USDA Natural Resources Conservation Service

Ecological site F134XY013AL
Northern Loess Fragipan Terrace - PROVISIONAL

Accessed: 05/18/2024

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): 134X–Southern Mississippi Valley Loess

The Southern Mississippi Valley Loess (MLRA 134) extends some 500 miles from the southern tip of Illinois to southern Louisiana. This MLRA occurs in Mississippi (39 percent), Tennessee (23 percent), Louisiana (15 percent), Arkansas (11 percent), Kentucky (9 percent), Missouri (2 percent), and Illinois (1 percent). It makes up about 26,520 square miles. Landscapes consist of highly dissected uplands, level to undulating plains, and broad terraces that are covered with a mantle of loess. The soils, mainly Alfisols, formed in the loess mantle. Stream systems of the MLRA typically originate as low-gradient drainageways in the upper reaches that broaden rapidly downstream to wide, level floodplains with highly meandering channels. Alluvial soils are predominantly silty where loess thickness of the uplands are deepest but grade to loamy textures in watersheds covered by thin loess. Underlying the loess mantle are Tertiary deposits of unconsolidated sand, silt, clay, gravel, and lignite. Crowley's Ridge, Macon Ridge, and Lafayette Loess Plains are discontinuous, erosional remnants that run north to south in southeastern Missouri - eastern Arkansas, northeastern Louisiana, and south-central Louisiana, respectively. Elevations range from around 100 feet on terraces in southern Louisiana to over 600 feet on uplands in western Kentucky. The steep, dissected uplands are mainly in hardwood forests while less sloping areas are used for crop, pasture, and forage production (USDA, 2006).

This site occurs throughout the Loess Plains (EPA Level IV Ecoregion: 74b) from western Kentucky south to the Southern Rolling Plains (EPA Level IV Ecoregion: 74c) in southwestern Mississippi.

Classification relationships

All or portions of the geographic range of this site falls within a number of ecological/land classifications including:
-NRCS Major Land Resource Area (MLRA) 134 – Southern Mississippi Valley Loess
-Environmental Protection Agency's Level IV Ecoregion: Loess Plains, 74b (Griffith et al., 1998; Woods et al., 2002; Chapman et al., 2004)
-231H - Coastal Plains-Loess section of the USDA Forest Service Ecological Subregion (McNab et al., 2005)
-LANDFIRE Biophysical Setting 4714270 and NatureServe Ecological System CES203.353 East Gulf Coastal Plain Jackson Plain Prairie and Barrens (LANDFIRE, 2009; NatureServe, 2009)
-LANDFIRE Biophysical Setting 4713250 and NatureServe Ecological System CES203.477 East Gulf Coastal Plain Northern Mesic Hardwood Forest (LANDFIRE, 2009; NatureServe, 2009)
-Western Mesophytic Forest Region - Mississippi Embayment Section (Braun, 1950)

Ecological site concept

The Northern Loess Fragipan Terrace is characterized by deep, moderately well drained soils that formed in a mantle of loess. Soils often perch water during wet seasons and/or high rainfall events due to moderately slow to slow permeability in a dense subsoil layer, typically a fragipan. This site primarily occurs on old fluvial terraces (generally above the 100-year flood zone) and secondarily on broad, nearly level toeslopes across the Loess Plains. Slopes range from 0 to 8 percent, but dominant gradients are 2 to 6 percent. Nearly all areas of this site are cleared and under production, today. Natural vegetation of this site prior to settlement likely consisted of a complex mosaic

of fire-maintained prairies (locally and historically known as “barrens”) to open, oak-dominated woodlands that may have been interspersed with pockets of mixed hardwood forests comprised of tuliptree, beech, green ash, maple, and sweetgum. Mixed hardwoods may have been more concentrated along areas bordering wetter environments. In the southern part of the range, shortleaf and loblolly pines may have been important historic components in addition to oak.

Associated sites

F134XY007AL	**Northern Loess Terrace - PROVISIONAL**

Similar sites

F134XY206AL	**Western Fragipan Terrace - PROVISIONAL**

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Physiographic features

The Northern Loess Fragipan Terrace is broadly distributed across the largest physiographic subsection or ecoregion of the MLRA, the Loess Plains. West to east, this ecological site extends from the border of the Loess Hills (EPA Level IV Ecoregion: 74a), across the Loess Plains, and into portions of the Southeastern Plains (EPA Level III Ecoregion: 65) where loess continues to cap old fluvial terraces and broad valleys. North to south, the site extends from the plains in northwestern Tennessee to the border of the Southern Rolling Plains in southwestern Mississippi. The latter forms the southern-most boundary of the site due to warmer average annual air temperatures, greater annual rainfall, and a transition to slightly warmer soils (Chapman et al., 2004).

Characteristics of this region generally include undulating uplands, gently rolling hills, and irregular plains. Topographic relief of the Loess Plains is generally low, averaging about 30 to 70 feet. Upland slopes typically range from 0 to 20 percent with 1 to 8 percent being dominant. Elevations in the range of 300 to 400 feet are commonplace to the south but increase to nearly 600 feet in the north. In portions of western Kentucky and Tennessee, the undulating pattern of the plains is interrupted by dissected landscapes. Such areas tend to be hillier with steeper slopes and greater relief and appear to be concentrated along the borders of broader valleys and floodplains. As the plains continue eastward, starkness of the terrain becomes even more pronounced, which signals the transition of the Loess Plains to the thin loess-capped ridges, hills, and plateaus along the western edge of the Southeastern Plains. To the south, through much of Mississippi, the Loess Plains consists of a very thin east – west belt, compressed between the dissected Loess Hills and Mississippi Alluvial Plain to the west and the Coastal Plain to the east. The convergence of such contrasting ecoregions contribute to a very complex pattern of soils, landforms, and vegetation communities.

This site primarily occurs on broad terraces that border the active floodplains of meandering rivers and large streams. Additionally, this site includes loess-capped, nearly level to gently-sloping toeslopes within broad valleys.

All aspects are well represented and included in this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Terrace
Flooding frequency	None
Ponding frequency	None
Elevation	37–152 m
Slope	0–8%

Ponding depth	0 cm
Water table depth	28–71 cm
Aspect	Aspect is not a significant factor

Climatic features

This site falls under the Humid Subtropical Climate Classification (Koppen System). The average annual precipitation for this site from 1980 through 2010 is 56 inches and ranges from 53 in the north to 58 inches in the south. Maximum precipitation occurs in winter and spring and precipitation decreases gradually throughout the summer, except for a moderate increase in midsummer. Rainfall often occurs as high-intensity, convective thunderstorms during warmer periods but moderate-intensity frontal systems can produce large amounts of rainfall during winter, especially in the southern part of the area. Snowfall generally occurs in the north during most years. However, accumulations are generally less than 12 inches and typically melt within 3 to 5 days. South of Memphis, winter precipitation sometimes occurs as freezing rain and sleet. The average annual temperature is 60 degrees F and ranges from 58 in the north to 64 degrees F in the south. The freeze-free period averages 222 days and ranges from 206 days in the north to 252 days in the south. The frost free period averages 197 days and ranges from 191 in the north to 224 days in the south.

The broad geographic distribution of this site north to south naturally includes much climatic variability with areas farther south having a longer growing season and increased precipitation. These climatic factors likely lead to important differences in overall plant productivity and key vegetation components between the southern and northern portions of this site. As future work proceeds, the current distribution of the Northern Loess Interfluve will likely be revised with a “central” site interjected between the northern and southern extremes of this MLRA.

Table 3. Representative climatic features

Frost-free period (average)	197 days
Freeze-free period (average)	222 days
Precipitation total (average)	1,422 mm

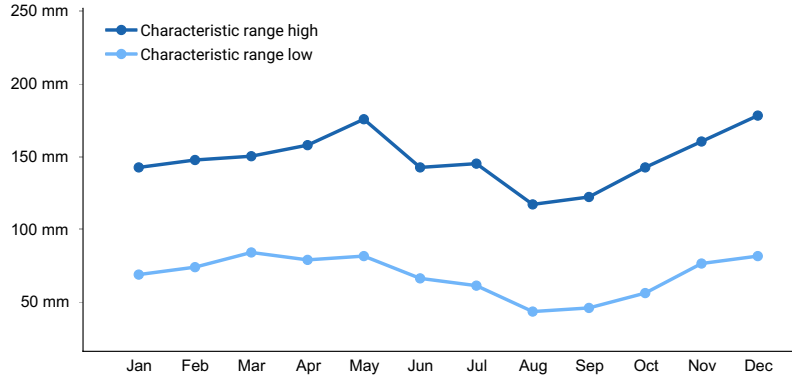

Figure 1. Monthly precipitation range

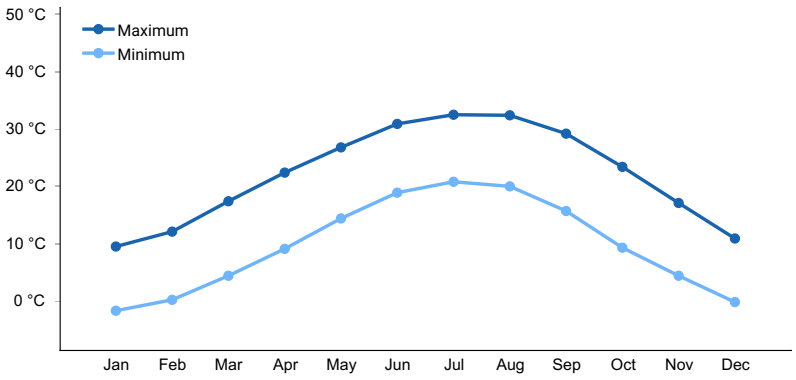

Figure 2. Monthly average minimum and maximum temperature

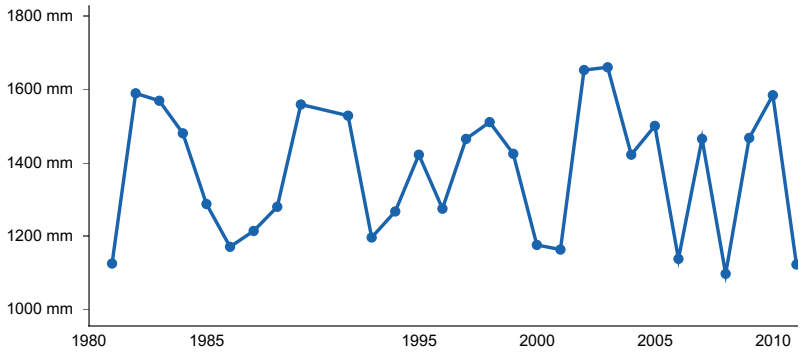

Figure 3. Annual precipitation pattern

Climate stations used

- (1) BARDWELL 2 E [USC00150402], Bardwell, KY
- (2) LOVELACEVILLE [USC00154967], Paducah, KY
- (3) CANTON 4N [USC00221389], Canton, MS
- (4) OAKLEY EXP STN [USC00226476], Raymond, MS
- (5) BOLIVAR WTR WKS [USC00400876], Bolivar, TN
- (6) DRESDEN [USC00402600], Dresden, TN
- (7) BATESVILLE 2 SW [USC00220488], Batesville, MS
- (8) GRENADA [USC00223645], Grenada, MS
- (9) SENATOBIA [USC00227921], Coldwater, MS
- (10) COLLIERVILLE [USC00401950], Collierville, TN
- (11) NEWBERN [USC00406471], Newbern, TN
- (12) UNION CITY [USC00409219], Union City, TN
- (13) JACKSON INTL AP [USW00003940], Pearl, MS
- (14) BROOKPORT DAM 52 [USC00110993], Paducah, IL
- (15) MURRAY [USC00155694], Murray, KY
- (16) LEXINGTON [USC00225062], Lexington, MS
- (17) COVINGTON 3 SW [USC00402108], Covington, TN
- (18) GILBERTSVILLE KY DAM [USC00153223], Gilbertsville, KY
- (19) HOLLY SPRINGS 4 N [USC00224173], Holly Springs, MS
- (20) VICKSBURG MILITARY PK [USC00229216], Vicksburg, MS
- (21) YAZOO CITY 5 NNE [USC00229860], Yazoo City, MS
- (22) MILAN EXP STN [USC00406012], Milan, TN
- (23) PADUCAH [USW00003816], West Paducah, KY

Influencing water features

This site does not flood and is not influenced by a hydrologic regime.

Soil features

Please note that the soils listed in this section of the description may not be all inclusive. There may be additional soils that fit the site's concepts. Additionally, the soils that provisionally form the concepts of this site may occur elsewhere, either within or outside of the MLRA and may or "may not" have the same geomorphic characteristics or support similar vegetation. Some soil map units and soil series included in this "provisional" ecological site were used as a "best fit" for a particular soil – landform catena during a specific era of soil mapping, regardless of the origin of parent material or the location of MLRA boundaries. Therefore, the listed soils may not be typical for MLRA 134 or a specific location, and the associated soil map units may warrant further investigation in a joint ecological site inventory – soil survey project. When utilizing this provisional description, the user is encouraged to verify that the area of interest meets the appropriate ecological site concepts by reviewing the soils, landform, vegetation, and physical location. If the site concepts do not match the attributes of the area of interest, please review the Similar or Associated Sites listed in the Supporting Information section of this description to determine if another site may be a better fit for your area of interest.

The soils of this site are deep, moderately well drained and formed in loess on level to moderately steep uplands and terraces. A distinguishing feature for the majority of these soils is the presence of a fragipan that generally perches water during wet seasons, typically late winter into early spring. Depth to the fragipan varies but generally ranges from 14 to 35 inches. Permeability is moderate above the fragipan and moderately slow to slow in the fragipan. Dominant slopes on this site range from 0 to 5 percent but may extend upwards to 8 percent, locally. Rate of runoff ranges from low to medium.

The principal or dominant soils of this site are the Loring (Fine-silty, mixed, active, thermic Oxyaquic Fragiudalfs), Grenada (Fine-silty, mixed, active, thermic Oxyaquic Fraglossudalfs), and Providence (Fine-silty, mixed, active, thermic Oxyaquic Fragiudalfs) series.

Loring and Grenada soils formed in loess greater than 48 inches. Loring has a single clay maximum in the Bt horizon above the fragipan, and Grenada soils are bisequal and have a glossic horizon. The Providence series is the only soil of this site that formed in a much thinner mantle of loess or silty materials. Providence soils formed in a mantle of silty materials about 2 feet thick and the underlying sandy and loamy sediments. Depth to the discontinuity with more than 15 percent fine sand and coarser material ranges from 24 to 48 inches of the surface.

Table 4. Representative soil features

Surface texture	(1) Silt loam (2) Silty clay loam
Family particle size	(1) Loamy
Drainage class	Moderately well drained
Permeability class	Very slow to moderate
Soil depth	23–81 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	11.18–21.59 cm
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	5–6
Subsurface fragment volume <=3" (Depth not specified)	0%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

The core concepts of this site are drawn from occurrences situated on ancient, loess-capped fluvial terraces that are above the active floodplain (i.e., the 100-year flood zone). The ages of these broad terraces may vary, but those that are currently adjacent to active floodplains today, probably date to the Pleistocene. In addition to terrace occurrences, this site is mapped on level to nearly level toeslopes of valley basins. Slope gradients vary but rarely do they extend beyond 8 percent; dominant slopes range from 2 to 5 percent.

The moderately well drained soils of this site occur on higher elevations and landforms of an otherwise level to nearly level landscape. Landforms represented are generally classed as “rises” on terrace treads. The higher physiographic features of this site coupled with soil properties create conditions suitable for the establishment of upland plant communities within a fairly low-lying environment. A key characteristic of these soils is a relatively shallow depth to a slowly permeable subsoil layer. Although the soils are quite wet during wetter periods of the year, they tend to become droughty by late summer due to evapotranspiration. This site is anticipated to support a

slightly drier plant community than its associate, the Northern Loess Terrace, which is generally very productive.

The pre-settlement plant community of this ecological site was removed more than a century ago, and there are no extant examples of that system remaining. It is possible that various vegetation types and management conditions existed on this site prior to settlement. Broad, level landscapes situated beside active floodplains would have presented exemplary conditions for habitation. Areas that supported human populations would have exerted tremendous influences on the composition and structure of local plant communities. Food, clothing, building, and cultural materials needed for subsistence were cultivated and harvested from surrounding environments. Favored mast and fruit producing trees, in addition to numerous shrubs, vines, and herbs, were selectively produced and managed (Delcourt and Delcourt, 2004). Fire was a critical tool for managing these areas, especially in keeping vegetation growth in check. This complex backdrop of human subsistence and influences on the surrounding landscape must have contributed to a “shifting mosaic” of biological communities as human populations moved about, increased, and waned. Plant communities of this site likely consisted of closed canopy forests, open woodlands and fire-maintained prairies.

Today, nearly the entire distribution of this site has been cleared and is under some form of agriculture production. Minor uses of this site include forest production or timberland and a few localities are in pasture and/or forage production.

Determining and ascribing reference conditions for this site is very challenging. With no example of the pre-settlement plant community remaining (which was likely a mosaic of prairie, woodland, and forest), reference conditions of this site are arbitrarily chosen to reflect the dominant plants that occur in a few existing woodlots. Such compartments have sustained a number of impacts over the past two centuries, but many of the native plant species occupying these areas are considered to be close correlates of the natural vegetation of this site.

In addition to the reference state, four alternate states represent the range of conditions and land uses associated with this site. One of these states, Conservation, is provided to illustrate a conservation alternative to the more intensive management activities on this site. That state involves a discontinuation of production and the decision to establish native vegetation, whether the establishment is predominantly woodland or an herbaceous community.

Following this narrative, a “provisional” state and transition model is provided that includes the “perceived” reference state and several alternative (or altered) vegetation states that have been observed and/or projected for the Northern Loess Fragipan Terrace ecological site. This model is based on limited reconnaissance, literature, expert knowledge, and interpretations. Plant communities will differ due to natural variability in soils and physiography. Depending on objectives, the reference plant community may not necessarily be the management goal.

The environmental and biological characteristics of this site are complex and dynamic. As such, the following diagram suggests pathways that the vegetation on this site might take, given that the modal concepts of climate and soils are met within an area of interest. Specific locations with unique soils and disturbance histories may have alternate pathways that are not represented in the model. This information is intended to show the possibilities within a given set of circumstances and represents the initial steps toward developing a defensible description and model. The model and associated information are subject to change as knowledge increases and new information is garnered. This is an iterative process. Most importantly, local and/or state professional guidance should always be sought before pursuing a treatment scenario.

State and transition model

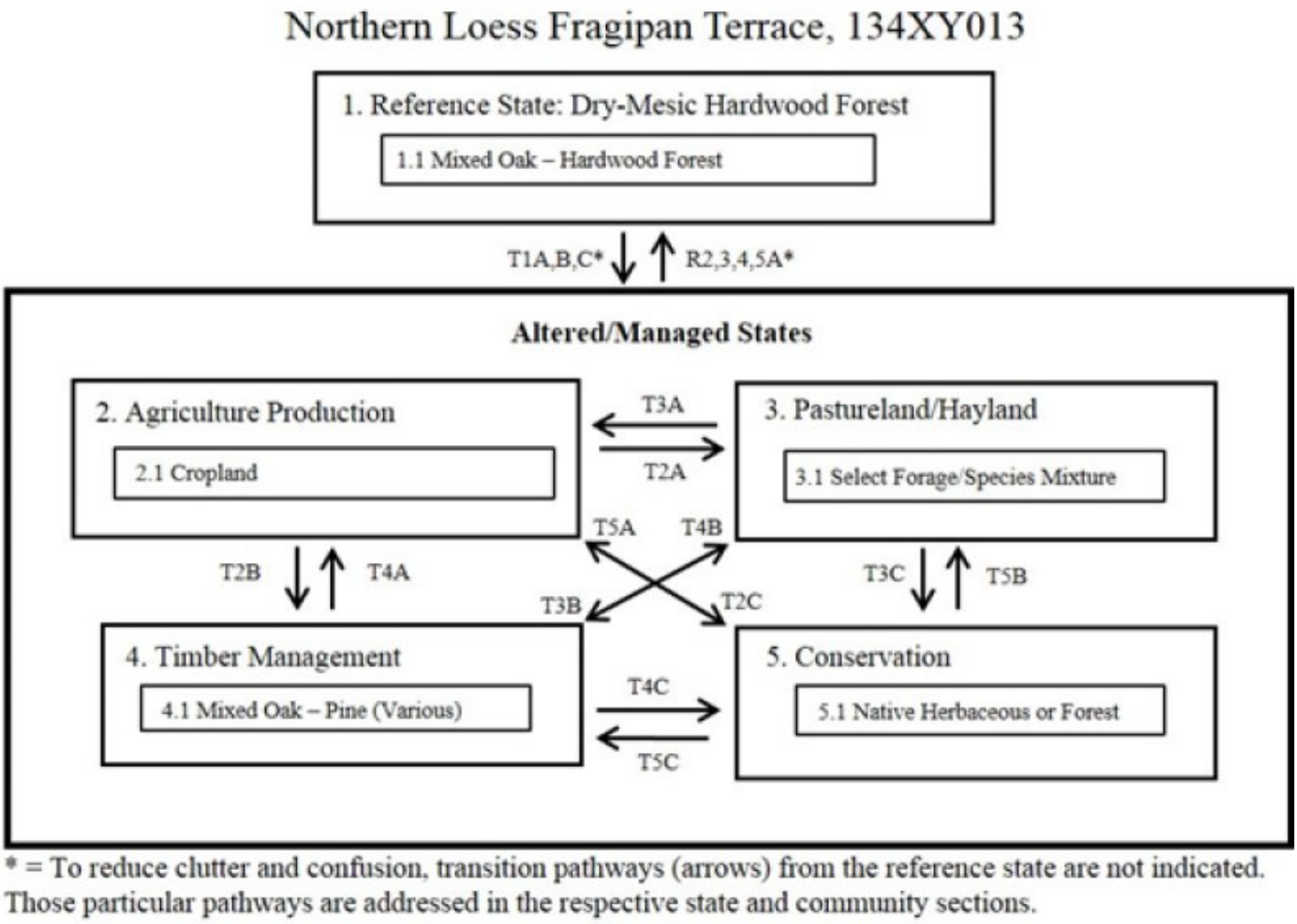

Figure 5. STM - Northern Loess Fragipan Terrace

Pathway	Practice
T1A, T3A, T4A, T5A	mechanical removal of vegetation; establish cultivation (State 2)
T1B, T2A, T4B, T5B	mechanical removal of vegetation; herbicide application; seedbed preparation; planting desired species at appropriate rate (State 3)
T1C, T2B, T3B, T5C	various approaches; includes uneven-age and even-age; goal of mixed oak or pine management; may consist of timber stand improvements; group selection; single tree harvest (State 4)
T2C, T3C, T4C	discontinuing cultivation/pastureland/timberland and establishing native grasses/forbs or managing for native woodland; includes "guided" natural succession and maintenance, periodic fire, select herbicide treatment (State 5)
R2A, R3A, R4A, R5A	natural succession over time; may require exotic plant control and reestablishment of missing species (State 1)

Figure 6. Legend - Northern Loess Fragipan Terrace

State 1
Dry-Mesic Hardwood Forest

The reference conditions of this ecological site are chosen to reflect the dominant plants that occur in a few existing woodlots. Many of the native plant species occurring within these areas are considered to be close correlates of the natural vegetation of this site, which is mainly comprised of a drier association of upland hardwoods. This projection of the natural community is based on the fragic properties of the soils associated with this site, particularly with respect to their tendency of becoming dry during periods of low rainfall. Characteristic species of the site include oaks and hickory typical of upland environments but may also include species more aligned with moist (i.e., mesic) conditions. The name of the reference state is reflective of the moisture tolerances of the species associated with this site. From a structural perspective, this site may have supported a mosaic of conditions that included closed forests, open woodlands, and meadows or small prairies, the latter either occurring along the fringes or within the site proper. A single community phase is provided to represent current conditions of protected stands, which is a

closed canopy, structurally complex forest. Additional reference community phases may be included in subsequent iterations of this site description, if warranted.

Community 1.1
Mixed Oak – Hardwood Forest

Canopy components of this site may include southern red oak, black oak, white oak, water oak, post oak, shagbark hickory, mockernut hickory, pignut hickory, elm, ash, and black gum. In areas where moisture is higher (e.g., near streams, local depressions, etc.), additional associates may include cherrybark oak, Shumard's oak, willow oak, swamp chestnut oak, sweetgum, tuliptree, maple, bitternut hickory, black walnut, and American beech. Loblolly and shortleaf pine may occur locally to the south in Mississippi. The occurrence of shortleaf pine may be more associated with the thin loess soil of this site, Providence soils. Mid-story and understory species may include smaller canopy species in addition to hophornbeam, dogwood, blueberry (Vaccinium spp.), spicebush, and pawpaw and red buckeye in moister spots.

State 2
Agriculture Production

Agriculture production is the dominant land use activity on this site, today. Most cropland is relegated to the uplands and broad terraces of the Loess Plains within MLRA 134.

Community 2.1
Cropland

Crops may include soybean, corn, wheat, and cotton.

State 3
Pastureland/Hayland

This state is representative of sites that have been converted to and maintained in pasture and forage cropland, typically a grass – legume mixture. For pastureland, planning or prescribing the intensity, frequency, timing, and duration of grazing can help maintain desirable forage mixtures at sufficient density and vigor (USDA-NRCS, 2010; Green et al., 2006). Overgrazed pastures can lead to soil compaction and numerous bare spots, which may then become focal points of accelerated erosion and colonization sites of undesirable plants or weeds. Establishing an effective pasture management program can help minimize the rate of weed establishment and assist in maintaining vigorous growth of desired forage. An effective pasture management program includes: selecting well-adapted grass and/or legume species that will grow and establish rapidly; maintaining proper soil pH and fertility levels; using controlled grazing practices; mowing at proper timing and stage of maturity; allowing new seedings to become well established before use; and renovating pastures when needed (Rhodes et al., 2005; Green et al., 2006). It is strongly advised that consultation with State Grazing Land Specialists and District Conservationists at local NRCS Service Centers be sought when assistance is needed in developing management recommendations or prescribed grazing practices.

Community 3.1
Select Forage/Species Mixture

This community phase represents commonly planted forage species on pasturelands and haylands. The suite of plants established on any given site may vary considerably depending upon purpose, management goals, usage, and soils. Most systems include a mixture of grasses and legumes that provide forage throughout the growing season. Cool season forage may include tall fescue (*Schedonorus arundinaceus*), orchardgrass (*Dactylis glomerata*), white clover (*Trifolium repens*), and red clover (*T. pratense*), and warm season forage often consists of bermudagrass (*Cynodon dactylon*), bahiagrass (*Paspalum notatum*), and annual lespedeza (Kummerowia spp.). Several additional plants and/or species combinations may be desired depending on the objectives and management approaches and especially, local soils. Should active management (and grazing) of the pastureland be halted, this phase will transition to "old field" conditions, which is the transitional period between a predominantly open, herbaceous field and the brushy stage of a newly initiated stand of trees.

State 4
Timber Management

This state represents a broad range of management objectives, options, and stand conditions including woodlots allowed to grow or revert naturally; repeated single-tree harvests (often high-graded); carefully prescribed treatments; and conversion to a monoculture or single-species stand. Various management or silvicultural methods can lead to very different structural and compositional results. For prescribed management options, methods are diverse, which include even-aged (e.g., clearcut and shelterwood) and uneven-aged (single tree, diameter-limit, basal area, group selection, etc.) approaches. Included within these methods is an option to use disturbance mechanisms (e.g., fire, TSI, etc.) to reduce competition and achieve maximum growth potential of the desired species. Inherently, these various approaches result in different community or “management phases” and possibly alternate states. The decision to represent these varying methods and management strategies into a single state and phase at this time hinges on the need for additional information in order to formulate definitive pathways, management actions, and community responses. Forthcoming inventories of this site will provide more detail on this state and associated management phases.

Community 4.1
Mixed Oak – Pine (Various)

Some of the most desirable timber on this site consists of oak. Depending on the desired end product, management activities will differ. Management for oak dominant stands may be achieved by shelterwood and/or seed tree approaches. Managing for other hardwoods, and pine to the south, may only require timber stand improvement methods or artificial regeneration may be called for where other hardwoods predominate. Pine management may be best relegated to southern portions of this site. Finding the appropriate approach for a given stand and environment necessitates close consultation with trained, experienced, and knowledgeable forestry professionals. It is strongly urged and advised that professional guidance be secured and a well-designed silvicultural plan developed in advance of any work conducted.

State 5
Conservation

This alternative state is included to represent the range or breadth of conservation actions that may be implemented and established should other land uses be discontinued within a given location. Several actions may be chosen including the standard of establishing: native warm season grasses; suitable forbs for pollinators; select native trees to manage for forest or woodland conditions. If at all possible, the herbaceous species established should be derived from the “wild types” (genetic stock) from the Loess Plains or from adjoining ecoregions. This action would help preserve the unique genetic material from the area and would help to reintroduce the native herbaceous taxa back into a portion of their former range.

Community 5.1
Native Herbaceous or Woodland

This community phase represents the establishment of select native plants to meet conservation objectives on this site. As alluded to above, the best case scenario is the establishment of native species selected from the genetic stock of the Loess Plains or neighboring ecoregions. Herbaceous species suitable for establishing on this site include big bluestem, Indian grass, little bluestem, threeawn, wild oat grasses, panic grass, wild indigo, blazing stars, evening-primrose, asters, black-eyed susans, compass plant, coneflowers, goldenrod, lanceleaf tickseed, tall tickseed, rattlesnake master, sunflowers, flowering spurge, Virginia strawberry, purple milkwort, slender milkwort, Sampson’s snakeroot, mountain mints, agave, New Jersey tea, goat’s-rue, various milkweeds, sedges, among many others (partially derived from Heineke, 1987; and from D. Estes). Key to the perpetuation and maintenance of this system is frequent fire, generally on a 1 to 3 year return interval (judgement based on early accounts of frequent burning; e.g., Loughridge, 1888). Although, LANDFIRE (2009) models suggest replacement or surface fire every 10 years maintains the early development characteristics of this system.

Transition T1A
State 1 to 2

Actions include mechanical removal of vegetation and stumps; preparation for and establishment of crops (State 2).

Transition T1B
State 1 to 3

This pathway represents an attempt to convert the woodland community to pasture or forage production. Actions include clearing, stump removal, seedbed preparation, and the establishment of desired plants (State 3).

Transition T1C
State 1 to 4

This pathway consists of prescribed silvicultural activities specifically designed to meet stand compositional and production objectives.

Restoration pathway R2A
State 2 to 1

This pathway represents natural succession back to perceived reference conditions. The period required for this transition to take place likely varies by location and is dependent upon local site conditions and the intensity of former land use impacts. LANDFIRE models (2009) suggest that over 80 years is required for a return to a late development community and this pathway is highly dependent upon species present in the developing stand and former disturbances. Significant efforts may be required before a return to reference conditions is achieved (e.g., exotic species control, potential artificial regeneration of community components, etc.).

Transition T2A
State 2 to 3

Seedbed preparation and establishment of desired forage/grassland mixture (State 3).

Transition T2B
State 2 to 4

This pathway represents prescribed management strategies for transitioning former cropland and/or cutover woodland to one that meets timber stand composition and production objectives. For enhanced oak production, actions may include artificial regeneration and reduction of oak competition. Managing for mixed hardwood production may require exotic species control and general timber stand improvement practices. The final option of this pathway is the establishment of a pine monoculture or plantation. Establishment of the latter may be most successful on thin loess soils and/or in the southern portions of this site (State 4).

Transition T2C
State 2 to 5

This pathway represents the decision to discontinue cultivation/production and establish native grasses/forbs or trees on this site. This action also includes management activities to “guide” natural succession and conservation maintenance. Actions may include prescribed fire for maintaining and enhancing herbaceous establishment and herbicide treatments for controlling exotic species invasions and to ensure select tree establishment (State 5).

Restoration pathway R3A
State 3 to 1

This pathway represents natural succession back to perceived reference conditions. The period required for this transition to take place likely varies by location and is dependent upon local site conditions and the intensity of former land use impacts. LANDFIRE models (2009) suggest that over 80 years is required for a return to a late development community and this pathway is highly dependent upon species present in the developing stand and former disturbances. Significant efforts may be required before a return to reference conditions is achieved (e.g., exotic species control, potential artificial regeneration of community components, etc.).

Transition T3A
State 3 to 2

Actions include removal of vegetation; herbicide treatment of residual plants; and preparation for crop establishment.

Transition T3B
State 3 to 4

This pathway represents natural succession of former pasture to non-managed “woods” or forest or implementing prescribed management strategies for meeting timber stand composition and production objectives. For enhanced oak production, actions may include artificial regeneration and reduction of oak competition. Managing for mixed hardwood production may require exotic species control and general timber stand improvement practices. The final option of this pathway is the establishment of a pine monoculture or plantation. Establishment of the latter may be most successful on thin loess soils and/or in the southern portions of the site.

Transition T3C
State 3 to 5

This pathway represents the decision to discontinue grazing/non-native forage management and establish native grasses/forbs or trees on this site. This action also includes management activities to “guide” natural succession. Actions may include prescribed fire for maintaining and enhancing herbaceous establishment and herbicide treatments for controlling exotic species invasions and to ensure select tree establishment.

Restoration pathway R4A
State 4 to 1

Natural succession over a period of time may transition a former timber-managed stand to one supporting reference conditions. Based on observations of some reference stands, a period greater than 50 years may be required, unless it was a former pine monoculture. Some question remains whether a return to reference conditions will occur in every situation, especially since some components may have been selectively culled from the stand. Management activities to aide recovery may include exotic species control and silvicultural treatment.

Transition T4A
State 4 to 2

Actions include removal of vegetation; herbicide treatment of residual plants; and preparation for planting.

Transition T4B
State 4 to 3

Seedbed preparation and establishment of desired forage/grassland mixture.

Transition T4C
State 4 to 5

This pathway represents the decision to discontinue timber management and establish native grasses/forbs on this site. This decision also includes the implementation of management activities to “guide” natural succession and conservation end goals. Actions may include prescribed fire for maintaining and enhancing herbaceous establishment and herbicide treatments for controlling exotic species invasions.

Restoration pathway R5A
State 5 to 1

This pathway represents natural succession back to perceived reference conditions. The period required for this transition to take place likely varies by location and is dependent upon local site conditions and the intensity of former land use impacts. LANDFIRE models (2009) suggest that over 80 years is required for a return to a late

development community and this pathway is highly dependent upon species present in the developing stand and former disturbances. Significant efforts may be required before a return to reference conditions is achieved (e.g., exotic species control, potential artificial regeneration of community components, etc.).

Transition T5A
State 5 to 2

This pathway represents the discontinuation of conservation practices and a return to production.

Transition T5B
State 5 to 3

This pathway represents the discontinuation of conservation practices and a return to pasture and/or hayland management entailing removal of vegetation, seedbed preparation, and establishment of desired forage/grassland mixture.

Transition T5C
State 5 to 4

This pathway represents the discontinuation of conservation practices and establishing prescribed management strategies for timber stand composition and production objectives. For enhanced oak production, actions may include artificial regeneration and reduction of oak competition. Managing for mixed hardwood production may require exotic species control and general timber stand improvement practices. The final option of this pathway is the establishment of a pine monoculture or plantation. Establishment of the latter may be most successful on thin loess soils and/or in the southern portions of the site.

Additional community tables

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Contributors

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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	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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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):**

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

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17. **Perennial plant reproductive capability:**
