USDA Natural Resources
Conservation Service

Ecological site PX136X00X630
Flood Plain Levee Forest, Sandy

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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
CEGL007013 *Fraxinus pennsylvanica* - *Platanus occidentalis* - *Celtis laevigata / Chasmanthium latifolium*

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 sandy natural levees on flood plains, which are subject to regular overbank flooding of short duration and high energy. It is most common along the banks of the major rivers which drain the Piedmont. This environment benefits from ongoing deposition of nutrient-rich sediment, but it is subject to scouring and other impacts associated with flooding. This ecological site is geographically restricted to the thermic soil temperature regime portion of the MLRA.

Levee forests of the Southern Piedmont are naturally closed forests which are regularly interrupted by small to medium sized canopy gaps. The reference forest type is best developed on broad flood plains, in which sandy streamside levees develop over raised surfaces and extensive areas of flood plain flats and backswamps occupy the lower ground further from the channel. On broad flood plains, vegetation communities tend to sort out better along gradients of soil texture, water table depth, and flooding energy and duration. These flood plains support more discrete natural communities which are more easily distinguished than those of narrower flood plains.

In the reference state, dominant canopy species include sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), and American sycamore (*Platanus occidentalis*). Dominant land uses include cropland, pasture and hayland, and wildlife habitat.

Soils on this ecological site are excessively drained Entisols. They are typically very deep, sandy throughout, and poorly-developed due to frequent flooding. Parent materials are generally coarse-textured recent alluvial sediments.

ES CHARACTERISTICS SUMMARY
• Thermic soil temperature regime
• Occurs on natural levees on flood plains in river valleys
• Sandy (≥ 70 percent sand and ≤ 15 percent clay throughout)
• Seasonal high water table: > 72 inches from the soil surface
• Soils: very deep, excessively drained Entisols

Associated sites

PX136X00X620	**Flood Plain Forest, Moist** Where associated, on broad flood plains of large river systems, PX136X00X120 is found in slightly lower landscape positions, on nearly level flood plain flats behind the natural levee. The seasonal high water table is generally shallower (24 inches or greater from the soil surface) and soils are finer textured, resulting in greater plant water availability during periods of drought. On account of decreased levels of sunlight away from the channel, herb cover tends to be lower.
PX136X00X610	**Flood Plain Forest, Wet** Where associated, on broad flood plains of large river systems, PX136X00X110 is found in lower landscape positions further from the channel, on nearly level flood plain flats. The seasonal high water table is shallower (12-24 inches from the soil surface), resulting in an increase in obligate or facultative wetland indicator species.

PX136X00X600	**Flood Plain Forest, Very Wet** Where associated, on broad flood plains of large river systems, PX136X00X100 is found in lower landscape positions furthest from the channel, often on concave depressional landforms such as backswamps, sloughs, and depressions. The flooding regime is typically of lower energy but longer duration. The seasonal high water table is much shallower (0-12 inches from the soil surface), resulting in a marked increase in obligate wetland indicator species.

Similar sites

PX136X00X130	**Mesic Temperature Regime, Flood Plain Levee Forest, Sandy** The soil temperature regime is mesic, occurring outside of the native range of loblolly pine (Pinus taeda).
PX136X00X620	**Flood Plain Forest, Moist** The seasonal high water table is generally shallower (24 inches or greater from the soil surface) and soils are finer textured, resulting in greater plant water availability during periods of drought.
PX136X00X835	**Piedmont Riverine Sandhills** Soils formed in old, sandy alluvial sediments that were reworked by wind. This ecological site is on irregular, undulating surfaces of high terraces, generally on the east sides of major rivers. It is not subject to regular overbank flooding. Although soils can be equally sandy, these surfaces are old and highly stable, supporting a higher cover of long-lived, drought-tolerant upland species under reference conditions.

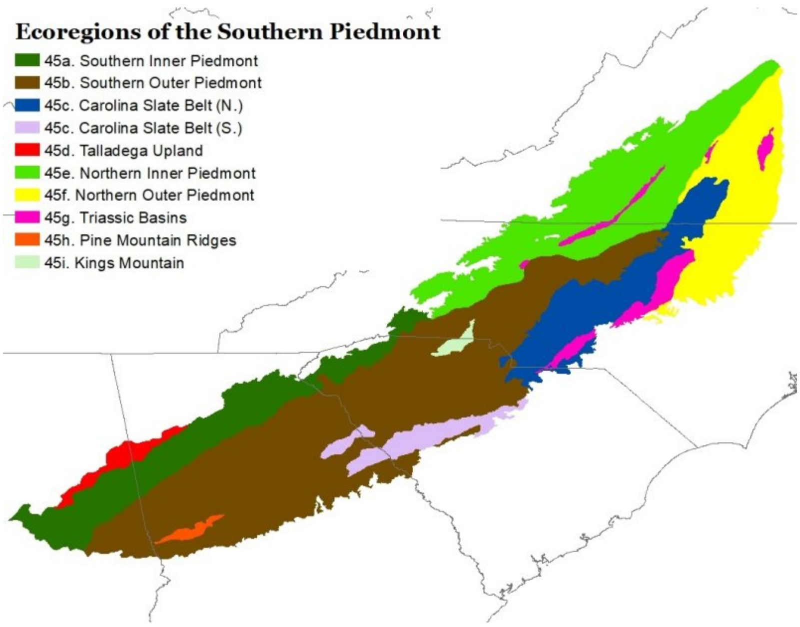


Figure 1. EPA level IV ecoregions of the Southern Piedmont (45).

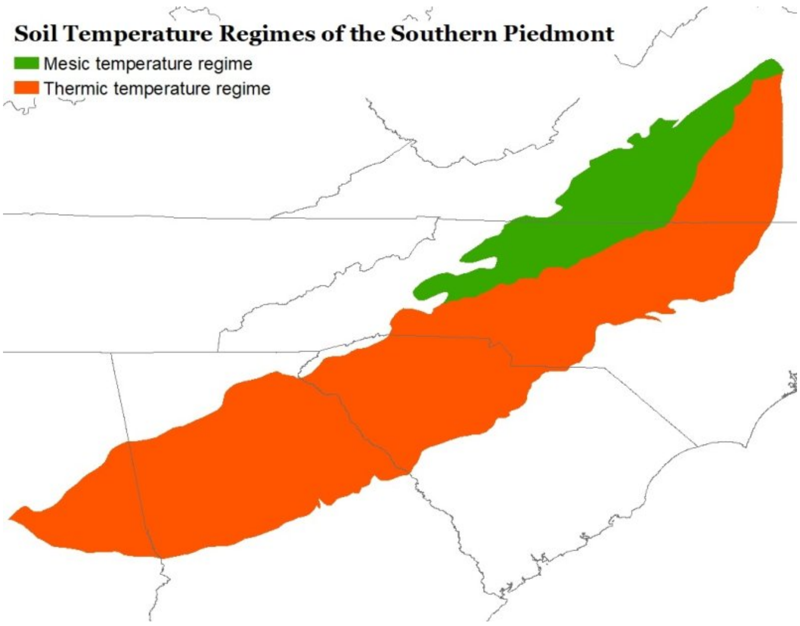


Figure 2. Spatial illustration of soil temperature regimes of the Southern Piedmont.

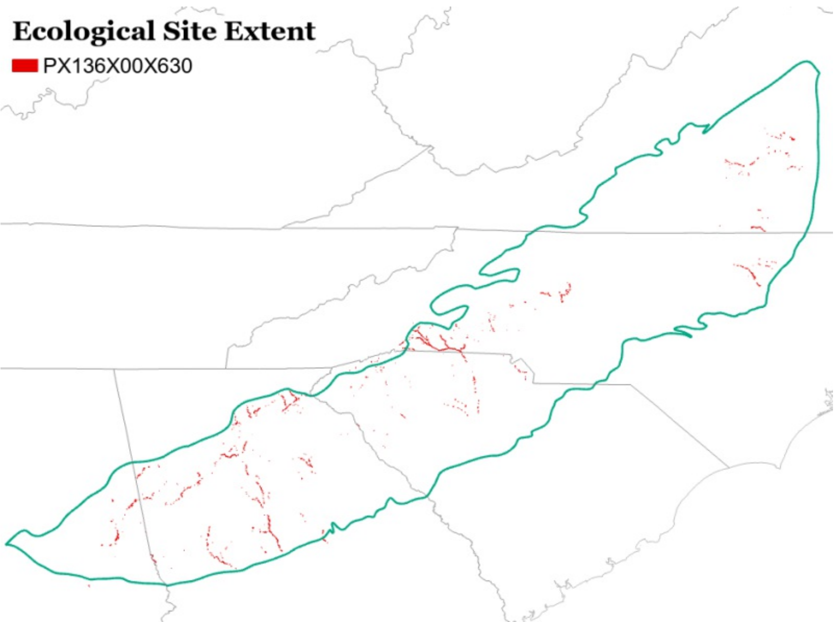


Figure 3. Spatial extent of this ecological site representing the major areas where this site is important on the landscape.

Table 1. Dominant plant species

Tree	(1) *Celtis laevigata* (2) *Ulmus americana*
Shrub	(1) *Asimina triloba* (2) *Arundinaria gigantea*
Herbaceous	(1) *Chasmanthium latifolium* (2) *Elymus virginicus*

Legacy ID

F136XY630GA

Physiographic features

This ecological site includes sandy natural levees, on active flood plains that are subject to regular overbank flooding. It is geographically restricted to the thermic soil temperature regime portion of the MLRA. Representative locations are gently sloping or nearly level, with a representative slope of 0 to 5 percent and a maximum slope of 6 percent. The geologic substrate is sandy recent alluvial sediments.

This ecological site is typically situated in broad river valleys of large river systems. Here, distinct landforms, such as stream terraces, flood plain flats, backswamps, and natural levees, tend to be better developed. During flooding events, sandy sediments fall out of suspension first, as the kinetic energy dissipates once the water is not confined by channel flow. On broad flood plains, floodwaters are seldom confined by the width of the flood plain as they often are on narrow flood plains after the river overflows its banks. This allows alluvial sediments to sort out better by particle size. Because floodwaters are rarely channelized during major flooding events, as they may be on narrower flood plains, the sandy sediments can accumulate more easily, producing distinct raised areas along the banks of the river (Ferguson and Brierley 1999).

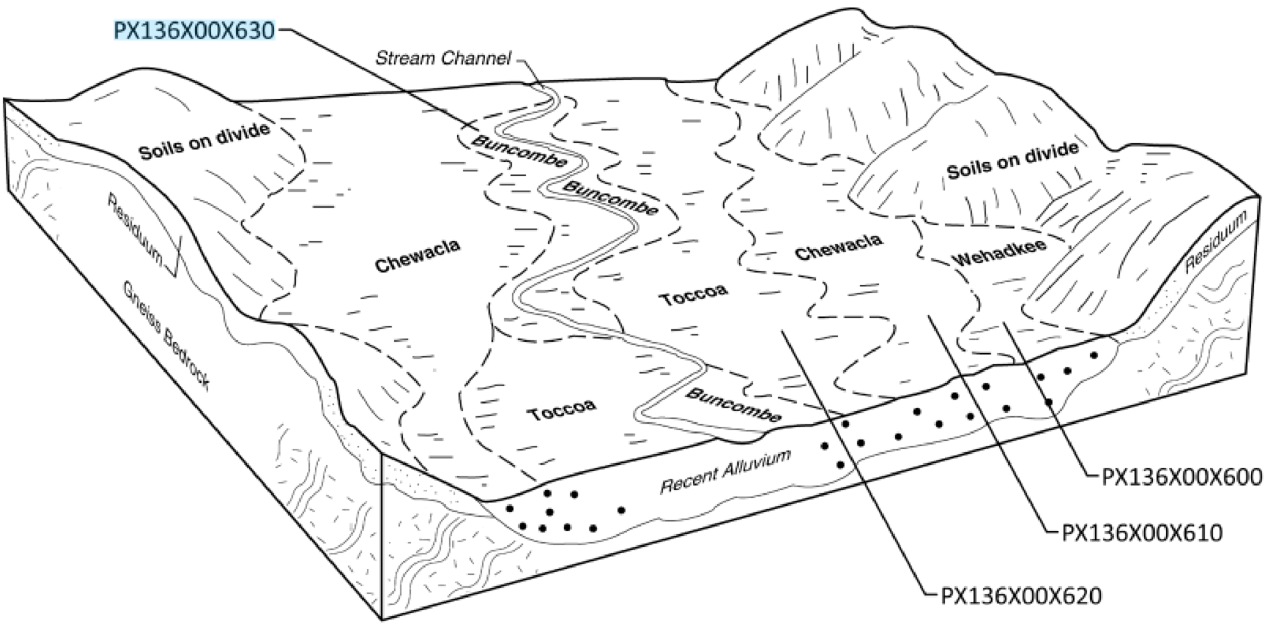


Figure 4. Typical soil-landscape relationships of a large river flood plain in the Southern Piedmont. Buncombe soils are associated with this ecological site, depicted here on natural levees, on an active flood plain, in a broad river valley.

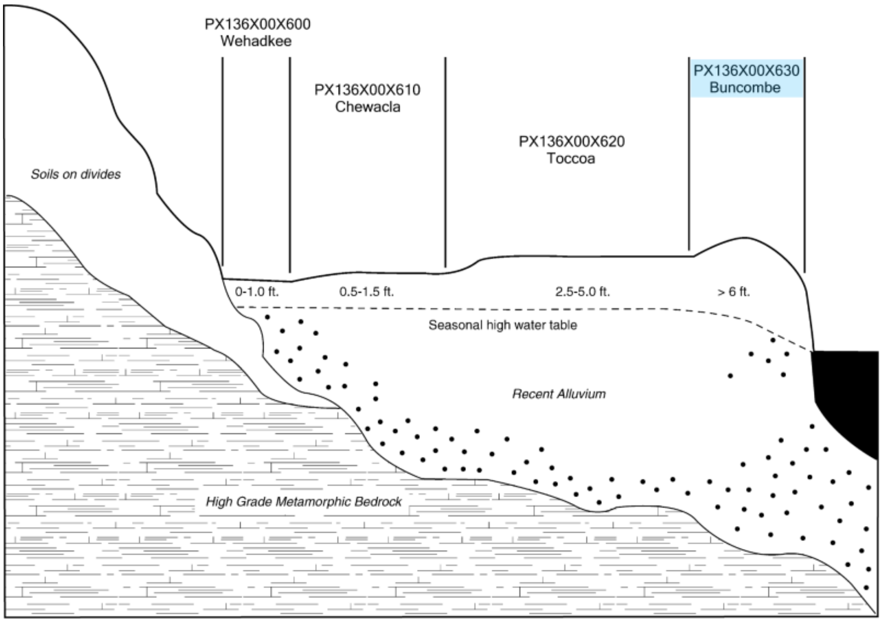


Figure 5. Cross section of a flood plain along a large river system in the Southern Piedmont. Buncombe soils are associated with this ecological site.

Table 2. Representative physiographic features

Landforms	(1) River valley > Natural levee
Runoff class	Negligible to very low
Flooding duration	Very brief (4 to 48 hours)
Flooding frequency	Frequent
Ponding frequency	None
Elevation	240–1,050 ft
Slope	0–5%
Water table depth	72–999 in
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Negligible to very low
Flooding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Flooding frequency	Rare to frequent
Ponding frequency	None
Elevation	150–1,570 ft
Slope	0–6%
Water table depth	72–999 in

Climatic features

On this ecological site, the average mean annual precipitation is 48 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)	164-192 days
Freeze-free period (characteristic range)	194-227 days
Precipitation total (characteristic range)	45-50 in
Frost-free period (actual range)	155-200 days
Freeze-free period (actual range)	179-238 days
Precipitation total (actual range)	43-56 in
Frost-free period (average)	178 days
Freeze-free period (average)	211 days
Precipitation total (average)	48 in

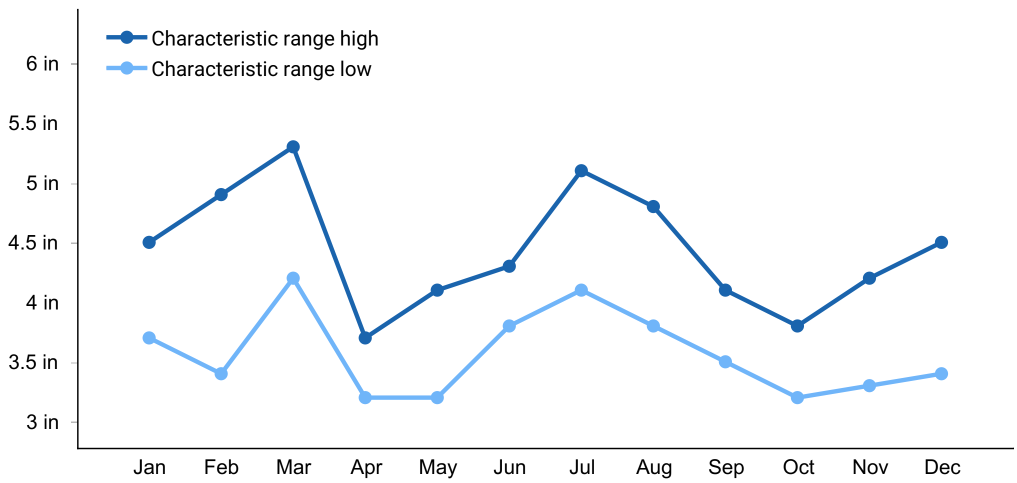


Figure 6. Monthly precipitation range

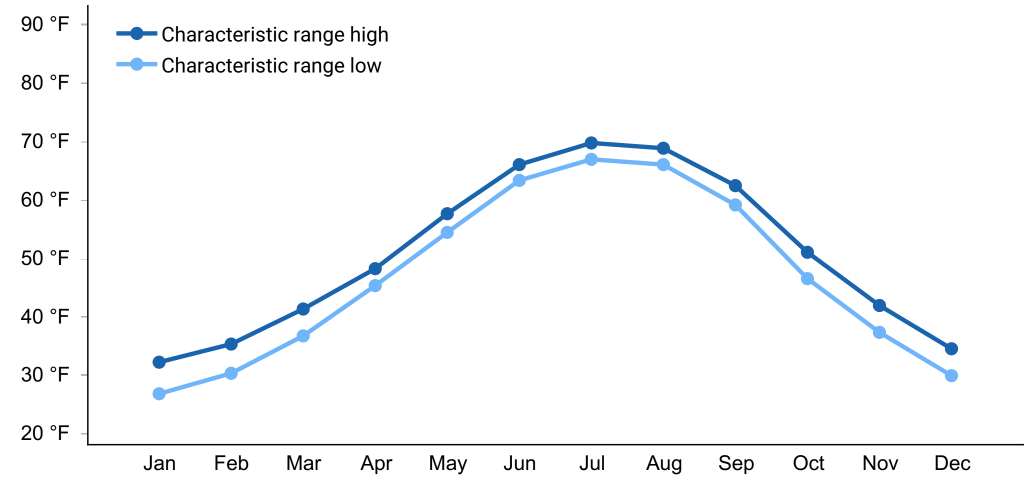


Figure 7. Monthly minimum temperature range

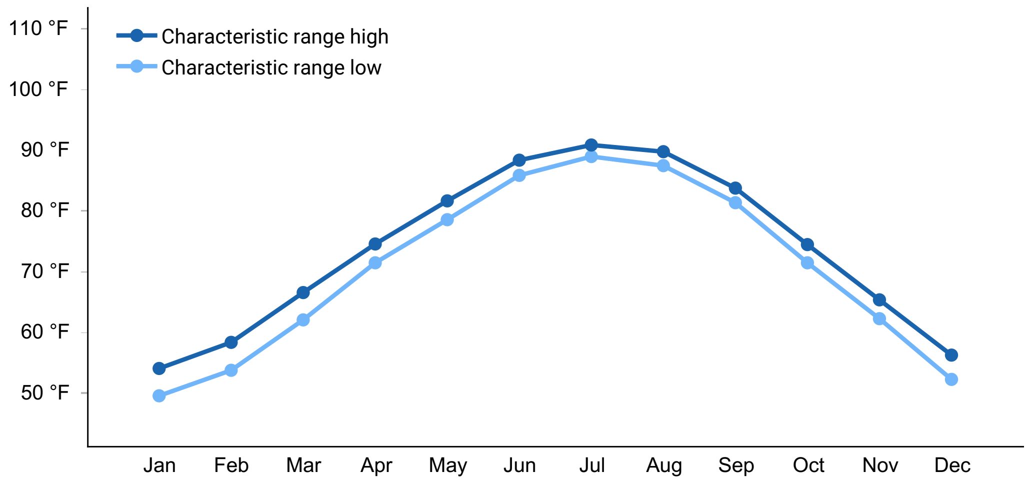


Figure 8. Monthly maximum temperature range

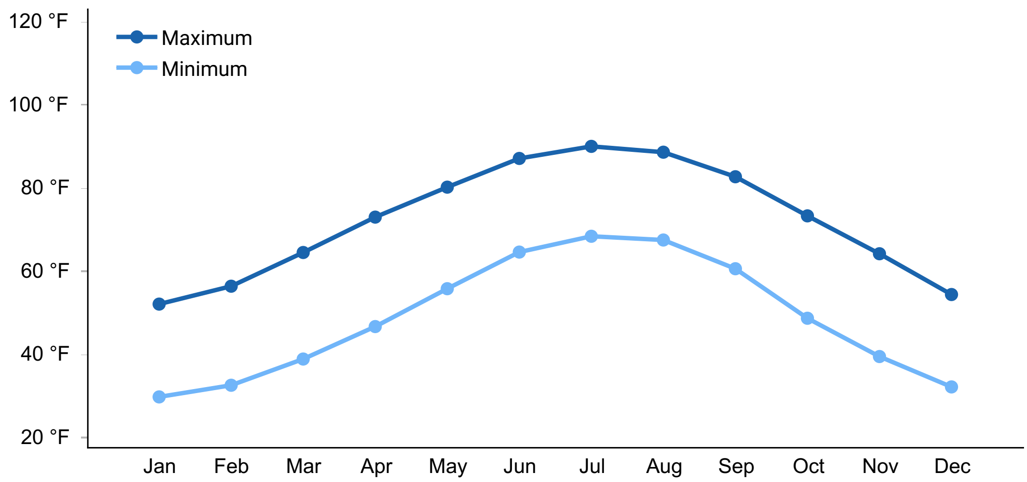


Figure 9. Monthly average minimum and maximum temperature

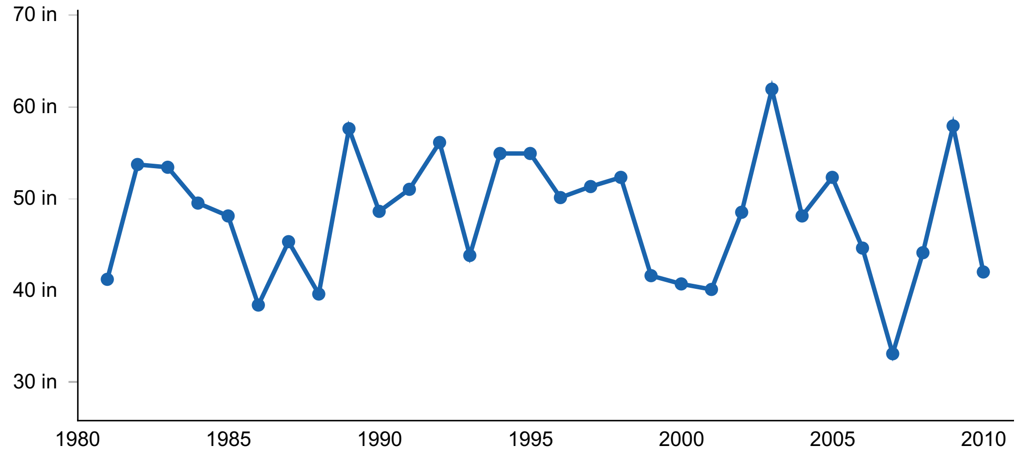


Figure 10. Annual precipitation pattern

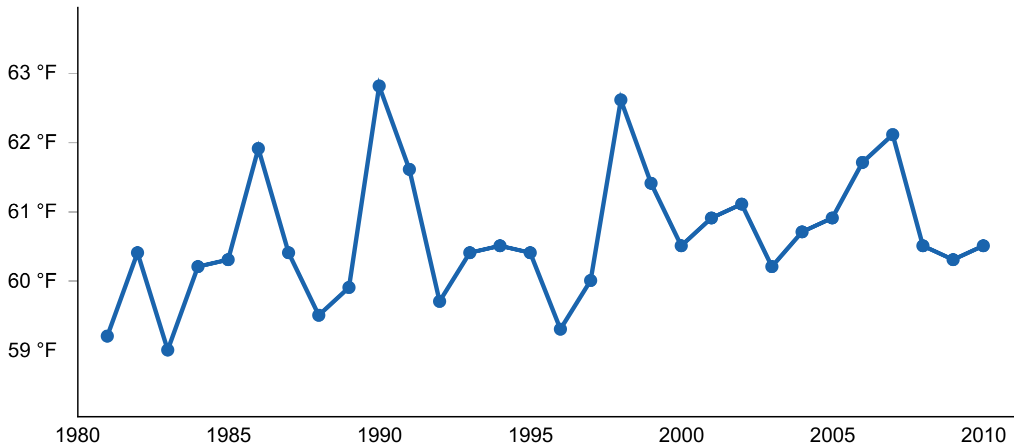


Figure 11. Annual average temperature pattern

Climate stations used

- (1) ASHLAND 3 ENE [USC00010369], Ashland, AL
- (2) ROCKFORD 3 ESE [USC00017020], Rockford, AL
- (3) EXPERIMENT [USC00093271], Griffin, GA
- (4) GAINESVILLE [USC00093621], Gainesville, GA
- (5) MILLEDGEVILLE [USC00095874], Milledgeville, GA
- (6) WEST POINT [USC00099291], Lanett, GA
- (7) SALISBURY [USC00317615], Salisbury, NC
- (8) SIMMS WTP [USC00387885], Chesnee, SC
- (9) CHARLOTTE DOUGLAS AP [USW00013881], Charlotte, NC
- (10) CARROLLTON [USC00091640], Carrollton, GA
- (11) COVINGTON [USC00092318], Covington, GA
- (12) ALBEMARLE [USC00310090], Albemarle, NC
- (13) NEWBERRY [USC00386209], Newberry, SC
- (14) COLUMBUS METRO AP [USW00093842], Columbus, GA
- (15) DALLAS 7 NE [USC00092485], Dallas, GA
- (16) ASHEBORO 2 W [USC00310286], Asheboro, NC

- (17) SILER CITY 2 N [USC00317924], Siler City, NC
- (18) CHESNEE 7 WSW [USC00381625], Chesnee, SC
- (19) CLEMSON UNIV [USC00381770], Clemson, SC
- (20) CHASE CITY [USC00441606], Chase City, VA
- (21) GREENWOOD [USC00383754], Greenwood, SC
- (22) CROZIER [USC00442142], Maidens, VA
- (23) ATHENS BEN EPPS AP [USW00013873], Athens, GA
- (24) CAMP PICKETT [USC00441322], Blackstone, VA
- (25) CLARKSVILLE [USC00441746], Clarksville, VA
- (26) AMELIA 8 NE [USC00440188], Amelia Court House, VA
- (27) FOREST CITY 6 SW [USC00313150], Forest City, NC
- (28) MONROE 2 SE [USC00315771], Monroe, NC
- (29) LOUISBURG [USC00315123], Louisburg, NC
- (30) HAW RIVER 1E [USC00313919], Graham, NC
- (31) SANFORD 8 NE [USC00317656], Sanford, NC
- (32) FALLS LAKE [USC00312993], Raleigh, NC
- (33) APEX [USC00310212], Apex, NC
- (34) THOMASTON [USC00098661], Thomaston, GA
- (35) PARR [USC00386688], Jenkinsville, SC
- (36) ATLANTA FULTON CO AP [USW00003888], Mableton, GA
- (37) TALBOTTON [USC00098535], Talbotton, GA
- (38) ALEXANDER CITY [USC00010160], Alexander City, AL
- (39) HEFLIN [USC00013775], Heflin, AL
- (40) SANTUCK [USC00387722], Union, SC
- (41) WEST PELZER 2 W [USC00389122], Pelzer, SC
- (42) NINETY NINE ISLANDS [USC00386293], Blacksburg, SC

Influencing water features

This ecological site occurs in riparian areas, on active flood plains which are subject to regular overbank flooding. It usually sits directly adjacent to the river and gets the brunt of the force associated with flooding.

GROUNDWATER FEATURES
On flood plains of the Southern Piedmont, the water table is tied to the height of the water in the channel, with groundwater generally moving from uplands towards the stream. High hydraulic gradients and coarse-textured soils along streambanks cause the water table to be deeper here than on most other parts of the flood plain. The seasonal high water table typically sits 6 feet or more from the mineral soil surface.

SURFACE WATER FEATURES
On well-developed natural levees, floodwaters generally overtop the levee in low spots initially rather than across the entire surface. As flooding intensifies, in the wake of large storm events, floodwaters may overtop the highest natural levee areas.

Flooding frequency on this ecological site is typically high, however the duration of flooding is generally very 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) channel morphology, and 4) the shape and topography of the watershed. These and other factors produce flooding regimes with specific signatures (Kilpatrick and Barnes 1964; Mulholland and Lenat 1992; Matthews et al. 2011).

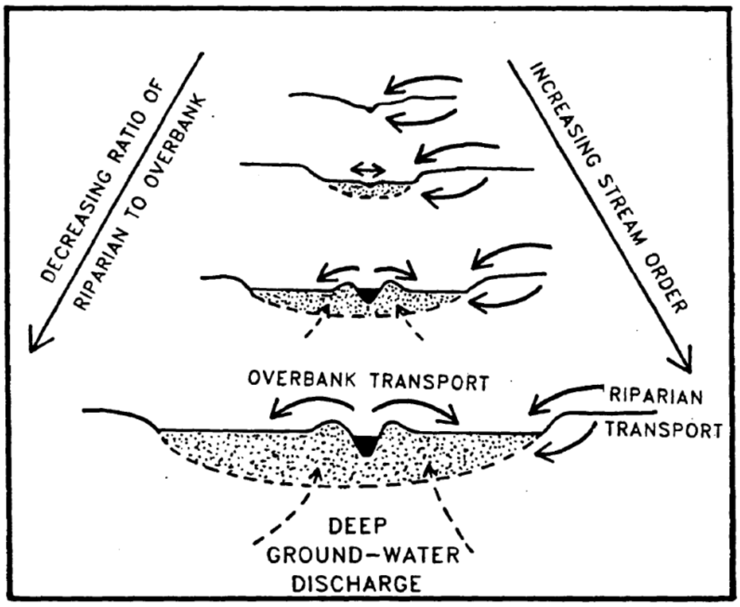


Figure 12. An illustration of the effect of stream order on 1) the severity of overbank flooding, and 2) the ratio of soil water derived from overbank flooding to the amount derived from overland water and groundwater moving towards the stream. From Brinson (1993).

Soil features

Soils on this ecological site are typically excessively drained Entisols. They are typically very deep, sandy throughout, and poorly-developed due to frequent flooding. Permeability is rapid to very rapid. Parent materials are typically coarse-textured recent alluvial sediments.

Reaction is typically slightly acid to strongly acid acid (pH 5.1 to 6.5) throughout, though it can be closer to neutral under unusually rich site conditions. The available water capacity is usually low, but on most natural levees, deep-rooted trees can make use of groundwater once established. Natural fertility can be relatively high for a sandy soil due to regular flooding, but like other sandy soils, soil fertility can be difficult to maintain under crop production. Flooding, droughty edaphic conditions, and low cation exchange capacity 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: Typic Udipsamments
Modal soil series include: Buncombe
No other soils are currently attributed to this ecological site.

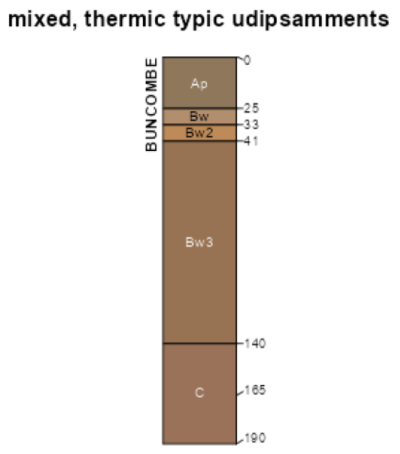


Figure 13. An illustration of a soil profile belonging to the Buncombe series, a representative soil series associated with this ecological site.

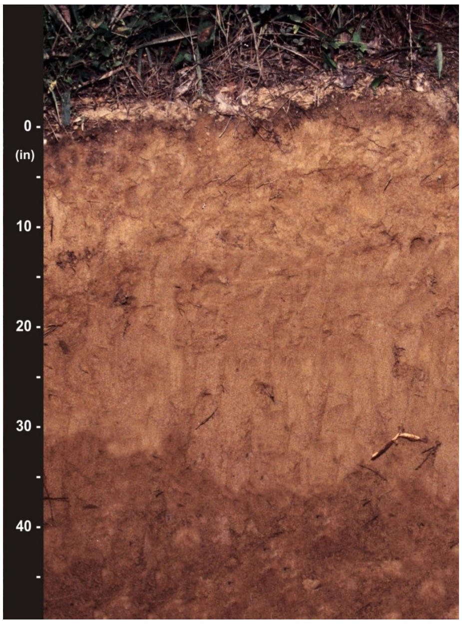


Figure 14. A soil profile of the Buncombe series.

Table 5. Representative soil features

Parent material	(1) Alluvium–igneous, metamorphic and sedimentary rock
Surface texture	(1) Loamy sand (2) Loamy fine sand (3) Sand (4) Coarse sand
Drainage class	Excessively drained

Permeability class	Rapid
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-80in)	3–6 in
Soil reaction (1:1 water) (10-40in)	5.1–6.5
Subsurface fragment volume <=3" (0-80in)	0–1%
Subsurface fragment volume >3" (0-80in)	0%

Table 6. Representative soil features (actual values)

Drainage class	Somewhat excessively drained to excessively drained
Permeability class	Rapid to very rapid
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-80in)	2–8 in
Soil reaction (1:1 water) (10-40in)	4.5–7.3
Subsurface fragment volume <=3" (0-80in)	0–5%
Subsurface fragment volume >3" (0-80in)	0%

Ecological dynamics

U.S. National Vegetation Classification (USNVC) associations that are consistent with reference conditions on this ecological site include CEGL007013 *Fraxinus pennsylvanica* - *Platanus occidentalis* - *Celtis laevigata* / *Chasmanthium latifolium*. This association covers two assemblages identified by Mathews et al. (2011), '*Fraxinus pennsylvanica* - *Platanus occidentalis* / *Acer negundo* / *Chasmanthium latifolium*,' which tends to occur farther upstream, and '*Ulmus americana* - *Celtis laevigata* / *Lindera benzoin*/*Osmorhiza longistylis*,' which is more typical of downstream examples on well-developed natural levees. The latter assemblage is thought to be more representative of mature stands (USNVC 2022).

MATURE FORESTS
Levee forests of the Southern Piedmont are naturally closed forests which are regularly interrupted by small to medium sized canopy gaps or areas of standing dead trees. Forest patches are typically long and narrow in shape. The herb layer is characteristically dense, unless invaded by non-native shrubs, due to increased levels of sunlight along the open river channel. In the reference state, the canopy contains a mixture of a large pool of possible species, with dominant species appearing in many different combinations. Differences in species composition likely reflect flooding-related variability, as well as the history of land use and the age of the stand.

In the reference state, dominant canopy species on sandy natural levees include sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), and American sycamore (*Platanus occidentalis*). Other species of high importance include bitternut hickory (*Carya cordiformis*), black walnut (*Juglans nigra*), and tuliptree (*Liriodendron tulipifera*), among others. On some high levees along small to medium-sized rivers of Triassic Basins, American beech (*Fagus grandifolia*) can be dominant or codominant. Many other species can be present in the canopy, including sweetgum (*Liquidambar styraciflua*), southern sugar maple (*Acer floridanum*), winged elm (*Ulmus alata*), red mulberry (*Morus rubra* var. rubra), and river birch (*Betula nigra*). Other less common but characteristic species include silver maple (*Acer saccharinum*), which is largely confined to the banks of rivers and streams, and southern catalpa (*Catalpa bignonioides*), though it is not native to the northern part of the MLRA.

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. shumardii*, *Q. nigra*, *Q. phellos*, *Q. pagoda*, 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.

In the subcanopy layer, representative tree species include box elder (*Acer negundo*), pawpaw (*Asimina triloba*), and American hornbeam (*Carpinus caroliniana*). Other notable species include black cherry (*Prunus serotina*), flowering dogwood (*Cornus florida*), and several species of hawthorn (Crataegus spp.).

In the shrub layer, representative species include pawpaw (*Asimina triloba*), giant cane

(*Arundinaria gigantea*), northern spicebush (*Lindera benzoin*), and possumhaw (*Ilex decidua*). Other common species include painted buckeye (*Aesculus sylvatica*), blackhaw (*Viburnum prunifolium*), and coralberry (*Symphoricarpos orbiculatus*). Due to increased levels of sunlight along the river banks, vines can be abundant. The most common species include devil's darning needles (*Clematis virginiana*), eastern poison ivy (*Toxicodendron radicans*), crossvine (*Bignonia capreolata*), and greenbrier (*Smilax rotundifolia*, *S. glauca*, *S. bona-nox*, *S. tamnoides*), though many others can be present.Non-native shrubs and vines are frequently present as well, though they are not usually abundant in mature stands.

The herb layer is typically dense, with grasses usually dominating. Most characteristic are Indian woodoats (*Chasmanthium latifolium*), Virginia wildrye (*Elymus virginicus*), and several species of Carex (C. grayi, radiata, blanda, amphibola, corrugata, etc.). The herb layer often includes species with a higher light requirement. The herb layer often includes species with a higher light requirement, of which several are more typical of canopy gaps away from the river channel. Common forbs which are consistent in plot data include longstyle sweetroot (*Osmorhiza longistylis*), smallspike false nettle (*Boehmeria cylindrica*), wingstem (*Verbesina alternifolia*), stickywilly (*Galium aparine*), Canadian woodnettle (*Laportea canadensis*), and many others.

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.

The primary drivers of natural successional on this ecological site are similar to those of other flood plain ecological site concepts. Environmental factors that differentiate this ecological site from other flood plain concepts include access to higher levels of sunlight, a deeper water table, sandier soils, shorter flooding duration, and higher flooding energy.

Trees that establish on sandy natural levees have access to plentiful sunlight, but they are confronted with other limiting factors, including a somewhat unusual soil water dynamic. Once established, groundwater supplies deep-rooted trees with an crucial source of water in an otherwise dry, sandy substrate. Still, seedlings that are not yet established can succumb to drought, or other diseases and pests exacerbated by drought stress. Also problematic, streamside trees have a tendency to lean towards the river in an effort to capture more sunlight. This tendency results in short-term gains, but it can ultimately have negative consequences. On top of that, the low shear strength of deep sands predisposes trees to anchorage-related mortality.

The riverfront environment is naturally subject to scouring, riverbank undercutting, heavy sediment deposition, as well as high energy flooding that is seldom experienced in other parts of the flood plain. Plants are often battered by floating debris. Shrubs and small trees are often bent as water and debris rush over them. Even so, natural disturbances on this ecological site rarely result in catastrophic tree mortality. Typically, only a few trees are affected at a time, producing an uneven-aged stand. Plants that grow along the levee generally have a short lifespan, and thus face somewhat greater selective pressure to reproduce quickly.

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.

Piedmont levee forests are among the most susceptible communities to invasion by non-native species, due to a combination of higher levels of sunlight, the formation of bare patches of soil caused by scouring, and the dispersal of seeds by floodwaters. Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), Chinese privet (*Ligustrum sinense*), and Nepalese browntop, or Japanese stiltgrass as it is often known (*Microstegium vimineum*), have come to dominate large areas along the banks of some major rivers, to the exclusion of the native herb layer. Other common non-native species on this ecological site include ground ivy (*Glechoma hederacea*), common chickweed (*Stellaria media*), Oriental false hawksbeard (*Youngia japonica*), and a number of other species. Non-native pioneer species may be present even in mature stands, as frequent scouring provides ample opportunity for these species to colonize bare soil.

YOUNG SECONDARY FORESTS
Although natural levees are often left in trees while the remainder of the flood plain is cleared and farmed, at least half of the acreage associated with this ecological site has been cleared for pasture or cropland at some point in the recent past. 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. Typically, these forests are strongly dominated by only a handful of species. On sandy natural levees, common pioneers include box elder (*Acer negundo*), American sycamore (*Platanus occidentalis*), tuliptree (*Liriodendron tulipifera*), and sweetgum (*Liquidambar styraciflua*). The dominance of early pioneers typically declines as the forest matures, though many of these species remain important in mature stands as well, albeit to a lesser extent.

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 (Barry 1980; Wharton et al. 1982; Wharton 1978; Nelson 1986; Schafale and Weakley 1990; Shear et al. 1997; Ruhlman and Nutter 1999; Schilling et al. 2004; Jackson et al. 2005; Allen et al. 2007; Matthews et al. 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: *Celtis laevigata*, *Ulmus americana*, *Fraxinus pennsylvanica*, *Platanus occidentalis*, *Carya cordiformis*, *Juglans nigra*, *Liriodendron tulipifera*, *Liquidambar styraciflua*, *Acer floridanum*, *Ulmus alata*, *Betula nigra*, *Quercus michauxii*, *Quercus nigra*, *Quercus shumardii*, *Fagus grandifolia*, *Quercus phellos*, *Quercus pagoda*, *Morus rubra* var. rubra, *Carya ovata*, *Carya carolinae-septentrionalis*, *Catalpa bignonioides*, *Populus deltoides*, *Acer saccharinum*, *Celtis occidentalis*

Subcanopy layer: *Acer negundo*, *Asimina triloba*, *Carpinus caroliniana*, *Acer floridanum*, *Prunus serotina*, *Cornus florida*, *Ulmus rubra*, *Ulmus alata*, *Morus rubra* var. rubra, Crataegus spp., *Ilex opaca*, *Hamamelis virginiana*

Vines/lianas: *Clematis virginiana*, *Toxicodendron radicans*, *Bignonia capreolata*, *Smilax rotundifolia*, *Smilax glauca*, *Smilax bona-nox*, *Smilax tamnoides*, *Parthenocissus quinquefolia*, *Vitis rotundifolia*, *Vitis vulpina*, *Vitis cinerea* var. baileyana, *Trachelospermum difforme*, *Passiflora lutea*, *Menispermum canadense*, *Vitis riparia*, *Lonicera japonica* (I), *Clematis terniflora* (I), *Dioscorea oppositifolia* (I),

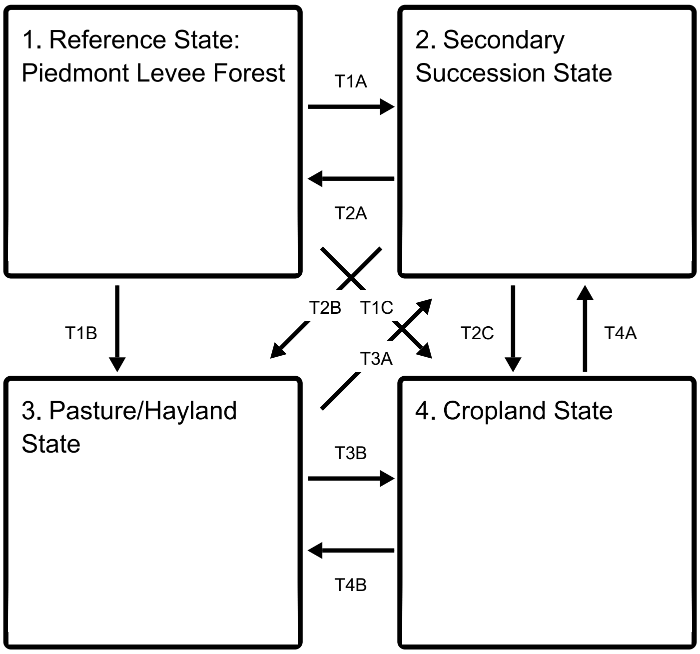
Shrub layer: *Asimina triloba*, *Arundinaria gigantea*, *Lindera benzoin*, *Ilex decidua*, *Aesculus sylvatica*, *Viburnum prunifolium*, *Symphoricarpos orbiculatus*, *Xanthorhiza simplicissima*, *Ptelea trifoliata*, *Hypericum hypericoides* ssp. multicaule, *Hypericum punctatum*, *Amorpha fruticosa*, *Ligustrum sinense* (I), *Rosa multiflora* (I), Herb layer - forbs: *Osmorhiza longistylis*, *Boehmeria cylindrica*, *Verbesina alternifolia*, *Galium aparine*, *Laportea canadensis*, *Geum canadense*, *Sanicula canadensis*, *Rudbeckia laciniata*, *Polygonum virginianum*, *Viola striata*, *Amphicarpaea bracteata*, *Ambrosia trifida*, *Asarum canadense*, *Cryptotaenia canadensis*, *Verbesina occidentalis*, *Galium triflorum*, *Polystichum acrostichoides*, *Podophyllum peltatum*, *Rumex altissimus*, *Scutellaria ovata*, Circaea canadensis, *Corydalis flavula*, *Solidago caesia*, *Ranunculus recurvatus*, *Allium canadense*, *Arisaema dracontium*, *Pilea pumila*, *Thalictrum thalictroides*, *Dicliptera brachiata*, *Claytonia virginica*, *Acalypha rhomboidea*, *Glechoma hederacea* (I), Steleria media (I), *Duchesnea indica* (I), *Youngia japonica* (I)

Herb layer - graminoids: *Chasmanthium latifolium*, *Elymus virginicus*, *Cinna arundinacea*, Carex spp. (grayi, radiata, blanda, amphibola, corrugata, etc.), *Poa autumnalis*, *Poa cuspidata*, *Festuca subverticillata*, *Bromus pubescens*, *Poa sylvestris*, *Melica mutica*, *Dichanthelium commutatum*, *Dichanthelium dichotomum*, *Agrostis perennans*, *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.

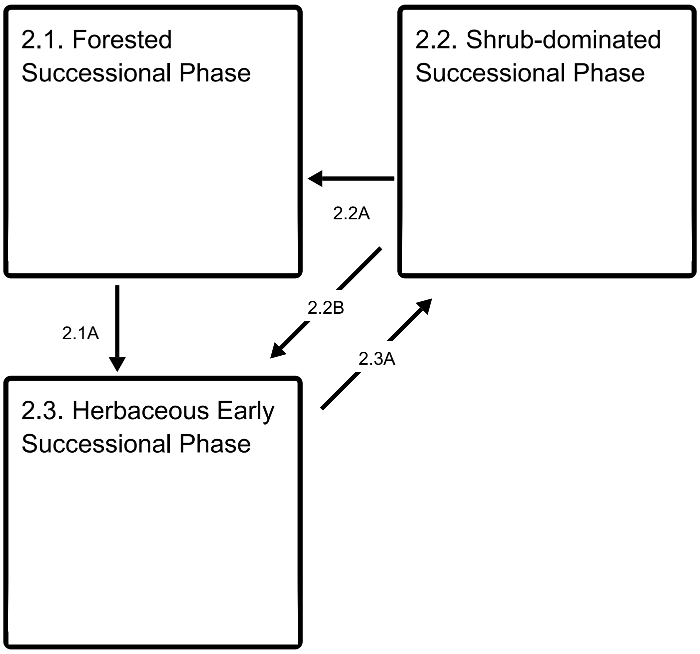
T3A - Long-term cessation of grazing.

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



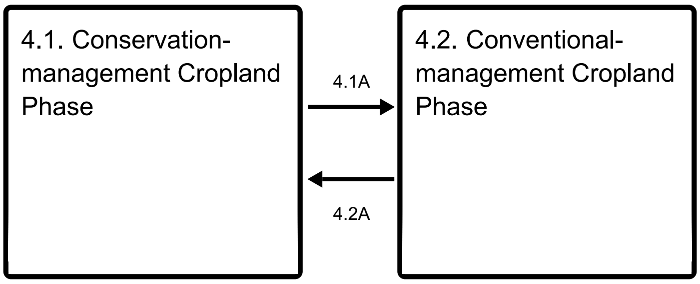
2.1A - Clearcut logging.

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: Piedmont Levee Forest

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, containing a mixture of a large pool of possible species. Bottomland oaks (*Quercus michauxii*, *Q. shumardii*, *Q. nigra*, *Q. phellos*, *Q. pagoda*) 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

- sugarberry (*Celtis laevigata*), tree
- American elm (*Ulmus americana*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- American sycamore (*Platanus occidentalis*), tree
- bitternut hickory (*Carya cordiformis*), tree
- black walnut (*Juglans nigra*), tree
- tuliptree (*Liriodendron tulipifera*), tree
- boxelder (*Acer negundo*), tree
- pawpaw (*Asimina triloba*), tree
- American hornbeam (*Carpinus caroliniana*), tree
- pawpaw (*Asimina triloba*), shrub
- giant cane (*Arundinaria gigantea*), shrub
- northern spicebush (*Lindera benzoin*), shrub
- possumhaw (*Ilex decidua*), shrub
- painted buckeye (*Aesculus sylvatica*), shrub
- blackhaw (*Viburnum prunifolium*), shrub
- devil's darning needles (*Clematis virginiana*), shrub
- eastern poison ivy (*Toxicodendron radicans*), shrub
- crossvine (*Bignonia capreolata*), shrub
- greenbrier (*Smilax*), shrub
- Indian woodoats (*Chasmanthium latifolium*), grass
- Virginia wildrye (*Elymus virginicus*), grass
- sweet woodreed (*Cinna arundinacea*), grass
- Gray's sedge (*Carex grayi*), grass
- eastern star sedge (*Carex radiata*), grass
- eastern woodland sedge (*Carex blanda*), grass
- eastern narrowleaf sedge (*Carex amphibola*), grass
- autumn bluegrass (*Poa autumnalis*), grass
- early bluegrass (*Poa cuspidata*), grass
- nodding fescue (*Festuca subverticillata*), grass
- hairy woodland brome (*Bromus pubescens*), grass
- longstyle sweetroot (*Osmorhiza longistylis*), other herbaceous
- smallspike false nettle (*Boehmeria cylindrica*), other herbaceous
- wingstem (*Verbesina alternifolia*), other herbaceous

- stickywilly (*Galium aparine*), other herbaceous
- Canadian woodnettle (*Laportea canadensis*), other herbaceous
- white avens (*Geum canadense*), other herbaceous
- Canadian blacksnakeroot (*Sanicula canadensis*), other herbaceous
- jumpseed (*Polygonum virginianum*), other herbaceous
- cutleaf coneflower (*Rudbeckia laciniata*), other herbaceous
- striped cream violet (*Viola striata*), 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. Unlike mature levee 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 American sycamore (Platanus occidentalis), green ash (Fraxinus pennsylvanica), box elder (Acer negundo), sweetgum (Liquidambar styraciflua), tuliptree (Liriodendron tulipifera), and river birch (Betula nigra), among others. 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.

Dominant plant species

- American sycamore (*Platanus occidentalis*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- boxelder (*Acer negundo*), tree
- sweetgum (*Liquidambar styraciflua*), tree
- tuliptree (*Liriodendron tulipifera*), tree
- river birch (*Betula nigra*), tree
- southern catalpa (*Catalpa bignonioides*), tree

- Chinese privet (*Ligustrum sinense*), shrub
- devil's darning needles (*Clematis virginiana*), shrub
- greenbrier (*Smilax*), shrub
- eastern poison ivy (*Toxicodendron radicans*), shrub
- multiflora rose (*Rosa multiflora*), shrub
- northern spicebush (*Lindera benzoin*), shrub
- giant cane (*Arundinaria gigantea*), shrub
- pawpaw (*Asimina triloba*), shrub
- Chinese yam (*Dioscorea oppositifolia*), shrub
- sweet autumn virginsbower (*Clematis terniflora*), shrub
- Nepalese browntop (*Microstegium vimineum*), grass
- Virginia wildrye (*Elymus virginicus*), grass
- Indian woodoats (*Chasmanthium latifolium*), grass
- Gray's sedge (*Carex grayi*), grass
- eastern star sedge (*Carex radiata*), grass
- eastern woodland sedge (*Carex blanda*), grass
- rosette grass (*Dichanthelium*), grass
- ground ivy (*Glechoma hederacea*), other herbaceous
- common chickweed (*Stellaria media*), other herbaceous
- stickywilly (*Galium aparine*), other herbaceous
- wingstem (*Verbesina alternifolia*), other herbaceous
- smallspike false nettle (*Boehmeria cylindrica*), other herbaceous
- white avens (*Geum canadense*), other herbaceous
- Indian strawberry (*Duchesnea indica*), other herbaceous
- Canadian blacksnakeroot (*Sanicula canadensis*), other herbaceous

Community 2.2
Shrub-dominated Successional Phase

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

Dominant plant species

- boxelder (*Acer negundo*), tree
- tuliptree (*Liriodendron tulipifera*), tree
- sweetgum (*Liquidambar styraciflua*), tree
- winged elm (*Ulmus alata*), tree
- black cherry (*Prunus serotina*), tree
- tree of heaven (*Ailanthus altissima*), tree
- silktree (*Albizia julibrissin*), tree
- Chinese privet (*Ligustrum sinense*), shrub
- blackberry (*Rubus*), shrub
- devil's darning needles (*Clematis virginiana*), shrub

- greenbrier (*Smilax*), shrub
- multiflora rose (*Rosa multiflora*), shrub
- Japanese honeysuckle (*Lonicera japonica*), shrub
- eastern poison ivy (*Toxicodendron radicans*), shrub
- giant cane (*Arundinaria gigantea*), shrub
- Japanese hop (*Humulus japonicus*), shrub
- Virginia wildrye (*Elymus virginicus*), grass
- Nepalese browntop (*Microstegium vimineum*), grass
- deertongue (*Dichanthelium clandestinum*), grass
- wingstem (*Verbesina alternifolia*), other herbaceous
- yellow crownbeard (*Verbesina occidentalis*), other herbaceous
- smallspike false nettle (*Boehmeria cylindrica*), other herbaceous
- dogfennel (*Eupatorium capillifolium*), 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 spotted field bindweed (*Convolvulus arvensis*), cutleaf evening primrose (*Oenothera laciniata*), Oriental false hawksbeard (*Youngia japonica*), Carolina horsenettle (*Solanum carolinense*), common chickweed (*Stellaria media*), great ragweed (*Ambrosia trifida*), Indian strawberry (*Duchesnea indica*), hairy white oldfield aster (*Symphyotrichum pilosum*), partridge pea (*Chamaecrista fasciculata*), Virginia dwarfdandelion (*Krigia virginica*), vente conmigo (*Croton glandulosus*), Virginia pepperweed (*Lepidium virginicum*), forked bluecurls (*Trichostema dichotomum*), clasping Venus' looking-glass (*Triodanis perfoliata*), poorjoe (*Diodia teres*), Virginia plantain (*Plantago virginica*), sleepy silene (*Silene antirrhina*), pale dock (*Rumex altissimus*), ground ivy (*Glechoma hederacea*), 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
- Japanese honeysuckle (*Lonicera japonica*), shrub
- sweet autumn virginsbower (*Clematis terniflora*), shrub

- Nepalese browntop (*Microstegium vimineum*), grass
- deertongue (*Dichanthelium clandestinum*), grass
- Virginia wildrye (*Elymus virginicus*), grass
- broomsedge bluestem (*Andropogon virginicus*), grass
- crabgrass (*Digitaria*), grass
- field paspalum (*Paspalum laeve*), grass
- dogfennel (*Eupatorium capillifolium*), other herbaceous
- Canadian horseweed (*Conyza canadensis*), other herbaceous
- annual ragweed (*Ambrosia artemisiifolia*), other herbaceous
- stickywilly (*Galium aparine*), other herbaceous
- crownbeard (*Verbesina*), other herbaceous
- Canada goldenrod (*Solidago altissima*), other herbaceous
- American pokeweed (*Phytolacca americana*), other herbaceous
- spotted beebalm (*Monarda punctata*), other herbaceous
- slender scratchdaisy (*Croptilon divaricatum*), other herbaceous
- great ragweed (*Ambrosia trifida*), 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. This ecological site is subject to regular overbank flooding, particularly in late winter and early spring. Landowners will need access to additional pasture or housing that is not subject to flooding, on which to move livestock during the cooler months.

Dominant plant species

- Bermudagrass (*Cynodon dactylon*), grass
- Johnsongrass (*Sorghum halepense*), 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.

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
- 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
- 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):**

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment**

and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:

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17. **Perennial plant reproductive capability:**
