USDA Natural Resources Conservation Service

Ecological site PX136X00X610
Flood Plain Forest, Wet

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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
CEGL004418 *Liquidambar styraciflua* - *Liriodendron tulipifera* / *Lindera benzoin* / *Arisaema triphyllum*

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 seasonally wet areas on active flood plains which are subject to regular overbank flooding of frequent or occasional frequency. It is geographically restricted to the thermic soil temperature regime portion of the MLRA. It is situated on flood plains, in relatively broad river valleys or along small stream bottoms, in which overbank flooding and alluvial deposition have created a more level surface than in the adjacent uplands. This environment benefits from ongoing deposition of nutrient-rich sediment, but it is subject to scouring and other impacts associated with flooding.

The reference state supports a mixture of bottomland hardwood species, including tulip poplar (*Liriodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), black walnut (*Juglans nigra*), and many others. These are diverse, distinctly multi-layered forests, often lacking a clear set of dominant species in the canopy. Dominant land uses include cropland, pasture and hayland, and wildlife habitat.

Soils are typically very deep, somewhat poorly drained Inceptisols or Entisols. Parent materials are typically loamy, recent alluvial sediments. Due to regular overbank flooding, the distribution of soil organic matter decreases irregularly with depth.

Soils on this ecological site typically remain moist throughout the growing season. Periods of soil saturation are typical of the cooler months. Redoximorphic features indicative of anaerobic conditions occur between the depths of 12 to 24 inches of the soil surface and below. These conditions typically support a mixture of mesophytic and hydrophytic plant species. Species diagnostic of better drainage, such as southern sugar maple (Acer floridanum), bitternut hickory (Carya cordiformis), shagbark hickory (Carya ovata), hophornbeam (Ostrya virginiana), flowering dogwood (Cornus florida), red mulberry (Morus rubra var. rubra), American beech (Fagus grandifolia), and white oak (Quercus alba), are usually scarce or absent.

ES CHARACTERISTICS SUMMARY
• Thermic soil temperature regime
• Occurs on flood plains in river valleys, or along small stream bottoms
• Seasonal high water table: 12 - 24 inches from the soil surface
• Soils: very deep, somewhat poorly drained Inceptisols or Entisols, with an irregular decrease in soil organic matter with depth

Associated sites

PX136X00X600	**Flood Plain Forest, Very Wet** Found in similar or slightly lower landscape positions, often on concave depressional landforms. The seasonal high water table is slightly shallower (0-12 inches from the soil surface), supporting a greater proportion of obligate wetland indicator species. On broad flood plains, it typically sits furthest from the stream channel, on concave depressional landforms such as backswamps, sloughs, and depressions.

PX136X00X620	**Flood Plain Forest, Moist** Typically in slightly higher and drier landscape positions. On broad flood plains, it typically sits closer to the stream channel. The seasonal high water table is deeper (24 inches or greater from the soil surface), resulting in a decrease in obligate or facultative wetland indicator species.
PX136X00X630	**Flood Plain Levee Forest, Sandy** Found in higher landscape positions adjacent to the stream channel, on sandy natural levees of large river systems. The vegetation is exposed to higher energy flooding, but it is usually of shorter duration. In this setting, increased levels of sunlight can support higher herb cover. The seasonal high water table is much deeper (72 inches or greater from the soil surface), resulting in a marked decrease in obligate or facultative wetland indicator species.

Similar sites

PX136X00X650	**Low Terraces and Drains, Rare Inundation** Occurs on low stream terraces (flood-plain steps) and other alluvial landforms not subject to regular overbank flooding. Being found on more stable surfaces, the relative importance of bottomland oaks and other long-lived species tend to increase under reference conditions. Soil pH and natural fertility are usually lower on these older surfaces.
PX136X00X110	**Mesic Temperature Regime, Flood Plain Forest, Wet** The soil temperature regime is mesic, occurring outside of the native range of loblolly pine (Pinus taeda).
PX136X00X600	**Flood Plain Forest, Very Wet** The seasonal high water table is slightly shallower (0-12 inches from the soil surface), supporting a higher proportion of obligate wetland indicator species.

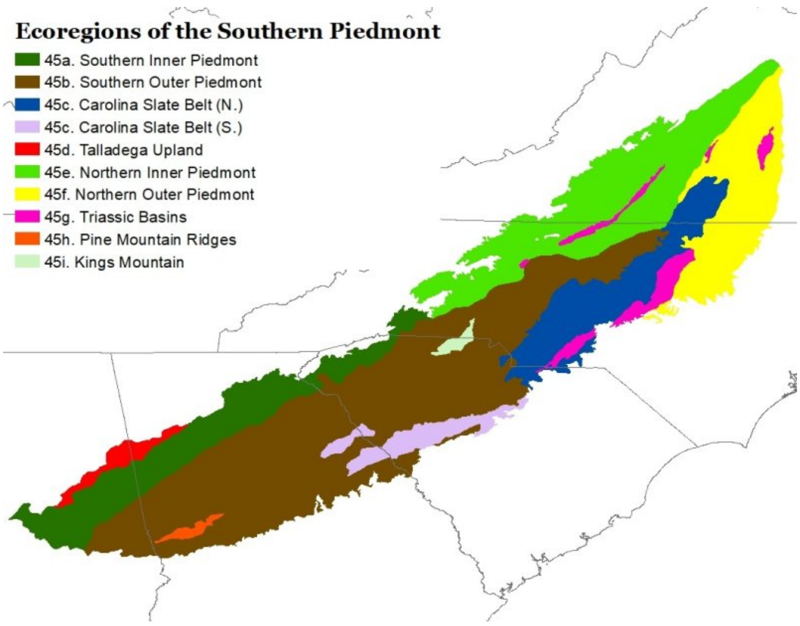


Figure 1. EPA level IV ecoregions of the Southern Piedmont (45).

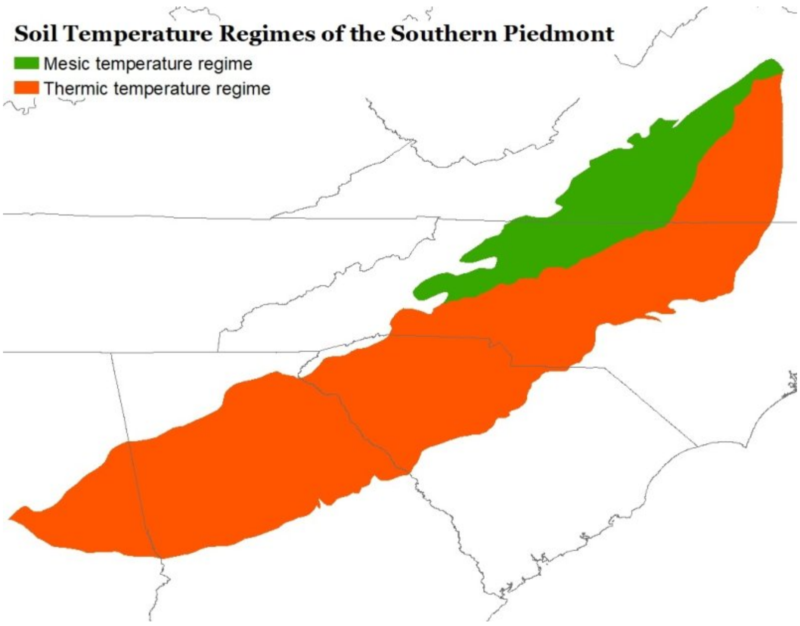


Figure 2. Spatial illustration of soil temperature regimes of the Southern Piedmont.

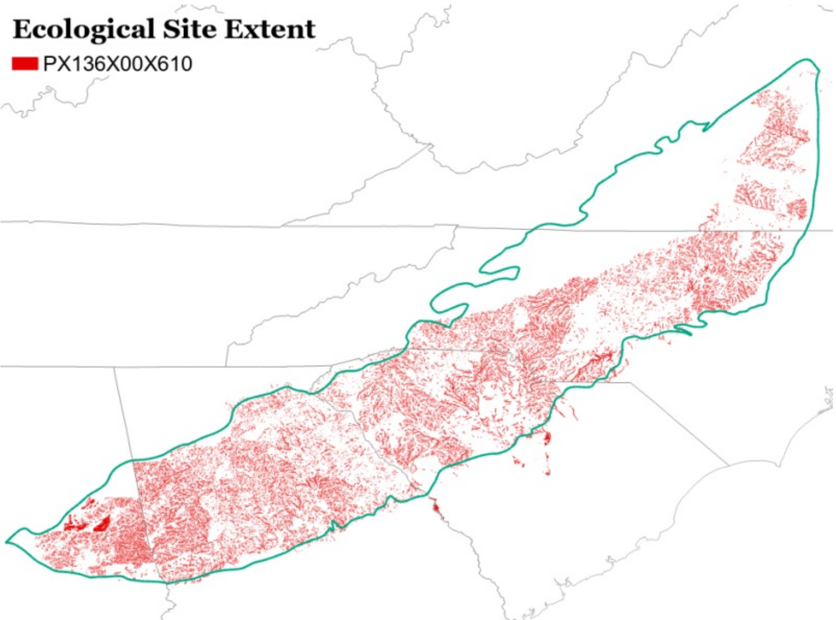


Figure 3. Spatial extent of this ecological site representing the major areas where this site is important on the landscape.

Table 1. Dominant plant species

Tree	(1) *Liquidambar styraciflua* (2) *Liriodendron tulipifera*
Shrub	(1) *Ilex decidua* (2) *Lindera benzoin*
Herbaceous	(1) *Boehmeria cylindrica* (2) *Arisaema triphyllum*

Legacy ID

F136XY610GA

Physiographic features

This ecological site includes seasonally wet areas on active flood plains which are subject to regular overbank flooding of frequent or occasional frequency. It is situated in river valleys or along small stream bottoms in the thermic soil temperature regime portion of the MLRA.

On the typical flood plain, this ecological site is found on flood plain flats, but it can also be found along the drier margins of backswamps. Along small stream bottoms, it may occupy most, if not the entire width of the flood plain, or it may be intermingled with wetter or drier flood plain ecological site concepts. Representative locations are nearly level to gently sloping, with a representative slope of 0 to 2 percent.

On flood plains in the Southern Piedmont, Quaternary alluvial deposits can be as much as 250 feet thick, or as little as 4 feet thick. Rocks of the Piedmont basement underlie the alluvial fill at some depth, but the vegetation is not usually influenced by the local underlying geology. Typically, the geologic substrate is loamy recent alluvial sediments.

Note: river valleys associated with Triassic Basins tend to be broader than in most other parts of the Southern Piedmont, irrespective of stream order, due to the high weatherability of Triassic sediments. Here, distinct landforms, such as stream terraces, flood plain flats, backswamps, and natural levees, tend to be better developed. This is known to have a strong influence over the vegetation communities that establish on a given site, allowing vegetation communities to sort out more neatly along gradients of hydroperiod, elevation above the river channel, and other flooding-related variables. At this time however, there is not enough data to support a geographic split between alluvial ecological site concepts associated with Triassic Basins (EPA ecoregion 45g) and those of other regions. Future ecological site work should consider targeting Triassic Basin river valleys to determine weather a distinct set of ecological site concepts is warranted, and if delineating these concepts across the landscape would be feasible.

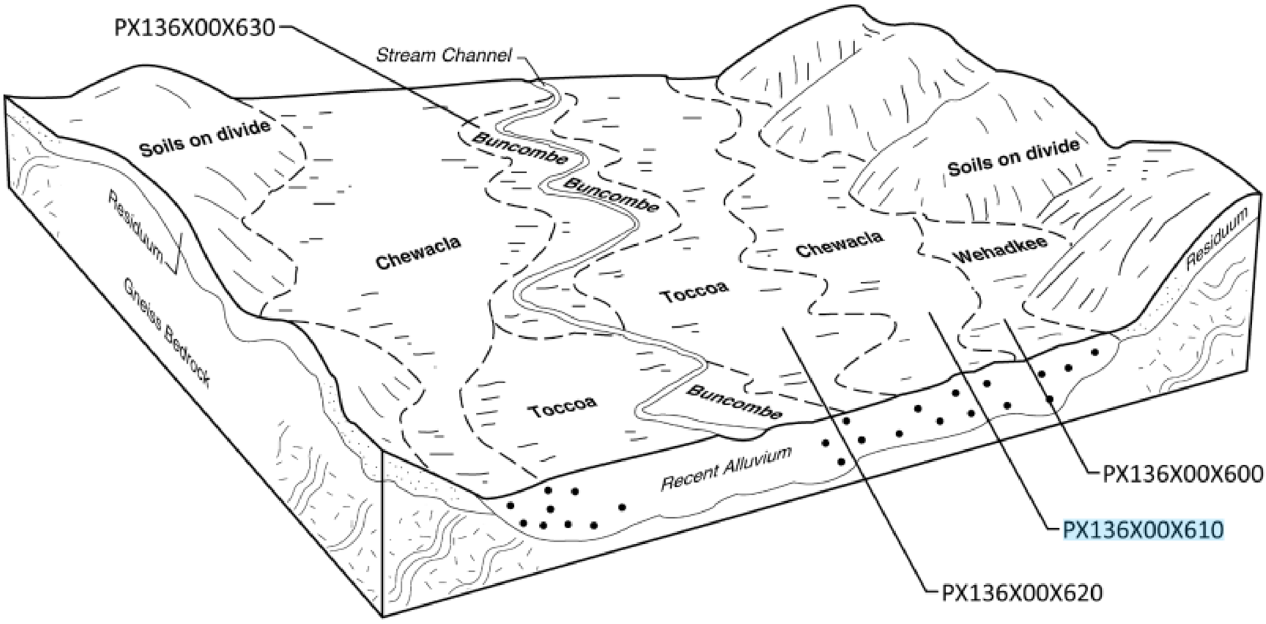


Figure 4. Typical soil-landscape relationships of a large river flood plain in the Southern Piedmont. Chewacla soils are associated with this ecological site, depicted here on flood plain flats in a broad river valley.

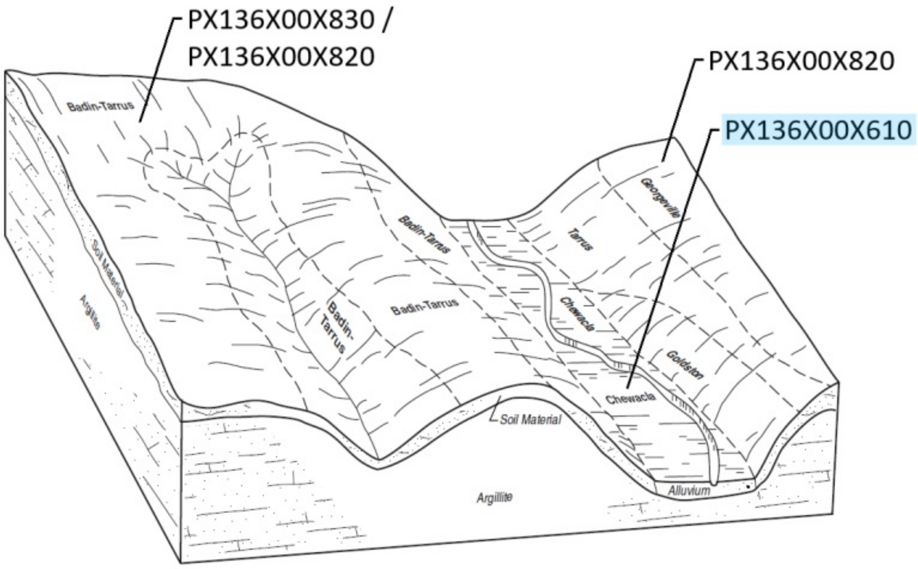


Figure 5. Typical soil-landscape relationships of a small stream flood plain in the Southern Piedmont. Chewacla soils are associated with this ecological site, depicted here along a small stream bottom in the Carolina Slate Belt.

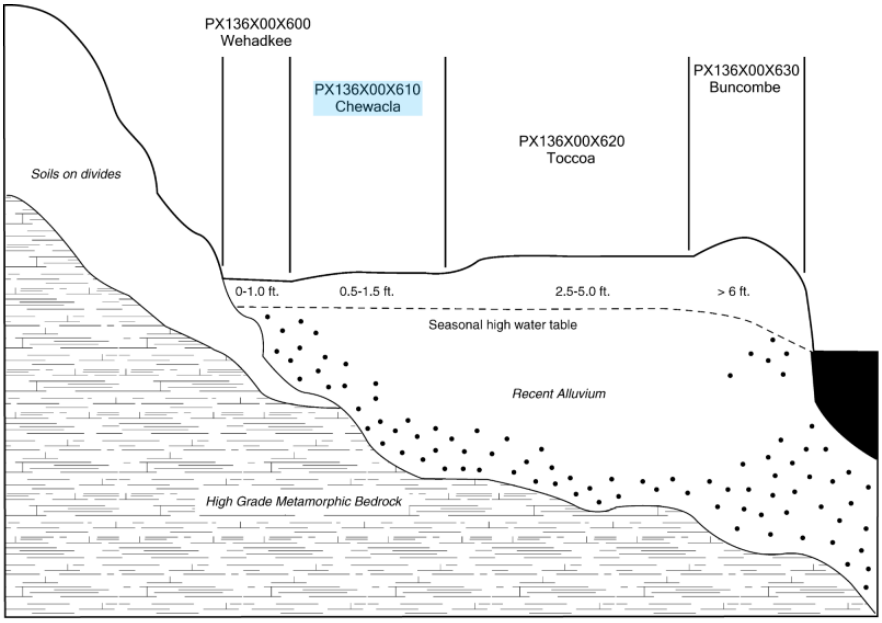


Figure 6. Cross section of a flood plain along a large river system in the Southern Piedmont. Chewacla soils are associated with this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Piedmont > Flood plain (2) River valley > Flood plain
Runoff class	Negligible to low
Flooding duration	Brief (2 to 7 days)
Flooding frequency	Frequent
Ponding frequency	None

Elevation	91–323 m
Slope	0–2%
Water table depth	30–61 cm
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Negligible to very high
Flooding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Flooding frequency	Occasional to frequent
Ponding frequency	None
Elevation	37–536 m
Slope	0–2%
Water table depth	15–61 cm

Climatic features

On this ecological site, the average mean annual precipitation is 49 inches. On average, the rainiest months occur in July and August, as well as in March. The driest months occur in April, May, and October.

Table 4. Representative climatic features

Frost-free period (characteristic range)	164-191 days
Freeze-free period (characteristic range)	195-226 days
Precipitation total (characteristic range)	1,168-1,346 mm
Frost-free period (actual range)	157-200 days
Freeze-free period (actual range)	181-237 days
Precipitation total (actual range)	1,092-1,473 mm
Frost-free period (average)	177 days
Freeze-free period (average)	210 days
Precipitation total (average)	1,245 mm

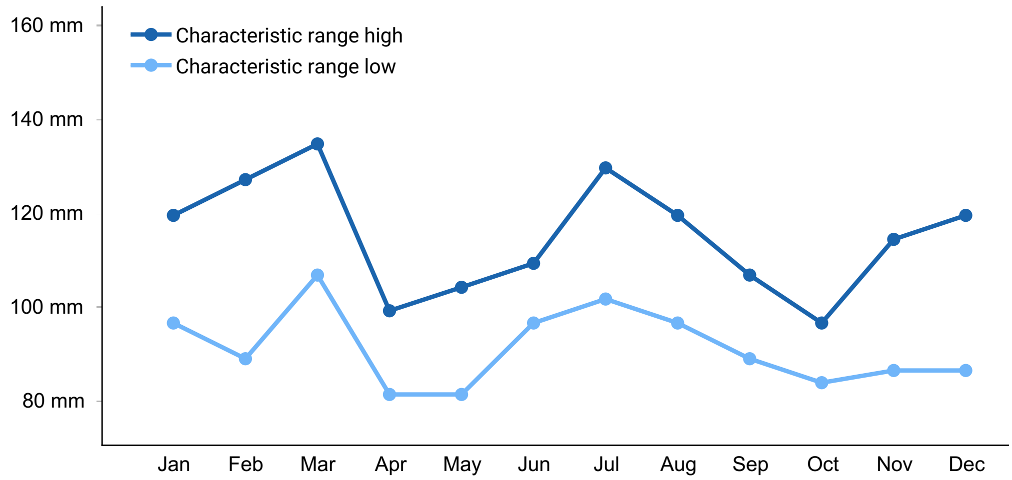


Figure 7. Monthly precipitation range

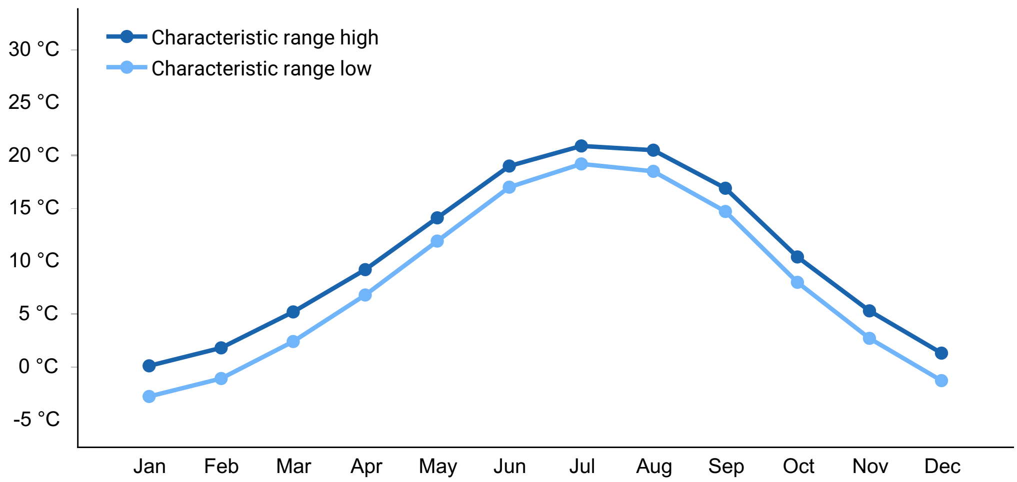


Figure 8. Monthly minimum temperature range

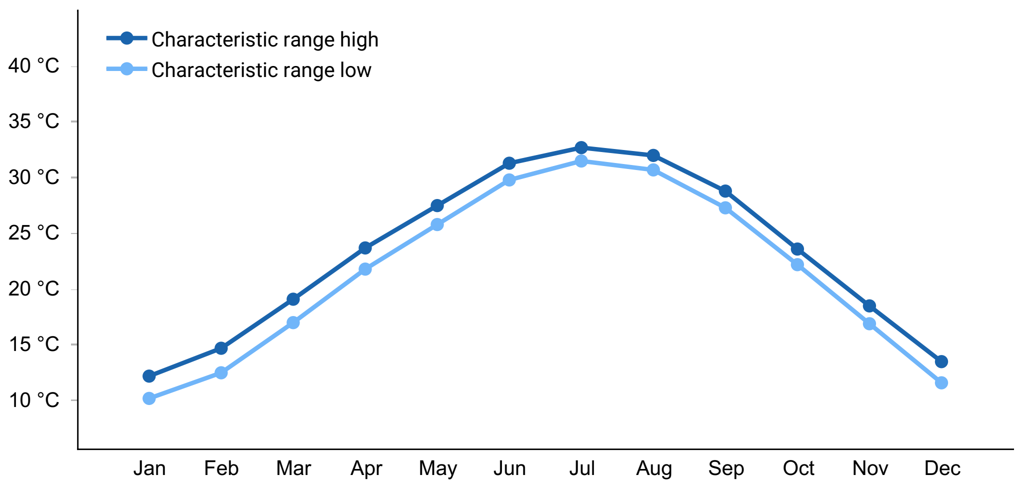


Figure 9. Monthly maximum temperature range

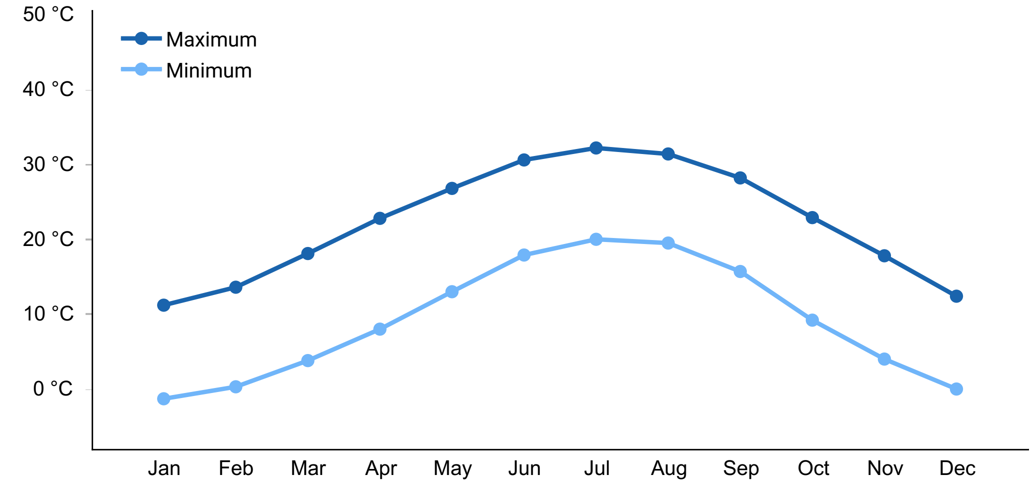


Figure 10. Monthly average minimum and maximum temperature

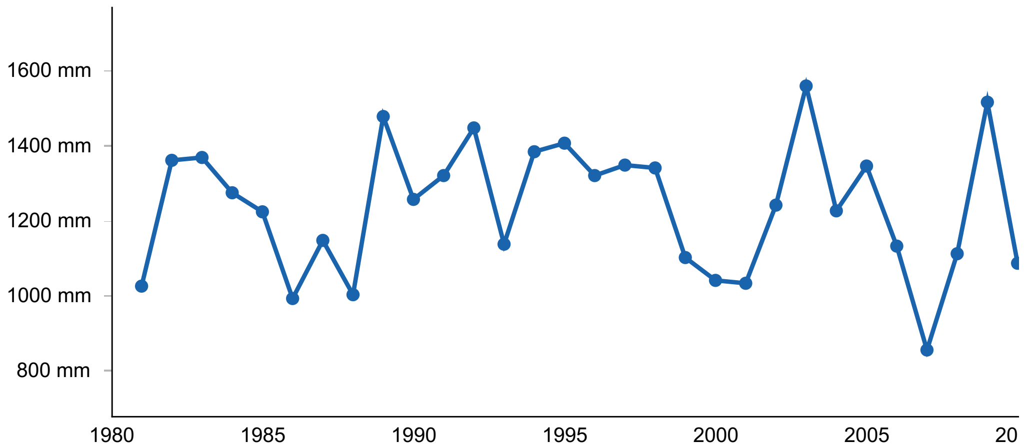


Figure 11. Annual precipitation pattern

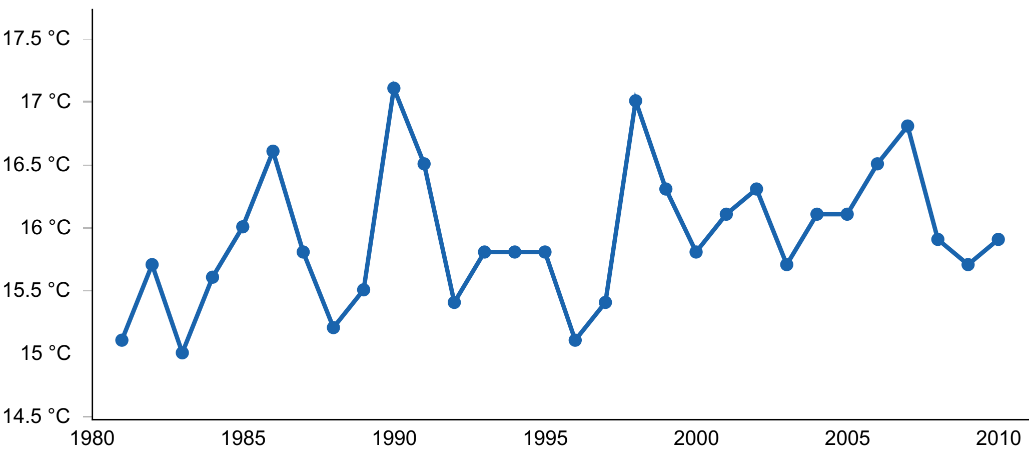


Figure 12. Annual average temperature pattern

Climate stations used

- (1) DALLAS 7 NE [USC00092485], Dallas, GA
- (2) SILER CITY 2 N [USC00317924], Siler City, NC
- (3) CHESNEE 7 WSW [USC00381625], Chesnee, SC
- (4) CLEMSON UNIV [USC00381770], Clemson, SC

- (5) CHASE CITY [USC00441606], Chase City, VA
- (6) EXPERIMENT [USC00093271], Griffin, GA
- (7) ASHEBORO 2 W [USC00310286], Asheboro, NC
- (8) GREENWOOD [USC00383754], Greenwood, SC
- (9) CROZIER [USC00442142], Maidens, VA
- (10) ATHENS BEN EPPS AP [USW00013873], Athens, GA
- (11) ASHLAND 3 ENE [USC00010369], Ashland, AL
- (12) ROCKFORD 3 ESE [USC00017020], Rockford, AL
- (13) GAINESVILLE [USC00093621], Gainesville, GA
- (14) MILLEDGEVILLE [USC00095874], Milledgeville, GA
- (15) WEST POINT [USC00099291], Lanett, GA
- (16) SALISBURY [USC00317615], Salisbury, NC
- (17) SIMMS WTP [USC00387885], Chesnee, SC
- (18) CHARLOTTE DOUGLAS AP [USW00013881], Charlotte, NC
- (19) CARROLLTON [USC00091640], Carrollton, GA
- (20) COVINGTON [USC00092318], Covington, GA
- (21) ALBEMARLE [USC00310090], Albemarle, NC
- (22) NEWBERRY [USC00386209], Newberry, SC
- (23) COLUMBUS METRO AP [USW00093842], Columbus, GA
- (24) LAWRENCEVILLE 3 E [USC00444768], Freeman, VA
- (25) CAMP PICKETT [USC00441322], Blackstone, VA
- (26) AMELIA 8 NE [USC00440188], Amelia Court House, VA
- (27) LOUISBURG [USC00315123], Louisburg, NC
- (28) MONROE AP [USW00053872], Monroe, NC
- (29) FOREST CITY 8 W [USC00313152], Rutherfordton, NC
- (30) GREER [USW00003870], Greer, SC
- (31) YORK 4 S [USC00389625], York, SC
- (32) KERSHAW 1SW [USC00384690], Kershaw, SC
- (33) UNION 8 S [USC00388786], Union, SC
- (34) WEST PELZER 2 W [USC00389122], Pelzer, SC
- (35) HARTWELL [USC00094133], Hartwell, GA
- (36) CLARKESVILLE [USC00091965], Clarkesville, GA
- (37) WINDER 4S [USC00099466], Bethlehem, GA
- (38) TALBOTTON [USC00098535], Talbotton, GA
- (39) LAFAYETTE 2W [USC00014502], Lafayette, AL
- (40) OPELIKA [USC00016129], Opelika, AL
- (41) HEFLIN [USC00013775], Heflin, AL
- (42) SANFORD 8 NE [USC00317656], Sanford, NC
- (43) WADESBORO [USC00318964], Wadesboro, NC
- (44) SANTUCK [USC00387722], Union, SC
- (45) LAURENS [USC00385017], Laurens, SC
- (46) MC CORMICK 9 E [USC00385658], Mc Cormick, SC
- (47) FOREST CITY 6 SW [USC00313150], Forest City, NC
- (48) ATLANTA FULTON CO AP [USW00003888], Mableton, GA
- (49) ROCK MILLS [USC00017025], Roanoke, AL

- (50) CLEVELAND [USC00092006], Cleveland, GA
- (51) WALHALLA [USC00388887], Walhalla, SC

Influencing water features

This ecological site occurs in riparian areas, on active flood plains which are subject to regular overbank flooding.

GROUNDWATER FEATURES
A seasonal high water table is apparent at depths between 12 to 24 inches in representative pedons, generally during the months of November to April. On flood plains of the Southern Piedmont, the water table is tied to the level of the water in the channel, with groundwater generally moving from uplands towards the stream.

SURFACE WATER FEATURES
Flooding frequency on this ecological site is generally high, however the duration of flooding is usually somewhat brief. Flooding-related variables that can have an effect on species composition on this ecological site include 1) stream order and relative position within the watershed, 2) the width of the flood plain, 3) the relative position within the flood plain, 4) channel morphology, and 5) the shape and topography of the watershed. These and other factors produce flooding regimes with specific signatures.

Note: this ecological site concept includes flood plains associated with a wide range of stream orders, from as little as first order along small creeks, to as high as sixth order along large rivers. Stream order is known to have a strong effect on the frequency and duration of flooding, the dominant sources of soil water, and the natural vegetation that establishes in response to these factors. At this time however, it is not feasible to separate flood plain ecological site concepts based on stream order due to limitations in soil mapping (Mulholland and Lenat 1992; Alexander et al. 2015; Mathews et al. 2011).

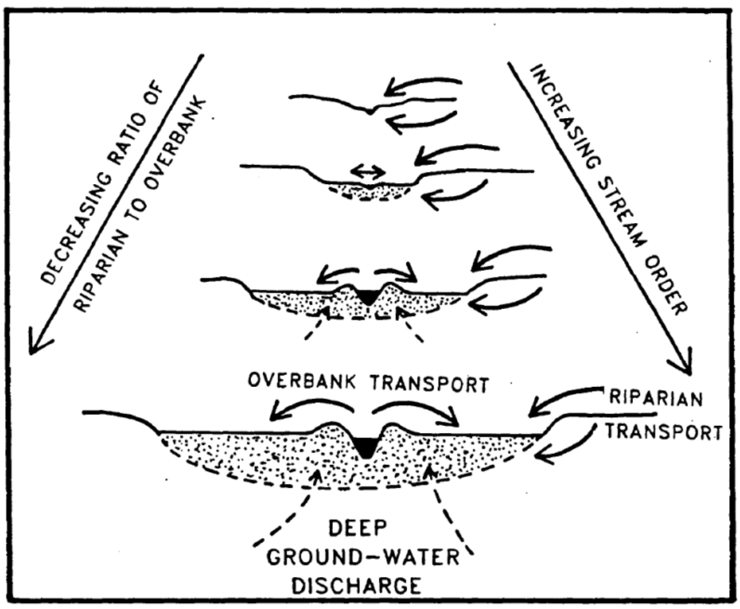


Figure 13. An illustration of the effect of stream order on 1) the severity of

overbank flooding, and 2) the ratio of soil water derived from overbank flooding to the amount derived from overland water and groundwater moving towards the stream. From Brinson (1993).

Soil features

Soils on this ecological site are typically very deep, somewhat poorly drained Inceptisols or Entisols, which have an irregular decrease in organic matter distribution with depth. They are typically in a fine-loamy particle size family. Redoximorphic features (iron and/or manganese depletions) are found at depths between 12 and 24 inches and below in representative pedons. Parent materials are typically loamy recent alluvial sediments.

Reaction is typically slightly acid to strongly acid (pH 5.1 to 6.5) throughout, though it can be closer to neutral under unusually rich site conditions. Natural fertility and available water capacity are typically high. Soil wetness and flooding are the principle limiting factors for most common land uses.

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

Modal taxa include: Fluvaquentic Dystrudepts
Modal soil series include: Chewacla
Other soils attributed to this ecological site include Cartecay, Chenneby, and Monacan

Figure 14. An illustration of a soil profile belonging to the Chewacla series, a representative soil series associated with this ecological site.

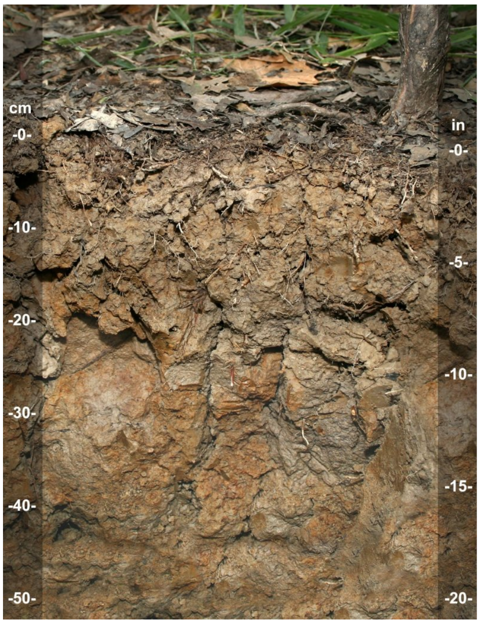


Figure 15. A soil profile of the Chewacla series.

Table 5. Representative soil features

Parent material	(1) Alluvium–igneous, metamorphic and sedimentary rock
Surface texture	(1) Loam (2) Silt loam (3) Sandy loam
Family particle size	(1) Fine-loamy (2) Coarse-loamy (3) Fine-silty
Drainage class	Somewhat poorly drained
Permeability class	Moderately rapid
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-203.2cm)	22.86–30.48 cm
Soil reaction (1:1 water) (0-101.6cm)	5.1–6.5
Subsurface fragment volume <=3" (0-203.2cm)	0–7%
Subsurface fragment volume >3" (0-203.2cm)	0%

Table 6. Representative soil features (actual values)

Drainage class	Somewhat poorly drained

Permeability class	Moderately rapid to rapid
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-203.2cm)	15.24–38.1 cm
Soil reaction (1:1 water) (0-101.6cm)	4.5–7.3
Subsurface fragment volume <=3" (0-203.2cm)	0–27%
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 CEGL004418 *Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum*. A similar association, CEGL007330 *Liquidambar styraciflua* - (*Liriodendron tulipifera*), is reserved for young secondary examples. These examples are usually even-aged, less diverse, more likely to be invaded by non-native understory species, and are more common on the landscape today (USNVC 2022).

MATURE FORESTS
The reference state supports a mixture of bottomland hardwood species. The forest typically has a closed canopy, though canopy gaps and standing dead trees are frequently interspersed. The canopy is diverse, often without a clear set of dominant species. Important canopy species include tulip poplar (*Liriodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), black walnut (*Juglans nigra*), red maple (*Acer rubrum*), and American sycamore (*Platanus occidentalis*), among others. Species composition varies with stream order, flood plain width, flooding frequency, latitude, elevation, and several other environmental factors.

Most of these species are capable of quickly colonizing and filling gaps, a valuable trait in environments characterized by frequent natural disturbances. Many of these species invest in rapid growth and early reproduction, a strategy often employed in unpredictable or changing environments. These tree species are also prolific seed producers, investing in small, easily dispersed seeds. Because riparian areas are subject to frequent disturbance events, including flooding, scouring, storm-related windthrow, deposition, and channel migration, these species can persist on a site indefinitely.

Bottomland oaks (*Quercus michauxii*, *Q. nigra*, *Q. pagoda*, *Q. phellos*, etc.) typically occupy a relatively small but important part of the canopy in mature stands. Comparatively speaking, these slower growing and slower to reproduce species are often scattered throughout the forest, and they are a good indicator of mature forest conditions, but they seldom make a very large contribution to the canopy or subcanopy layers on this ecological site. On the more stable portions of river valleys, such as stream terraces and on some broad flood plain flats (particularly in Triassic basins), bottomland oaks are more likely to achieve and maintain dominance in mature examples.

In the reference state, the subcanopy is well-developed. Important subcanopy trees include American hornbeam (*Carpinus caroliniana*), boxelder (*Acer negundo*), and possumhaw (*Ilex decidua*), along with canopy dominants.

The shrub layer is typically dominated by northern spicebush (*Lindera benzoin*) and other water-tolerant shrubs, including possumhaw (*Ilex decidua*) and giant cane (*Arundinaria gigantea*). By far, the most important vine on this ecological site is eastern poison ivy (*Toxicodendron radicans*). This species can be oppressively abundant on flood plains and bottomlands of the Southern Piedmont.

The herb layer is not usually dense, except in canopy gaps, but species diversity is typically high. Characteristic forbs include smallspike false nettle (*Boehmeria cylindrica*), Jack in the pulpit (*Arisaema triphyllum*), cutleaf coneflower (*Rudbeckia laciniata*), American hogpeanut (*Amphicarpaea bracteata*), rattlesnake fern (*Botrychium virginianum*), fringed loosestrife (*Lysimachia ciliata*), jumpseed (*Polygonum virginianum*), and many others. Typical graminoids include Indian woodoats (*Chasmanthium latifolium*), sweet woodreed (*Cinna arundinacea*), Virginia wildrye (*Elymus virginicus*), deertongue (*Dichanthelium clandestinum*), and several species of Carex (C. tribuloides, amphibola, radiata, intumescens,.). Numerous shrub and herb species associated with basic upland forests are also typical of flood plain forests. These base-loving species have a high nutrient requirement, satisfied here through ongoing deposition of nutrient-rich sediments.

Because of a variety of anthropogenic impacts, including changes to channel morphology, past selective or clearcut logging, installation of water impoundments, agriculture, and urban development, unaltered examples of the reference community are uncommon on the landscape today.

DYNAMICS OF NATURAL SUCCESSION
Regular overbank flooding is the main driver of ecological dynamics on this ecological site. Flood plains are continually dynamic, with the deposition of new sediment and the loss of old sediment in the form of scouring. Flooding can disturb vegetation through various mechanisms. Herbaceous plants are susceptible to being washed away or buried. Though sediment deposition is beneficial for fertility, heavy sediment deposition during the growing season has the potential to kill herbaceous plants, and even the seedlings or saplings of trees and shrubs. On rare occasions during the most severe floods, parts of the forest may be eroded or washed away entirely. Occasional tornadoes and hurricanes can also be a

significant source of natural disturbance on this ecological site.

Shallow root systems allow flood plain trees to use the uppermost region of the soil, where anaerobic conditions occur over shorter intervals, but this also makes them more vulnerable to windthrow. On the typical flood plain, trunks of wind-toppled trees often lie scattered across the forest floor. The openings created by downed or standing dead trees increase the abundance and diversity of herbaceous plants.

On most landscapes in the Southeast, forest succession, or the predictable progression from light-demanding species to shade-tolerant tree species, continues until a major disturbance occurs. On flood plains however, flood-tolerance interacts with shade-tolerance, producing substantially different and complex successional patterns that are rarely observed in upland forests. It is believed that these interactions allow species with pioneering traits to maintain perpetual importance in many flood plain settings of the Southeast. Unless the flooding regime or hydrology is altered by some means, either natural or human-induced, a near steady-state subclimax community of predominantly light-demanding, but flood-tolerant trees can be expected to persist.

This ecological site is particularly vulnerable to invasion by Chinese privet (*Ligustrum sinense*), a non-native shrub or small tree which was introduced in the mid-nineteenth century. Many thousands of acres of flood plain forests and bottomlands now have a nearly continuous layer of Chinese privet, excluding most of the native flora beneath. Nepalese browntop, or Japanese stiltgrass as it is often known (*Microstegium vimineum*), is another widespread non-native species that thrives on flood plains and other low-lying areas. It too can have a dramatic impact on native understory vegetation. These species usually require disturbance to gain a foothold, but once they do, they are remarkably persistent due to their reproductive capacity and tolerance for shade.

YOUNG SECONDARY FORESTS
Young secondary forests associated with this ecological site are usually even-aged, less diverse, and more likely to be invaded by non-native understory species. These forests are more common on the landscape today due to the long history of agricultural use and logging on flood plains of the Southern Piedmont. Typically, these forests are strongly dominated by only a handful of species, of which sweetgum (*L. styraciflua*) is probably most common overall. The dominance of sweetgum (*L. styraciflua*) and other early pioneers declines as the forest matures, though many of these species remain important in mature stands as well, albeit to a lesser extent. Other characteristic species of young secondary flood plain forests include box elder (*Acer negundo*), river birch (*Betula nigra*), American sycamore (*Platanus occidentalis*), tuliptree (*Liriodendron tulipifera*), red maple (*Acer rubrum*), and loblolly pine (*Pinus taeda*).

HUMAN IMPACTS
Adding to the complexity of deciphering successional patterns on flood plains of the Piedmont, are the potential for human-induced changes to the flooding regime and hydrology. Accelerated flood plain aggradation is well-documented in the Southern

Piedmont, as a consequence of past agricultural practices and other human activities. From the colonial era forward, until soil conservation measures were adopted more widely, floodwaters of the recent past laid down sediment in a remarkably short period of time, as compared to estimates of the pre-colonial era. This, along with runoff-induced incision of stream channels, gradually produced streams with deeper channels than in the past, effectively channelizing the flow of water in many places. As might be expected, reduced connectivity of rivers and flood plains ultimately has an impact on flood plain ecological processes.

At the present time, as a result of changes to channel and flood plain morphology, overbank flows occur less frequently in the region as a whole than in the past. At the same time, the risk of flooding on some downstream flood plains has likely increased. Channel incision can also affect the movement of groundwater on flood plains, by increasing hydraulic gradients towards the stream, thereby lowering water tables across the flood plain.

Some argue that these changes have resulted in a shift toward less flood-tolerant tree species in the affected areas over time. If so, this trend will likely continue, though stream channel restoration can be utilized to counteract some of these effects (Wharton 1978; Golden 1979; Barry 1980; Peet and Christensen 1980; Nelson 1986; Schafale and Weakley 1990; Shear et al. 1997; Ruhlman and Nutter 1999; Schilling et al. 2004; Jackson et al. 2005; Schlindwein 2006; Allen et al. 2007; Matthews 2011; Spira 2011; Schafale 2012a, 2012b; Edwards et al. 2013; Turner et al. 2015; Dearman and James 2019; Fleming et al. 2021).

SPECIES LIST

Canopy layer: *Liriodendron tulipifera*, *Liquidambar styraciflua*, *Celtis laevigata*, *Ulmus americana*, *Fraxinus pennsylvanica*, *Juglans nigra*, *Acer rubrum*, *Platanus occidentalis*, *Quercus michauxii*, *Ulmus alata*, *Quercus phellos*, *Quercus nigra*, *Quercus pagoda*, *Betula nigra*, *Gleditsia triacanthos*, *Pinus taeda*

Subcanopy layer: *Carpinus caroliniana*, *Acer negundo*, *Ilex decidua*, Crataegus spp., *Acer rubrum*, *Asimina triloba*, *Diospyros virginiana*, *Ulmus alata*, *Ulmus rubra*,

Vines/lianas: *Toxicodendron radicans*, *Smilax rotundifolia*, *Smilax bona-nox*, *Smilax tamnoides*, *Smilax glauca*, *Campsis radicans*, *Clematis virginiana*, *Bignonia capreolata*, *Gelsemium sempervirens*, *Parthenocissus quinquefolia*, *Vitis rotundifolia*, *Matelea gonocarpos*, *Trachelospermum difforme*, *Apios americana*, *Mikania scandens*, *Decumaria barbara*, *Berchemia scandens*, *Polygonum scandens* var. scandens, *Dioscorea oppositifolia* (ex.), *Lonicera japonica* (I)

Shrub layer: *Lindera benzoin*, *Ilex decidua*, *Arundinaria gigantea*, *Viburnum recognitum*, *Viburnum prunifolium*, *Viburnum dentatum*, *Cornus amomum*, *Xanthorhiza simplicissima*, *Hypericum nudiflorum*, *Ligustrum sinense* (I), *Rosa multiflora* (I)

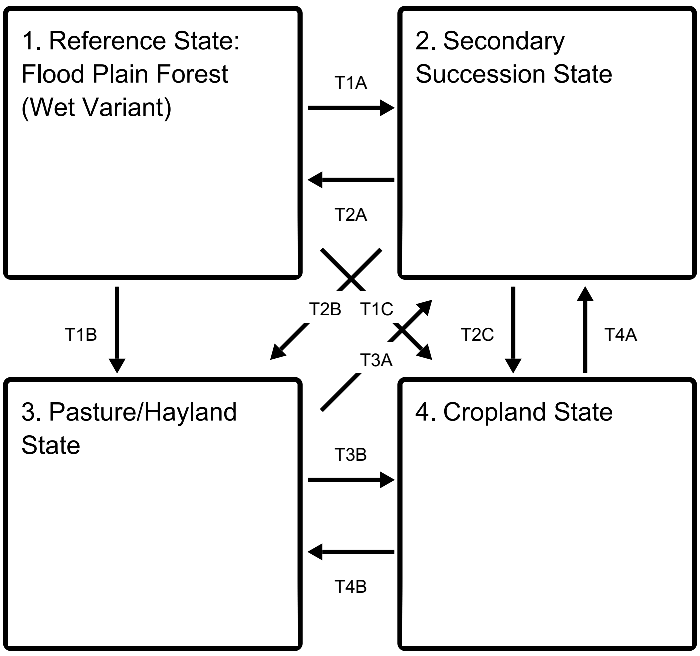
Herb layer - forbs: *Boehmeria cylindrica*, *Arisaema triphyllum*, *Rudbeckia laciniata*, *Amphicarpaea bracteata*, *Botrychium virginianum*, *Lysimachia ciliata*, *Polygonum virginianum*, *Verbesina alternifolia*, *Athyrium filix-femina* ssp. asplenioides, *Impatiens capensis*, *Botrychium dissectum*, *Cryptotaenia canadensis*, *Onoclea sensibilis*, *Phryma leptostachya*, *Arisaema dracontium*, *Galium triflorum*, *Woodwardia areolata*, Zephyranthes atamasco, *Lobelia cardinalis*, *Pluchea camphorata*, *Viola striata*, *Mitchella repens*, *Botrychium biternatum*, Parathelypteris noveboracensis, *Ophioglossum vulgatum*, *Laportea canadensis*, *Pilea pumila*, *Galium aparine*, *Galium tinctorium*, *Galium circaezans*, *Oxalis stricta*, *Bidens frondosa*, *Bidens tripartita*, *Smallanthus uvedalius*, *Ambrosia trifida*, *Eutrochium fistulosum*, *Hypericum mutilum*, *Symphyotrichum racemosum*, *Symphyotrichum lateriflorum*, *Ptilimnium capillaceum*, *Ranunculus abortivus*, *Stellaria media* (I), *Glechoma hederacea* (I), *Lamium purpureum* (I), *Lysimachia nummularia* (I)

Herb layer - graminoids: *Chasmanthium latifolium*, *Cinna arundinacea*, *Elymus virginicus*, *Dichanthelium clandestinum*, Carex spp. (tribuloides, amphibola, radiata, intumescens, grayi, blanda, rosea, squarrosa), *Poa autumnalis*, *Leersia virginica*, *Dichanthelium sphaerocarpon* var. isophyllum, *Elymus glabriflorus*, *Juncus coriaceus*, *Microstegium vimineum* (I)

(I) = introduced

State and transition model

Ecosystem states



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

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

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

T2C - Mechanical tree/brush/stump/debris removal, seedbed preparation, applications of fertilizer/lime, weed control, planting of crop or cover crop seed.

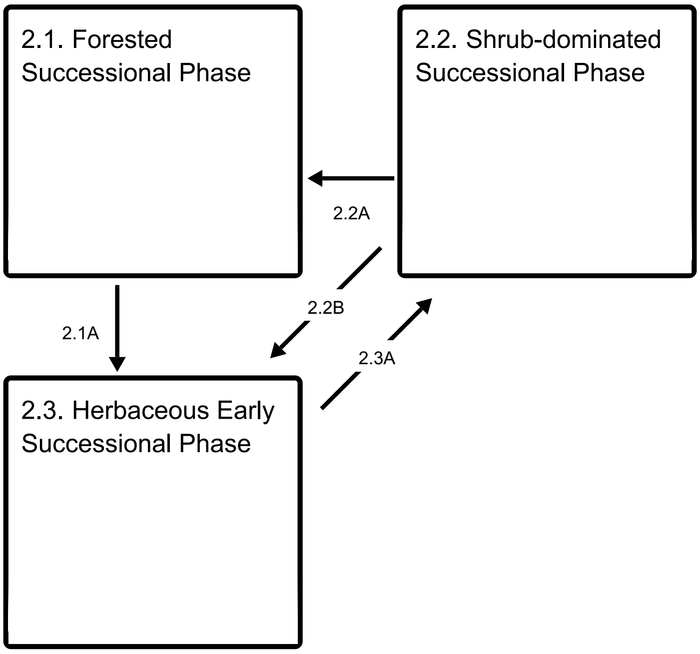
T3A - Long-term cessation of grazing.

T3B - Seedbed preparation, applications of fertilizer/lime, weed control, and planting of crop or cover crop seed.

T4A - Agricultural abandonment.

T4B - Seedbed preparation, weed control, and planting of perennial grasses and forbs.

State 2 submodel, plant communities



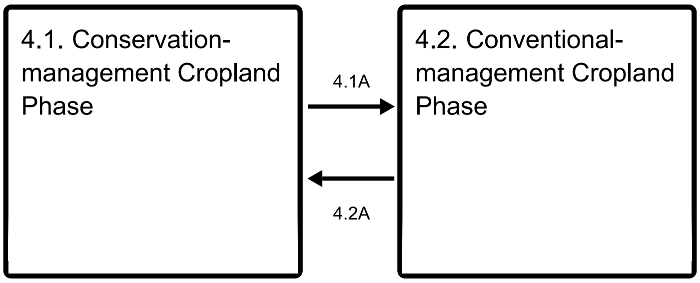
2.1A - Clearcut logging.

2.2A - Natural succession.

2.2B - Brush management.

2.3A - Natural succession.

State 4 submodel, plant communities



4.1A - Conventional tillage is reintroduced.

4.2A - Implementation of conservation tillage and other soil conservation practices

State 1
Reference State: Flood Plain Forest (Wet Variant)

This mature forest state supports a diverse mixture of bottomland hardwood species.

Characteristics and indicators. Stands are uneven-aged with a broad diameter class distribution. The forest typically has a closed canopy, though canopy gaps and standing dead trees are frequently interspersed. The canopy is diverse, often without a clear set of dominant species. Bottomland oaks (*Q. michauxii*, *Q. shumardii*, *Q. nigra*, *Q. pagoda*, *Q. phellos*, etc.) typically occupy a relatively small but important portion of the canopy. Their presence is a good indicator of mature forest conditions. In contrast with young, recently disturbed stands, native species are more likely to dominate the shrub and herb layers.

Dominant plant species

- tuliptree (*Liriodendron tulipifera*), tree
- sweetgum (*Liquidambar styraciflua*), tree
- sugarberry (*Celtis laevigata*), tree
- American elm (*Ulmus americana*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- black walnut (*Juglans nigra*), tree
- red maple (*Acer rubrum*), tree
- American hornbeam (*Carpinus caroliniana*), tree
- boxelder (*Acer negundo*), tree
- swamp chestnut oak (*Quercus michauxii*), tree
- northern spicebush (*Lindera benzoin*), shrub
- possumhaw (*Ilex decidua*), shrub
- giant cane (*Arundinaria gigantea*), shrub
- eastern poison ivy (*Toxicodendron radicans*), shrub
- southern arrowwood (*Viburnum recognitum*), shrub
- blackhaw (*Viburnum prunifolium*), shrub
- greenbrier (*Smilax*), shrub
- devil's darning needles (*Clematis virginiana*), shrub
- crossvine (*Bignonia capreolata*), shrub
- Indian woodoats (*Chasmanthium latifolium*), grass
- sweet woodreed (*Cinna arundinacea*), grass
- Virginia wildrye (*Elymus virginicus*), grass
- deertongue (*Dichanthelium clandestinum*), grass
- eastern narrowleaf sedge (*Carex amphibola*), grass
- blunt broom sedge (*Carex tribuloides*), grass
- autumn bluegrass (*Poa autumnalis*), grass
- whitegrass (*Leersia virginica*), grass
- roundseed panicgrass (*Dichanthelium sphaerocarpon var. isophyllum*), grass
- southeastern wildrye (*Elymus glabriflorus*), grass
- smallspike false nettle (*Boehmeria cylindrica*), other herbaceous
- Jack in the pulpit (*Arisaema triphyllum*), other herbaceous

- cutleaf coneflower (*Rudbeckia laciniata*), other herbaceous
- American hogpeanut (*Amphicarpaea bracteata*), other herbaceous
- rattlesnake fern (*Botrychium virginianum*), other herbaceous
- fringed loosestrife (*Lysimachia ciliata*), other herbaceous
- jumpseed (*Polygonum virginianum*), other herbaceous
- wingstem (*Verbesina alternifolia*), other herbaceous
- asplenium ladyfern (*Athyrium filix-femina ssp. asplenioides*), other herbaceous
- jewelweed (*Impatiens capensis*), other herbaceous

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 usually even.

Community 2.1
Forested Successional Phase

This successional phase develops in the wake of long-term agricultural abandonment, logging, storm-related catastrophic tree mortality, or other large-scale disturbances that have led to canopy removal in the recent past. It is typically a closed canopy forest dominated by bottomland hardwoods, or a mixture of bottomland hardwoods and pines. Unlike mature flood plain forests, which have a characteristically diverse canopy layer, young secondary forests of this type are typically dominated by only a handful of species. Stands are usually even-aged and tend to have an abundance of non-native species in the understory.

Forest overstory. Representative canopy species include sweetgum (Liquidambar styraciflua), box elder (Acer negundo), river birch (Betula nigra), American sycamore (Platanus occidentalis), tuliptree (Liriodendron tulipifera), red maple (Acer rubrum), and loblolly pine (Pinus taeda). All of these species need not be present in a particular forest patch. Frequently, two or three species are strongly dominant and some may be absent altogether. Bottomland oaks are typically absent in the canopy.

Forest understory. In the shrub layer, Chinese privet (Ligustrum sinense) is often strongly dominant, appearing alongside northern spicebush (Lindera benzoin), and other native species.

Several vines are common in the understory, notably eastern poison ivy (Toxicodendron radicans), trumpet creeper (Campsis radicans), several species of greenbrier (Smilax rotundifolia, S. bona-nox, S. tamnoides, S. glauca), and many others.

In the herb layer, Nepalese browntop, or Japanese stiltgrass as it is commonly known (Microstegium vimineum) is often abundant. This non-native bamboo-like grass gains a foothold after disturbance.

Dominant plant species

- sweetgum (*Liquidambar styraciflua*), tree
- boxelder (*Acer negundo*), tree
- river birch (*Betula nigra*), tree
- American sycamore (*Platanus occidentalis*), tree
- tuliptree (*Liriodendron tulipifera*), tree
- red maple (*Acer rubrum*), tree
- loblolly pine (*Pinus taeda*), tree
- Chinese privet (*Ligustrum sinense*), shrub
- eastern poison ivy (*Toxicodendron radicans*), shrub
- greenbrier (*Smilax*), shrub
- multiflora rose (*Rosa multiflora*), shrub
- northern spicebush (*Lindera benzoin*), shrub
- trumpet creeper (*Campsis radicans*), shrub
- devil's darning needles (*Clematis virginiana*), shrub
- sweet autumn virginsbower (*Clematis terniflora*), shrub
- Nepalese browntop (*Microstegium vimineum*), grass
- sedge (*Carex*), grass
- deertongue (*Dichanthelium clandestinum*), grass
- Virginia wildrye (*Elymus virginicus*), grass
- sweet woodreed (*Cinna arundinacea*), grass
- Indian woodoats (*Chasmanthium latifolium*), grass
- leathery rush (*Juncus coriaceus*), grass
- ground ivy (*Glechoma hederacea*), other herbaceous
- smallspike false nettle (*Boehmeria cylindrica*), other herbaceous
- wingstem (*Verbesina alternifolia*), other herbaceous
- common chickweed (*Stellaria media*), other herbaceous
- stickywilly (*Galium aparine*), other herbaceous
- striped cream violet (*Viola striata*), other herbaceous
- American hogpeanut (*Amphicarpaea bracteata*), other herbaceous
- purple deadnettle (*Lamium purpureum*), other herbaceous
- jewelweed (*Impatiens capensis*), other herbaceous
- creeping jenny (*Lysimachia nummularia*), other herbaceous

Community 2.2
Shrub-dominated Successional Phase

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

Forest overstory. Non-native species usually occupy a large portion of the vine or shrub cover in most examples, with Chinese privet (Ligustrum sinense) being the most troublesome species on this ecological site. Other common shrub species include black elderberry (Sambucus nigra) and blackberry (Rubus spp.).

Characteristic vines include poison ivy (Toxicodendron radicans), trumpet creeper (Campsis radicans), and several species of greenbrier (Smilax rotundifolia, S. bona-nox, S. tamnoides, S. glauca).

Dominant plant species

- boxelder (*Acer negundo*), tree
- sweetgum (*Liquidambar styraciflua*), tree
- tuliptree (*Liriodendron tulipifera*), tree
- red maple (*Acer rubrum*), tree
- common persimmon (*Diospyros virginiana*), tree
- loblolly pine (*Pinus taeda*), tree
- devil's walkingstick (*Aralia spinosa*), tree
- Chinese privet (*Ligustrum sinense*), shrub
- black elderberry (*Sambucus nigra*), shrub
- eastern poison ivy (*Toxicodendron radicans*), shrub
- greenbrier (*Smilax*), shrub
- trumpet creeper (*Campsis radicans*), shrub
- devil's darning needles (*Clematis virginiana*), shrub
- multiflora rose (*Rosa multiflora*), shrub
- sweet autumn virginsbower (*Clematis terniflora*), shrub
- eastern baccharis (*Baccharis halimifolia*), shrub
- deertongue (*Dichanthelium clandestinum*), grass
- velvet panicum (*Dichanthelium scoparium*), grass
- Virginia wildrye (*Elymus virginicus*), grass
- Nepalese browntop (*Microstegium vimineum*), grass
- leathery rush (*Juncus coriaceus*), grass
- common rush (*Juncus effusus*), grass
- wingstem (*Verbesina alternifolia*), other herbaceous
- wrinkleleaf goldenrod (*Solidago rugosa ssp. rugosa*), other herbaceous
- Canada goldenrod (*Solidago altissima*), other herbaceous
- hairy leafcup (*Smallanthus uvedalius*), other herbaceous
- trumpetweed (*Eutrochium fistulosum*), other herbaceous
- New York ironweed (*Vernonia noveboracensis*), other herbaceous
- smallspike false nettle (*Boehmeria cylindrica*), other herbaceous
- common boneset (*Eupatorium perfoliatum*), other herbaceous
- sensitive fern (*Onoclea sensibilis*), other herbaceous
- great ragweed (*Ambrosia trifida*), 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. Species composition is highly variable at this stage of succession. In addition to the named species, other herbaceous pioneers common to this ecological site include various knotweeds (Polygonum spp.), Carolina horsenettle (*Solanum carolinense*), field pansy (*Viola bicolor*), striped cream violet (*Viola striata*), herbwilliam (*Ptilimnium capillaceum*), Oriental false hawksbeard (*Youngia japonica*), littleleaf buttercup (*Ranunculus abortivus*), golden ragwort (*Packera aurea*), false daisy (*Eclipta prostrata*), rough cocklebur (*Xanthium strumarium*), ground ivy (*Glechoma hederacea*), Virginia buttonweed (*Diodia virginiana*), camphor pluchea (*Pluchea camphorata*), beefsteakplant (*Perilla frutescens*), Carolina foxtail (*Alopecurus carolinianus*), smooth white oldfield aster (*Symphyotrichum racemosum*), and many others.

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

- devil's darning needles (*Clematis virginiana*), shrub
- greenbrier (*Smilax*), shrub
- Nepalese browntop (*Microstegium vimineum*), grass
- velvet panicum (*Dichanthelium scoparium*), grass
- rush (*Juncus*), grass
- barnyardgrass (*Echinochloa crus-galli*), grass
- sedge (*Carex*), grass
- deertongue (*Dichanthelium clandestinum*), grass
- small carpetgrass (*Arthraxon hispidus*), grass
- field paspalum (*Paspalum laeve*), grass
- annual bluegrass (*Poa annua*), grass
- smallspike false nettle (*Boehmeria cylindrica*), other herbaceous
- beggarticks (*Bidens*), other herbaceous
- wingstem (*Verbesina alternifolia*), other herbaceous
- stickywilly (*Galium aparine*), other herbaceous
- wrinkleleaf goldenrod (*Solidago rugosa ssp. rugosa*), other herbaceous
- annual ragweed (*Ambrosia artemisiifolia*), other herbaceous
- great ragweed (*Ambrosia trifida*), other herbaceous
- Canada goldenrod (*Solidago altissima*), other herbaceous

- common chickweed (*Stellaria media*), other herbaceous
- dock (*Rumex*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.3

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

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

Pathway 2.2A
Community 2.2 to 2.1

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

Pathway 2.2B
Community 2.2 to 2.3

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

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

Pathway 2.3A
Community 2.3 to 2.2

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

State 3
Pasture/Hayland State

This converted state is dominated by herbaceous forage species.

Resilience management. Flooding: This ecological site is subject to regular overbank flooding, particularly in late winter and early spring. The duration of flooding is usually short-lived, though pastures may remain wet for longer periods. Landowners will need access to additional pasture or housing that is not subject to flooding, on which to move livestock during the cooler months. 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.), curly dock (*Rumex crispus*), bitter dock (*Rumex obtusifolius*), Virginia buttonweed (*Diodia virginiana*), Oriental lady's thumb (*Polygonum cespitosum* var. longisetum), Carolina horsenettle (*Solanum carolinense*), small carpetgrass (*Arthraxon hispidus*), nimblewill (*Muhlenbergia schreberi*), Nepalese browntop (*Microstegium vimineum*), and common rush (*Juncus effusus*), among others. 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 Chinese privet (*Ligustrum sinense*), blackberry (Rubus spp.), rose (Rosa spp.), and common persimmon (*Diospyros virginiana*).

Dominant plant species

- tall fescue (*Schedonorus arundinaceus*), grass
- orchardgrass (*Dactylis glomerata*), grass
- beaked panicgrass (*Panicum anceps*), grass
- eastern gamagrass (*Tripsacum dactyloides*), grass
- Bermudagrass (*Cynodon dactylon*), grass
- Johnsongrass (*Sorghum halepense*), grass
- sedge (*Carex*), grass
- rush (*Juncus*), grass
- white clover (*Trifolium repens*), other herbaceous
- vetch (*Vicia*), other herbaceous

State 4
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. Soil wetness and flooding are the principle limiting factors for crop production, particularly for winter cereals and other cool-season crops.

Community 4.1
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

Community 4.2
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

Pathway 4.1A
Community 4.1 to 4.2

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 4.2A
Community 4.2 to 4.1

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 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 T1C
State 1 to 4

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.

Constraints to recovery. Even with long-term natural succession, non-native species that gain a foothold after disturbance may still be problematic in the understory of flood plain forests nearing maturity. It is unknown whether the understory will eventually approach the composition of old-growth stands without significant human intervention. Species such as Chinese privet (*Ligustrum sinense*) and Nepalese browntop (*Microstegium vimineum*) may become fixtures in mature flood plain forests of the near future, due to their reproductive capacity and tolerance for shade. The importance of these weedy invaders will likely decline over time, though the extent to which they will persist in the long-term absence of anthropogenic disturbance is unknown.

Transition T2B
State 2 to 3

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 T2C
State 2 to 4

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

Transition T3B
State 3 to 4

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 T4A
State 4 to 2

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

Transition T4B
State 4 to 3

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):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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

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

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

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:**
