolia, Liquidambar styraciflua, Ilex opaca, Chionanthus virginicus

Vines/lianas: Vitis rotundifolia, Toxicodendron radicans, Smilax rotundifolia, Smilax glauca, Parthenocissus quinquefolia, Lonicera japonica (I),

Shrub layer: Vaccinium stamineum, Vaccinium tenellum, Euonymus americanus, Viburnum rafinesqueanum, Vaccinium pallidum, Viburnum acerifolium, Ligustrum sinense (I), Elaeagnus umbellata (I)

Herb layer: Desmodium nudiflorum, Hexastylis arifolia, Asplenium platyneuron, Tipularia discolor, Erythronium umbilicatum, Chimaphila maculata, Elephantopus tomentosus, Aristolochia serpentaria, Galium pilosum, Helianthus divaricatus, Hieracium venosum, Goodyera pubescens, Sanicula smallii, Galium circaezans, Desmodium rotundifolium, Polystichum acrostichoides, Hypoxis hirsuta, Cypripedium acaule, Lespedeza cuneata (I),

Herb layer - graminoids: Dichanthelium spp., Danthonia spicata, Carex spp. (cephalophora, albicans, digitalis, hirsutella, laxiflora), Andropogon ternarius,

(I) = introduced

State and transition model

Additional community tables

Table 11. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 12. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 13. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 14. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 15. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 16. Community 6.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 17. Community 6.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

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	08/20/2026
Approved by	
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:**

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

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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:

17. **Perennial plant reproductive capability:**