USDA Natural Resources Conservation Service

Ecological site F134XY012AL
Northern Loess Fragipan Upland - PROVISIONAL

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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.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

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 4713060 and NatureServe Ecological System CES203.482 East Gulf Coastal Plain Northern Loess Plain Oak-Hickory Upland, (LANDFIRE, 2009; NatureServe, 2009)
-LANDFIRE Biophysical Setting 4713070 and NatureServe Ecological System CES203.483 East Gulf Coastal Plain Northern Dry Upland Hardwood Forest (LANDFIRE, 2009; NatureServe, 2009)
-Western Mesophytic Forest Region - Mississippi Embayment Section (Braun, 1950)

Ecological site concept

The Northern Loess Fragipan Upland 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 occurs on broad, nearly level upland interfluves to strongly sloping sideslopes. Slopes range from 0 to 20 percent, but dominant gradients are 2 to 12 percent. Nearly all areas of this site are cleared and under production, today. However, the natural vegetation prior to settlement likely consisted of a complex mosaic of conditions that ranged from fire-maintained prairies (locally and historically known as "barrens") to open, oak-dominated woodlands. In the southern part of the range, shortleaf and loblolly pines may have been important historic components in addition to oak.

Associated sites

F134XY003AL	**Northern Loess Interfluve - PROVISIONAL**
F134XY004AL	**Northern Moderately Wet Loess Interfluve - PROVISIONAL**
F134XY006AL	**Northern Loess Sideslope - PROVISIONAL**

Similar sites

F134XY207AL	**Western Fragipan Uplands - PROVISIONAL**
F134XY105MS	**Southern Rolling Plains Loess Fragipan Upland - PROVISIONAL** The southern counterpart to the Northern Loess Fragipan Upland.
F134XY003AL	**Northern Loess Interfluve - PROVISIONAL**

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Physiographic features

The Northern Loess Fragipan Upland 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 upland interfluves. North to south, the site extends from the plains in western Kentucky 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 particular site occurs on broad interfluves and lower-gradient sideslopes (up to 20 percent) of the Loess Plains but also on moderately broad to narrower ridgetops and divides where landscape dissection increases. Slopes of this site are generally less than 12 percent, but locally may extend to nearly 20 percent. Aspect influences are minimal; only the steepest slopes may experience some effect from exposure.

Table 2. Representative physiographic features

Landforms	(1) Interfluve (2) Divide (3) Hill
Flooding frequency	None
Ponding frequency	None
Elevation	61–198 m
Slope	0–20%
Ponding depth	0 cm
Water table depth	28–71 cm
Aspect	N, S, W

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

Climate stations used

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

Influencing water features

This site is not influence by a hydrologic regime. Of note, inclusions of highly localized depressions that support seasonal ponding have been observed on level, broad interfluves of this site. The presence of such features does not influence the overall characteristics of this particular ecological site. Localized depressions are influenced by different soils and ecological processes and hence, support different plant communities. Therefore, they represent a different ecological site.

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. A distinguishing feature for the majority of these soils is the presence of a fragipan that perches water during wet seasons, typically late winter into early spring. Depth to the fragipan varies but generally ranges from 14 to 35 inches, although one soil series has depths less than 12 inches. Permeability is moderate above the fragipan and moderately slow to slow in the fragipan. Dominant Slopes on this site range from 0 to 12 percent but may extend upwards to 20 percent, locally. Rate of runoff ranges from low to high and is contingent upon slope gradient –

higher rates of runoff occurring on steeper slopes.

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. Secondary soils of this site include Purchase (Coarse-silty, mixed, active, thermic Oxyaquic Fragiudalfs), and Center (Fine-silty, mixed, active, thermic Aquic Hapludalfs) series.

Loring, Grenada, Purchase, and Center soils formed in loess greater than 48 inches. Loring has a single clay maximum in the Bt horizon above the fragipan. Grenada soils are bisequal and have a glossic horizon. Purchase soils have a shallow to very shallow depth to the fragipan, commonly less than 12 inches. Center is the only soil series provisionally associated with this site that does not have a fragipan. However, some pedons exhibit weak prismatic structure and have moderately slow permeability. Areas supporting Center soils have slopes ranging from 0 to 3 percent and have a drainage gradient from moderately well to somewhat poorly drained.

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	8–91 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	9.4–21.59 cm
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	5–5.9
Subsurface fragment volume <=3" (Depth not specified)	1–2%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

This provisional ecological site is broadly mapped across MLRA 134. The site occurs across one of the most distinctive landforms of the region, the broad, gently sloping and undulating interfluves and divides of the Loess Plains. Where dissection of the landscape increases, the site becomes compressed along narrower ridgetops and summits. This upland site receives full insolation and accordingly, can become quite droughty. This effect is compounded given the shallow nature of the soils to a fragipan. The effects of evapotranspiration may remove soil moisture above the impermeable subsoil layer. Plant communities developing under this moisture regime generally consist of a drier association.

Determining and ascribing reference conditions for this site is extremely challenging. The pre-settlement plant community of this site was removed and/or severely altered soon after settlement nearly 200 years ago, and there

are no intact examples of that system remaining. The only source of information that provides some indication of the former natural communities of this site are accounts from early settlers, observations recorded in state geologic surveys, and clues pieced together from remnant strands occurring in small woodlots, along roadsides, and in old fields. With no example of the pre-settlement plant community remaining, reference conditions of this site have been arbitrarily chosen to reflect the range of physiognomic characteristics and/or vegetation types that reportedly occurred.

The perceived reference community phases of this ecological site consisted of: woodland (includes areas of closed forest) and prairie or savanna. Of the two, the prevailing community phase may have been woodland and/or forest (NatureServe, 2009). This conclusion is drawn from accounts and broad characterizations provided in Loughridge (1888), Killebrew (1879), and Lowe (1921) with reference to the site's distribution through western Kentucky, West Tennessee, and Mississippi, respectively. Based on those combined accounts, the predominant vegetation community of the "brown loam soil" (i.e., loess of varying thickness) was essentially an oak – hickory or mixed hardwood association with an increased presence or entrance of loblolly pine and shortleaf pine to the south in Mississippi (the latter reported by Lowe, 1921).

The second community phase, prairie and/or savanna, represents a system that occurred in the northern portion of this site in western Kentucky and portions of northwest Tennessee. Perhaps the best evidence regarding the presence and distribution of this vegetation type was a map provided by Loughridge (1886) and his descriptions in a later volume (Loughridge, 1888). Loughridge illustrated the general distribution of broadly defined land cover types across the Jackson Purchase of western Kentucky. Two significant cover types on his map coincide with the distribution of this ecological site: the "Brown Loam 'Timbered Lands' and "Brown Loam 'Barrens' (originally Prairie)" (single quotes and parentheses represent his punctuations). His map depicted "barrens" (prairies) extending southward into northwest Tennessee. Perhaps the best evidence and description of that former community in Tennessee was an account from an early settler into the region, Colonel John A. Gardner. Gardner's (1876) eloquent description of the "appearance of the country" clearly evoke imagery of a nearly treeless, herbaceous plain.

The distribution of prairies farther south within the Loess Plains are not as well documented. But, wherever local indigenous communities existed, patches of open, herbaceous vegetation most certainly existed, too. Conceivably, such openings would have graded to the surrounding woodland matrix by transitioning from treeless prairie to savanna and on to woodland conditions.

The overall vegetation communities of this site may be very similar to an associated site, the Northern Loess Interfluve. The main difference between these sites is the presence of a fragipan of the associated soils. It is hypothesized that vegetation communities occurring on fragic soils are generally drier and less productive than their non-fragipan counterparts due to possible root restrictions and shallower depths to the restriction layer. The latter tends to enhance the drying effects of evapotranspiration leading to additional influences on vegetation. Therefore, the presence and existence of fire-influenced communities such as prairie and oak – hickory woodland may have been more pronounced and better developed on this site than the well-drained, deep soil counterpart, Northern Loess Interfluve.

Today, a vastly different picture portrays this ecological site. The predominant land use of this site is agriculture production, particularly in areas of little relief and where loess deposits are thickest – the core of the Loess Plains. This region is known for its fertile soils and consistently high yields, and some areas likely have been under production for nearly 175 years.

Secondary uses of this site include some pasturage and timber management. These uses rarely occur on prime cropland and are typically relegated to more dissected landscapes. Incidentally, these uses increase in prominence and importance along the eastern edge of the MLRA where loess depths are thin and conditions more droughty.

An additional use is recognized and represented for this site: conservation. This use or "state" is provided to represent the range of conservation related actions and management that either "reconstructs" the perceived historic conditions (both composition and ecological processes) or enhances a degraded and highly altered location by planting species native to this site.

Of particular note and concern, the broad range of soils "provisionally" associated with this site vary in a number of critical soil properties including loess thickness, natural fertility (or base saturation percentages), presence/absence

of a fragipan, and subsoil texture, to name a few. Further confounding these influences, climate differences also occur north to south. The breadth of environmental variability of this site, as it is currently mapped, necessitates future investigations to ascertain the collective influences of both climate and soils on local vegetation communities. Future work may culminate in the determination of a latitudinal division or break within this site, leading to a much more accurate and defensible soil – vegetation community correlation. Succinctly put, one or more ecological sites are likely to be defined based on soil differences and climatic influences. This provisional site is essentially a foundation from which to begin future soil – site surveys and ecological site inventories.

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 Upland ecological site. This model is based on limited inventories, literature, expert knowledge, and interpretations. Plant communities will differ across MLRA 134 due to natural variability in climate, 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

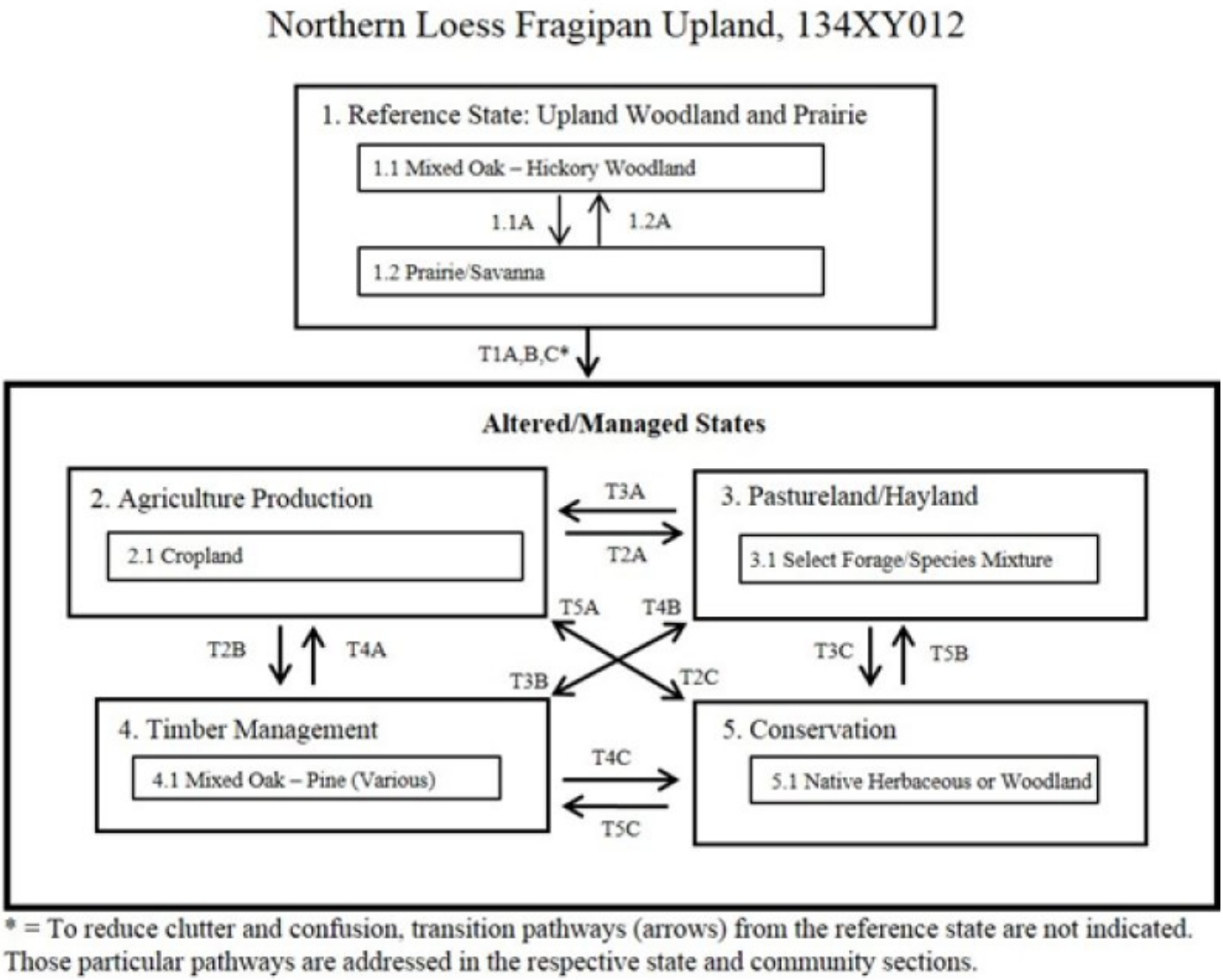

Figure 6. STM - Northern Loess Fragipan Upland

Pathway	Practice
1.1A	major stand-scale disturbance (extensive, prolonged drought, wind, catastrophic ice, replacement fire) followed by periodic surface fire on a frequent return interval
1.2A	natural succession; infrequent fire (long return interval); small, gap-scale disturbance (wind, ice, mixed-severity fire); to maintain woodland, return of periodic surface fires
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)

Figure 7. Legend - Northern Loess Fragipan Upland

State 1
Upland Woodland and Prairie

The reference state of this ecological site was chosen to represent the breadth of community types that historically occurred across the loess capped uplands of MLRA 134. Exemplary examples of the full range of plant communities and ecological processes that were once commonplace on this ecological site no longer exist. Where trees occur today, they typically form a closed canopy forest comprised of exotic species and an understory entangled by native and non-native vines. Vestiges of this once vast system are primarily relegated to cutover forest

blocks, narrow roadway and powerline corridors, and corners of old fields and pastures that now hold the only remaining examples of native prairie vegetation (Estes et al., 2016). Therefore, a complete and exhaustive description and treatment of this system cannot be provided. However, some native plant species that comprised the woodlands and prairies of long ago still exist. It is from these instances coupled with historical accounts that define the reference conditions of the site. The name of the reference state, woodland and prairie, implies the existence of systems maintained and directly influenced by fire. The accounts provided by Loughridge (1888), Gardner (1876), and many others are testament of the historic importance of fire on the Loess Plains, some natural but most were first induced by Native Americans and second, by early settlers striving to maintain and enhance pasturage.

Community 1.1
Mixed Oak – Hickory Woodland

This community phase represents what is perceived to be the predominant condition or vegetation type associated with the loess capped uplands. The structural descriptor of “woodland” in the community name represents what likely occurred in areas where fire from adjoining systems (e.g., prairies and savannas) moved into and across areas that supported trees. Most current community classifications associated with the distribution of this site recognize “forest” as the single structural descriptor (e.g., NatureServe, 2009). This is mainly due to the predominant structural characteristic of today’s “stand” of trees. This does not negate the existence of closed canopy forests on this site. Closed forests may have developed in areas where a natural fire break existed, such as within highly dissected landscapes (Estes et al., 2016). Areas supporting very deep loess deposits are reknown for producing tremendous hardwoods (see Johnson, 1958). However, the presence of a root restriction layer (although not a cemented and truly impervious feature) and droughty nature of fragipan soils may have thwarted that production. Canopy components dominating sites where soil moisture was higher likely included white oak, cherrybark oak, black oak, and secondarily southern red oak and post oak. Additional associates may have included shagbark hickory, mockernut hickory, pignut hickory, black gum, elm, white ash, hophornbeam, and flowering dogwood. Farther east, a change in species dominance may have occurred with cherrybark becoming less common along with a concomitant increase in post oak, southern red oak, and blackjack oak on the driest sites. Here, the movement of fire may have had few natural breaks and the understory more open with an increase in herbaceous ground cover. Where dissection of the landscape increased, fire may have had more difficulty in moving across large expanses, resulting in an increase in forest structure. Transition to a distinctly dry plant association occurred along the eastern border of this site where the loess cap thinned to within 3 feet. Canopy associates of the higher and drier locations would have consisted of post, southern red, blackjack, and black oak along with hickory, black gum, hophornbeam, dogwood, sourwood, persimmon, sassafras, and winged elm. It is possible that shortleaf pine may have occurred locally in the northern portions of the site (e.g., on Providence soils) but its presence, along with loblolly pine, was more concentrated to the south in Mississippi.

Community 1.2
Prairie/Savanna

This community phase is representative of a relatively small area, which is primarily restricted to the site’s northern extent in western Kentucky and northwest Tennessee. However, it is possible that prairies or savannas occurred in small, local patches farther south. This community phase may have been more representative of thin loess and non-loess soils rather than on the deeper loess soils of the plains (NatureServe, 2009). Although, the account by Gardner (1876), which is from an area that supports deep loess soils (i.e., greater than 4 feet thick) in northwest Tennessee, challenges this supposition to some degree. The presence of humans coupled with the ease with which fire moved across the landscape (e.g., areas of little relief) likely played a more significant role than loess depth alone. Fire was a critical and frequent factor for maintaining this community phase, and most fires were deliberately set (Gardner, 1876; Loughridge, 1888). Gardner (1876) provided general characterizations of the plains and mentioned “barren grass” growing three to four feet high, and being able to see a horseman miles away. Referring to the nearly treeless plains, he specifically mentioned woody vegetation occurring as “…small clumps of scrubby blackjack oak, post oak, and hickory bushes a few feet high, interspersed with patches of sumac and hazel.” This community likely consisted of a dense herbaceous layer that was dominated by tall grasses such as big bluestem, little bluestem, and Indian grass (DeSelm, 1989; NatureServe, 2009). Common associates of the tall grasses likely included switchgrass, splitbeard bluestem, threeawns, panic-grass, wild indigo, blazing star, evening-primrose, New England aster, compass plant, goldenrod, lanceleaf tickseed, tall tickseed, rattlesnake master, ashy sunflower, flowering spurge, Virginia strawberry, purple milkwort, slender milkwort, Sampson’s snakeroot, agave, New Jersey tea, goat’s-rue, various milkweeds, sedges, and many additional species (Heineke, 1987; also selected from an

exhaustive list provided D. Estes). This broad, open system transitioned to a dense, oak – hickory forest within 30 years of settlement and cessation of frequent fires (DeFriese, 1880; Loughridge, 1888).

Pathway 1.1A
Community 1.1 to 1.2

This pathway represents a major stand-scale disturbance that effectively removed the overstory such as extensive, prolonged drought, wind, catastrophic ice, tree girdling/removal by humans, and/or stand replacement fire. Such catastrophic events would then be followed by low-intensity surface fires on a frequent return interval, which would support transition to prairie and/or savanna conditions.

Pathway 1.2A
Community 1.2 to 1.1

This pathway represents a return to an open woodland or forest structural characteristic. Processes leading to woodland conditions is a relaxation of fire or fire occurring on a much longer return interval. Disturbance occurs or returns at the gap-scale, often single tree (i.e., less than 1 acre).

State 2
Agriculture Production

Agriculture production is the dominant land use activity on this site, today. Most cropland is relegated to the Loess Plains and in areas of little topographic relief (generally long, gradual slopes).

Community 2.1
Cropland

Crops may include soybean, corn, wheat, canola, and cotton with tobacco grown locally in the north.

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. Fire can be a management tool on this site given its location on drier summit and shoulder slope positions. Low intensity ground fires on a frequent return interval can be effective for reducing competition and potentially enhancing production of individual trees. 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. Various options are available for establishing conservation measures on this site, but ideally, the best case scenario is to reconstruct the perceived reference conditions of this site. This action requires a concerted effort to reestablish herbaceous species most common to the prairies (“barrens”) of western Kentucky, West Tennessee and Mississippi with the possible addition of planting widely spaced hardwoods (e.g., upland oaks from the reference state) characteristic of savanna or open woodland conditions. If at all possible, the herbaceous species established should be derived from the “wild types” (genetic stock) of species native to the Loess Plains or from adjoining ecoregions. This action would help to preserve the unique genetic material from the area and would help to reintroduce the native prairie system back into a portion of its 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 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. Managing for native open woodlands on this site entails establishment and maintenance of the most commonly reported tree species, which generally includes southern red oak, blackjack oak, post oak, white oak, black oak, pignut hickory, mockernut hickory, and shrub/small tree stratum of hophornbeam, dogwood, deerberry, and hazelnut among others. Canopy closure will range from 20 to 60 percent and coverage of the herbaceous layer may exceed that of the trees. Shrubs are widely scattered and limited in abundance and coverage. Trees are widely spaced or dispersed and open-grown. Mixed-severity fire every 20 years or low intensity surface fire within every 10 years is modeled to maintain the open woodland condition (LANDFIRE, 2009).

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 initially consisted of fire suppression (for areas formerly in prairie or woodland conditions) followed by a series of selective cuttings for firewood, construction, staves, and income. Many stands have been high-graded due to repeated, select-tree harvest methods (State 4).

Transition T2A
State 2 to 3

Seedbed preparation and establishment of desired forage/grassland mixture.

Transition T2B
State 2 to 4

This pathway represents prescribed management strategies for transitioning former cropland 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, such as Providence, and/or in the southern portions of the site.

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. 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.

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.

Transition T4A
State 4 to 2

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

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 or forest cover and establish native grasses/forbs or woodland/savanna 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.

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:**

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:**