USDA Natural Resources Conservation Service

Ecological site F148XY033PA
Dry, Ultra-Mafic, Upland, Serpentine Barrens Complex

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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 “megalopolis” 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 stellate (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., 201). 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 falcate (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 ecological site is characterized by the unique characteristics of serpentine derived soil. The landscape commonly has rock fragments on the surface and has areas of rock outcrop and slightly deeper soils within close proximity. Serpentine derived soils generally suffer from an unusual soil mineral condition that has been called the “serpentine soil syndrome” (Jenny 1980). This condition is a result of high concentrations of Mg and low concentrations of Ca. Soils with this condition have Ca:Mg ratios in the 0.25:1 to 0.5:1 range, which is toxic to most plants. On convex shoulders and ridges in the uplands, the low moisture availability combined with serpentine soil syndrome creates a harsh growing environment and results in unique vegetation communities.

This ecological site corresponds with:
US National Vegetation Classification (USGS, 2011)
• Pine Barrens (USNVC Group 162)

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).

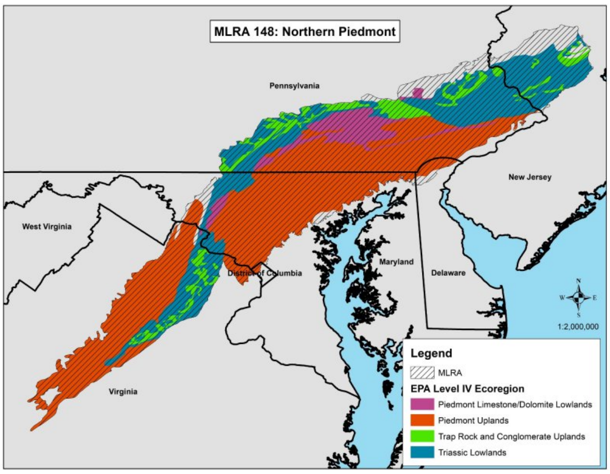


Figure 1. EPA Level IV ecoregions across MLRA 148.

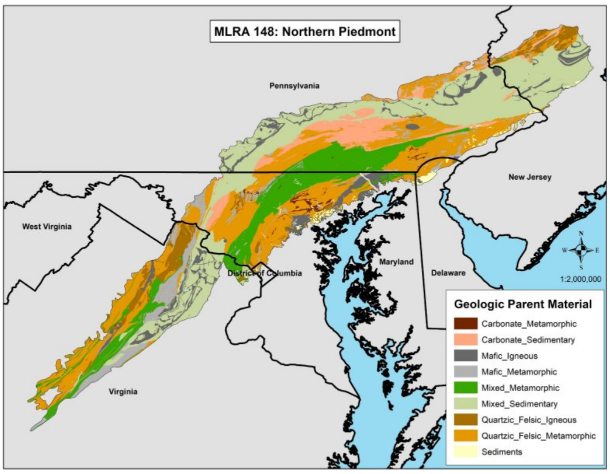


Figure 2. Geologic parent material across MLRA 148.

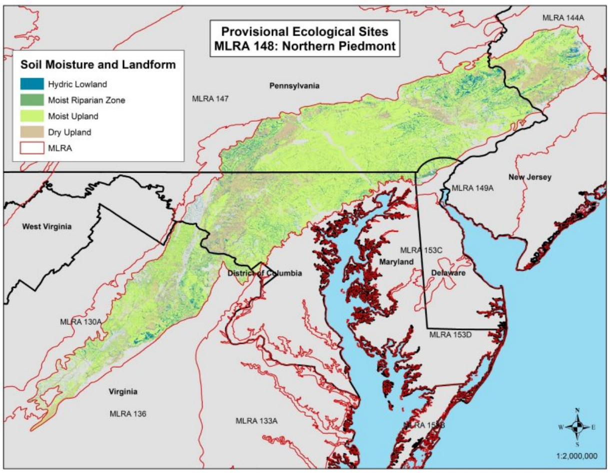


Figure 3. Ecological Site soil moisture and landform groups across MLRA 148.

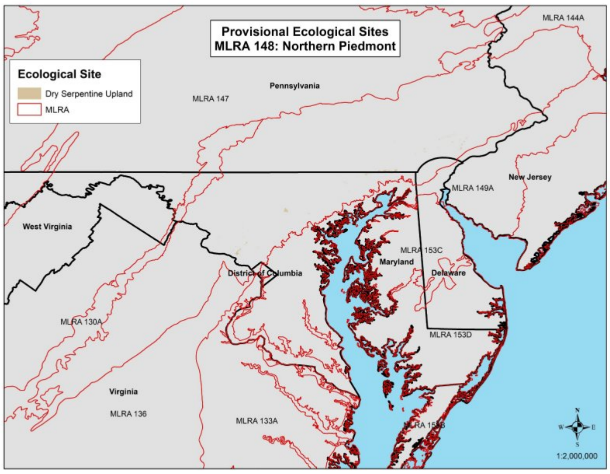


Figure 4. The Dry Serpentine Upland Ecological Site footprint.

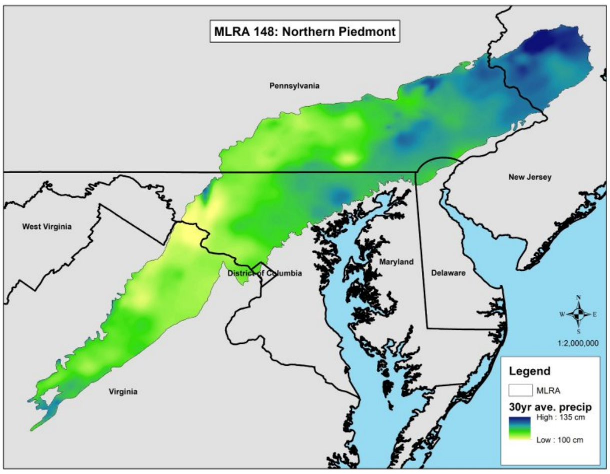


Figure 5. PRISM 30 year mean annual precipitation across MLRA 148.

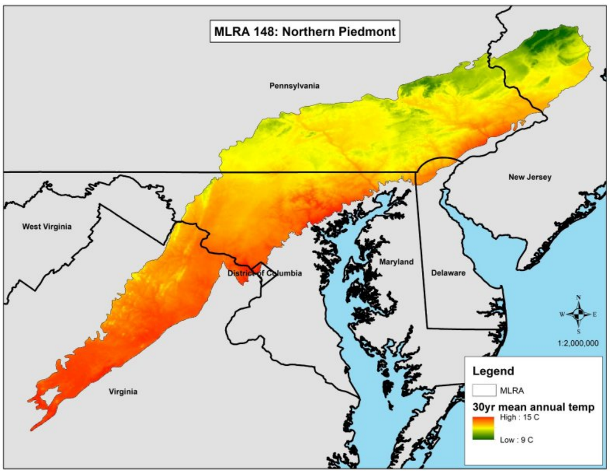


Figure 6. PRISM 30 year mean annual temperature across MLRA 148.

Table 2. Representative physiographic features

Aspect	S, SW

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).

Across most-to-all of MLRA 148, precipitation is generally thought to be adequate to meet all vegetation demands and is greater than evapotranspiration for most-to-all of the year (USDA-NRCS, 2006). Note that the footprint of the “dry/xeric” ecological sites corresponds well with the portions of the Northern Piedmont that the climate data suggest are the hottest and driest.

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 3. Representative climatic features

Frost-free period (actual range)	
Freeze-free period (actual range)	
Precipitation total (actual range)	1,016-1,346 mm
Frost-free period (average)	
Freeze-free period (average)	205 days
Precipitation total (average)	1,143 mm

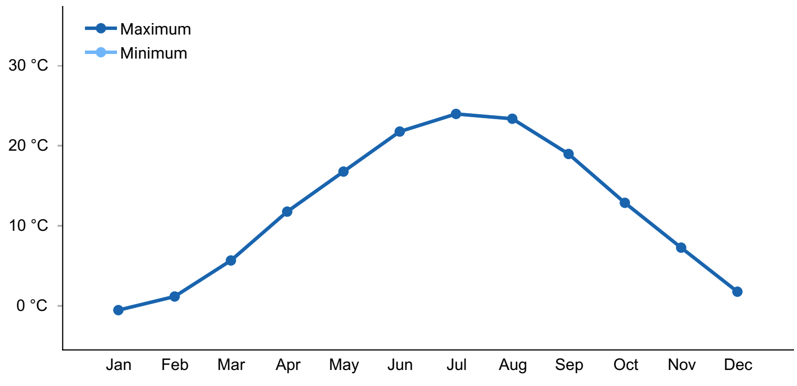


Figure 7. Monthly average minimum and maximum temperature

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

All ecological sites in MLRA 148 listed as “dry” are either well drained, somewhat excessively drained, or excessively drained.

Representative soil components on this ecological site include:

Lithic Hapludolls
Chrome

Table 4. Representative soil features

Drainage class	Well drained to excessively drained

Table 5. Representative soil features (actual values)

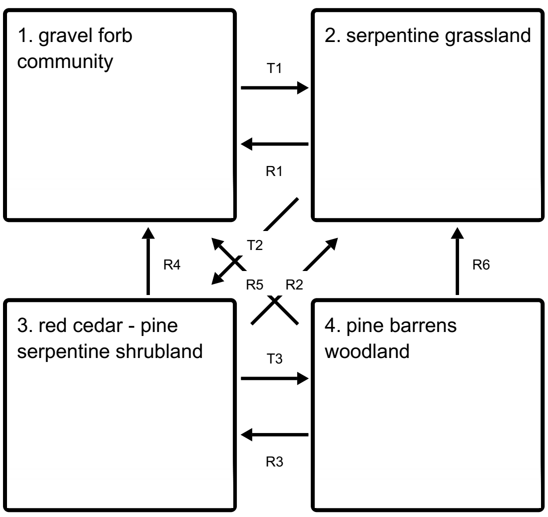
Drainage class	Well drained to excessively drained

Ecological dynamics

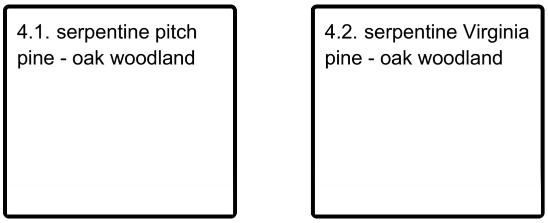
Fire and accumulation of soil organic matter are historically the most important factors influencing succession in the serpentine barrens complex. Fire helps to maintain the open, early successional serpentine forb, grassland, and shrubland vegetation communities, which are well suited to the xeric conditions on these shallow, well drained sites. Fire exclusion leads to accumulation of soil organic matter, which pushes these early successional vegetation communities towards closed canopy forests and greenbriar forests. In recent years, southern pine beetles killed large areas of pine overstory in the serpentine barrens. The vegetation dynamics of these sites, however, are driven by the understory community at the time of overstory death and by management actions in response to the beetle infestation. Soil scraping may be required in addition to fire to create the conditions that promote restoration of these unique, early successional vegetation communities.

State and transition model

Ecosystem states



State 4 submodel, plant communities



State 1
gravel forb community

This dry, ultra-mafic, upland phase is on soils that are exceptionally shallow and dry. This community type generally grades into the Serpentine Grassland phase. It may be delineated where sod formation and graminoid dominance begins (Zimmerman et al., 2012).

Resilience management. Accumulation of soil organic matter will facilitate succession away from this community. This community requires relatively frequent and relatively intense disturbance including disturbance of soil organic horizons.

Dominant plant species

- whorled milkweed (*Asclepias verticillata*), grass
- lyrate rockcress (*Arabis lyrata*), grass
- Michaux's stitchwort (*Minuartia michauxii*), grass
- serpentine aster (*Symphyotrichum depauperatum*), grass
- field chickweed (*Cerastium arvense*), grass
- annual fimbry (*Fimbristylis annua*), grass
- churchmouse threeawn (*Aristida dichotoma*), grass
- slimspike threeawn (*Aristida longespica*), grass
- partridge pea (*Chamaecrista fasciculata*), grass
- lopsided rush (*Juncus secundus*), grass
- roundseed panicgrass (*Dichanthelium sphaerocarpon*), grass
- whorled milkwort (*Polygala verticillata*), grass
- pleatleaf knotweed (*Polygonum tenue*), grass
- poverty dropseed (*Sporobolus vaginiflorus*), grass
- arrowleaf violet (*Viola sagittata*), grass
- fewflower nutrush (*Scleria pauciflora*), grass
- quill fameflower (*Phemeranthus teretifolius*), grass
- moss phlox (*Phlox subulata ssp. subulata*), grass
- little bluestem (*Schizachyrium scoparium*), grass

State 2
serpentine grassland

This phase is in areas where soil organic matter has mostly covered the exposed gravel surface of the gravel forb community and the site supports dense, prairie-like graminoid cover typically dominated by warm-season grasses. This community may be said to end either (1) where graminoid dominance and continuous soil substrate ends (where the "Serpentine gravel forb community" generally begins) or (2) where shrub cover reaches about 25 percent (where the "Red-cedar–pine serpentine shrubland" generally begins) (Zimmerman et al., 2012).

Characteristics and indicators. The list of representative herbaceous species is too long to fit in the database, so they are listed here: *Schizachyrium scoparium* (little bluestem) *Muhlenbergia mexicana* (muhly) *Eragrostis spectabilis* (purple love-grass) Setaria geniculata (perennial foxtail) *Andropogon gerardii* (big bluestem) *Sporobolus heterolepis*s (prairie dropseed) *Sorghastrum nutans* (Indian grass) *Bouteloua curtipendula*s (side-oats gramma) Senecio anonymuss (plain ragwort) *Aristida purpurascens*s (arrowfeather) *Aristida dichotoma* (churchmouse three-awn) Aster depauperatuss (serpentine aster) Panicum acuminatum (a panicgrass) Panicum annulum (annulus panicgrass) Panicum dichotomum (a panicgrass) Panicum oligosanthes (a panicgrass) Panicum sphaerocarpon (a panicgrass) *Potentilla canadensis* (old-field cinquefoil) *Rosa carolina* (prairie rose) Setaria geniculata (perennial foxtail) *Cerastium arvense* var. villosissimums (barrens chickweed) *Phlox subulata* ssp. subulata (creeping phlox) *Achillea millefolium*l (yarrow) Eupatorium aromaticum (small white snakeroot) *Scleria pauciflora* (few-flowered nutrush) *Oenothera fruticosa* (sundrops) *Solidago nemoralis* (gray goldenrod) *Antennaria plantaginifolia* (plantain pussytoes) *Asclepias verticillata* (whorled milkweed) *Asclepias viridiflora* (green milkweed)

State 3
red cedar - pine serpentine shrubland

This phase is in areas where soil organic matter has mostly covered the exposed gravel surface of the gravel forb community, and the soil has developed sufficiently to support tree cover. This community commonly is a savanna with dense, prairie-like graminoid cover and scattered trees and shrubs. Although the most typical aspect is that of a shrubland, some examples of this community type have a woodland physiognomy. This community may be said to end either (1) where woody cover of at least 25 percent ends (where the "Serpentine barren grassland community" generally begins) or (2) where trees exceed 5 meters in height and the tree canopy reaches about 60 percent total cover, thereby becoming sufficiently continuous to prohibit dense graminoid cover (where the "Serpentine Virginia pine-oak" or "Serpentine pitch pine-oak forest" generally begins). This type commonly grades into the one of the serpentine forest types downslope on somewhat deeper soils. This community shares many dominants with both the "Pitch pine-scrub oak woodland" and "Pitch pine-mixed hardwood woodland." The distinction between the communities lies in the less common species present in the serpentine type (e.g. *Sporobolus heterolepis*, Panicum depauperatum, *Bouteloua curtipendula*s) and the geology itself. Trees on this site are commonly less than 5 meters tall (Zimmerman et al., 2012).

Characteristics and indicators. The list of representative herbaceous species is too long to fit in the database, so they are listed here: *Schizachyrium scoparium* (little bluestem) *Andropogon gerardii* (big bluestem) *Sporobolus heterolepis*s (prairie dropseed) Panicum depauperatums (poverty panicgrass) *Sporobolus vaginiflorus* (poverty grass) Aristida longispica (slimspike three-awn) *Aristida purpurascens*s (arrowfeather) *Aristida dichotoma* (churchmouse three-awn) *Muhlenbergia mexicana* (satin grass) Setaria geniculata (knotroot fox-tail) *Eragrostis spectabilis* (purple lovegrass) *Scleria pauciflora*s (few-flowered nut-rush) *Sorghastrum nutans* (Indian grass) *Bouteloua curtipendula*s (side-oats gramma) Aster depauperatuss (serpentine aster) *Potentilla canadensis* (old-field cinquefoil) *Phlox subulata* ssp. subulata (creeping phlox) *Cerastium arvense* var. uillosissimums (barrens chickweed) *Achillea millefolium*l (yarrow) Eupatorium aromaticum (small white snakeroot) *Oenothera fruticosa* (sundrops) Senecio anonymuss (plain ragwort) *Solidago nemoralis* (gray goldenrod) *Antennaria plantaginifolia* (plantain pussytoe)

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- pitch pine (*Pinus rigida*), tree
- Virginia pine (*Pinus virginiana*), tree
- post oak (*Quercus stellata*), tree
- black locust (*Robinia pseudoacacia*), tree
- blackjack oak (*Quercus marilandica*), tree
- sassafras (*Sassafras albidum*), tree
- winged sumac (*Rhus copallinum*), shrub
- smooth sumac (*Rhus glabra*), shrub
- dwarf chinquapin oak (*Quercus prinoides*), shrub
- black huckleberry (*Gaylussacia baccata*), shrub

State 4
pine barrens woodland

Community 4.1
serpentine pitch pine - oak woodland

On these serpentine forest sites, soil development has proceeded enough to support closed forest vegetation, but not far enough to override the influence of serpentine chemistry on species composition. Fire is an important factor affecting the establishment and persistence of pitch pine. In the absence of fire, pine is likely to decrease in favor of hardwood species. *Pinus virginiana* produces denser shade and thicker litter than does *Pinus rigida*. Herbaceous and shrub growth is generally more well developed under *Pinus rigida*. The fire ecology of the two species is also vastly different (Zimmerman et al., 2012). Characteristic overstory species include *Quercus stellata* (post oak), *Quercus marilandica* (blackjack oak), *Pinus rigida* (pitch pine), *Sassafras albidum* (sassafras), *Juniperus virginiana* (red-cedar), *Nyssa sylvatica* (blackgum), *Populus grandidentata* (large-toothed aspen), and *Robinia pseudoacacia* (black locust)—which is generally invasive in these systems. The shrub layer is commonly dominated by an impenetrable tangle of *Smilax rotundifolia* (greenbrier) and *S. glauca* (catbrier). *Quercus prinoides* (chinquapin oak) is in the understory and in openings; *Quercus ilicifolia* (scrub oak) is also in openings. Low shrub species include *Vaccinium pallidum* (lowbush blueberry), *Vaccinium stamineum* (deerberry), and *Gaylussacia baccata* (black huckleberry). Herbaceous species include *Pteridium aquilinum* (bracken fern), *Aralia nudicaulis* (wild sarsaparilla), and a variety of graminoids (Zimmerman et al., 2012).

Resilience management. frequent low intensity fire will benefit the longer-term persistence and resilience of this vegetation community on these dry sites.

Dominant plant species

- post oak (*Quercus stellata*), tree
- blackjack oak (*Quercus marilandica*), tree
- pitch pine (*Pinus rigida*), tree
- sassafras (*Sassafras albidum*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- blackgum (*Nyssa sylvatica*), tree
- bigtooth aspen (*Populus grandidentata*), tree
- black locust (*Robinia pseudoacacia*), tree
- dwarf chinquapin oak (*Quercus prinoides*), tree
- bear oak (*Quercus ilicifolia*), tree
- roundleaf greenbrier (*Smilax rotundifolia*), shrub
- cat greenbrier (*Smilax glauca*), shrub
- Blue Ridge blueberry (*Vaccinium pallidum*), shrub
- deerberry (*Vaccinium stamineum*), shrub
- black huckleberry (*Gaylussacia baccata*), shrub
- western brackenfern (*Pteridium aquilinum*), grass
- wild sarsaparilla (*Aralia nudicaulis*), grass

Community 4.2
serpentine Virginia pine - oak woodland

On these serpentine forest sites, soil development has proceeded enough to support forest vegetation, but not enough to override the influence of serpentine chemistry on species composition. *Pinus virginiana* produces denser shade and thicker litter than does *Pinus rigida*. Herbaceous and shrub growth under *Pinus virginiana* is generally sparse. The fire ecology of the two species is also vastly different (Zimmerman et al., 2012). Characteristic overstory species include *Quercus stellata* (post oak), *Quercus marilandica* (blackjack oak), *Pinus virginiana* (Virginia pine), *Sassafras albidum* (sassafras), *Prunus serotina* (wild black cherry), *Juniperus virginiana* (red-cedar), *Nyssa sylvatica* (blackgum), *Robinia pseudoacacia* (black locust), and *Acer rubrum* (red maple). The shrub layer may be quite sparse under the dense shade and heavy litter of *Pinus virginiana* (Virginia pine). Where the canopy is more open, *Smilax rotundifolia* (greenbrier) and *S. glauca* (catbrier) may form an impenetrable tangle. Other shrub species include *Vaccinium pallidum* (lowbush blueberry), *Vaccinium stamineum* (deerberry), and *Gaylussacia baccata* (black huckleberry). *Quercus prinoides* (chinquapin oak) may be in the understory or in openings. *Quercus ilicifolia* (scrub oak) may also be in openings. Herbaceous cover is also low; species include *Pteridium aquilinum* (bracken fern) and *Aralia nudicaulis* (wild sarsaparilla) (Zimmerman et al., 2012).

Dominant plant species

- post oak (*Quercus stellata*), tree
- blackjack oak (*Quercus marilandica*), tree
- Virginia pine (*Pinus virginiana*), tree
- sassafras (*Sassafras albidum*), tree
- black cherry (*Prunus serotina*), tree
- eastern redcedar (*Juniperus virginiana*), tree

- blackgum (*Nyssa sylvatica*), tree
- black locust (*Robinia pseudoacacia*), tree
- red maple (*Acer rubrum*), tree
- dwarf chinquapin oak (*Quercus prinoides*), tree
- bear oak (*Quercus ilicifolia*), tree
- roundleaf greenbrier (*Smilax rotundifolia*), shrub
- cat greenbrier (*Smilax glauca*), shrub
- Blue Ridge blueberry (*Vaccinium pallidum*), shrub
- deerberry (*Vaccinium stamineum*), shrub
- black huckleberry (*Gaylussacia baccata*), shrub
- western brackenfern (*Pteridium aquilinum*), grass
- wild sarsaparilla (*Aralia nudicaulis*), grass

Transition T1
State 1 to 2

This transition typically occurs in the absence of fire or physical disturbance of the soil and is facilitated by the accumulation of organic matter on the soil surface.

Restoration pathway R1
State 2 to 1

this restoration pathway includes removal of most trees and other woody vegetation, frequent repeated fire, and/or physical disturbance (e.g. scraping) of the surface soil.

Conservation practices

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

Transition T2
State 2 to 3

This transition typically occurs in the absence of fire or physical disturbance of the soil and is facilitated by the accumulation of organic matter on the soil surface. In some cases, the soil can accumulate sufficient depth to support a closed canopy forest, but these closed canopy forests are susceptible to moisture stress and other stress related vectors of mortality (insects for example).

Conservation practices

Tree/Shrub Establishment

Restoration pathway R4
State 3 to 1

this restoration pathway includes removal of most trees and other woody vegetation, frequent repeated fire, and/or physical disturbance (e.g. scraping) of the surface soil.

Conservation practices

Brush Management
Prescribed Burning
Early Successional Habitat Development/Management

Prescribed Grazing

Restoration pathway R2
State 3 to 2

this restoration pathway includes removal of many trees and most other woody vegetation, as well as frequent repeated fire.

Conservation practices

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

Transition T3
State 3 to 4

This transition typically occurs in the absence of fire or physical disturbance of the soil and is facilitated by the accumulation of organic matter on the soil surface. In some cases, the soil can accumulate sufficient depth to support a closed canopy forest, but these closed canopy forests are susceptible to moisture stress and other stress related vectors of mortality (insects for example).

Conservation practices

Tree/Shrub Establishment

Restoration pathway R5
State 4 to 1

this restoration pathway includes removal of most trees and other woody vegetation, frequent repeated fire, and/or physical disturbance (e.g. scraping) of the surface soil.

Conservation practices

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

Restoration pathway R6
State 4 to 2

this restoration pathway includes removal of most trees and other woody vegetation, and frequent repeated fire.

Conservation practices

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

Restoration pathway R3
State 4 to 3

this restoration pathway includes removal of many trees and most other woody vegetation, as well as frequent repeated fire.

Conservation practices

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

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:**

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

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7. **Amount of litter movement (describe size and distance expected to travel):**

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

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

---

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):**

---

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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

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

17. **Perennial plant reproductive capability:**