USDA Natural Resources
Conservation Service

Ecological site F115XC013IL
Sand Woodland

Last updated: 12/30/2024
Accessed: 01/05/2025

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): 115X–Central Mississippi Valley Wooded Slopes

This MLRA is characterized by deeply dissected, loess-covered hills bordering well defined valleys of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers and their tributaries. It is used to produce cash crops and livestock. About one-third of the area is forested, mostly on the steeper slopes. This area is in Illinois (50 percent), Missouri (36 percent), Indiana (13 percent), and Iowa (1 percent) in two separate areas. It makes up about 25,084 square miles (64,967 square kilometers).

Most of this area is in the Till Plains section and the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The Springfield-Salem plateaus section of the Ozarks Plateaus province of the Interior Highlands occurs along the Missouri River and the Mississippi River south of the confluence with the Missouri River. The nearly level to very steep uplands are dissected by both large and small tributaries of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers. The Ohio River flows along the southernmost boundary of this area in Indiana. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to undulating. Karst topography is common in some parts along the Missouri and Mississippi Rivers and their tributaries. Well-developed karst areas have hundreds of sinkholes, caves, springs, and losing streams. In the St. Louis area, many of the karst features have been obliterated by urban development.

Elevation ranges from 90 feet (20 meters) on the southernmost flood plains to 1,030 feet (320 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters) but can be 50 to 150 feet (15 to 45 meters) in the steep, deeply dissected hills bordering rivers and streams. The bluffs along the major rivers are generally 200 to 350 feet (60 to 105 meters) above the valley floor.

The uplands in this MLRA are covered almost entirely with Peoria Loess. The loess can be more than 7 feet (2 meters) thick on stable summits. On the steeper slopes, it is thin or does not occur. In Illinois, the loess is underlain mostly by Illinoian-age till that commonly contains a paleosol. Pre-Illinoian-age till is in parts of this MLRA in Iowa and Missouri and to a minor extent in the western part of Illinois. Wisconsin-age outwash, alluvial deposits, and sandy eolian material are on some of the stream terraces and on dunes along the major tributaries. The loess and glacial deposits are underlain by several bedrock systems. Pennsylvanian and Mississippian bedrock are the most extensive. To a lesser extent are Silurian, Devonian, Cretaceous, and Ordovician bedrock. Karst areas have formed where limestone is near the surface, mostly in the southern part of the MLRA along the Mississippi River and some of its major tributaries. Bedrock outcrops are common on the bluffs along the Mississippi, Ohio, and Wabash Rivers and their major tributaries and at the base of some steep slopes along minor streams and drainageways.

The annual precipitation ranges from 35 to 49 inches (880 to 1,250 millimeters) with a mean of 41 inches (1,050 millimeters). The annual temperature ranges from 48 to 58 degrees F (8.6 to 14.3 degrees C) with a mean of 54 degrees F (12.3 degrees C). The freeze-free period ranges from 150 to 220 days with a mean of 195 days.

Soils The dominant soil orders are Alfisols and, to a lesser extent, Entisols and Mollisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, excessively drained to poorly drained, and loamy, silty, or clayey.

The soils on uplands in this area support natural hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak and eastern redcedar grow on some sites. The soils on flood plains support mixed forest vegetation, mainly American elm, eastern cottonwood, river birch, green ash, silver maple, sweetgum, American sycamore, pin oak, pecan, and willow. Sedge and grass meadows and scattered trees are on some low-lying sites. (United States Department of Agriculture, Natural Resources Conservation Service, 2022)

LRU notes

The Central Mississippi Valley Wooded Slopes, Northern part (Land Resource Unit (LRU) (115XC) encompasses the Wyaconda River Dissected Till Plains, Mississippi River Hills, and Mississippi River Alluvial Plain (Schwegman et al. 1973; Nelson 2010). It spans three states – Illinois (73 percent), Iowa (6 percent), and Missouri (21 percent) – comprising about 13,650 square miles (Figure 1). The elevation ranges from 420 feet above sea level (ASL) along the Mississippi River floodplains to 885 feet on the upland ridges. Local relief varies from 10 to 20 feet but can be as high as 50 to 100 feet along drainageways and streams and the bluffs on the major rivers reaching 250 feet above valley floors. Wisconsin-aged loess covers the uplands, while Illinoian glacial drift lies directly below. The loess and drift deposits are underlain by several bedrock systems, including the Cretaceous, Pennsylvania, Mississippian, Silurian, Devonian, and Ordovician Systems. Wisconsin outwash deposits and sandy eolian material occur along stream terraces of major tributaries (USDA-NRCS 2006).

The vegetation across the region has undergone drastic changes over time. At the end of the last glacial episode – the Wisconsinan glaciation – the evolution of vegetation began with the development of tundra habitats, followed by a phase of spruce and fir forests, and eventually spruce-pine forests. Not until approximately 9,000 years ago did the climate undergo a warming trend which prompted the development of deciduous forests dominated by oak and hickory. As the climate continued to warm and dry, prairies began to develop approximately 8,300 years ago. Another shift in climate that resulted in an increase in moisture prompted the emergence of savanna-like habitats from 8,000 to 5,000 years before present (Taft et al. 2009). During the most recent climatic shifts, forested ecosystems maintained footholds on steep valley sides and wet floodplains. Due to the physiography of the MLRA, forests were the dominant ecosystems and were affected by such natural disturbances as droughts, wind, lightning, and occasional fire (Taft et al. 2009).

Classification relationships

USFS Subregions: Central Dissected Till Plains (251C)Section; Western Mississippi River Hills (251Ce), Mississippi River and Illinois Alluvial Plains (251Cf), Eastern Mississippi River Hills (251Ci), Galesburg Dissected Till Plain (251Cj), and Wyaconda River Dissected Till Plain (251Cm) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Upper Mississippi River Alluvial Plain (72d), River Hills (72f), and Western Dissected Illinoian Till Plain (72i) (USEPA 2013)

National Vegetation Classification – Ecological Systems: North-Central Oak Barrens (CES202.727) (NatureServe 2018)

National Vegetation Classification – Plant Associations: Quercus velutina – (Quercus alba)/Schizachyrium scoparium – Lupinus perennis Wooded Grassland (CEGL002492) (Nature Serve 2018)

Biophysical Settings: North-Central Interior Dry-Mesic Oak Forest and Woodland (BpS 4213100) (LANDFIRE 2009)

Illinois Natural Areas Inventory: Dry-mesic sand savanna, Dry-mesic barren (White and Madany 1978)

Missouri Terrestrial Natural Communities: Sand savanna (Nelson 2010)

Ecological site concept

Sand Woodlands are located within the green areas on the map. They occur on uplands and high stream terraces.

The soils are Alfisols and Entisols that are moderately well to excessively drained and very deep, formed in eolian sands, eolian deposits, and outwash.

The historic pre-European settlement vegetation on this ecological site was dominated by open oak woodlands. Black oak (Quercus velutina Lam.) , little bluestem (Schizachyrium scoparium (Michx.) Nash), and flaxleaf whitetop aster (Ionactis linariifolius (L.) Greene) are the dominant and diagnostic species on the site. White oak (Quercus alba L.) and, in the north, northern pin oak (Quercus ellipsoidalis E.J. Hill) and eastern white pine (Pinus strobus L.), are common canopy associates (NatureServe 2018). Other grasses present can include Indiangrass (*Sorghastrum nutans* (L.) Nash), porcupinegrass (*Hesperostipa spartea* (Trin.) Barkworth), and big bluestem (*Andropogon gerardii* Vitman) (White and Madany 1978; NatureServe 2018). Forbs typical of an undisturbed plant community associated with this ecological site include tall blazing star (Liatris aspera Michx.), showy goldenrod (Solidago speciosa Nutt.), and birdfoot violet (Viola pedata L.) (Taft et al. 1997). Fire is the primary disturbance factor that maintains this ecological site, while periodic drought and large mammal grazing are secondary factors (LANDFIRE 2009; Taft et al. 2009; NatureServe 2018).

Associated sites

F115XC005IL	**Loess Upland Forest** Loess and loess-covered substrates on uplands including Atlas, Baylis, Bunkum, Caseyville, Creal, Derinda, Dodge, Fayette, Fishhook, Hickory, Kendall, Keomah, Keswick, Menfro, Metea, Navlys, Rozetta, Seaton, Stookey, Stronghurst, Sylvan, Thebes, Timula, Ursa, and Winfield soils
F115XC007IL	**Loess Protected Backslope Forest** Loess and loess-covered substrate parent material on north and east-facingbackslopes including Atlas, Baylis, Fayette, Hennepin, Hickory, Keswick, Menfro, Seaton, Stookey, Sylvan, Timula, and Ursa soils
F115XC008IL	**Loess Exposed Backslope Woodland** Loess and loess-covered substrate parent material on south and west-facing backslopes including Atlas, Baylis, Fayette, Hennepin, Hickory, Keswick, Menfro, Seaton, Stookey, Sylvan, Timula, and Ursa soils

Table 1. Dominant plant species

Tree	(1) *Quercus velutina*
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Ionactis linariifolius*

Physiographic features

Sand Woodlands occur on uplands and high stream terraces. They are situated on elevations ranging from approximately 341 to 1948 feet ASL. The site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

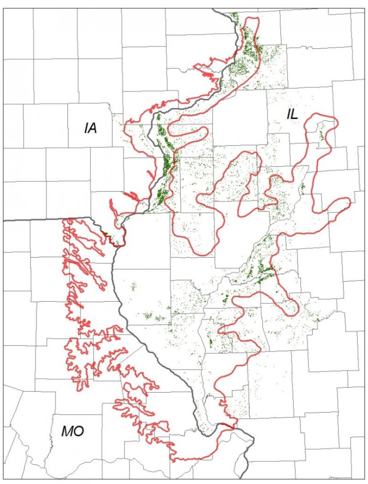


Figure 1. Location of Sand Woodland ecological site within LRU 115XC.

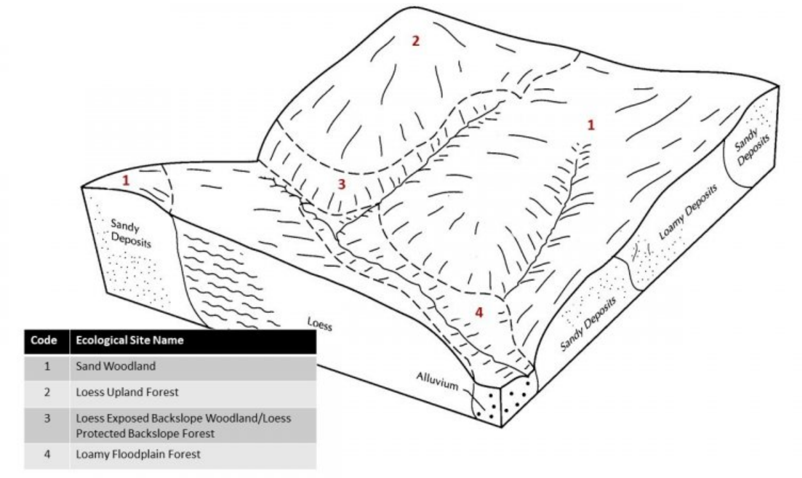


Figure 2. Representative block diagram of Sand Woodland and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Convex
Slope shape up-down	(1) Convex
Landforms	(1) Upland (2) River valley > Stream terrace
Runoff class	Low to high
Flooding frequency	None
Ponding frequency	None
Elevation	341–1,948 ft
Slope	0–35%
Water table depth	33–80 in
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The Central Mississippi Valley Wooded Slopes, Northern Part falls into the humid subtropical (Cfa) and hot-summer humid continental climate (Dfa) Köppen-Geiger climate classifications (Peel et al. 2007). The two main factors that drive the climate of the MLRA are latitude and weather systems. Latitude, and the subsequent reflection of solar input, determines air temperatures and seasonal variations. Solar energy varies across the seasons, with summer receiving three to four times as much energy as opposed to winter. Weather systems (air masses and cyclonic storms) are responsible for daily fluctuations of weather conditions. High-pressure systems are responsible for settled weather patterns where sun and clear skies dominate. In fall, winter, and spring, the polar jet stream is responsible for the creation and movement of low-pressure systems. The clouds, winds, and precipitation associated with a low-pressure system regularly follow high-pressure systems every few days (Angel n.d.).

The soil temperature regime of LRU 115XC is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south one travels. The average freeze-free period of this ecological site is about 180 days, while the frost-free period is about 147 days. The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is 38 inches, which includes rainfall plus the water equivalent from snowfall. The average annual low and high temperatures are 41 and 62°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	135-161 days
Freeze-free period (characteristic range)	164-197 days

Precipitation total (characteristic range)	37-40 in
Frost-free period (actual range)	115-168 days
Freeze-free period (actual range)	145-201 days
Precipitation total (actual range)	36-40 in
Frost-free period (average)	147 days
Freeze-free period (average)	180 days
Precipitation total (average)	38 in

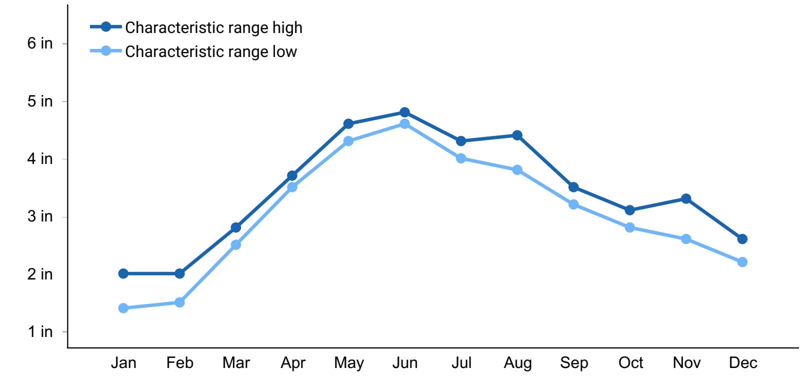


Figure 3. Monthly precipitation range

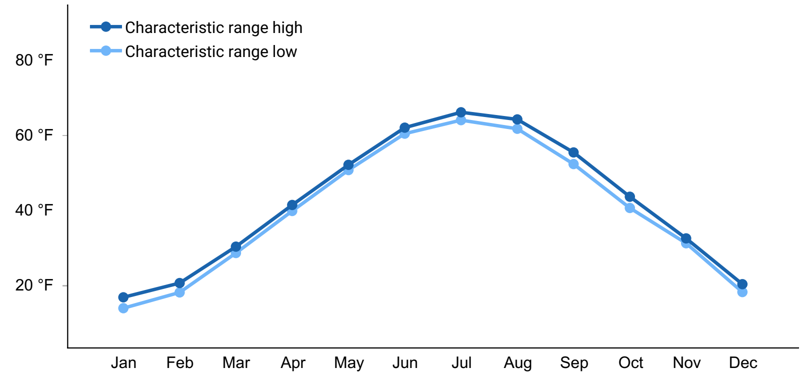


Figure 4. Monthly minimum temperature range

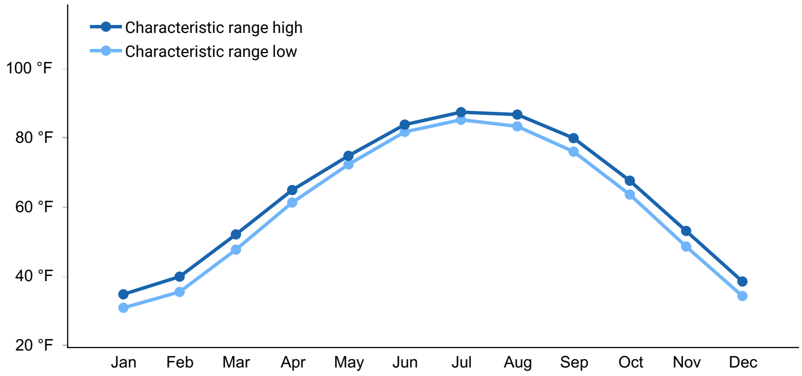


Figure 5. Monthly maximum temperature range

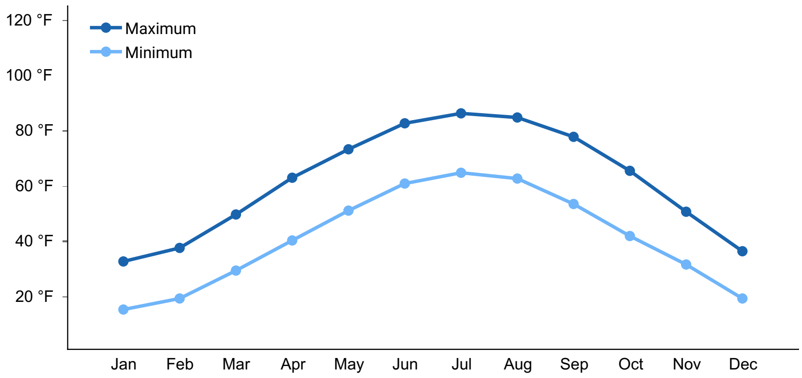


Figure 6. Monthly average minimum and maximum temperature

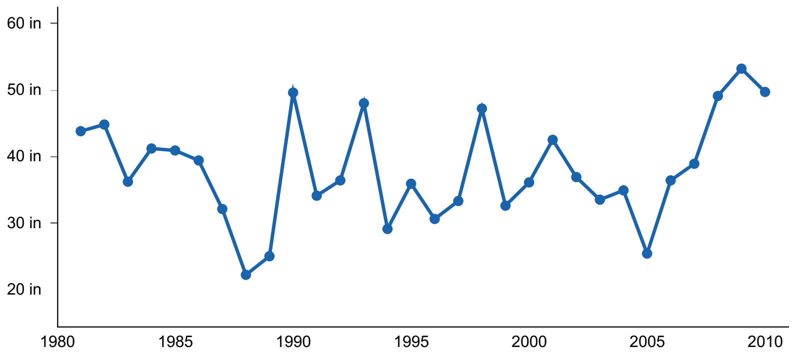


Figure 7. Annual precipitation pattern

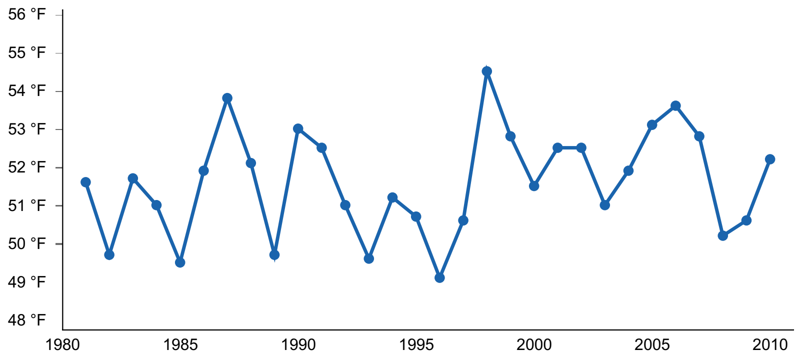


Figure 8. Annual average temperature pattern

Climate stations used

- (1) MT CARROLL [USC00115901], Mount Carroll, IL
- (2) LE CLAIRE L&D 14 [USC00134705], Bettendorf, IA
- (3) GLADSTONE DAM 18 [USC00113455], Burlington, IL
- (4) HAVANA [USC00113940], Lewistown, IL
- (5) WINCHESTER [USC00119331], Winchester, IL

Influencing water features

Sand Woodlands are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is moderate to high (Hydrologic Groups A and B), and surface runoff is low to high. Surface runoff contributes some water to downslope ecological sites.

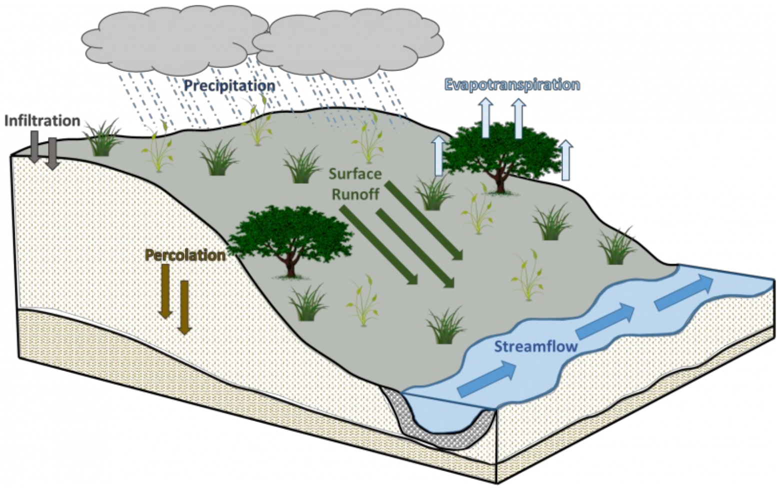


Figure 9. Hydrologic cycling in Sand Woodland ecological site.

Soil features

Soils of Sand Woodlands are in the Alfisols and Entisols orders, further classified as Lamellic Haludalfs, Oxyaquic Hapludalfs, Typic Hapludalfs, and Lamellic Udipsamments with moderate to high infiltration and low to high runoff potential. The soil series associated with this site includes Alvin, Bloomfield, Chelsea, Coloma, El Dara, Lamont, and Tell. The parent material is eolian sands, eolian deposits, and outwash, and the soils are moderately well to excessively drained and very deep. Soil pH classes are very strongly acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site.

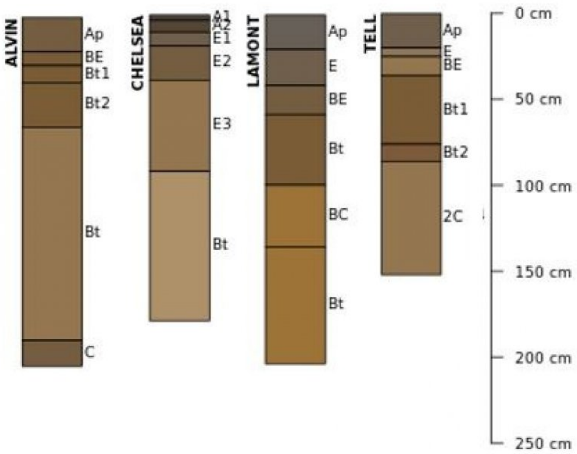


Figure 10. Profile sketches of soil series associated with Sand Woodland.

Table 4. Representative soil features

Parent material	(1) Eolian sands (2) Eolian deposits (3) Outwash
Surface texture	(1) Fine sandy loam (2) Sandy loam (3) Fine sand (4) Loamy fine sand
Family particle size	(1) Coarse-loamy (2) Sandy
Drainage class	Moderately well drained to excessively drained
Permeability class	Slow to rapid
Depth to restrictive layer	80 in

Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	3–8 in
Calcium carbonate equivalent (Depth not specified)	0–30%
Electrical conductivity (Depth not specified)	0–2 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	4.5–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–6%
Subsurface fragment volume >3" (Depth not specified)	0–2%

Ecological dynamics

The information in this Ecological Site Description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

The MLRA lies within the tallgrass prairie ecosystem of the Midwest, but a variety of environmental and edaphic factors resulted in a landscape that historically supported upland hardwood forests, lowland mixed forests, and scattered grass and sedge meadows. Sand Woodlands form an aspect of this vegetative continuum. This ecological site occurs on uplands and high stream terraces on moderately well to excessively drained soils. Species characteristic of this ecological site consist of an open canopy of oaks with a continuous understory of herbaceous vegetation.

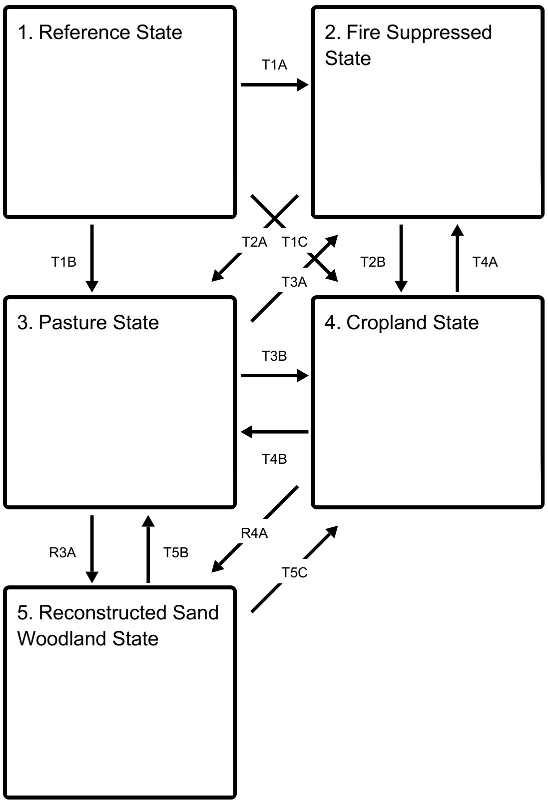
Fire is a critical factor that maintains Sand Woodlands. Fire typically consisted of low- to moderate-severity surface fires every 15 to 25 years (LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and fall seasons. Native Americans regularly set fires to improve sight lines for hunting, drive large game, improve grazing and browsing habitat, agricultural clearing, and enhance vital ethnobotanical plants (Barrett 1980; LANDFIRE 2009).

Drought, grazing, and windthrow have also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the excessively-drained soils have favored the proliferation of plant species tolerant of such conditions. Drought can also slow the growth of plants and result in dieback of certain species. Damage to trees from storms can vary from minor, patchy effects of individual trees to stand effects that temporarily affect community structure and species richness and diversity (Irland 2000; Peterson 2000). When coupled with fire, periods of drought, herbivory, and high wind events can greatly delay the establishment and maturation of woody vegetation (Pyne et al. 1996).

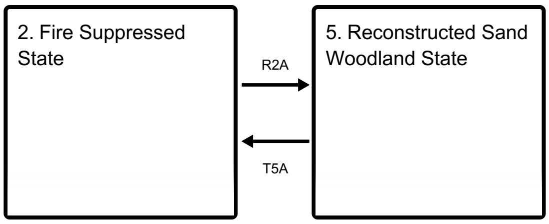
Today, Sand Woodlands have been reduced from their pre-settlement extent. Low to moderate slopes have been converted to cropland, while steeper slopes have been converted to forage land. Remnants that do exist have had fire suppressed long enough to allow the site to convert to a closed canopy forest. A return to the historic plant community may not be possible following extensive land modification, but long-term conservation agriculture or woodland reconstruction efforts can help to restore some biotic diversity and ecological function. The state-and-transition model that follows provides a detailed description of each state, community phase, pathway, and transition. This model is based on available experimental research, field observations, literature reviews, professional consensus, and interpretations.

State and transition model

Ecosystem states



States 2 and 5 (additional transitions)



T1A - Long-term fire suppression and/or land abandonment

T1B - Management inputs to increase forage quality and yield

T1C - Management inputs; transition to cropland

T2A - Management inputs to increase forage quality and yield

T2B - Agricultural conversion via tillage, seeding, and non-selective herbicide

R2A - Site preparation, tree planting, non-native species control, and native seeding

T3A - Long-term fire suppression and/or land abandonment

T3B - Agricultural conversion via tillage, seeding, and non-selective herbicide

R3A - Site preparation, tree planting, non-native species control, and native seeding

T4A - Long-term fire suppression and/or land abandonment

T4B - Management inputs to increase forage quality and yield

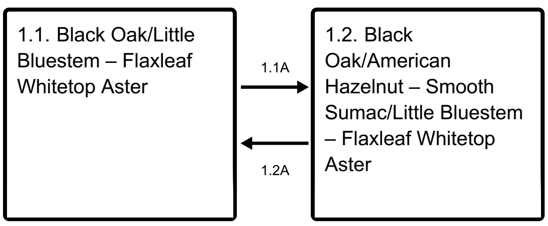
R4A - Site preparation, tree planting, non-native species control, and native seeding

T5A - Long-term fire suppression and/or land abandonment

T5B - Management inputs to increase forage quality and yield

T5C - Agricultural conversion via tillage, seeding, and non-selective herbicide

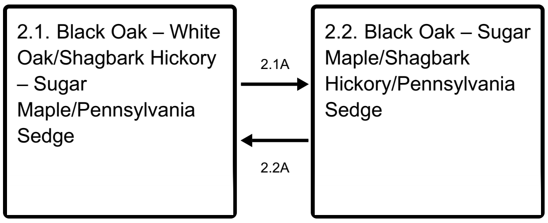
State 1 submodel, plant communities



1.1A - Fire return interval greater than 25 years

1.2A - Replacement fire every 20 years

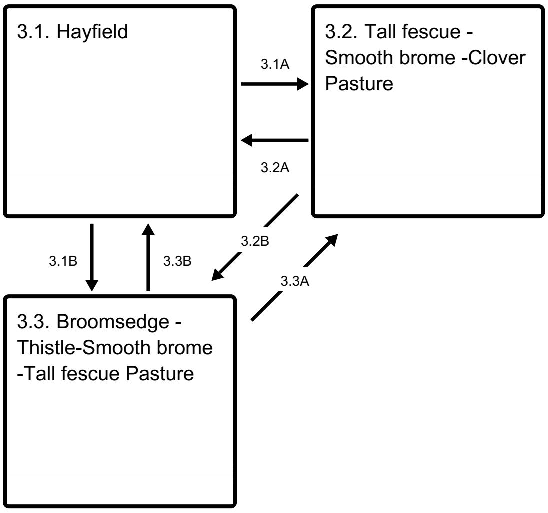
State 2 submodel, plant communities



2.1A - Lack of fire

2.2A - Severe disturbance

State 3 submodel, plant communities



3.1A - Grazing; proper forage-to-animal balance

3.1B - Grazing; overutilization of forage plants

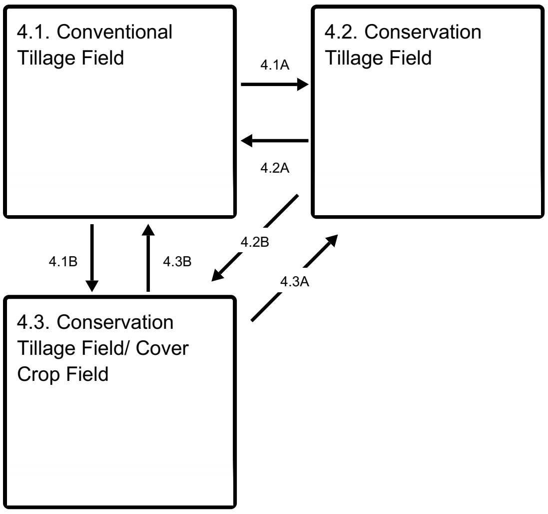
3.2A - Mechanical harvest

3.2B - Grazing; overutilization of forage plants

3.3B - Mechanical harvest

3.3A - Grazing; proper forage-to-animal balance

State 4 submodel, plant communities



4.1A - Less tillage, residue management

4.1B - Less tillage, residue management, and implementation of cover cropping

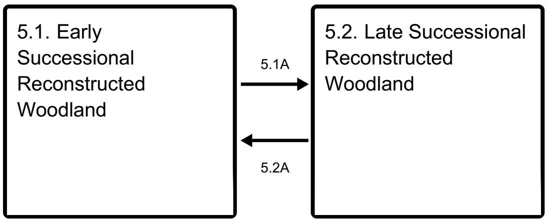
4.2A - Intensive tillage; remove residue; monoculture row cropping

4.2B - Cover cropping

4.3B - Intensive tillage; remove residue; monoculture row cropping

4.3A - Remove cover cropping

State 5 submodel, plant communities



5.1A - Invasive species control and implementation of disturbance regimes

5.2A - Drought or improper timing/use of management actions

State 1
Reference State

The reference plant community is categorized as a dry, open oak woodland community, dominated by deciduous trees and herbaceous vegetation. The two community phases within the reference state are dependent on recurring fire intervals. The severity and intensity of fire alters species composition, cover, and extent, while regular fire intervals keep woody species from closing the canopy. Drought, grazing, and windthrow have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- black oak (*Quercus velutina*), tree
- little bluestem (*Schizachyrium scoparium*), grass
- flaxleaf whitetop aster (*Ionactis linariifolius*), other herbaceous

Community 1.1
Black Oak/Little Bluestem – Flaxleaf Whitetop Aster

Sites in this reference community phase are an open canopy woodland. Black oak and white oak are the dominant trees, but northern pin oak and eastern white pine can be a common canopy associates in the north. Trees are large (21 to 33 inches DBH) and cover ranges from 21 to 60 percent (LANDFIRE 2009). The open canopy allows for a continuous herbaceous layer. Little bluestem, Indiangrass (*Sorghastrum nutans* (L.) Nash), porcupinegrass (*Hesperostipa spartea* (Trin.) Barkworth), and big bluestem (*Andropogon gerardii* Vitman) are the dominant grasses. Characteristic forbs include flaxleaf whitetop aster, roundhead lespedeza (*Lespedeza capitata* Michx), Carolina puccoon (*Lithospermum caroliniense* (Walter ex J.G. Gmel.) MacMill.), and white heath aster (*Symphyotrichum ericoides* (L.) G.L. Nesom) (NatureServe 2018). Surface fires occurring approximately every 20 years will maintain this phase, but fire intervals beyond 25 years will start shifting it to community phase 1.2 (LANDFIRE 2009).

Dominant plant species

- black oak (*Quercus velutina*), tree
- little bluestem (*Schizachyrium scoparium*), grass
- flaxleaf whitetop aster (*Ionactis linariifolius*), other herbaceous

Community 1.2
Black Oak/American Hazelnut – Smooth Sumac/Little Bluestem – Flaxleaf Whitetop Aster

This reference community phase represents natural succession as a result an extended fire return interval. The lack of fire allows shrubs, such as American hazelnut (*Corylus americana* Walter) and smooth sumac (*Rhus glabra* L.), to develop. Tree size class remains steady, but canopy cover ranges from 61 to 80 percent shifting the site to a closed canopy woodland. Forbs may become more important in the herbaceous layer as woody cover increases (NatureServe 2018). Surface fires will maintain this phase. (LANDFIRE 2009).

Dominant plant species

- black oak (*Quercus velutina*), tree
- American hazelnut (*Corylus americana*), shrub
- smooth sumac (*Rhus glabra*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- flaxleaf whitetop aster (*Ionactis linariifolius*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Fire return interval greater than 25 years.

Pathway 1.2A
Community 1.2 to 1.1

Phase 1.2A – fire every 20 years.

State 2
Fire Suppressed State

Long term fire suppression can transition the reference plant community from an open woodland to a closed canopy forest. As the natural fire regime is removed from the landscape, encroachment and dominance by shade-tolerant, fire-intolerant species ensues. This results in a positive feedback loop of mesophication whereby plant community succession continuously creates cool, damp shaded conditions that perpetuate a closed canopy ecosystem (Nowacki and Abrams 2008). Succession to this forested state can occur in as little as 50 years from the last fire (LANDFIRE 2009).

Dominant plant species

- black oak (*Quercus velutina*), tree
- white oak (*Quercus alba*), tree
- Pennsylvania sedge (*Carex pensylvanica*), grass

Community 2.1
Black Oak – White Oak/Shagbark Hickory – Sugar Maple/Pennsylvania Sedge

This community phase represents the early stages of long-term fire suppression. The oak canopy increases to 81 to 100 percent cover (LANDFIRE 2009). The subcanopy supports both fire-tolerant and fire-intolerant species including shagbark hickory (*Carya ovata* (Mill.) K. Koch) and sugar maple (*Acer saccharum* L.), respectively. The herbaceous layer diversity is reduced and begins to shift to shade-tolerant species such as Pennsylvania sedge (*Carex pensylvanica* Lam.). As fire suppression continues, the site will shift to community phase 2.2

Dominant plant species

- black oak (*Quercus velutina*), tree
- white oak (*Quercus alba*), tree
- shagbark hickory (*Carya ovata*), tree
- sugar maple (*Acer saccharum*), tree
- Pennsylvania sedge (*Carex pensylvanica*), grass

Community 2.2
Black Oak – Sugar Maple/Shagbark Hickory/Pennsylvania Sedge

Sites falling into this community phase have a well-established closed forest canopy. Tree size class is still large, but stem density increases (LANDFIRE 2009). Oaks are still present, but seedlings and saplings are greatly reduced or absent as they are unable to develop in the shade of the forest. Under these closed-canopy stands, the subcanopy and herbaceous layers support only the most shade-intolerant species.

Dominant plant species

- black oak (*Quercus velutina*), tree
- sugar maple (*Acer saccharum*), tree
- shagbark hickory (*Carya ovata*), tree
- Pennsylvania sedge (*Carex pensylvanica*), grass

Pathway 2.1A
Community 2.1 to 2.2

Continued fire suppression.

Pathway 2.2A
Community 2.2 to 2.1

Severe disturbance event such as a replacement fire, severe drought, or windstorm.

State 3
Pasture State

The pasture state occurs when the reference state is converted to a farming system that emphasizes domestic livestock production known as grassland agriculture. Fire suppression, periodic cultural treatments (e.g., clipping, drainage, soil amendment applications, planting new species and/or cultivars, mechanical harvesting) and grazing by domesticated livestock transition and maintain this state (USDA-NRCS 2003). Early settlers seeded non-native species, such as smooth brome (*Bromus inermis* Leyss.), tall fescue (*Schedonorus arundinaceus*), and Kentucky bluegrass (*Poa pratensis* L.), to help extend the grazing season. Over time, as lands were continuously harvested or grazed by herds of cattle, the non-native species were able to spread and expand across the landscape, reducing the native species diversity and ecological function.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- white clover (*Trifolium repens*), other herbaceous
- red clover (*Trifolium pratense*), other herbaceous

Community 3.1
Hayfield

Sites in this community phase consist of forage plants that are planted and mechanically harvested. Mechanical harvesting removes much of the aboveground biomass and nutrients that feed the soil microorganisms (Franzluebbers et al. 2000; USDA-NRCS 2003). As a result, soil biology is reduced leading to decreases in nutrient uptake by plants, soil organic matter, and soil aggregation. Frequent biomass removal can also reduce the site's carbon sequestration capacity (Skinner 2008).

Dominant plant species

- tall fescue (*Schedonorus arundinaceus*), grass
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- timothy (*Phleum pratense*), grass
- red clover (*Trifolium pratense*), other herbaceous
- white clover (*Trifolium repens*), other herbaceous

Community 3.2
Tall fescue - Smooth brome -Clover Pasture

This community is characterized by seeded cool-season grass and forbs. Species will depend upon landowner goals and objectives and may include many different grasses and forbs. Common species include smooth brome (*Bromus inermis*), tall fescue (Festuca arundinacea), Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), red clover (*Trifolium pratense*) and white clover (*Trifolium repens* L.). Management inputs include control of weeds and brush. These sites are managed to ensure a proper forage/animal balance. Plants are not overutilized and have adequate rest and recovery.

Dominant plant species

- tall fescue (*Schedonorus arundinaceus*), grass
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- white clover (*Trifolium repens*), other herbaceous
- red clover (*Trifolium pratense*), other herbaceous

Community 3.3
Broomsedge -Thistle-Smooth brome -Tall fescue Pasture

Over utilization of the pasture will result in a shift to include more undesirable species such as thistle (Cirsium spp.), broomsedge (*Andropogon virginicus* L.), ironweed (*Vernonia gigantea*), buttercup (Ranunculus spp.), ragweed (Ambrosia spp.) and blackberries (Rubus spp.). Many woody and weed species may be present depending on seed sources and level of soil disturbance. This community reflects an improper forage-to-animal balance which will negatively impact forage productivity and reproduction, soil health, and water quality. Ecological resiliency is compromised under these conditions.

Dominant plant species

- broomsedge bluestem (*Andropogon virginicus*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- smooth brome (*Bromus inermis*), grass
- thistle (*Cirsium*), other herbaceous
- buttercup (*Ranunculus*), other herbaceous
- ragweed (*Ambrosia*), other herbaceous

Pathway 3.1A
Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock grazing.

Pathway 3.1B
Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock grazing. Overutilization of forage plants.

Pathway 3.2A
Community 3.2 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.2B
Community 3.2 to 3.3

Grazing of livestock with overutilization of the forage plants.

Pathway 3.3B
Community 3.3 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.3A
Community 3.3 to 3.2

Forage plants are not overutilized and the site has a proper forage-to-animal balance.

State 4
Cropland State

The continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) has effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn and soybeans are the dominant crops for the site, and oats (Avena L.) and alfalfa (*Medicago sativa* L.) may be rotated periodically. These areas are likely to remain in crop production for the foreseeable future.

Dominant plant species

- soybean (*Glycine max*), other herbaceous
- corn (*Zea mays*), other herbaceous

Community 4.1
Conventional Tillage Field

Sites in this community phase typically consist of monoculture row-cropping maintained by conventional tillage practices. They are cropped in either continuous corn or corn-soybean rotations. The frequent use of deep tillage, low crop diversity, and bare soil conditions during the non-growing season negatively impacts soil health. Under these practices, soil aggregation is reduced or destroyed, soil organic matter is reduced, erosion and runoff are increased, and infiltration is decreased, which can ultimately lead to undesirable changes in the hydrology of the watershed (Tomer et al. 2005).

Dominant plant species

- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous

Community 4.2
Conservation Tillage Field

This community phase is characterized by rotational crop production that utilizes various conservation tillage methods to promote soil health and reduce erosion. Conservation tillage methods include strip-till, ridge-till, vertical-till, or no-till planting systems. Strip-till keeps seedbed preparation to narrow bands less than one-third the width of the row where crop residue and soil consolidation are left undisturbed in-between seedbed areas. Strip-till planting may be completed in the fall and nutrient application either occurs simultaneously or at the time of planting. Ridge-till uses specialized equipment to create ridges in the seedbed and vegetative residue is left on the surface in between the ridges. Weeds are controlled with herbicides and/or cultivation, seedbed ridges are rebuilt during cultivation, and soils are left undisturbed from harvest to planting. Vertical-till systems employ machinery that lightly tills the soil and cuts up crop residue, mixing some of the residue into the top few inches of the soil while leaving a large portion on the surface. No-till management is the most conservative, disturbing soils only at the time of planting and fertilizer application. Compared to conventional tillage systems, conservation tillage methods can improve soil ecosystem function by reducing soil erosion, increasing organic matter and water availability, improving water quality, and reducing soil compaction.

Dominant plant species

- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous

Community 4.3
Conservation Tillage Field/ Cover Crop Field

Community Phase 4.3 Conservation Tillage Field/Alternative Crop Field – This community phase applies conservation tillage methods as described above as well as adds cover crop practices. Cover crops typically include nitrogen-fixing species (e.g., legumes), small grains (e.g., rye, wheat, oats), or forage covers (e.g., turnips, radishes, rapeseed). The addition of cover crops not only adds plant diversity but also promotes soil health by reducing soil erosion, limiting nitrogen leaching, suppressing weeds, increasing soil organic matter, and improving the overall soil ecosystem. In the case of small grain cover crops, surface cover and water infiltration are increased, while forage covers can be used to graze livestock or support local wildlife. Of the three community phases for this state, this phase promotes the greatest soil sustainability and improves ecological functioning within a cropland system.

Dominant plant species

- oat (*Avena*), grass
- rye (*Secale*), grass
- wheat (*Triticum*), grass
- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous
- radish (*Raphanus*), other herbaceous

Pathway 4.1A
Community 4.1 to 4.2

Tillage operations are greatly reduced, crop rotation occurs on a regular interval, and crop residue remains on the soil surface.

Pathway 4.1B
Community 4.1 to 4.3

Tillage operations are greatly reduced or eliminated, crop rotation occurs on a regular interval, crop residue remains on the soil surface, and cover crops are planted following crop harvest.

Pathway 4.2A
Community 4.2 to 4.1

Intensive tillage is utilized, and monoculture row-cropping is established.

Pathway 4.2B
Community 4.2 to 4.3

Cover crops are implemented to minimize soil erosion.

Pathway 4.3B
Community 4.3 to 4.1

Intensive tillage is utilized, cover crops practices are abandoned, monoculture row-cropping is established, and crop rotation is reduced or eliminated.

Pathway 4.3A
Community 4.3 to 4.2

Cover crop practices are abandoned.

State 5
Reconstructed Sand Woodland State

The combination of natural and anthropogenic disturbances occurring today has resulted in numerous forest health issues, and restoration back to the historic reference condition may not be possible. Woodlands are being stressed by non-native diseases and pests, habitat fragmentation, changes in soil conditions, and overabundant deer populations on top of naturally-occurring disturbances (severe weather and native pests) (IFDC 2018). However, these habitats provide multiple ecosystem services including carbon sequestration; clean air and water; soil conservation; biodiversity support; wildlife habitat; timber, fiber, and fuel products; as well as a variety of cultural activities (e.g., hiking, camping, hunting) (Millennium Ecosystem Assessment 2005; IFDC 2018). Therefore, conservation of forests and woodlands should still be pursued. Woodland reconstructions are an important tool for repairing natural ecological functioning and providing habitat protection for numerous species associated with Sand Woodlands. Therefore, ecological restoration should aim to aid the recovery of degraded, damaged, or destroyed ecosystems. A successful restoration will have the ability to structurally and functionally sustain itself, demonstrate resilience to the ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002). The reconstructed sand woodland state is the result of a long-term commitment involving a multi-step, adaptive management process.

Dominant plant species

- oak (*Quercus*), tree

Community 5.1
Early Successional Reconstructed Woodland

Community Phase 5.1 Early Successional Reconstructed Woodland – This community phase represents the early community assembly from woodland reconstruction. It is highly dependent on the current condition of the site based on past and current land management actions, invasive species, and proximity to land populated with non-native pests and diseases. Therefore, no two sites will have the same early successional composition. Technical forestry assistance should be sought to develop suitable conservation management plans.

Community 5.2
Late Successional Reconstructed Woodland

Community Phase 5.2 Late Successional Reconstructed Woodland – Appropriately timed management practices (e.g., prescribed fire, hazardous fuels management, forest stand improvement, continuing integrated pest management) applied to the early successional community phase can help increase the stand maturity, pushing the site into a late successional community phase over time. A late successional reconstructed woodland will have an uneven-aged canopy and a well-developed shrub layer and understory.

Pathway 5.1A
Community 5.1 to 5.2

Application of stand improvement practices in line with a developed management plan.

Pathway 5.2A
Community 5.2 to 5.1

Reconstruction experiences a setback from extreme weather event or improper timing of management actions.

Transition T1A
State 1 to 2

Long-term fire suppression transitions the site to the fire-suppressed state (2).

Transition T1B
State 1 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the pasture state (3).

Transition T1C
State 1 to 4

Tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Transition T2A
State 2 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the pasture state (3).

Transition T2B
State 2 to 4

Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Restoration pathway R2A
State 2 to 5

Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed sand woodland state (5).

Transition T3A
State 3 to 2

Land abandonment transitions the site to the fire-suppressed state (2).

Transition T3B
State 3 to 4

Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Restoration pathway R3A
State 3 to 5

Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed sand woodland state (5).

Transition T4A
State 4 to 2

Land abandonment transitions the site to the fire-suppressed state (2).

Transition T4B
State 4 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the pasture state (3).

Restoration pathway R4A
State 4 to 5

Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed sand woodland state (5).

Transition T5A
State 5 to 2

Fire suppression and removal of active management transitions this site to the fire-suppressed state (2).

Transition T5B
State 5 to 3

Cultural treatments to enhance forage quality and yield transition the site to the pasture state (3).

Transition T5C
State 5 to 4

Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Additional community tables

Inventory data references

No field plots were available for this site. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in this ecological site description.

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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.

Author(s)/participant(s)	Lisa Kluesner
Contact for lead author	
Date	01/05/2025
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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:**