Ecological site F108XB017IL
Sand Woodland

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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): 108X–Illinois and Iowa Deep Loess and Drift

The Illinois and Iowa Deep Loess and Drift, East-Central Part (MLRA 108B) includes the Rock River Hill Country, Grand Prairie, and Western Forest-Prairie physiographic divisions (Schewman et al. 1973). It falls entirely in one state (Illinois), encompassing approximately 7,450 square miles (Figure 1). The elevation ranges from approximately 985 feet above sea level (ASL) in the northern and western parts to 660 feet ASL in south and west. Local relief is mainly 3 to 10 feet on the broad, upland flats and about 160 feet along the major streams and dissected drainageways. Wisconsin-aged loess forms a moderately thin to thick layer across the entire area with Illinoisan glacial drift below. Bedrock lies beneath the glacial material with Pennsylvania shales, siltstones, and limestones in the south and west and Ordovician and Silurian limestone in the extreme north. This bedrock can be exposed on bluffs along the major rivers (USDA-NRCS 2006).

The vegetation in the MLRA 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. Moisture continued to increase in the southernmost region 5,000 years ago, resulting in an increase of forested systems (Taft et al. 2009). Fire, droughts, and grazing by native mammals helped to maintain the prairies and savannas until the arrival of European settlers, and the forests were maintained by droughts, wind, lightning, and occasional fire (Taft et al. 2009; NatureServe 2018).

Classification relationships

USFS Subregions: Southwestern Great Lakes Morainal (222K), Central Till Plains-Oak Hickory Section (223G), Central Dissected Till Plains (251C), and Central Till Plains and Grand Prairies (251D) Sections; Rock River Old Drift Country (222Kh), Effingham Plain (222Ga), Mississippi River and Illinois Alluvial Plains (251 Cf), East Mississippi River Hills (251Ci), Galesburg Dissected Till Plain (251Cj), Carlinville Dissected Till Plain (251Ck), Green River Lowland (251Da), Western Grand Prairie (251Db), Northern Grand Prairie (251Dc), Southern Grand Prairie (251De), and Springfield Plains (251Df) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Illinois/Indiana Prairies (54a), Sand Area (54d), Rock River Hills (54g), 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 (White and Madany 1978)

Ecological site concept

Sand Woodlands are located within the green areas on the map (Figure 1). They occur on dunes on lake plains. The soils are Entisols that are excessively-drained and deep, formed in eolian sands.

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

R108XB018IL	**Wet Lacustrine Prairie** Lacustrine sediments that are shallow to the water table including Aholt, Booker, Denrock, and Montgomery

Similar sites

F108XB014IL	**Loamy Outwash Forest** Loamy Outwash Forests are in a similar landscape position, but the parent material is loess over outwash or eolian sands

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 dunes on lake plains (Figure 2). They are situated on elevations ranging from approximately 600 to 1200 feet ASL. The site does not experience flooding, but rather generates runoff to downslope, adjacent ecological sites (Table 1).

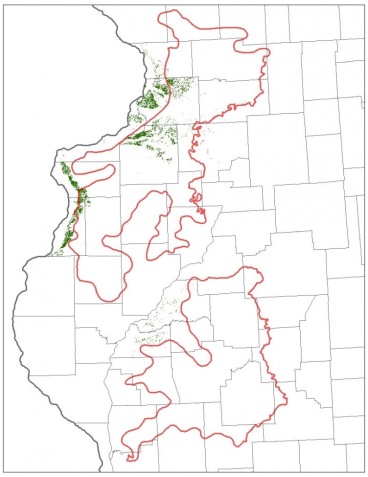


Figure 1. Figure 1. Location of Sand Woodland ecological site within MLRA 108B.

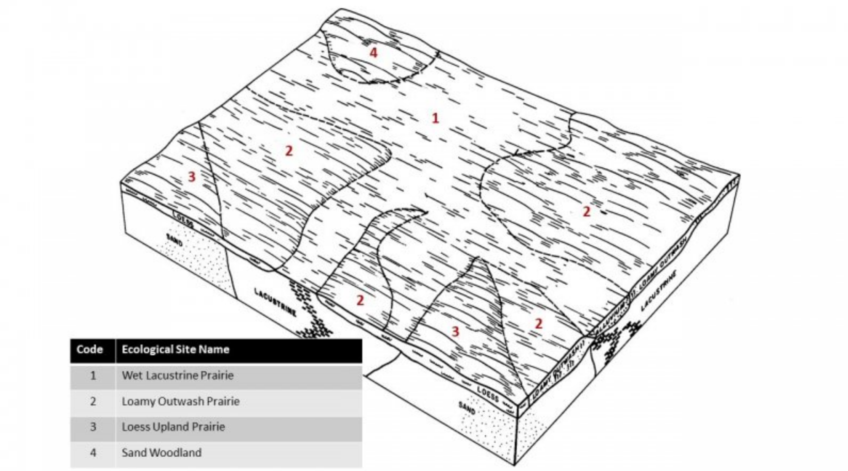


Figure 2. Figure 2. Representative block diagram of Sand Woodland and associated ecological sites.

Table 2. Representative physiographic features

Landforms	(1) Lake plain > Dune
Runoff class	Negligible to medium
Elevation	183–366 m
Slope	1–60%
Water table depth	203 cm
Aspect	Aspect is not a significant factor

Climatic features

The Illinois and Iowa Deep Loess and Drift, East-Central Part falls into the hot-summer humid continental climate (Dfa) and the humid subtropical continental climate (Cfa) 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 MLRA 108B 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 176 days, while the frost-free period is about 137 days (Table 2). The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is approximately 38 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 40 and 60°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from three National Oceanic and Atmospheric Administration (NOAA) weather stations contained within the range of this ecological site (Table 4).

Table 2. Frost-free and freeze-free days and annual precipitation. (Data were obtained from NOAA weather stations within the range of this ecological site, using 30-year averages.)
Average Days
Frost-Free Period (32.5°F or greater, 90% probability) (days) 137.0
Freeze-Free Period (Less than 28.5°F, 90% probability) (days) 175.7
Annual Precipitation (inches) 38.0

Table 3. Monthly and annual precipitation and temperature in the range of Sand Woodland. (Data were obtained from NOAA weather stations within the range

Table 3. Representative climatic features

Frost-free period (characteristic range)	128-145 days
Freeze-free period (characteristic range)	170-181 days
Precipitation total (characteristic range)	965 mm
Frost-free period (actual range)	126-151 days
Freeze-free period (actual range)	167-184 days
Precipitation total (actual range)	965 mm
Frost-free period (average)	137 days
Freeze-free period (average)	176 days
Precipitation total (average)	965 mm

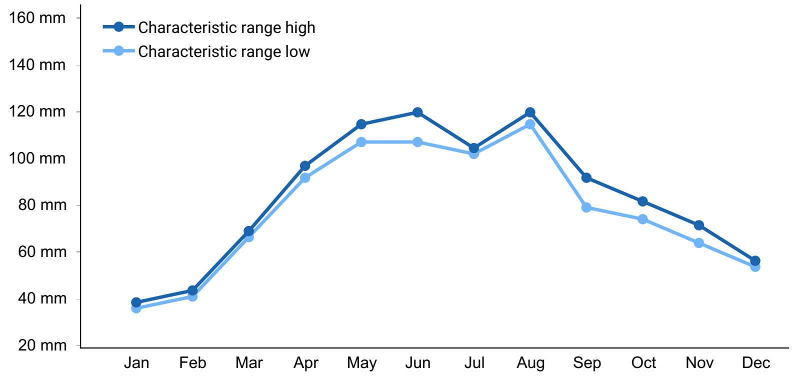


Figure 3. Monthly precipitation range

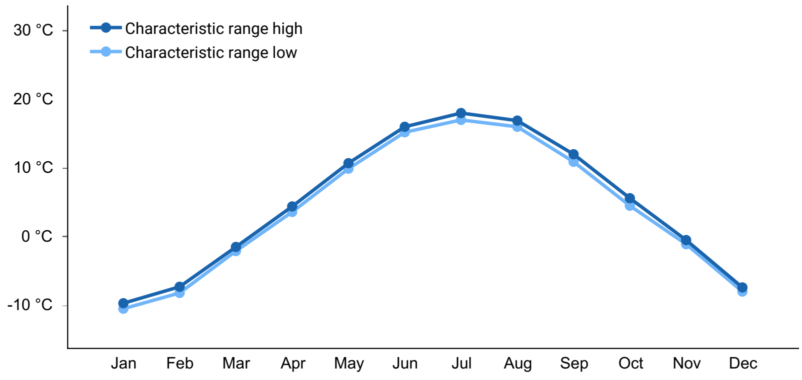


Figure 4. Monthly minimum temperature range

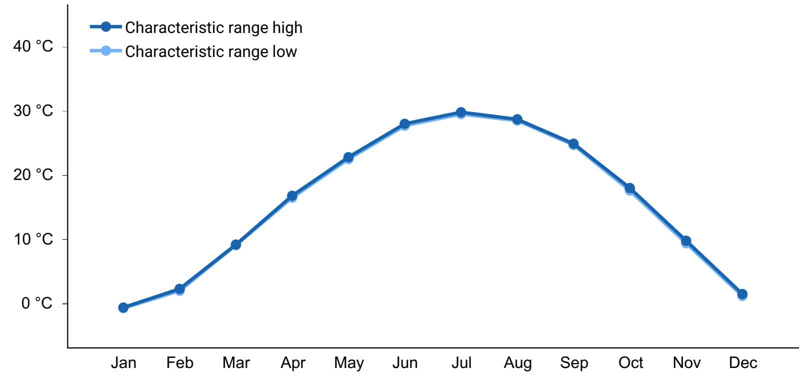


Figure 5. Monthly maximum temperature range

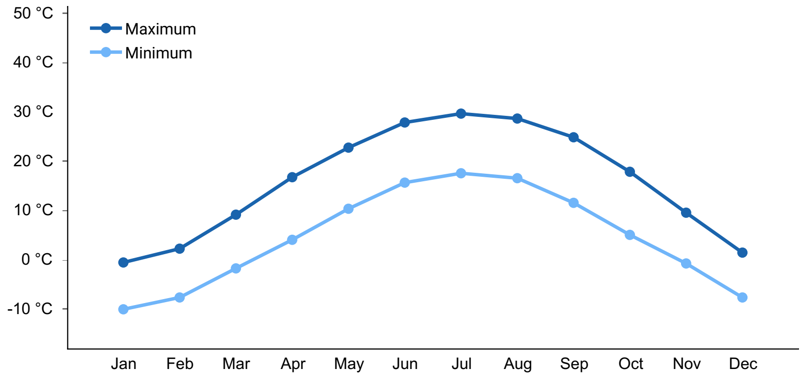


Figure 6. Monthly average minimum and maximum temperature

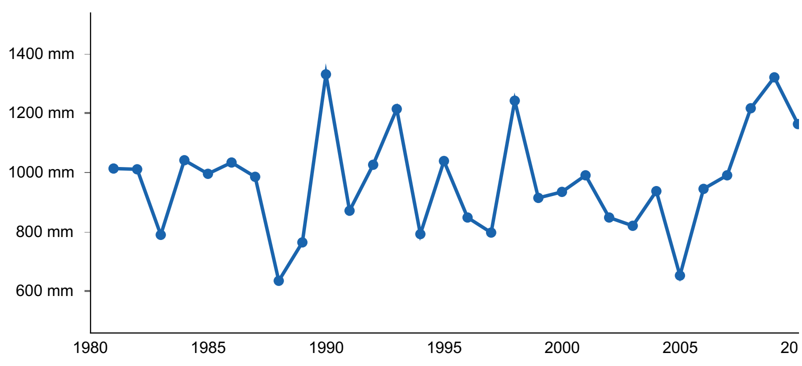


Figure 7. Annual precipitation pattern

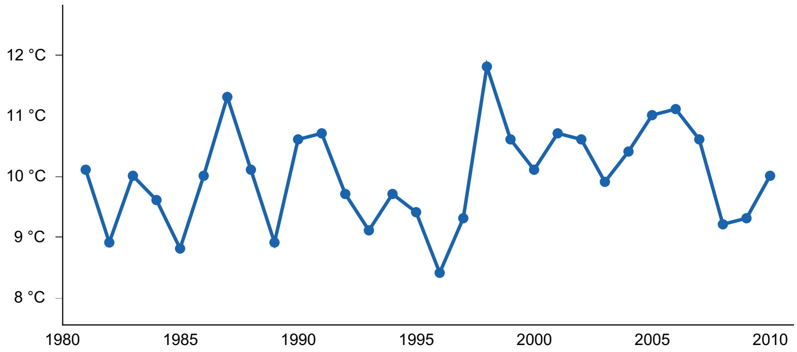


Figure 8. Annual average temperature pattern

Climate stations used

- (1) MORRISON [USC00115833], Morrison, IL
- (2) GENESEO [USC00113384], Geneseo, IL
- (3) MONMOUTH 4NW [USC00115772], Monmouth, 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 high (Hydrologic Group A), and surface runoff is negligible to medium. Surface runoff contributes some water to downslope ecological sites (Figure 5).

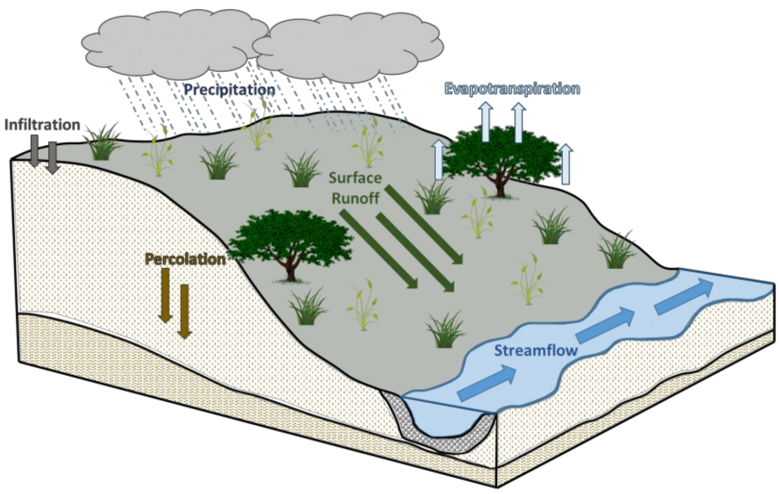


Figure 9. Figure 5. Hydrologic cycling in Sand Woodland ecological site.

Soil features

Soils of Sand Woodlands are in the Entisols orders, further classified as Typic Udipsamments with high infiltration and negligible to medium runoff potential. The soil series associated with this site includes Oakville. The parent material is eolian sands, and the soils are excessively-drained and deep. Soil pH classes are very strongly acid to neutral. No rooting restrictions are noted for the soils of this ecological site (Table 5).

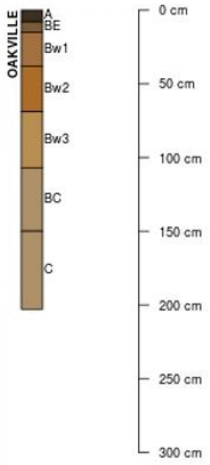


Figure 10. Figure 6. Profile sketch of soil series associated with Sand Woodland.

Table 4. Representative soil features

Parent material	(1) Eolian sands
Drainage class	Excessively drained
Permeability class	Rapid
Depth to restrictive layer	203 cm
Soil depth	203 cm

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.

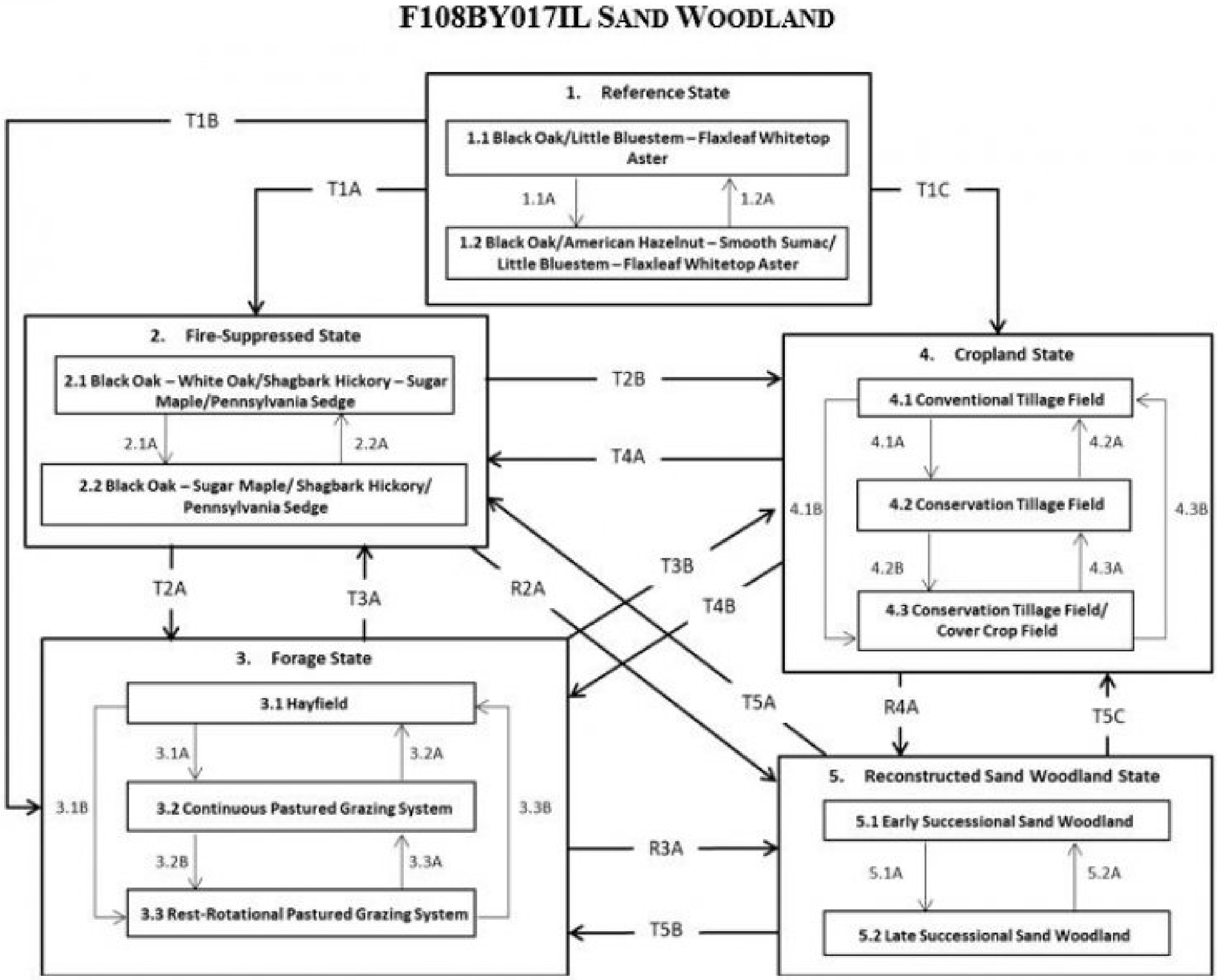
The MLRA lies within the tallgrass prairie ecosystem of the Midwest. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in support prairies, savannas, and forests. Sand Woodlands form an aspect of this vegetative continuum. This ecological site occurs on dunes on lake plains on 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



Code	Process
1.1A	Fire return interval greater than 25 years
1.2A	Replacement fire every 20 years
T1A, T3A, T4A, T5A	Long-term fire suppression and/or land abandonment
2.1A	Continued fire suppression
2.2A	Severe disturbance event such as fire, drought, or windstorm
T1B, T2A, T4B, T5B	Cultural treatments are implemented to increase forage quality and yield
3.1A	Mechanical harvesting is replaced with domestic livestock and continuous grazing
3.1B	Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing
3.2A, 3.3B	Domestic livestock grazing is replaced by mechanical harvesting
3.2B	Implementation of rest-rotational grazing
3.3A	Implementation of continuous grazing
T1C, T2B, T3B, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row cropping
4.3A	Remove cover cropping
R2A, R3A, R4A	Site preparation, tree planting, non-native species control, and native seeding
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
- American hazelnut (*Corylus americana*), shrub
- smooth sumac (*Rhus glabra*), shrub
- little bluestem (*Schizachyrium*), other herbaceous
- flaxleaf whitetop aster (*Ionactis linariifolius*), other herbaceous

Community 1.1
Black Oak/Little Bluestem – Flaxleaf Whitetop Aster

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 shift it to community phase 1.2 (LANDFIRE 2009).

Dominant plant species

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

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

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, but replacement fires every 20 years will shift the community back to phase 1.1 (LANDFIRE 2009).

Dominant plant species

- black oak (*Quercus velutina*), tree
- American hazelnut (*Corylus americana*), shrub
- smooth sumac (*Rhus glabra*), shrub
- little bluestem (*Schizachyrium*), other herbaceous
- 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

Replacement 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
- shagbark hickory (*Carya ovata*), tree
- sugar maple (*Acer saccharum*), tree
- Pennsylvania sedge (*Carex pensylvanica*), other herbaceous

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

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*), other herbaceous

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

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*), other herbaceous

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 fire, drought or windstorm

State 3
Forage State

The forage 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.) 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.

Community 3.1
Hayfield

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).

Community 3.2
Continuous Pastured Grazing System

Continuous Pastured Grazing System – This community phase is characterized by continuous grazing where domestic livestock graze a pasture for the entire season. Depending on stocking density, this can result in lower forage quality and productivity, weed invasions, and uneven pasture use. Continuous grazing can also increase the amount of bare ground and erosion and reduce soil organic matter, cation exchange capacity, water-holding capacity, and nutrient availability and retention (Bharati et al. 2002; Leake et al. 2004; Teague et al. 2011). Smooth brome, Kentucky bluegrass, and white clover (*Trifolium repens* L.) are common pasture species used in this phase. Their tolerance to continuous grazing has allowed these species to dominate, sometimes completely excluding the native vegetation.

Community 3.3
Rest-Rotation Pastured Grazing System

Rest-Rotation Pastured Grazing System – This community phase is characterized by rotational grazing where the pasture has been subdivided into several smaller paddocks. Through the development of a grazing plan, livestock utilize one or a few paddocks, while the remaining area is rested allowing plants to restore vigor and energy reserves, deepen root systems, develop seeds, as well as allow seedling establishment (Undersander et al. 2002; USDA-NRCS 2003). Rest-rotation pastured grazing systems include deferred rotation, rest rotation, high intensity – low frequency, and short duration methods. Vegetation is generally more diverse and can include orchardgrass (*Dactylis glomerata* L.), timothy (Phleum pretense L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.). The addition of native prairie species can further bolster plant diversity and, in turn, soil function. This community phase promotes numerous ecosystem benefits including increasing biodiversity, preventing soil erosion, maintaining and enhancing soil quality, sequestering atmospheric carbon, and improving water yield and quality (USDA-NRCS 2003).

Pathway 3.1A
Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock and continuous grazing

Pathway 3.1B
Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing

Pathway 3.2A
Community 3.2 to 3.1

Domestic livestock grazing is replaced by mechanical harvesting

Pathway 3.2B
Community 3.2 to 3.3

Implementation of rest-rotational grazing

Pathway 3.3B
Community 3.3 to 3.1

Domestic livestock grazing is replaced by mechanical harvesting

Pathway 3.3A
Community 3.3 to 3.2

Implementation of continuous grazing

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. Community Phase 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).

Community 4.1
Conventional Tillage Field

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).

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.

Community 4.3
Conservation Tillage Field/Alternative Crop Field

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.

Pathway 4.1A
Community 4.1 to 4.2

Less tillage, residue management

Pathway 4.1B
Community 4.1 to 4.3

Less tillage, residue management and implementation of cover cropping

Pathway 4.2A
Community 4.2 to 4.1

Intensive tillage, remove residue and reinitialize monoculture row cropping

Pathway 4.2B
Community 4.2 to 4.3

Implementation of cover cropping

Pathway 4.3B
Community 4.3 to 4.1

Intensive tillage, remove residue and reinitialize monoculture row cropping

Pathway 4.3A
Community 4.3 to 4.2

Remove cover cropping

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.

Community 5.1
Early Successional Reconstructed Woodland

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

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

Invasive species control and implementation of disturbance regimes

Pathway 5.2A
Community 5.2 to 5.1

Drought or improper timing/use of management decisions

Transition T1A
State 1 to 2

Long-term fire suppression and/or land abandonment

Transition T1B
State 1 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition T1C
State 1 to 4

Agricultural conversion via tillage, seeding and non-selective herbicide

Transition T2A
State 2 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition T2B
State 2 to 4

Agricultural conversion via tillage, seeding and non-selective herbicide

Transition R2A
State 2 to 5

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

Restoration pathway T3A
State 3 to 2

Long-term fire suppression and/or land abandonment

Transition T3B
State 3 to 4

Agricultural conversion via tillage, seeding and non-selective herbicide

Constraints to recovery. Agricultural conversion via tillage, seeding and non-selective herbicide

Transition R3A
State 3 to 5

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

Restoration pathway T4A
State 4 to 2

Long-term fire suppression and/or land abandonment

Restoration pathway T4B
State 4 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition R4A
State 4 to 5

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

Restoration pathway T5A
State 5 to 2

Long-term fire suppression and/or land abandonment

Restoration pathway T5B
State 5 to 3

Cultural treatments are implemented to increase forage quality and yield

Restoration pathway T5C
State 5 to 4

Agricultural conversion via tillage, seeding and non-selective herbicide

Additional community tables

Inventory data references

No field plots have been developed 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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Approval

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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)	
Contact for lead author	
Date	05/19/2024
Approved by	Chris Tecklenburg
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:**

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

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:**

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17. **Perennial plant reproductive capability:**
