Ecological site F134XY009AL
Northern Natric Loess Terrace - PROVISIONAL

Accessed: 05/04/2024

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. Underlying the loess are Tertiary deposits of unconsolidated sand, silt, clay, gravel, and lignite. 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, mostly Entisols and Inceptisols, are predominantly silty where loess thickness of the uplands are deepest but grade to loamy textures in watersheds covered by thin loess. 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-NRCS, 2006).

This site has a very spotty distribution in the MLRA and occurs mainly in portions of the Loess Plains (EPA Level IV Ecoregion: 74b) in western Tennessee and 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; Chapman et al., 2004)
-234A – Southern Mississippi Alluvial Plain section of the USDA Forest Service Ecological Subregion (McNab et al., 2005)
-Alkali Post Oak Flats (Klimas et al., 2012)
-Quercus stellata/Q. marylandica Forest on Saline Soils (Heineke, 1987)
-Western Mesophytic Forest Region - Mississippi Embayment Section (Braun, 1950)

Ecological site concept

The Northern Natric Loess Terrace is characterized by deep, somewhat poorly drained and poorly drained soils that formed in loess or silty, loess-like material. This site occurs on level, pre-Holocene aged terraces, active alluvial terraces, and stream floodplains with slopes 0 to 2 percent. Soils of this site are high in exchangeable sodium and are noted for producing poor quality woodlands. Historically, the natural vegetation of this site likely consisted of open grasslands to a sparse, woodland community. Occurrences of this site may have been appropriately deemed “deer licks” or “slick spots” due to the high sodium content and open spots of bare ground.

Associated sites

F134XY010AL	**Northern Wet Loess Terrace - PROVISIONAL**

Similar sites

F134XY203AL	**Western Alkali Flatwoods - PROVISIONAL** This site occurs on natric soils in the Western Lowlands ecoregion of Arkansas and Missouri.
F134XY303LA	**West Central Natric Loess Terrace - PROVISIONAL** This site occurs on natric soils in the Macon Ridge physiographic subsection.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Physiographic features

The Northern Natric Loess Terrace is spottily distributed across portions of the MLRA. Occurrences are primarily located along the western margin of the Loess Plains in West Tennessee and locally, southward to the Southern Rolling Plains (EPA Level IV Ecoregion: 74c) in southwestern Mississippi. This site occurs on Pleistocene-age fluvial terraces that are broad and level (USDA-NRCS, 2016); on large interfluves of rivers, streams, and tributaries; and on benches at the base of the steep loess bluffs within the Loess Hills (Pettry and Switzer, 1998). All aspects are well represented and included in this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Terrace (2) Flat
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None to frequent
Ponding frequency	None
Elevation	61–122 m
Slope	0–2%
Ponding depth	0 cm
Water table depth	15–30 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 57 inches and ranges from 55 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 61 degrees F and ranges from 58 in the north to 64 degrees F in the south. The freeze-free period averages 227 days and ranges from 206 days in the north to 252 days in the south. The frost free period averages 199 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)	199 days
Freeze-free period (average)	227 days
Precipitation total (average)	1,448 mm

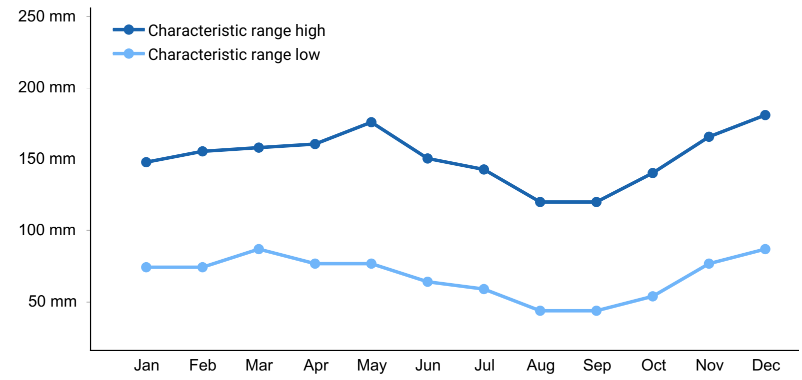

Figure 1. Monthly precipitation range

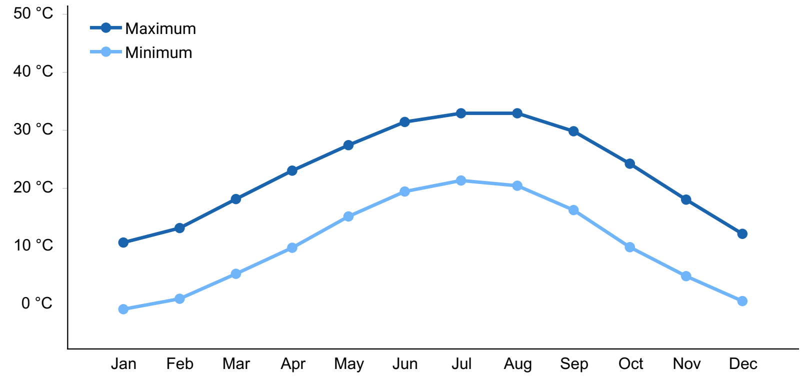

Figure 2. Monthly average minimum and maximum temperature

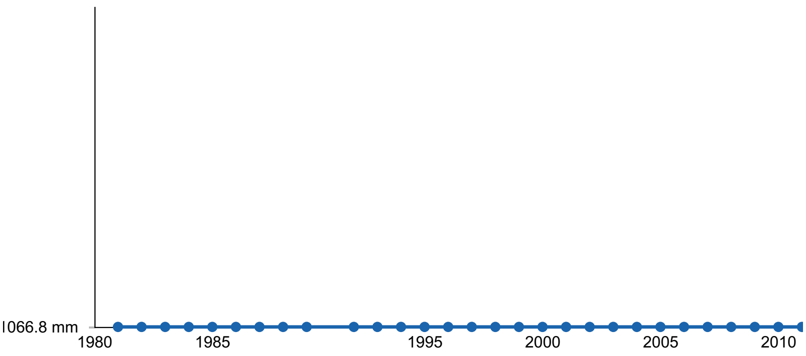

Figure 3. Annual precipitation pattern

Climate stations used

- (1) BATESVILLE 2 SW [USC00220488], Batesville, MS
- (2) GRENADA [USC00223645], Grenada, MS
- (3) LEXINGTON [USC00225062], Lexington, MS
- (4) MARTIN U OF T BRANCH E [USC00405681], Martin, TN

- (5) JACKSON INTL AP [USW00003940], Pearl, MS
- (6) CANTON 4N [USC00221389], Canton, MS
- (7) OAKLEY EXP STN [USC00226476], Raymond, MS
- (8) SENATOBIA [USC00227921], Coldwater, MS
- (9) NEWBERN [USC00406471], Newbern, TN
- (10) UNION CITY [USC00409219], Union City, TN
- (11) MEMPHIS [USW00093839], Millington, TN

Influencing water features

The soils associated with this site are poorly drained and have a seasonally high water table that is within 0 to 2 feet of the soil surface in late winter and spring during most years. Some local soil map units may occur near or adjacent to the active floodplain of streams, and flooding may occur on those particular units. However, the vast majority of this site's distribution occurs outside of active floodplains. In general, this site is not influenced by a riverine hydrologic regime, although occasional, shallow depressions may occur. Such instances may be primarily influenced by precipitation.

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, somewhat poorly to poorly drained that formed in loess or silty sediments from loess. Slopes range from 0 to 2 percent, although many areas are within 0 to 1 percent. These soils have a seasonally high water table that is within 0 to 2 feet of the soil surface in late winter and spring in most years. A key characteristic of these soils is that they are high in exchangeable sodium. This is a severe limitation to most types of plants, and for those that do occur, overall productivity is generally low. Runoff is slow and permeability is very slow due to the high concentration of sodium which causes dispersion of the clay in the subsoil. Pettry and Switzer (1998) emphasized that natric horizons have physical properties similar to fragipans.

Principal soils associated with this site include the Bonn (Fine-silty, mixed, superactive, thermic Glossic Natraqualfs) and Deerford (Fine-silty, mixed, superactive, thermic Albic Glossic Natraqualfs) series. Bonn soils are poorly drained with slopes ranging from 0 to 1 percent. Exchangeable sodium saturation ranges from 15 to 50 percent in all horizons below a depth of 16 inches. Reaction ranges from very strongly acid to neutral in the A and E horizons; from medium acid to strongly alkaline in the Bt horizon; and neutral to strongly alkaline in the C horizon. Deerford soils are somewhat poorly drained. Depth to a subhorizon with more than 15 percent exchangeable sodium ranges from 16 to 32 inches (USDA, 2016).

Natraqualfs (sodium soils) are commonly found throughout the loessal regions of the U.S. The sodium in these soils originated from in-situ weathering of Na-rich feldspars of the parent loess. The natric soil horizons act as a root restriction layer. Natric horizons typically have compound soil structure consisting of prismatic parting to subangular blocky structure. The natric horizons are dense with firm consistency and brittleness. The horizons also have very low hydraulic conductivity and tend to perch water during wet periods. The natric horizons are often considerably drier than overlying horizons. It is important not only to recognize salinity stress and toxicity, but also to determine where the sodium problem is located in the soil profile. Accelerated erosion and land leveling can truncate the surface soil and expose the underlying natric horizons with disastrous consequences. (Pettry and Switzer, 1998).

Bare soil areas in agricultural fields essentially devoid of vegetation, or containing stunted and dead plants, have been referred to as slick-spots, salt-spots, and deer licks. Areas range in size from less than an acre to entire fields. Crops have different sensitivities to elevated salt contents. Generally, cotton and bermudagrass are more tolerant than corn and soybeans. Seasonal changes in soil moisture affect the ability of crops to tolerate high salt levels. Greater soil moisture at spring planting may maintain low enough levels for plant establishment and growth; however drier conditions in mid-summer may concentrate salt levels to a point at which they become toxic to the plant. Plants stressed from high sodium levels often exhibit various symptoms of nutritional disorders due to competitive uptake of ions. The exposed surface soil commonly has a light-colored, bleached appearance and is vulnerable to accelerated surface erosion. Salt-impacted areas are not as evident in forests, but the impact can be seen in areas containing stunted trees.

Natric soils commonly have poor physical conditions due to dispersive properties associated with sodium that negatively impact reclamation. The poor physical conditions reduce permeability to air and water movement. These adverse properties give rise to the observable physical characteristics of the soil being sticky when wet and hard when dry. Early reclamation of sodic soils used ponded water to leach salts below the root zone in arid regions, but these practices often required long periods of time and could not flush the salts due to low soil permeability. Sodium must be displaced on the soil exchange complex and leached from the soil to remediate the Na-toxicity and improve physical conditions. Gypsum is commonly used for reclamation of sodic soils. The amount of gypsum need to displace sodium depends on soil texture, cation exchange capacity, and sodium content. Large quantities of organic matter incorporated into the soil at gypsum application can increase replacement efficiency. The organic matter improves soil structure and drainage, increases cation exchange capacity and water holding capacity (Pettry and Switzer, 1998).

Table 4. Representative soil features

Surface texture	(1) Silt loam
Family particle size	(1) Loamy
Drainage class	Poorly drained to somewhat poorly drained
Permeability class	Very slow to moderate
Soil depth	30–61 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	12.19–18.03 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–19
Soil reaction (1:1 water) (0-101.6cm)	5.5–7.8
Subsurface fragment volume <=3" (Depth not specified)	2–3%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

Very little exists in the literature concerning natural vegetation communities on high sodium soils east of the Mississippi River. A little more information has been documented and reported on the western counterpart of this site, which occurs within the Western Lowlands ecoregion of eastern Arkansas and southeastern Missouri. The following treatment regarding the plant communities and ecological dynamics of this site are drawn from existing literature and observations of the western counterpart.

This ecological site occurs primarily on Pleistocene-age terraces and potentially along the margins of alluvial floodplains. The site is characterized by soils that are high in exchangeable sodium. These “edaphic” effects (i.e., ecological influences from soil properties) have tremendous impacts on the local plant community. Where depths are shallow to a high sodium exchange horizon, limitations to rooting depth generally results in poor vegetation response. Communities that develop under these conditions often consist of stunted trees, low-quality woodlands, and open spots of bare ground (Heineke, 1987). An additional characteristic of this site is the occasional presence of small, shallow depressions that pond during wetter periods of the year, generally in late winter to spring. These vernal pools may contribute to habitat complexity and the occurrence of additional species into an otherwise, naturally depauperate community.

The dominant species associated with the non-ponded portions of this site is post oak with associates consisting of blackjack oak, southern red oak, honey locust, hawthorn, and winged elm (USDA-NRCS, 2016). Farther to the south, loblolly pine may occur in locations where depth to the natric subsoils are deeper. (This pattern may be more associated with Deerford soils, which is currently under review.) Structurally, the site is relatively open, which provides conditions suitable for the development of an herbaceous ground layer. Ground cover may consist of poverty oat grass, threeawns, dropseeds, and sedges. Vernal pools of this site may consist of a greater concentration of water oak and willow oak, but this has not been substantiated on this site.

Historically, fire may have been a factor or influence on this site, and a range of habitat or community types likely existed. Where trees occurred, conditions probably ranged from savanna to open woodlands. Locally, prairies likely existed in a patchwork pattern among the woodlands. This mosaic likely persisted as a “physiognomic gradient” with meadows grading to savannas and savannas grading to woodlands.

Today, various land use activities have been attempted on this site. Some areas that were once cleared and farmed are now idle. Such abandoned areas may now support a moderate cover of poor quality oaks and hickory. However, there are some areas of this site under cultivation. Those sites generally occur on the deeper soils (i.e., depths to natric subhorizons are fairly deep, greater than 24 inches). Where rooting depths to natric subsoils are shallow, yields are likely to be poor and those spots avoided (Pettry and Switzer, 1998).

A minor use on this site is reportedly pastureland and hayland, though grazing periods may be limited to shorter periods in the spring (USDA-NRCS, 2016). The more productive pastures are mainly limited to areas where the depth to natric subsoils are much greater. Limitations for pastureland and/or hayland are the same as those for cropland (i.e., seasonal wetness and high sodium content).

Woodland or forest production on this site is generally poorly suited on these soils (USDA-NRCS, 2003; USDA-NRCS, 2016). However, Deerford soils reportedly have a higher potential for loblolly pine, sweetgum, and water oak (USDA-SCS, 1978). Based on what is currently known regarding extreme saline sites to the west in Arkansas and southeast Missouri (see Heineke, 1987; and personal observations, B. Hart), a timber management state is not included for this provisional site at this time. Future inventories and investigations may dictate that timber management should be included as a management option. Those efforts may also suggest that a separate ecological site is warranted for those soils possessing greater depths to the natric subsoil.

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 Natric Loess Terrace 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

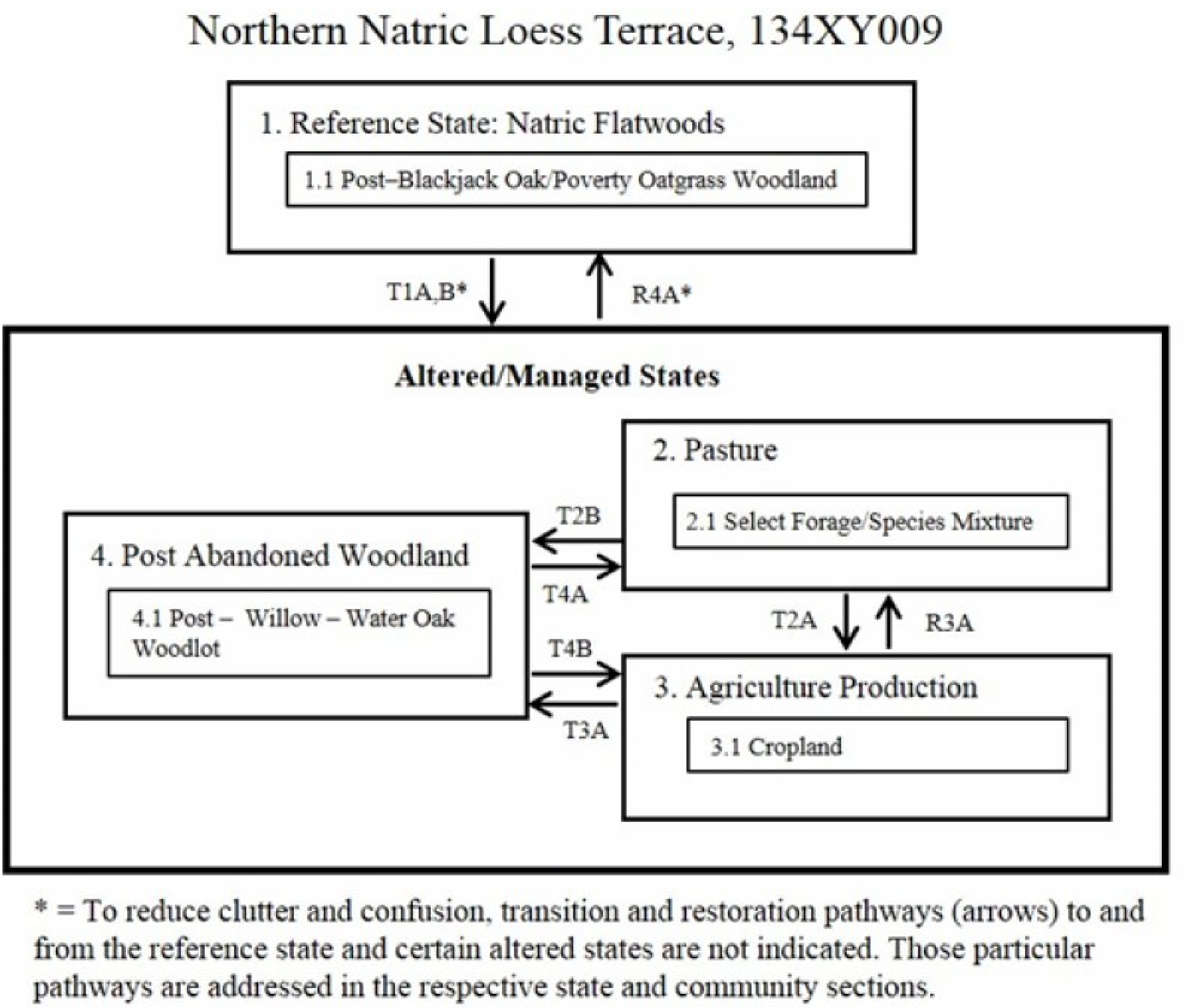

Figure 5. STM - Northern Natric Loess Terrace

Pathway	Practice
T1A, R3A, T4A	mechanical removal of vegetation; herbicide application; seedbed preparation; planting desired species at appropriate rate (State 2)
T1B, T2A, T4B	mechanical removal of vegetation; potential construction of artificial drainage system, preparation for cultivation (State 3)
T2B, T3A	natural succession (State 4)
R4A	natural succession; return of maintenance or disturbance (e.g., fire); any former alteration to soil drainage MUST be restored before returning to true reference conditions (State 1)

Figure 6. Legend - Northern Natric Loess Terrace

State 1
Natric Flatwoods

The following treatment of the reference state is based on observations and literature review of similar soils in the Western Lowlands ecoregion in eastern Arkansas and southeast Missouri. Field investigations must be conducted to adequately and accurately describe the plant communities and ecological dynamics of this site east of Mississippi River. The key factors influencing the plant community of this site are the soils. The high exchangeable sodium of the subsoil limits the types of plants that can tolerant these extreme conditions. Heineke (1987) compared the natural community of this site to the "…xeric, acidic, rocky blufftops of the Ozark Plateau." The trees are stunted, twisted, and small with diameters that seldom reach 12 inches. Heineke reported an instance where trees below 12 inches had ages of 170 years, and the structure of the stand was park-like with much of the ground surface being covered by lichens. The pre-settlement community of this ecological site may have consisted of a complex of physiognomic characteristics that included meadow or barren-like conditions, savannas, and open woodlands. Fire may have been a key disturbance factor, historically, particularly where fires extended onto this site from adjoining or nearby areas. Barren-like conditions (i.e., local bare spots) may have existed locally where depths to natric horizons were very shallow. Such “bare spots” would represent pedons of extreme root restriction.

Community 1.1
Post Oak – Blackjack Oak – Poverty Oatgrass Woodland

This community phase represents the successional stage, compositional, and structural complexity of stands supporting perceived reference conditions. Post oak is reported as the dominant species on this site; however willow oak and water oak may occur within small, shallow depressions (Klimas et al., 2012). These depressions or vernal pools are ponded only during the wetter times of the year, typically from winter to spring. Additional components and characteristics of the system include the presence of blackjack oak with an understory of hawthorn, persimmon, winged elm, and farkleberry. Ground cover may consist of blazing star, poverty oatgrass, broomsedge, woodoats, and tridens. Most notable of the ground layer is the coverage of lichens and mosses, which are interspersed by areas of bare ground. The reference community is noted for having an open woodland profile. The subcanopy stratum is open throughout much of the community and the ground layer is thinly covered (Heineke, 1987).

State 2
Pasture

This state is representative of sites that have been converted to and maintained in pasture and forage cropland, typically a grass – legume mixture. However, soils exhibiting the core concepts of this site (i.e., a relatively shallow depth to a root restriction layer of high sodium content), are known for producing poor pasturage. Areas where natric horizons are deeper have a much better chance in pasture development and management. 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, further complicating the natural limitations of this site. Because of the limitations of this site, grazing may be limited to small intervals within the appropriate season(s). These soils have low available water capacity, low nutrients, and are prone to droughtiness. 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 on this site.

Community 2.1
Select Forage/Species Mixture

This community phase represents commonly planted forage species on pasturelands, haylands, and open grasslands. The suite of plants established on any given site may vary considerably depending upon purpose, management goals, usage, and soils. The limitations of this site preclude many of the commonly planted mixtures. However, there is some indication that tall fescue, common bermudagrass, and annual lespedeza have been planted on this site, but yields are reported as low (USDA-NRCS, 2006b). This site is generally considered poorly suited to not suited for this land use (USDA-NRCS, 2003; USDA-NRCS, 2006b). 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 3
Agriculture Production

Agriculture production on this site is fairly limited. Crops that are or have been grown include soybean and cotton but plants may be stunted and often will not reach maturity (Pettry and Switzer, 1998; USDA-SCS, 1978). Many idle woodlots today were likely cropped at some point in the past and met with disappointing results.

Community 3.1

Cropland

Soybean and cotton have been planted on this site. Poor yields may result where depths to the natric horizon is shallow.

State 4
Post Abandoned Woodland

Most, if not all, of the woodlots and local patches of woodlands occurring on this site represent this state. Former cropland and pastureland that failed to meet expectations were abandoned and are now considered “idle”. These stands still support some of the components that characterizes the community. The structure of these stands are typically denser than a late development, fire-influenced stand. However, small openings and a ground cover of herbaceous species provide indications of strong edaphic influences. Restoration potential of these sites back to reference conditions may be fairly high, provided the appropriate management regime is initiated and maintained. Where depth to the natric subsoil is much greater, productivity and plant composition may be very different. More work is needed to ascertain the full characteristics of this ecological site.

Community 4.1
Post – Willow – Water Oak Woodlot

This community phase represents the species characteristic of the regenerating woodlots. Post oak is often the dominant species with associates consisting of willow oak, water oak, southern red oak, hickory, and winged elm. Loblolly pine may be an additional component to the south, especially where depth to the natric subsoil is greater.

Transition T1A
State 1 to 2

This pathway represents an attempt to convert the woodland community to pasture or forage production. Actions include clearing, stump removal, herbicide application, seedbed preparation, and the establishment of desired plants (State 2).

Transition T1B
State 1 to 3

Actions include mechanical removal of vegetation and stumps; herbicide treatment of residual plants; and preparation for cultivation (State 3).

Transition T2A
State 2 to 3

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

Transition T2B
State 2 to 4

Abandonment of grassland/pastureland management and allowing natural succession to proceed beyond the old field stage to canopy development of the young woodland.

Transition R3A
State 3 to 2

Seedbed preparation and establishment of desired forage/grassland mixture.

Transition T3A
State 3 to 4

Abandonment of cropland management and allowing natural succession to proceed to canopy development of the young woodland.

Restoration pathway R4A
State 4 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. In some cases, a return to the reference state may not be possible without considerable management effort. That effort may involve exotic species control, restoration of the natural hydrologic regime of a given locality, and the reestablishment of components considered characteristic of the reference state.

Transition T4A
State 4 to 2

This pathway represents an attempt to convert the woodland community to pasture or forage production. Actions include clearing, stump removal, herbicide application, seedbed preparation, and the establishment of desired plants (State 2).

Transition T4B
State 4 to 3

Actions include mechanical removal of vegetation and stumps; herbicide treatment of residual plants; and preparation for cultivation (State 3).

Additional community tables

Other references

Braun, E.L. 1950. Deciduous Forests of Eastern North America. Hafner Press, New York. 596 p.

Chapman, S.S, G.E. Griffith, J.M. Omernik, J.A. Comstock, M.C. Beiser, and D. Johnson. 2004. Ecoregions of Mississippi (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,000,000).

Green, Jonathan D., W.W. Witt, and J.R. Martin. 2006. Weed management in grass pastures, hayfields, and other farmstead sites. University of Kentucky Cooperative Extension Service, Publication AGR-172.

Griffith, G.E., J.M. Omernik, S. Azevedo. 1998. Ecoregions of Tennessee (color poster with map, descriptive text, summary tables, and photographs): Reston, VA., U.S. Geological Survey (map scale 1:1,000,000).

Heineke, T.E. 1987. The Flora and Plant Communities of the Middle Mississippi River Valley. Doctoral Dissertation, Southern Illinois University, Carbondale, IL. 669 p.

Klimas, C., T. Foti, J. Pagan, E. Murray, and M. Williamson. 2012. Potential Natural Vegetation of the Mississippi Alluvial Valley: Western Lowlands, Arkansas, Field Atlas. Ecosystem Management and Restoration Research Program ERDC/EL TR-12-27, U.S. Army Corps of Engineers. Environmental Laboratory. 318 p.

Pettry, D.E. and R.E. Switzer. 1998. Sodium soils in Mississippi. Mississippi Agriculture and Forestry Experiment Station, Mississippi State University, Starkville, MS. Technical Bulletin 221. 13 p.

[USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2003. Soil Survey of Attala County, Mississippi. 171 p. Available online:
http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=MS
(Accessed: 20 July 2016).

[USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2006a. Land

Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.

[USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2006b. Soil Survey of Greene County, Arkansas. 231 p. Available online: http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/arkansas/AR055/0/Greene%20County_Arkansas.pdf. (Accessed: 30 November 2015).

[USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2010. Conservation Practice Standard: Prescribed Grazing. Practice Code 528. Updated: September 2010. Field Office Technical Guide, Notice 619, Section IV. [Online] Available: efotg.sc.egov.usda.gov/references/public/ne/ne528.pdf.

[USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2016. Official Soil Series Descriptions. Available online: https://soilseries.sc.egov.usda.gov/osdname.asp. (Accessed: 17 May 2016).

[USDA-SCS] United States Department of Agriculture, Soil Conservation Service. 1978. Soil Survey of Yalobusha County, Mississippi. 98 p. Available online: http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=MS
(Accessed: 20 July 2015).

Contributors

Barry Hart

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):

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

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

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

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

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

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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:

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

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

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

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:**