

Ecological site F148XY026PA

Moist, High Base-Saturation, Upland, Mixed Oak - Hickory - Conifer Forest

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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): 148X–Northern Piedmont

This ecological site description was developed for the Northern Piedmont Major Land Resource Area (MLRA) 148 as defined by USDA Handbook 296. The Northern Piedmont is a major land resource area within the North Atlantic Slope Diversified Farming Land Resource Region (LRR). The Northern Piedmont MLRA extends from northeast to southwest for approximately 325 miles (525 km) and is approximately 100 miles (160 km) inland from the Atlantic coast. It is approximately 12,800 square miles (33,150 square kilometers) and is spread across portions of Virginia (30%), Maryland (21%), Pennsylvania (38%), Delaware (1%), and New Jersey (10%) (USDA-NRCS, 2006).

Most of the land in the Northern Piedmont is privately owned. Farming is highly diversified, and common crops include truck crops, horticultural trees, fruits, soybeans, grain, forage, poultry, beef, and dairy cattle. The Washington D.C. to Boston “megapolopolis” development corridor dominates an important extent of the land (1/3 or more), and urban areas are encroaching on farmland and woodlands across the region. The remaining forests commonly are on steep slopes, rocky soils, or riparian zones where both agriculture and development are difficult (USDA-NRCS, 2006; Woods et al., 1999).

The extent to which indigenous peoples altered the precolonial vegetation of the region is unclear. Some evidence indicates that savannah-like woodlands and grasslands occupied portions of the Northern Piedmont at the onset of European settlement. The evidence suggests that the indigenous communities may have used fire as a land-management tool.

The vegetation communities across the Northeast began experiencing significant influences from European settlers in approximately 1650. These influences included widespread agricultural land clearing, forest harvesting, charcoal production, and the introduction of exotic species, insects, and disease vectors, especially chestnut blight. The loss of American chestnut has been significant across the entire eastern United States. This loss, however, may be less ecologically significant in portions of the Northern Piedmont. For example, little evidence exists to suggest that American chestnut was an important constituent of forests growing on soils derived from carbonate parent materials (Virginia DCR, 2016).

The acreage of forest across the Northern Piedmont reached its low in the mid-nineteenth century. The acreage then increased as agriculture expanded to the Midwest and industrialization concentrated populations into urban areas. The Northern Piedmont includes some of the most productive farmland in the East, so farm abandonment was not as common in MLRA 148 as in other parts of the Northeast. Regionally, widespread farm abandonment led to a trend of reforestation. The recovering forest appears to have included all native forest species, with the notable exception of American chestnut. The proportions, however, were different (maples are notably more common) and more homogenous. The current forest vegetation communities in the Northern Piedmont likely do not show the same level of sorting by local climatic and edaphic factors as influenced precolonial forest composition. Urban sprawl is once again removing land from vegetation cover, but, in the Northern Piedmont, this impact is on both forested and agricultural lands. Additionally, the continued and increasing introduction of exotic and invasive plants, insects, and disease vectors remains a profound threat to forest stability (Thompson et al., 2013).

In the Northern Piedmont, *Pinus virginiana* (Virginia pine) and *Liriodendron tulipifera* (tulip-poplar) are common early-successional forest pioneers, especially on uplands. The composition of the more mature forest stands tends to vary with soils, topography, and succession. Dry, nutrient poor sites tend to be dominated by an oak-heath forest community. More mesic sites on soils that have a more basic chemistry tend to support an oak-hickory forest cover. *Quercus alba* (white oak) is a relative generalist, and it is a common component in all types of upland oak forest of the Northern Piedmont. *Quercus rubra* (northern red oak) and *Quercus velutina* (black oak) commonly join the overstory on mesic and submesic sites. *Quercus montana* (chestnut oak), *Quercus coccinea* (scarlet oak), and *Quercus falcata* (southern red oak) prefer drier sites. *Quercus stellata* (post oak) and *Quercus marilandica* var. *marilandica* (blackjack oak) tend to do well on the most drought-prone sites.

Carya (hickories) show a preference for sites that have a higher base saturation, so they are common in both the overstory and understory of the more basic oak-hickory types. Overall species richness tends to be higher on these higher base saturation sites as well. Common constituents include *Carya ovata* (shagbark hickory), *Fraxinus americana* (white ash), and *Cercis canadensis* var. *canadensis* (eastern redbud). Ericaceous (heather) shrubs tend to be absent on these alkaline sites, but herbaceous species richness tends to be high. Hickories are also common on intermediate oak-hickory sites. The understories, however, are more dominated by *Cornus florida* (flowering dogwood), *Viburnum acerifolium* (mapleleaf viburnum), and dry-mesophytic herbaceous generalists.

Most oak-heath forests support few hickories and have few herbaceous species in the understory. These forest communities tend to have an understory dominated by *Acer rubrum* (red maple), *Nyssa sylvatica* (blackgum), and deciduous ericad (plants that dislike alkaline soils) shrubs, such as *Vaccinium pallidum* (early lowbush blueberry), *Gaylussacia baccata* (black huckleberry), and other heathers (Virginia DCR, 2016).

In cool, moist ravines that have acidic soils, a mesic mixed hardwood forest of American beech (*Fagus grandifolia*), white oak, northern red oak, and tulip-poplar is common. This forest community is thought to be replacing upland oak-hickory forests in many areas where fire has been excluded for long periods or where oak recruitment has declined for other reasons (Zimmerman et al., 2011). In cool, moist ravines that have more mafic or calcareous substrates, similar mesic mixed hardwood forests also commonly include *Fraxinus americana* (white ash), *Carya cordiformis* (bitternut hickory), *Tilia americana* (basswood), *Quercus muehlenbergii* (chinquapin oak), *Acer saccharum* (sugar maple), and dense, species-rich understories where overstory shade is not too extreme.

Riparian forests and flood-plain forests grow widely across the Northern Piedmont. Along larger rivers, these forests tend to be dominated by flood-tolerant trees, such as *Acer saccharinum* (silver maple), *Platanus occidentalis* (sycamore), *Ulmus americana* (American elm), *Acer negundo* (eastern boxelder), *Celtis occidentalis* (common hackberry), and *Betula nigra* (river birch). In high energy environments, these flood-plain forest types are commonly broken by flood-scoured deposition bars, outcrops, and early successional vegetation communities. Along stretches that do not flood as deeply, hydrophytic oaks—such as *Quercus palustris* (pin oak), *Quercus bicolor* (swamp white oak), *Quercus phellos* (willow oak), *Quercus lyrata* (overcup oak), and *Quercus michauxii* (swamp chestnut oak)—may dominate the overstory, and *Carex* (sedges) commonly form large, dense understory communities.

Some additional minor, small-patch forest types (such as eastern white pine-hardwood types and eastern hemlock-hardwood types) and some rock outcrop barrens are scattered across the Northern Piedmont in isolated areas. The eastern hemlock ecological communities are much more consistent with the MLRA concepts of the Northern Blue Ridge and the Ridge and Valley. In the Northern Piedmont, the eastern hemlock communities are thought to represent the last vestiges of a community that is migrating to cooler sites in response to global climate change over the past several thousand years (Virginia DCR, 2016).

Classification relationships

Several modern classification systems for vegetation are used across the United States. The Federal Geographic Data Committee suggests that the U.S. National Vegetation Classification (USNVC) should be the Federal standard. An analysis of the existing vegetation cover using the U.S. Geological Survey, Gap Analysis Program (2011) indicates that the natural vegetation areas in the Northern Piedmont MLRA are predominantly Appalachian-Northeastern Oak-Hardwood-Pine Forest and Woodland (USNVC Macrogroup, 502). A few additional USNVC macrogroups are also present. On a finer scale, USNVC Groups 15 and 650 dominate nearly all site types across the MLRA. This dominance supports the theory that extreme anthropogenic disturbances near the turn of the century significantly homogenized the forests of this region. At any specific field site, existing vegetation may not be

a good indication of the best suited potential vegetation. Representative USNVC groups are listed for each ecological site. Groups have been identified by analyzing both existing vegetation cover indicated by GAP/Landfire (USGS, 2011) as well as the vegetation inventory data from the Natural Heritage programs.

The Northern Piedmont MLRA as defined in USDA Handbook 296 (USDA-NRCS, 2006) very nearly matches the Northern Piedmont Level III Ecoregion as defined by the U.S. Environmental Protection Agency. The U.S. EPA Level III Ecoregions have also been further subdivided into Level IV Ecoregions. Within MLRA 148 Northern Piedmont, the EPA Level IV Ecoregions are:

- Triassic Lowlands
- Trap Rock (Diabase) and Conglomerate Uplands
- Piedmont Uplands
- Piedmont Limestone/Dolomite Lowlands
- Passaic Basin Freshwater Wetlands

These Level IV Ecoregions explain much of the ecological variation across the MLRA and have been used extensively to assist with defining the Ecological Sites.

Triassic Lowlands

The Triassic Lowlands are dominated by Alfisols derived from Triassic sedimentary rocks. These soils are relatively fertile and typically have a moderate to high level of base saturation in the subsoil. The landscape is comparatively flat and is not highly dissected. The region is characterized by wide undulating ridges; broad, nearly level valleys; and limited local relief. Streams and wetlands are important in the Triassic Lowlands. Wetlands are becoming rarer, especially adjacent to the urban sprawl of megalopolis (Woods et al., 1999).

Trap Rock and Conglomerate Uplands

The Trap Rock and Conglomerate Uplands are often also referred to as the Diabase and Conglomerate Uplands. Trap rock is a common term for diabase and other mafic igneous intrusions. This landscape was developed during the Triassic and Jurassic eras as diabase sills, and dikes intruded the sedimentary rocks of the surrounding Triassic Lowlands. The landscape is characterized by wooded, stony hills and steep ridges underlain by a mixture of highly resistant rocks rising relatively sharply above the Triassic Lowlands. The soils are mostly thin (shallow), fine-textured, clayey, non-acidic Alfisols that are hard to till and best suited to forest or pasture. The forests of these uplands are somewhat distinct from those of the rest of the Northern Piedmont because acid loving plants are largely absent, especially on soils derived from diabase. Woodlands continue to be comparatively common in this landscape, especially on steep slopes and in areas where surface rocks and boulders are common (Woods et al., 1999).

Piedmont Uplands

The Piedmont Uplands are dominated by deep Ultisols and Inceptisols that developed from crystalline bedrock. The Piedmont Uplands have substantially higher relief than the Triassic Lowlands. The region is characterized by rounded hills, low ridges, and narrow valleys. The eastern edge of the piedmont creates a relatively abrupt “fall line” as the landscape drops down to the adjacent sediments of the coastal plain. The drop includes high stream gradient, waterfalls, and exposed bedrock. Due to the mixed source materials, the mineralogy of the soils of the Piedmont Uplands varies. The typical piedmont upland is comprised of soils derived from felsic crystalline rocks, but some piedmont soils are derived from more mafic rocks. Some locations have chrome soils derived from ultra-mafic serpentine, which is low in calcium but high in magnesium, chromium, and nickel. Variations in geologic parent material commonly create soils that support corresponding variations in vegetation communities. Serpentine soils support unique “barrens” vegetation communities of oak and pine, greenbrier, and prairie grass (Woods et al., 1999).

Piedmont Limestone/Dolomite Lowlands

The Piedmont Limestone/Dolomite Lowlands are comprised of Hapludalfs derived from carbonate bedrock. Hapludalfs are soils that have a horizon of clay accumulation with a significant decrease in clay content within a depth of 150 centimeters. The soils are potentially highly fertile. The carbonate bedrock weathered to create a landscape of undulating terrain that includes karst features, such as sinkholes, caves, and underground streams. Nearly all the forests on these carbonate lowlands have been replaced by agriculture. This is one of the most productive farming regions of the eastern United States. The predominant natural vegetation community is oak forests dominated by red oak and white oak, but the flora on these basic carbonate soils is distinct from the heath communities on the acidic and less fertile soils of the surrounding areas (Woods et al., 1999).

The Northern Piedmont (MLRA 148) is within the U.S. Forest Service Eastern Broadleaf Forest Province (biome). The Eastern Broadleaf Forest Province is mesophytic and dominated by the drought-resistant oak-hickory forest association, which includes *Quercus alba* (white oak), *Quercus rubra* (northern red oak), *Quercus falcata* (southern red oak), *Quercus velutina* (black oak), *Carya cordiformis* (bitternut hickory), and *Carya ovata* (shagbark hickory). It has well-developed understories of *Cornus* spp. (dogwood), *Sassafras albidum* (sassafras), and *Carpinus* spp. and *Ostrya* spp. (hornbeam). *Ulmus americana* (American elm), *Liriodendron tulipifera* (tuliptree), and *Liquidambar styraciflua* (sweetgum) are common on somewhat richer sites (Bailey, 1995).

As defined by USDA (USDA-NRCS, 2006), MLRA 148, the Northern Piedmont, coincides well with the U.S. Forest Service ecological section the Northern Appalachian Piedmont. The northwest corner of MLRA 148 also includes a small portion of the Lower New England ecological section (the Reading Prong), where some glacial landforms intermingle with typical piedmont landforms. The main cover types in Northern Appalachian Piedmont Section, as defined by the U.S. Forest Service, are oak-hickory and loblolly-shortleaf pine (McNab et al., 2007).

U.S. Forest Service ecological subsections that coincide with MLRA 148 include the Reading Prong Subsection of the Lower New England Section, the Gettysburg Piedmont Lowland, the Northern Piedmont, the Piedmont Upland, and the Triassic Basins. Note the high level of coincidence between the U.S. Forest Service ecological subsections and the EPA level IV ecoregions.

Ecological site concept

This site is in areas of soils that have a relatively high base saturation derived from either mafic or calcareous parent materials. It is commonly on lower slopes, on back slopes, and in ravines where soils are relatively deep and sites are protected from exposure. This site is also on some uplands where sufficient soil moisture is available for plants to resist drought (Zimmerman et al., 2012). The vegetation community on this site occurs in two distinct phases: a Rich Phase, which is specific to the high base saturation of mafic and calcareous soils, and a Generalist Phase, which consists of communities that are tolerant of the rich sites but do not necessarily require that specific soil chemistry.

This ecological site corresponds with:

US National Vegetation Classification (USGS, 2011)

- Dominant: Oak-Hickory (USNVC Groups 15 and 650)
- (Mesic) Hardwood and Hardwood-Conifer (USNVC Groups 20, 742, and 743)
- Alkaline Open Glade and Barrens (USNVC Group 179)

Related Types

The rich phase of this site is closely related to the mesic generalist phase. They share many species, but the mesic generalist phase is more widespread, has a broader ecological range, and is typically dominated by oaks and hickories. The dominance of beech, tulip, and maple and the near-absence of heaths, such as *Gaultheria procumbens* (teaberry) and *Kalmia latifolia* (mountain laurel), distinguish the rich phase forests from the oak-dominated mesic generalist phase. In sites that have a conifer component, *Pinus strobus* (eastern white pine) is in the mesic generalist phase. This species is largely absent from the rich phase.

Diagnostic:

Plants that are diagnostic of basic oak-hickory forests in the Piedmont include *Carya ovata* (shagbark hickory), *Fraxinus americana* (white ash), *Cercis canadensis* (eastern redbud), *Actaea racemosa* (black bugbane), *Chrysogonum virginianum* (green and gold), *Salvia urticifolia* (nettleleaf sage), *Triosteum angustifolium* (lesser horse-gentian), *Ruellia purshiana* (Pursh's wild petunia), and *Muhlenbergia sobolifera* (rocky muhly) (Virginia DCR, 2016). Species such as *Magnolia tripetala* (umbrella magnolia), *Asimina triloba* (pawpaw), *Staphylea trifolia* (bladdernut), *Corydalis flavula* (yellow fumewort), *Sanguinaria canadensis* (bloodroot), and *Dicentra* (Dutchman's breeches and squirrel corn) are more typical of the richest sites within this group (Zimmerman et al., 2012).

Associated sites

F148XY024PA	Moist, Piedmont - felsic, Upland, Mixed Oak - Hardwood - Conifer Forest It is believed that mesic upland sites on mafic and calcareous geologic parent materials are significantly different from mesic upland sites on typical felsic piedmont geologic parent materials. The significance of this difference is diminished with positive increase in soil moisture status, so the differences are strongest on the driest sites.
F148XY025PA	Moist, Triassic, Upland, Mixed Oak - Hardwood - Conifer Forest It is believed that mesic upland sites on mafic and calcareous geologic parent materials are significantly different from mesic upland sites on Triassic geologic parent materials. The significance of this difference is diminished with positive increase in soil moisture status, so the differences are strongest on the driest sites.
F148XY034PA	Moist, Ultra-Mafic, Upland, Serpentine Barrens Complex It is believed that mesic upland sites on ultramafic (e.g. serpentine) geologic parent materials are significantly different from mesic upland sites on all other geologic parent materials. The significance of this difference is diminished with positive increase in soil moisture status, so the differences are strongest on the driest sites.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Physiographic features

The Northern Piedmont (MLRA 148) is surrounded by the Northern Appalachian Ridges and Valleys (MLRA 147), the Northern Blue Ridge (MLRA 130A), the Northern Coastal Plain (MLRA 149A), the Southern Piedmont (MLRA 136), and the New England and eastern New York Uplands (MLRA 144A). From the northwest to southeast, the landscape transitions between three dominant physiographic regions: mountains, piedmont, and coastal plain. This transition is much narrower across the Northern Piedmont than across the Southern Piedmont. The Northern Piedmont has a cooler climate than the Southern Piedmont (MLRA 136). The Northern Piedmont also has taller intrusive dikes and sills of resistant rocks which, along with differential erosion, have created sharp ridges. These ridges have longer and steeper slopes in 148, and are more common in MLRA 148 than in MLRA 136.

The dominant feature (besides climate) that distinguishes the Northern Piedmont from the ecoregions further to the north is that the Northern Piedmont has never been glaciated (with the minor exception of the Reading Prong area). The glaciated regions to the north are dominated by mineral soils that have not yet differentiated into distinct horizons (Entisols). The Northern Piedmont transitions to the west and northwest into the Northern Blue Ridge (MLRA 130A) and Northern Appalachian Ridges and Valleys (MLRA 147), which have increased mountainous topography, and to the east into the flat sedimentary landscapes of the Northern Coastal Plain (USDA-NRCS, 2006).

The Northern Piedmont is a transitional region between the flat coastal plain to the southeast and the mountains to the northwest. It is comprised of low, rounded hills and open valleys. Along the northeast edge of the MLRA, the low areas are below sea level. Some areas have elevations as low as 165 feet below sea level (-51 meters). In the central and western areas of the Northern Piedmont, the highest elevations rise to 2,125 feet (649 meters). These highest elevations are not typical and are formed by diabase intrusions. Crested elevations typically range from about 325 feet (99 meters) on limestone to 1,300 feet (396 meters) on more resistant crystalline rock (Woods et al., 1999).

As a transition zone between distinctly different ecoregions, the Northern Piedmont is a landscape of diverse landforms. Across the MLRA, less than 5 percent of the landscape is covered by depositional landforms and 75 to 95 percent of the landscape is distinctly erosional.

Landform Percent of MLRA

Flat* 3%

Summit 2%

Ridge 15%

Shoulder 2%
Spur 17%
Slope 30%
Hollow 11%
Footslope 3%
Valley 14%
Depression 2%
* Flat landforms include surface water features

The geology of the Northern Piedmont is highly complex and variable. The eastern boundary of the MLRA marks the “fall line,” that is, the transition from the crystalline bedrock of the interior to the Coastal Plain sediments of the east. The eastern third of the MLRA is dominated by metamorphic gabbro, gneiss, serpentine, marble, slate, and schist as well as intrusive granite. The central portions of the Northern Piedmont are comprised of Triassic period sandstone, shale, and conglomerate basin deposits dissected by Jurassic diabase and basalt dikes and sills. The western portion of the Northern Piedmont includes large areas underlain by limestone (USDA-NRCS, 2006; USGS, 2011).

Areas of metamorphic and igneous bedrock are typically covered by a mantle of soil that formed in residuum (Ultisols) and saprolite that weathered in place. Areas of mixed sedimentary rock are typically derived from sediments deposited in basins created by Mesozoic (Triassic and Jurassic) rift-valley drop blocks. The Culpepper Basin is a typical Triassic basin in the Virginia range of the Northern Piedmont.

Ultisols are the dominant soil order in the Northern Piedmont, but Alfisols and Inceptisols are also widespread and locally dominant. Entisols occur locally in high-energy fluvial and colluvial settings (USDA-NRCS, 2006; Virginia DCR, 2016). Ultisols, Alfisols, Inceptisols, and Entisols are 4 of the 12 orders in the USDA system of soil classification. Ultisols have low base status and a clay-enriched subsoil. Alfisols are naturally fertile and have high base saturation and a clay-enriched subsoil horizon. Inceptisols have a weak, but noticeable degree of horizon development. Entisols have little or no horizon development. Details regarding soil classification are available from the USDA (USDA-NRCS, 2018).

The Ultisols in the Northern Piedmont are commonly leached, acidic, and infertile (deficient in calcium, magnesium, potassium, and total base saturation) and have well-developed, red or yellowish red, clay subsurface horizons. The Alfisols tend to be deep, well-developed, and moderately to highly fertile, especially those soils that have a high base saturation and that formed in material weathered from calcareous or mafic bedrock. The Inceptisols vary highly in texture and composition. In the Northern Piedmont, they are most common on the erosive slopes of the inner (western) Piedmont foothills.

Udalfs, Udults, Udepts, and fragipans are common across the North Atlantic Slope Diversified Farming Region (of which the Northern Piedmont is a sub-division). In low, wet depressions, Aquults and Aquepts are common. Udepts and Fluvents are typically on flood plains and in riparian areas. The soil temperature regime is predominantly mesic. The soil moisture regime is predominantly udic, and the dominant soil mineralogy across the region is micaceous, kaolinitic (Ultisols), or mixed (Alfisols and Inceptisols) (USDA-NRCS, 2006).

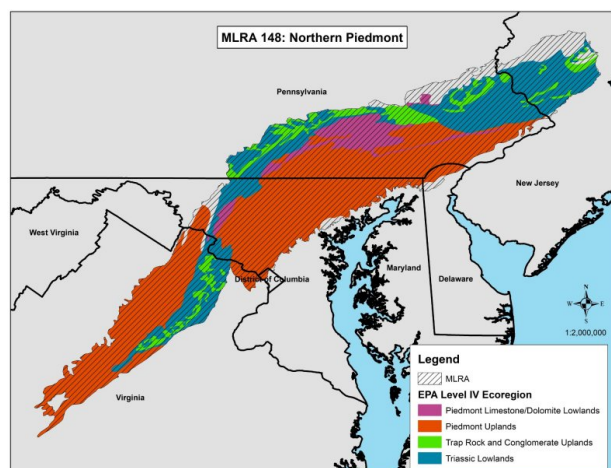


Figure 1. EPA Level IV ecoregions across MLRA 148.

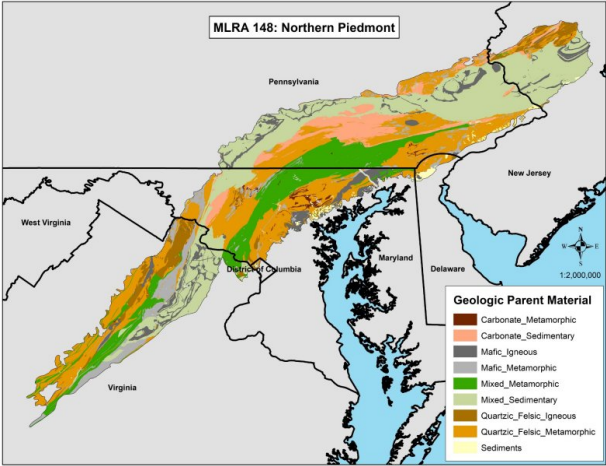


Figure 2. Geologic parent material across MLRA 148.

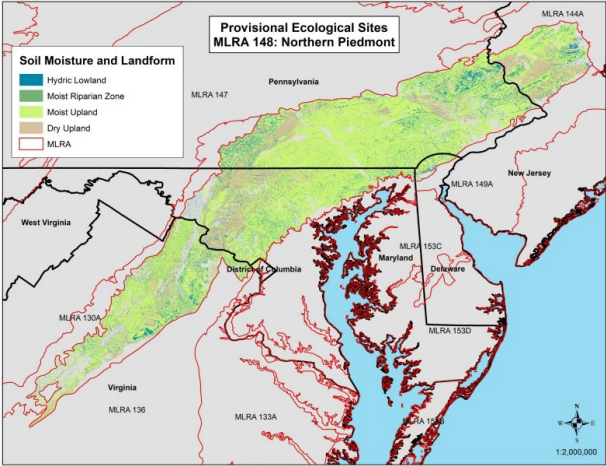


Figure 3. Ecological Site soil moisture and landform groups across MLRA 148.

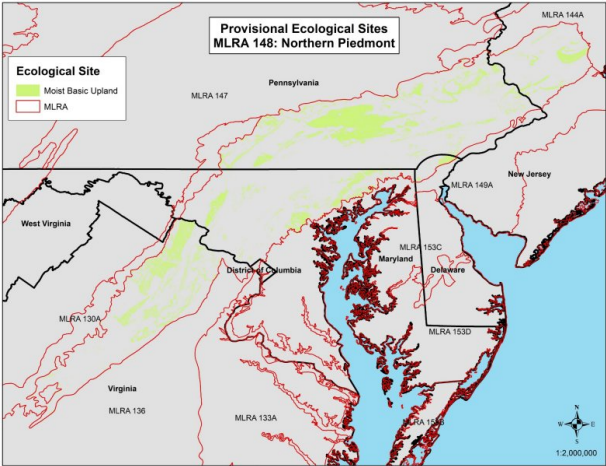


Figure 4. The Moist Basic Upland Ecological Site footprint.

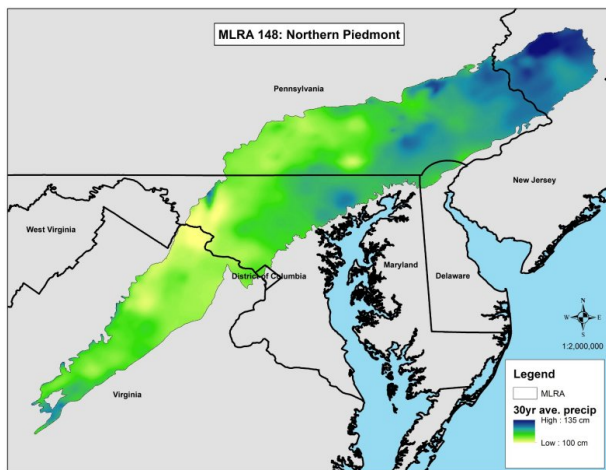


Figure 5. PRISM 30 year mean annual precipitation across MLRA 148.

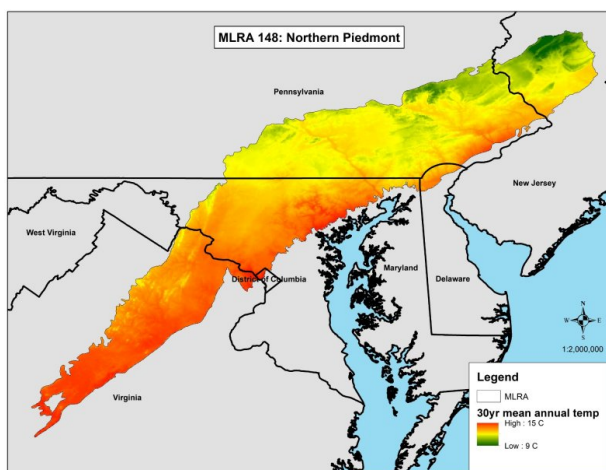


Figure 6. PRISM 30 year mean annual temperature across MLRA 148.

Climatic features

The climate of the Northern Piedmont is humid, temperate, and continental with variable weather patterns across the region. The four seasons are distinctly different. Winters are cold and moist. Occasionally, the jet stream dips south over the Northern Piedmont during the winter, resulting in brief periods of bitter cold. Both spring and fall tend to be cool and wet. Summers are hot, humid, and have short periods of drought that can be interrupted by intense thunderstorms (USDA-NRCS, 2006; Woods et al., 1999).

The average annual precipitation for the Northern Piedmont is 40 to 55 inches (100 to 135 cm). The average is higher in the northern areas of the region and on the eastern edge nearer the Atlantic. Most of the precipitation for this region is received during the spring and fall. Precipitation is moderate in the winter and is mainly from snow. Occasionally, hurricanes and “nor’easters” produce extreme-precipitation events, but the typical maximum-precipitation events occur as high intensity, convective thunderstorms in spring and early summer. Local droughts of 10 to 14 days are common in the region during summer (USDA-NRCS, 2006).

The northern part of the MLRA tends to be on the cooler and wetter end of the range. The southern part tends to be warmer and drier. The average annual temperature in the Northern Piedmont ranges from 48 to 58 degrees Fahrenheit (9 to 14 degrees C). The hottest average temperatures are in the southern parts of the region. The freeze-free period averages 205 days across the region and ranges from 170 to 240 days (USDA-NRCS, 2006).

Precipitation (mm)

Month Min Mean Max

Jan 61 80 97

Feb 59 70 89

March 82 96 113

April 79 93 112

May 96 108 127

June 77 101 125

July 85 111 138
Aug 70 91 116
Sept 95 111 154
Oct 76 95 122
Nov 81 92 111
Dec 68 88 107
Annual 1,009 1,136 1,337

Precipitation (inches)
Month Min Mean Max
Jan 2.4 3.1 3.8
Feb 2.3 2.8 3.5
March 3.2 3.8 4.4
April 3.1 3.7 4.4
May 3.8 4.3 5.0
June 3.0 4.0 4.9
July 3.3 4.4 5.4
Aug 2.7 3.6 4.6
Sept 3.7 4.4 6.1
Oct 3.0 3.7 4.8
Nov 3.2 3.6 4.4
Dec 2.7 3.5 4.2
Annual 39.7 44.7 52.6

Temperature (Celsius)
Month Min Mean Max
Jan -5.3 -0.3 4.6
Feb -4.2 1.2 6.5
March -0.4 5.5 11.4
April 5.0 11.4 17.9
May 10.2 16.6 23.0
June 15.4 21.6 27.7
July 18.0 24.0 29.9
Aug 17.1 23.1 29.0
Sept 12.9 19.1 25.2
Oct 6.5 12.8 19.0
Nov 1.7 7.4 13.0
Dec -3.0 1.9 6.7
Annual 6.2 12.0 20.5

Temperature (Fahrenheit)
Month Min Mean Max
Jan 23 31 40
Feb 25 34 44
March 31 42 52
April 41 53 64
May 50 62 73
June 60 71 82
July 64 75 86
Aug 63 74 84
Sept 55 66 77
Oct 44 55 66
Nov 35 45 55
Dec 27 35 44
Annual 43 54 69

Table 2. Representative climatic features

Frost-free period (actual range)	
Freeze-free period (actual range)	
Precipitation total (actual range)	40-53 in
Frost-free period (average)	
Freeze-free period (average)	205 days
Precipitation total (average)	45 in

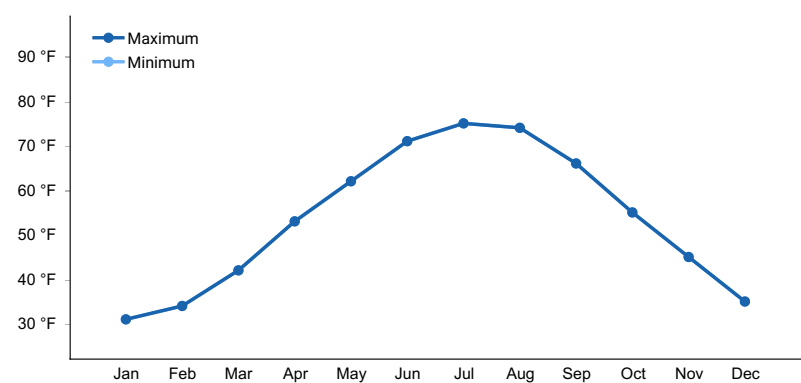


Figure 7. Monthly average minimum and maximum temperature

Influencing water features

Fresh surface water is abundant in this region, and groundwater springs are common. Abundant precipitation, numerous perennial streams, and good aquifers provide ample supplies of fresh water. Surface water quality is marginal but generally sufficient for all uses across the region. It can be good for public supply if treated properly. Many streams and rivers have been degraded by sedimentation, mining waste, and municipal and industrial discharges.

Major rivers in the Northern Piedmont include the Delaware River, which separates Pennsylvania and Delaware from New Jersey; the Susquehanna River; and the Potomac River, which separates Washington D.C. and Maryland from Virginia. The Susquehanna River valley is unique in this ecoregion because the river is large and incised with local relief as high as 590 feet (180 m) along the valley margins. Gorges flowing into the Susquehanna contain high-gradient streams and waterfalls, including Otter Creek, Tucquan Glen, Wildcat Run, Counselman Run, Kelly Run, Ferncliff Run, and Oakland Run. The Northern Piedmont also includes several National Wild and Scenic Rivers, including the Schuylkill, Octoraro, Patuxent, Monocacy, and Rappahannock Rivers and Goose Creek and Deer Creek (USDA-NRCS, 2006; Woods et al., 1999).

Soil features

Representative soil components on this ecological site include:

- Adamstown
- Alanthus
- Amwell
- Bedington
- Benevola
- Buckeystown
- Clarksburg
- Conestoga
- Duffield
- Dyke
- Elk
- Hagerstown

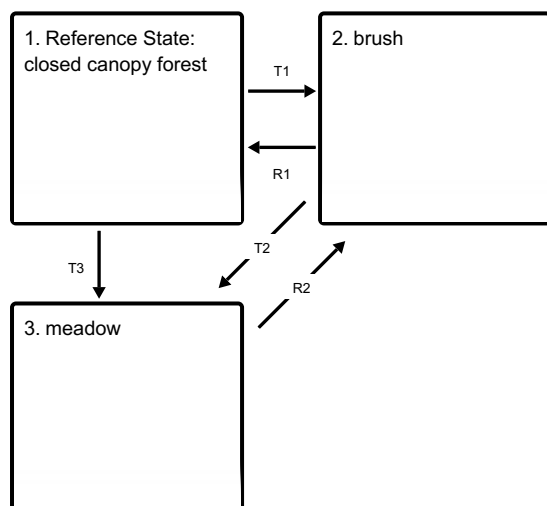
Haymarket
Hollinger
Jackland
Legore
Letort
Lew
Mine Run
Minnieville
Montalto
Mount Lucas
Neshaminy
Penlaw
Pequea
Purcellville
Relay
Swampoodle
Talleyville
Turbotville
Walkersville
Wiltshire

Ecological dynamics

Succession proceeds quickly to forest. The reference state for this ecological site is forest because soil moisture conditions are sufficient to resist (or prevent) extreme moisture stress under normal precipitation patterns. Grasslands are highly transient, rarely occur without a significant shrub component, and typically occur as small disturbance derived openings within the forest matrix. Woody invasion can be slowed by microclimate (frost pockets), frequent fire, or other disturbances, but succession typically proceeds quickly to forest. Conifers may be scattered, locally abundant, and dominant in the subcanopy. In some areas, eastern white pine forms a relict supracanopy or grows up through large gaps in the canopy. The herbaceous layer is commonly sparse because of the dense canopy cover and the thick litter of resistant oak and ericad leaves (Zimmerman et al., 2012).

State and transition model

Ecosystem states



State 1 submodel, plant communities

1.1. Mesic Basic
Upland Rich Forest
Phase

1.2. Mesic Upland
Generalist Forest
Phase

1.3. Vernal Pool Phase

State 1

Reference State: closed canopy forest

Closed canopy forests are the reference state on moist sites across the Northern Piedmont. Classic succession proceeds relatively quickly through the meadow and brush states to a forest state, and closed canopy forests are relatively persistent on these sites. The composition and structure of closed canopy forests are variable, dynamic, and largely dependent on disturbance history as well as the silvics of tree species present on the site or nearby. Closed canopy forests on this site typically occur in one of two general phases: - Mesic Upland Heath Phase - Mesic Upland Generalist Forest Phase Both phases are described in detail in the community phases sub-model

Resilience management. There are many threats to the health of forests across the Northern Piedmont including invasive plants, insects, and diseases as well as changing weather patterns including both wind and precipitation in particular. These threats can have a profound impact on the composition, structure, and ecological function of forest stands, but the forest state itself is highly resilient on these sites. The impacts of individual disturbance vectors can potentially be reduced through: - overstory stocking management and quality tree retention - managing for a variety of tree species - managing for a variety of tree ages - controlling invasive species - managing for advance regeneration

Community 1.1

Mesic Basic Upland Rich Forest Phase

The Northern Piedmont MLRA as a whole is dominated by the Oak-Hickory group (USNVC 2.01, 2016), but this does not mean that representative oaks or hickories are on all sites. The cover-type expressions of this ecological site group vary. *Quercus rubra* (northern red oak) and *Quercus velutina* (black oak) tend to be more important in the drier areas within this ecological site group. *Quercus alba* (white oak) is ubiquitous. Although the species composition is very mixed, the most consistent tree species are *Acer rubrum* (red maple) and *Liriodendron tulipifera* (tuliptree). *Fagus grandifolia* (American beech) is common and, where present, is commonly codominant. Other commonly associated trees include *Carya ovata* (shagbark hickory), *Carya cordiformis* (bitternut hickory), *Carya tomentosa* (mockernut hickory), *Nyssa sylvatica* (blackgum), *Betula lenta* (sweet birch), *Betula alleghaniensis* (yellow birch), *Fraxinus Americana* (white ash), *Cercis canadensis* (eastern redbud), *Prunus serotina* (wild black cherry), *Tilia americana* (basswood), *Quercus muehlenbergii* (chinquapin oak), and *Acer saccharum* (sugar maple). *Tsuga canadensis* (eastern hemlock) grows on some sites. It may be either a minor or dominant component (Virginia DCR, 2016; USNVC 2.01, 2016; USGS, 2011; Zimmerman et al., 2012). In many places, the herb and shrub flora are dense and well developed with a wide variety of species. *Rhododendron maximum* (rosebay), *Hamamelis virginiana* (witchhazel), and *Lindera benzoin* (spicebush) are abundant on many sites. A dense understory of *Asimina triloba* (common pawpaw) is common. Other common species include viburnum spp., *Carpinus caroliniana* (hornbeam), *Cornus florida* (flowering dogwood), *Ostrya virginiana* (hophornbeam), and *Staphylea trifolia* (bladdernut). *Magnolia tripetala* (umbrella magnolia) is not uncommon (Zimmerman et al., 2012). Areas that are under a hardwood canopy and are not overbrowsed can have a dense cover of shrubs or herbs. Herb and shrub cover tend to be less dense under hemlock cover. Some herbaceous species are more sensitive to nutrient conditions. Nutrient-loving herbs that are representative of this ecological site include *Caulophyllum*

thalictroides (blue cohosh), *Actaea racemosa* (black bugbane), *Chrysogonum virginianum* (green and gold), *Salvia urticifolia* (nettleleaf sage), *Triosteum angustifolium* (lesser horse-gentian), *Ruellia purshiana* (Pursh's wild petunia), *Muhlenbergia sobolifera* (rocky muhly), *Asarum canadense* (wild ginger), *Adiantum pedatum* (maidenhair fern), *Podophyllum peltatum* (mayapple), *Tiarella cordifolia* (foamflower), *Jeffersonia diphylla* (twinleaf), *Dicentra cucullaria* (Dutchman's breeches), *Erythronium americanum* (trout lily), *Uvularia perfoliata* (perfoliate bellwort), *Botrychium virginianum* (rattlesnake fern), *Dicentra canadensis* (squirrel corn), *Allium tricoccum* (wild leek), *Claytonia virginica* (springbeauty), *Sanguinaria canadensis* (bloodroot), *Anemone quinquefolia* (wood anemone), *Cimicifuga racemosa* (black snakeroot), *Geranium maculatum* (wood geranium), *Hepatica nobilis* (liverleaf), *Arisaema triphyllum* (Jack in the pulpit), *Mitella diphylla* (bishop's-cap), *Cardamine concatenata* (cutleaf toothwort), *Maianthemum canadense* (Canada mayflower), *Corydalis flavula* (yellow fumewort), *Asplenium* spp. (spleenworts), and *Polystichum acrostichoides* (Christmas fern). Mesophytic forest generalist herbs include *Hylodesmum nudiflorum* (nakedflower ticktrefoil), *Polygonatum biflorum* (Solomon's-seal), *Smilacina racemosa* (false Solomon's-seal), *Dryopteris marginalis* (evergreen wood fern), *Aster divaricatus* (white wood aster), and *Maianthemum racemosum* (eastern Solomon's-plume) (Virginia DCR, 2016; Zimmerman et al., 2012; USNVC 2.01, 2016). Plants that are diagnostic of basic oak-hickory forests in the Piedmont include *Carya ovata* (shagbark hickory), *Fraxinus americana* (white ash), *Cercis canadensis* (eastern redbud), *Actaea racemosa* (black bugbane), *Chrysogonum virginianum* (green and gold), *Salvia urticifolia* (nettleleaf sage), *Triosteum angustifolium* (lesser horse-gentian), *Ruellia purshiana* (Pursh's wild petunia), and *Muhlenbergia sobolifera* (rocky muhly) (Virginia DCR, 2016). This phase of this ecological site corresponds with: Pennsylvania Communities (Zimmerman et al., 2012) • Tuliptree-beech-maple forest • Sugar maple-basswood forest • Rich hemlock-mesic hardwoods forest • Hemlock-tuliptree-birch forest • Red maple (terrestrial) forest Representative herbaceous species are listed here: • *Actaea racemosa* (black bugbane) • *Adiantum pedatum* (maidenhair fern) • *Allium tricoccum* (wild leek) • *Anemone quinquefolia* (wood anemone) • *Arisaema triphyllum* (Jack in the pulpit) • *Asarum canadense* (wild ginger) • *Asplenium* spp. (spleenworts) • *Aster divaricatus* (white wood aster) • *Botrychium virginianum* (rattlesnake fern) • *Cardamine concatenata* (cutleaf toothwort) • *Caulophyllum thalictroides* (blue cohosh) • *Chrysogonum virginianum* (green and gold) • *Cimicifuga racemosa* (black snakeroot) • *Claytonia virginica* (springbeauty) • *Corydalis flavula* (yellow fumewort) • *Dicentra canadensis* (squirrel corn) • *Dicentra cucullaria* (dutchman's breeches) • *Dryopteris marginalis* (evergreen wood fern) • *Erythronium americanum* (trout lily) • *Geranium maculatum* (wood geranium) • *Hepatica nobilis* (liverleaf) • *Hylodesmum nudiflorum* (nakedflower ticktrefoil) • *Jeffersonia diphylla* (twinleaf) • *Maianthemum canadense* (Canada mayflower) • *Maianthemum racemosum* (eastern Solomon's-plume) • *Mitella diphylla* (bishop's-cap) • *Muhlenbergia sobolifera* (rocky muhly) • *Podophyllum peltatum* (mayapple) • *Polygonatum biflorum* (Solomon's-seal) • *Polystichum acrostichoides* (Christmas fern) • *Ruellia purshiana* (Pursh's wild petunia) • *Salvia urticifolia* (nettleleaf sage) • *Sanguinaria canadensis* (bloodroot) • *Smilacina racemosa* (false Solomon's-seal) • *Tiarella cordifolia* (foamflower) • *Triosteum angustifolium* (lesser horse-gentian) • *Uvularia perfoliata* (perfoliate bellwort)

Dominant plant species

- red maple (*Acer rubrum*), tree
- sugar maple (*Acer saccharum*), tree
- yellow birch (*Betula alleghaniensis*), tree
- sweet birch (*Betula lenta*), tree
- bitternut hickory (*Carya cordiformis*), tree
- shagbark hickory (*Carya ovata*), tree
- mockernut hickory (*Carya tomentosa*), tree
- eastern redbud (*Cercis canadensis*), tree
- American beech (*Fagus grandifolia*), tree
- white ash (*Fraxinus americana*), tree
- tuliptree (*Liriodendron tulipifera*), tree
- blackgum (*Nyssa sylvatica*), tree
- black cherry (*Prunus serotina*), tree
- white oak (*Quercus alba*), tree
- chinquapin oak (*Quercus muehlenbergii*), tree
- northern red oak (*Quercus rubra*), tree
- black oak (*Quercus velutina*), tree
- American basswood (*Tilia americana*), tree
- eastern hemlock (*Tsuga canadensis*), tree
- pawpaw (*Asimina triloba*), shrub

- American hornbeam (*Carpinus caroliniana*), shrub
- flowering dogwood (*Cornus florida*), shrub
- American witchhazel (*Hamamelis virginiana*), shrub
- northern spicebush (*Lindera benzoin*), shrub
- umbrella-tree (*Magnolia tripetala*), shrub
- hophornbeam (*Ostrya virginiana*), shrub
- great laurel (*Rhododendron maximum*), shrub
- American bladdernut (*Staphylea trifolia*), shrub
- mapleleaf viburnum (*Viburnum acerifolium*), shrub
- southern arrowwood (*Viburnum dentatum*), shrub
- southern arrowwood (*Viburnum recognitum*), shrub

Community 1.2

Mesic Upland Generalist Forest Phase

The Mesic Generalist communities of the Northern Piedmont have a very broad ecological amplitude. The Northern Piedmont MLRA as a whole is dominated by the Oak-Hickory group (USNVC 2.01, 2016), but this does not mean that representative oaks or hickories are on all sites. The cover-type expressions of this ecological site group vary. On this site, in this phase, *Quercus rubra* (northern red oak) is typically present and is commonly dominant or codominant. On these sites, it is most commonly in association with *Acer rubrum* (red maple), *Quercus velutina* (black oak), *Quercus alba* (white oak), *Carya tomentosa* (mockernut hickory), *Carya ovata* (shagbark hickory), *Betula lenta* (sweet birch), *Betula alleghaniensis* (yellow birch), *Fraxinus americana* (white ash), *Fagus grandifolia* (American beech), *Prunus serotina* (wild black cherry), and/or *Liriodendron tulipifera* (tuliptree). Some areas have a significant conifer component in which *Tsuga canadensis* (eastern hemlock), *Pinus strobus* (eastern white pine), or both contribute the most. Conifers may be scattered, locally abundant, and dominant in the subcanopy. In some areas, eastern white pine forms a relict supracanopy or grows in large gaps in the former canopy (USNVC 2.01, 2016; Zimmerman et al., 2012; Virginia DCR, 2016). Shrubs include *Viburnum acerifolium* (mapleleaf viburnum), *Viburnum recognitum* (northern arrowwood), *Viburnum dentatum* (southern arrowwood), *Rhododendron periclymenoides* (pinxter-flower), *Amelanchier laevis* (smooth serviceberry), *Amelanchier arborea* (shadbush), *Carpinus caroliniana* (hornbeam), *Ostrya virginiana* (hophornbeam), *Hamamelis virginiana* (witchhazel), *Cornus florida* (flowering dogwood), and *Lindera benzoin* (spicebush). *Kalmia latifolia* (mountain laurel) and *Gaylussacia baccata* (black huckleberry) are also present in some areas (Zimmerman et al., 2012). The herbaceous layer is highly variable. Representative species include *Smilacina racemosa* (false Solomon's-seal), *Polygonatum biflorum* (Solomon's seal), *Gaultheria procumbens* (teaberry), *Maianthemum canadense* (Canada mayflower), *Podophyllum peltatum* (mayapple), *Uvularia sessilifolia* (wild-oats), *Chimaphila maculata* (pipissewa), *Medeola virginiana* (Indian cucumber-root), *Caulophyllum thalictroides* (blue cohosh), and, on richer sites, *Dryopteris* (wood ferns) and *Dennstaedtia punctilobula* (hayscented fern) (Zimmerman et al., 2012). This phase of this ecological site corresponds with: Pennsylvania Communities (Zimmerman et al., 2012) • Hemlock (white pine)-red oak-mixed hardwood forest • Red oak-mixed hardwood forest • Red maple (terrestrial) forest

Dominant plant species

- red maple (*Acer rubrum*), tree
- yellow birch (*Betula alleghaniensis*), tree
- sweet birch (*Betula lenta*), tree
- shagbark hickory (*Carya ovata*), tree
- mockernut hickory (*Carya tomentosa*), tree
- American beech (*Fagus grandifolia*), tree
- white ash (*Fraxinus americana*), tree
- tuliptree (*Liriodendron tulipifera*), tree
- eastern white pine (*Pinus strobus*), tree
- black cherry (*Prunus serotina*), tree
- white oak (*Quercus alba*), tree
- northern red oak (*Quercus rubra*), tree
- black oak (*Quercus velutina*), tree
- eastern hemlock (*Tsuga canadensis*), tree
- common serviceberry (*Amelanchier arborea*), shrub
- Allegheny serviceberry (*Amelanchier laevis*), shrub

- American hornbeam (*Carpinus caroliniana*), shrub
- flowering dogwood (*Cornus florida*), shrub
- black huckleberry (*Gaylussacia baccata*), shrub
- American witchhazel (*Hamamelis virginiana*), shrub
- mountain laurel (*Kalmia latifolia*), shrub
- northern spicebush (*Lindera benzoin*), shrub
- hophornbeam (*Ostrya virginiana*), shrub
- pink azalea (*Rhododendron periclymenoides*), shrub
- mapleleaf viburnum (*Viburnum acerifolium*), shrub
- southern arrowwood (*Viburnum dentatum*), shrub
- southern arrowwood (*Viburnum recognitum*), shrub
- blue cohosh (*Caulophyllum thalictroides*), grass
- striped prince's pine (*Chimaphila maculata*), grass
- eastern hayscented fern (*Dennstaedtia punctilobula*), grass
- woodfern (*Dryopteris*), grass
- eastern teaberry (*Gaultheria procumbens*), grass
- Canada mayflower (*Maianthemum canadense*), grass
- mayapple (*Podophyllum peltatum*), grass
- smooth Solomon's seal (*Polygonatum biflorum*), grass
- sessileleaf bellwort (*Uvularia sessilifolia*), grass

Community 1.3

Vernal Pool Phase

This site is a micro-site in the matrix of mesic uplands. The vernal pools site occupies areas of depressions and deeper pools that are seasonally inundated but typically dry completely over the summer (Zimmerman et al., 2012). This phase of this ecological site corresponds with: International Vegetation Classification Associations (Zimmerman et al., 2012) Eastern Woodland Vernal Pool Sparse Vegetation (CEGL006453)

Dominant plant species

- red maple (*Acer rubrum*), tree
- blackgum (*Nyssa sylvatica*), tree
- swamp white oak (*Quercus bicolor*), tree
- pin oak (*Quercus palustris*), tree
- common buttonbush (*Cephalanthus occidentalis*), shrub
- common winterberry (*Ilex verticillata*), shrub
- highbush blueberry (*Vaccinium corymbosum*), shrub
- southern arrowwood (*Viburnum recognitum*), shrub
- devil's beggartick (*Bidens frondosa*), grass
- smallspike false nettle (*Boehmeria cylindrica*), grass
- fringed sedge (*Carex crinita*), grass
- greater bladder sedge (*Carex intumescens*), grass
- shallow sedge (*Carex lurida*), grass
- floating mannagrass (*Glyceria septentrionalis*), grass
- northern bugleweed (*Lycopus uniflorus*), grass
- dotted smartweed (*Polygonum punctatum*), grass
- Canadian clearweed (*Pilea pumila*), grass
- eastern marsh fern (*Thelypteris palustris*), grass
- sphagnum (*Sphagnum*), grass

State 2 brush

The brush state on this site is a transient state which can be arrived at from at least two different pathways. It can be a normal step in classic succession from the very early succession meadow state through the shrub state towards a forest condition, or, alternatively, it can result from a disturbance vector that reduces or eliminates overstory tree cover and releases the understory woody shrub component. In either case, it's occupation of a site is

typically transient with the normal successional pathway progressing out of shrubland towards forest.

Resilience management. Without frequent disturbance, this state is transient in the normal successional pathway. Frequent prescribed fire, prescribed grazing, and/or brush management are necessary to facilitate the persistence of the brush state.

State 3 meadow

The meadow state on this site is a transient state which can be arrived at from at least two different pathways. It can be a normal step in classic succession from the very early succession meadow state through the brush state towards a forest condition, or, alternatively, it can result from a disturbance vector that reduces or eliminates most or all woody cover including overstory tree cover and the understory woody shrub component. In either case, it's occupation of a site is typically transient with the normal successional pathway progressing out of meadow towards brush and then forest.

Resilience management. Without frequent disturbance, this state is transient in the normal successional pathway. Frequent prescribed fire, prescribed grazing, and/or brush management are necessary to facilitate the persistence of the meadow state.

Transition T1 State 1 to 2

The transition from the forest state to the brush state will occur as the result of any disturbance that reduces overstory tree cover but does not similarly reduce understory woody vegetation cover. Examples include tree disease, tree pests, windthrow, and timber harvest.

Context dependence. This transition will only occur when shrubs are already well established beneath the overstory tree canopy prior to release.

Conservation practices

Brush Management
Prescribed Burning
Early Successional Habitat Development/Management
Forest Stand Improvement
Prescribed Grazing

Transition T3 State 1 to 3

The transition from the forest state to the meadow state will occur as the result of any disturbance that reduces (or eliminates) all (most) woody vegetation cover including both trees and shrubs. Examples include tree disease, tree pests, windthrow, and timber harvest.

Conservation practices

Brush Management
Prescribed Burning
Early Successional Habitat Development/Management
Forest Stand Improvement
Prescribed Grazing

Restoration pathway R1

State 2 to 1

The brush state will likely succeed to the forest state without any management intervention, but the management practices listed below will facilitate the process.

Conservation practices

Brush Management
Prescribed Burning
Tree/Shrub Establishment
Prescribed Grazing

Transition T2 State 2 to 3

The transition from the brush state to the meadow state will occur as the result of any disturbance that reduces (or eliminates) all (most) woody vegetation cover including both trees and shrubs. Examples include tree disease, tree pests, windthrow, and timber harvest.

Conservation practices

Brush Management
Prescribed Burning
Early Successional Habitat Development/Management
Prescribed Grazing

Restoration pathway R2 State 3 to 2

The meadow state will likely succeed to the brush state without any management intervention, but the management practices listed below will facilitate the process.

Conservation practices

Prescribed Burning
Tree/Shrub Establishment
Prescribed Grazing
Herbaceous Weed Control

Additional community tables

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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.

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Date	09/28/2018
Approved by	Matthew Duvall
Approval date	
Composition (Indicators 10 and 12) based on	

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:

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

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

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

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

-
17. **Perennial plant reproductive capability:**
-