

# **Ecological site F131AY604MS**

## **Batture - Frequently Flooded Moderately Wet Low Ridge Forest**

Last updated: 6/10/2025  
Accessed: 03/28/2026

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### **General information**

**Provisional.** A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

### **MLRA notes**

Major Land Resource Area (MLRA): 131A–Southern Mississippi River Alluvium

The Southern Mississippi River Alluvium (MLRA 131A) is the largest of 4 MLRAs within Land Resource Region O, the Mississippi Delta Cotton and Feed Grains Region. It occurs in portions of 7 states including Louisiana (32 percent), Arkansas (26 percent), Mississippi (26 percent), Missouri (12 percent), Tennessee (3 percent), Kentucky (1 percent), and Illinois (less than 1 percent). The MLRA is comprised of 29,555 square miles and extends roughly 650 miles from an area near Cape Girardeau, Missouri in the north to the MLRA's transition to the Gulf Coast Marsh (MLRA 151) in the south. Average elevations range from 330 feet in the north to sea level in the southern part of the area. For much of the north-south distance, the MLRA is bounded to the east by an abrupt rise in elevation of loess-capped bluffs and hills, the Southern Mississippi Valley Loess (MLRA 134). West of the Mississippi River, the boundary is less distinct except to the northwest where the MLRA abuts the Ozark Plateaus and Ouachita province (MLRAs 116A, 117, and 118A). South of the Ozark and Ouachita escarpment, the MLRA adjoins the Southern Mississippi River Terraces (MLRA 131D), which includes the fabled Grand Prairie and merges with the valleys of the Arkansas and Ouachita rivers (MLRA 131B) and the Red River (MLRA 131C). Occurring within or bordering the Southern Mississippi River Alluvium are three separate loess-capped, upland remnants: Crowley's Ridge, Macon Ridge, and Lafayette Loess Plain, which are western units of MLRA 134 (USDA-NRCS, 2006).

MLRA 131A is characterized by landscapes that were created and influenced by the current and earlier paths of the Mississippi River and its tributaries. Waters transporting the materials that formed the area originate from as far west as the east slope of the Continental Divide to the western edge of the Appalachian Divide in the east. This

comprises a drainage basin of roughly 1,245,000 square miles and includes all or parts of thirty-one U.S. states and two Canadian provinces (Elliott, 1932). The drainage basin of the Mississippi River roughly resembles a funnel which has its spout at the Gulf of America. Waters from as far east as New York and as far west as Montana contribute to flows in the lower extent of the river (USACE, 2017). The soils of these alluvial landscapes are very deep, dominantly poorly and somewhat poorly drained, and have textures that are mostly loamy or clayey. Principal soil orders are Alfisols, Vertisols, Inceptisols, and Entisols (USDA-NRCS, 2006).

The fluvial processes that shaped the area were highly dynamic, diverse, and complex. During the Pleistocene epoch, multiple continental glacial-interglacial cycles resulted in extreme fluctuations in river discharge and sediment loads. A braided river regime characterized the fluvial dynamics of the Mississippi River through much of the last glacial cycle (Autin et al., 1991; Rittenhour et al., 2007). Rapid aggradation of glacial outwash led to the development of prominent valley train features over a large portion of the area (Autin et al., 1991; Saucier, 1994; Aslan and Autin, 1999; Blum et al., 2000; Rittenhour et al., 2007). A changing climate, meltwater withdrawal, and sea-level change induced a transition from a braided river regime to a predominantly single-channeled, laterally migrating river system during the Holocene epoch (Rittenhour et al., 2007; Shen et al., 2012) – characteristics that continue today. Fluvial dynamics of the migrating river resulted in the development of broad meander belts, backswamp environments, and extensive deltaic complexes (Saucier, 1994; Klimas et al., 2011).

Tremendous expanses of bottomland hardwood forests once covered much of the area. Today, the land base is largely in agriculture production, and soybeans, cotton, corn, and rice are the principal crops with sugarcane rising in importance in the southernmost portion of the MLRA (USDA-NRCS, 2022).

Due to its size and biophysical variability, the technical team advised subdividing the MLRA into six subregions: Western Lowlands, St. Francis Basin, Yazoo Basin, Tensas Basin, Delta Plain, and Batture.

## **LRU notes**

For the purpose of ecological site concepts, the MLRA was separated by the technical team into 6 subregions based on various assemblages of data reviewed. The subregion where this site is delineated extends through the length of MLRA 131A, but it differs from other subregions because it is still hydrologically impacted by the regular flow of the Mississippi River and its tributaries. This subregion is locally known as “Batture” which is defined for the purposes of this Ecological Site as the alluvial land between the Mississippi River channel and the constructed levee system or other flood constricting natural features, such as natural levees or high bluffs. Individual levee systems have been present along the Mississippi River since the first Europeans settled the region in the early 18th century, but its design has changed many times since that first levee. The changes were brought about mainly by flooding, which in turn drove other factors such as costs and

politics (Rogers, 2005).

The Mississippi River and Tributaries (MR and T) Project is a comprehensive flood control and navigation plan for the Lower Mississippi River and tributary streams. The MR&T was authorized under the Flood Control Act of 1928 and is the responsibility of the Mississippi River Commission (MRC). The project consists primarily of a system of levees, channel improvement works, and floodways. Currently, the river is entirely contained by either bluffs or levees from Cairo, IL to a point 90 river miles below New Orleans, except where major tributaries are confluent. This effort has been extremely successful in reducing or eliminating flooding over most of the historic floodplain and contributing to agricultural and urban development. Over one million acres of this remnant bottomland forest lies within the leveed floodplain of the Lower Mississippi River where most sites are still subject to annual flooding. Peak river flows typically occur in March, April, and May (Klimas, 1988).

The Ecological sites within the Batture region of MLRA 131A will be the most transient of all the sites of the MLRA. In the protected subregions, the landscape will maintain a progression of development, unless there are anthropogenic forces that alter it or there is a catastrophic river event that breaches the levee system. Landforms throughout the Batture have direct hydrologic connectivity to the Mississippi River and are subject to annual or near annual flooding, sedimentation, and potential modification. For instance, low elevation landforms that are frequently flooded and ponded are subject to and may receive sediment deposition of several feet, transforming the local area to conditions more similar to a natural levee or ridge ecological site. Conversely, a local natural levee or ridge landform could receive severe scouring impacts during a catastrophic flood event, resulting in a complete removal of the former elevated feature to one that becomes lower in elevation and subject to frequent flooding and ponding. In this dynamic environment, migration of the river channel to new pathways along with redistribution of sediments is a persistent possibility. There is a potential for a given ecological site at the local level to undergo rapid transformation and development to any of the sites that have been identified within the Batture.

When working within the Batture Subregion, onsite verification of the conditions of a given location is critical to planning. It has been witnessed by the Author of this site concept, flooding in a crop field due to current high flows of the Mississippi River. While at the same time seeing irrigation of the adjacent growing crops, due to dry conditions in the higher elevation areas of the field. It has also been noted by members of the technical team, where restoration plantings on ridge sites was converted to eroded swales, while adjacent shallow water areas were completely filled by sandy sediment creating ridges, from a single flooding event.

## **Classification relationships**

Major Land Resource Area (MLRA) and Land Resource Unit (LRU) (USDA-NRCS, 2006)  
MLRA 131A Southern Mississippi River Alluvium

EPA Level IV Ecoregion - 73a Northern Holocene Meander Belts, 73k Southern Holocene Meander Belts

The Natural Communities of Louisiana - (Louisiana Natural Heritage Program - Louisiana Department of Wildlife and Fisheries) - Forested Wetland, Bottomland Hardwood Forest, Batture

### **Ecological site concept**

This ecological site occurs within the undulating landscape between the active river and man-made levee or upland bluffs of adjacent MLRA's. Active flooding, overwash, scour and sedimentation by the Mississippi River will impact the site. These sites have been altered greatly by anthropogenic means; the hydrology, soils, and vegetation have been altered beyond what would have naturally occurred in the region. Due to these alterations by construction of flood protection levees, the ecological sites that would have occurred on these locations are no longer relevant. There will be similarities to the sites found on the protected side of the levees, however, the hydrology, sedimentation and erosion have overshadowed all other ecological processes.

This site occupies positions intermediate to the higher, better drained areas and the lower, wetter toeslopes of natural levees and meander scroll ridges. The soils are deep, moderately well to somewhat poorly drained that formed in recent silty and loamy alluvium. Permeability and drainage are improved compared to the lower elevation sites. Accordingly, productivity is likely to improve. Plant composition on this site is anticipated to be fairly diverse given its landscape position, reduced flooding impacts, and better drainage.

Of note, this site occurs within the “unprotected” or “batture lands” (i.e., the alluvial land between the river channel and the constructed levee system) side of the extensive Mississippi River levee system and is distinguished from similar landforms that are protected from current flooding by constructed levees or natural features.

### **Associated sites**

F131AY603MS	<b>Batture - Frequently Flooded Wet Backswamp Flat Forest</b> This site is found lower on the local landscape and at times can be minor inclusions of wetter areas within a field.
F131AY605MS	<b>Batture - Frequently Flooded Natural Levee and Ridge Forest</b> This site is similar, however, it will be slightly higher and the soils will be less developed.

### **Similar sites**

F131AY405LA	<b>Tensas Basin - Somewhat Poorly Drained Bottomland Hardwoods</b> This site will be in a similar landscape position within the protected side of the levee in the Tensas Basin of the MLRA.
F131AY311MS	<b>Yazoo - Recent Moderately Wet Natural Levee and Meander Scroll Ridge Forest</b> This site will be in a similar landscape position within the protected side of the levee in the Yazoo Basin of the MLRA.

**Table 1. Dominant plant species**

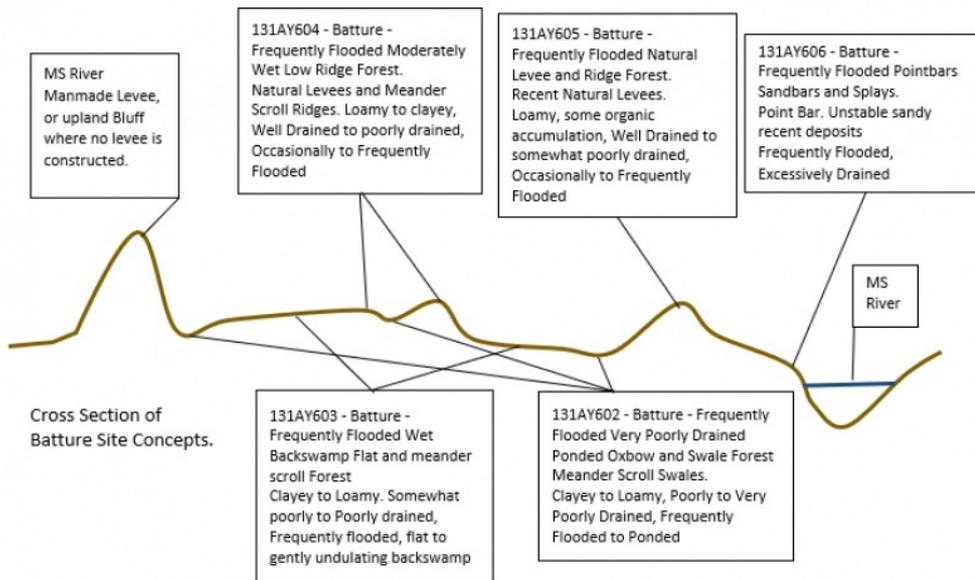
Tree	(1) <i>Quercus texana</i> (2) <i>Quercus phellos</i>
Shrub	(1) <i>Ilex decidua</i>
Herbaceous	(1) <i>Arundinaria gigantea</i>

## Physiographic features

Site concepts of the Batture subregion emphasize the extreme hydrologic drivers of them. The sites differ from the natural system due to increased frequency and duration of flooding as a result of confining the river to a narrowed floodplain. Within the Batture subregion there are open pastures and crop fields that can receive beneficial added nutrients and sediments from the flooding, but during extreme events can lose this sediment by erosion from the river's currents. These flooding forces not only can remove recent sediment but can also scour the land's surface, leaving large gullies, as well as uprooting trees and causing similar erosion in forested areas.

A landscape profile shows the undulating nature of the landscape (Figure 1) between the constructed levees, and the surface elevation within the Batture may be higher than outside the levee system. This higher elevation could be attributed to the continuous accretion of material from flooding.

The additional sediment deposition on these sites has substantially altered them from their historical state. Most of the historic site soils are buried by the current soil surface, so to describe a historic landscape position is not beneficial. These sites potentially could be described as hardwood stands with relatively frequent inundation or flooding due to the proximity to the river channel over a gradient of species composition from the relatively bare soil surface of sandy material, through low frequently flooded backswamp positions to the higher natural levees.



**Figure 1. Batture Subregion typical cross section from the constructed levee to the Mississippi River Channel. Diagram notes the Ecological Sites as they would fit across the landscape.**

**Table 2. Representative physiographic features**

Landforms	(1) Alluvial plain > Natural levee (2) Alluvial plain > Meander scroll (3) Alluvial plain > Flat
Runoff class	Negligible to very high
Flooding duration	Long (7 to 30 days)
Flooding frequency	None to frequent
Ponding frequency	None
Elevation	15–107 m
Slope	0–3%
Water table depth	20–107 cm
Aspect	Aspect is not a significant factor

## Climatic features

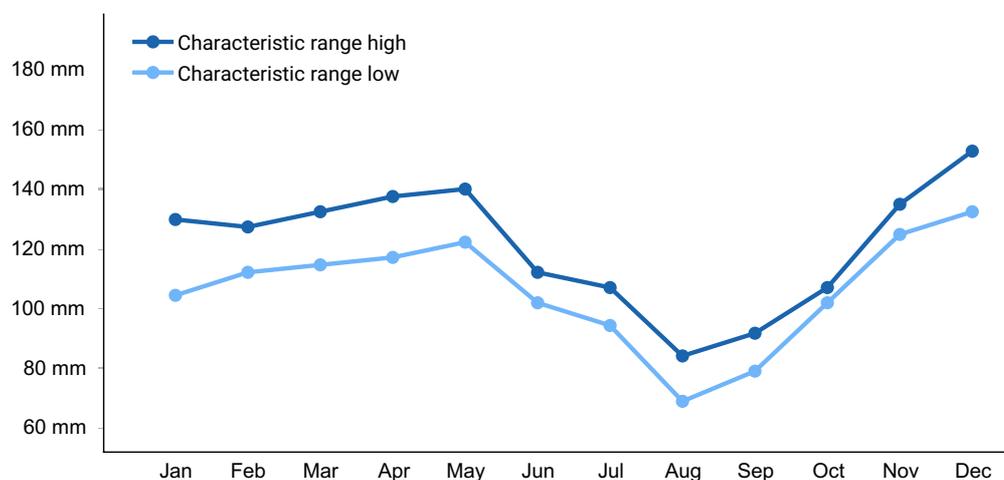
The climate of MLRA 131A is classified as humid subtropical (Koppen System), which is typified by mostly mild winters; long, hot summers; and no routinely recurring wet or dry season (Smith and Klimas, 2002; NCDC, 2018).

In the warmer season (and throughout much of the year), winds from the south convey moisture from the gulf leading to humid, subtropical conditions that are favorable for afternoon thunderstorms. These storms produce an average of about 25 percent of the area’s annual precipitation and are at times accompanied by locally destructive winds. An

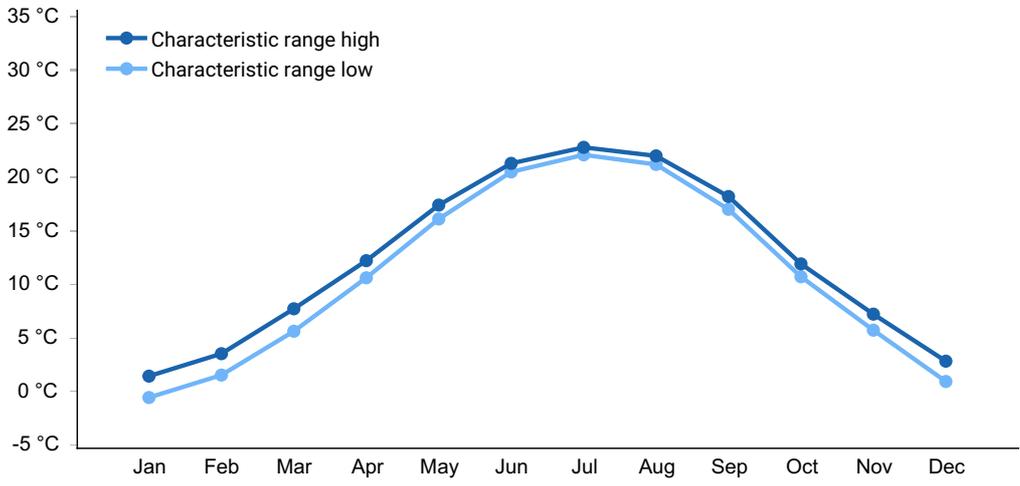
additional hazard of concern during late summer through early fall is the tropical cyclone. While most impacts from hurricanes and tropical storms are confined along the coastal zone, heavy rainfall, severe flooding, and high winds can occur well into the Batture Subregion when such systems pass through the area. To the extreme, the region is susceptible to the effects of a strong Bermuda high during the summer, which can cause devastating drought conditions for weeks and even months in some years.

**Table 3. Representative climatic features**

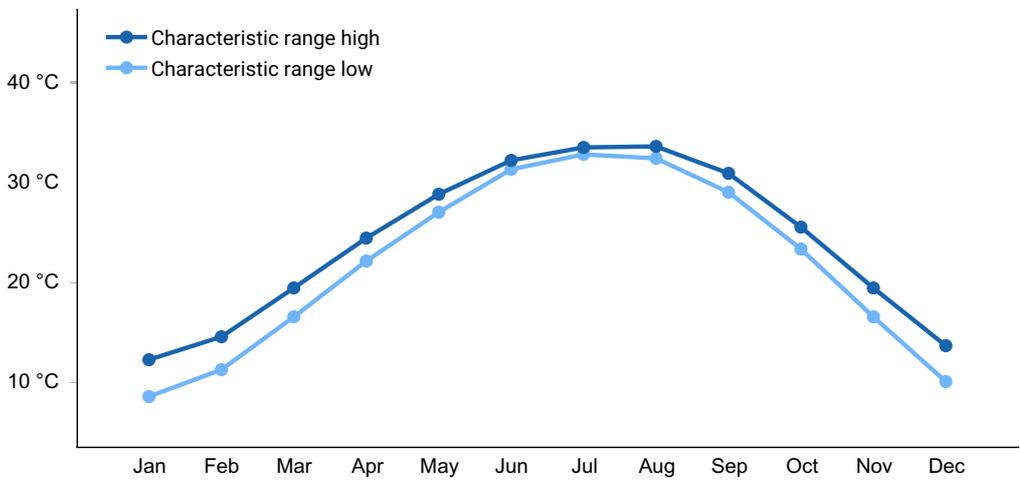
Frost-free period (characteristic range)	192-221 days
Freeze-free period (characteristic range)	225-248 days
Precipitation total (characteristic range)	1,321-1,397 mm
Frost-free period (actual range)	186-223 days
Freeze-free period (actual range)	218-251 days
Precipitation total (actual range)	1,321-1,422 mm
Frost-free period (average)	206 days
Freeze-free period (average)	236 days
Precipitation total (average)	1,372 mm



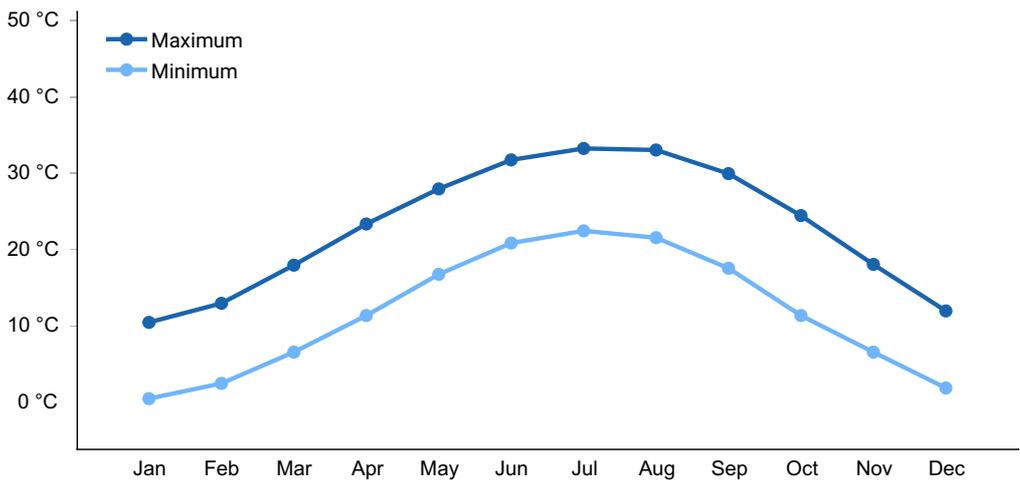
**Figure 2. Monthly precipitation range**



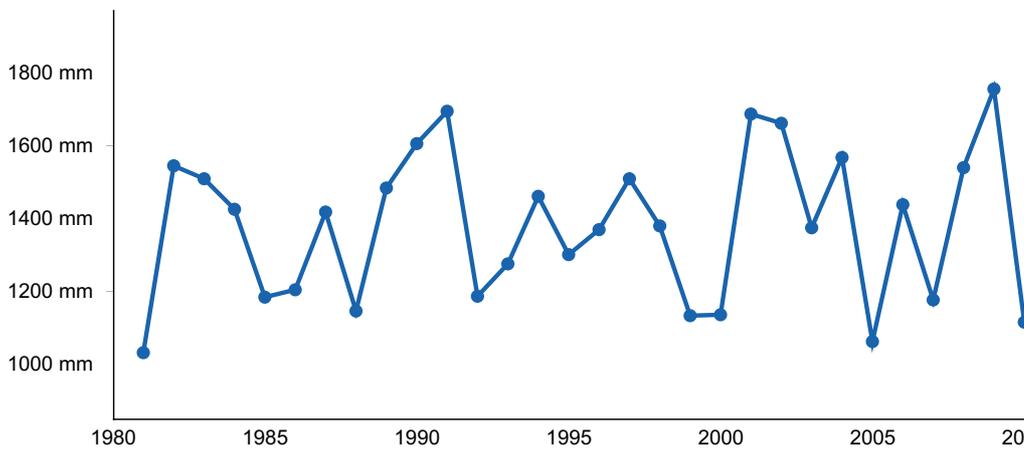
**Figure 3. Monthly minimum temperature range**



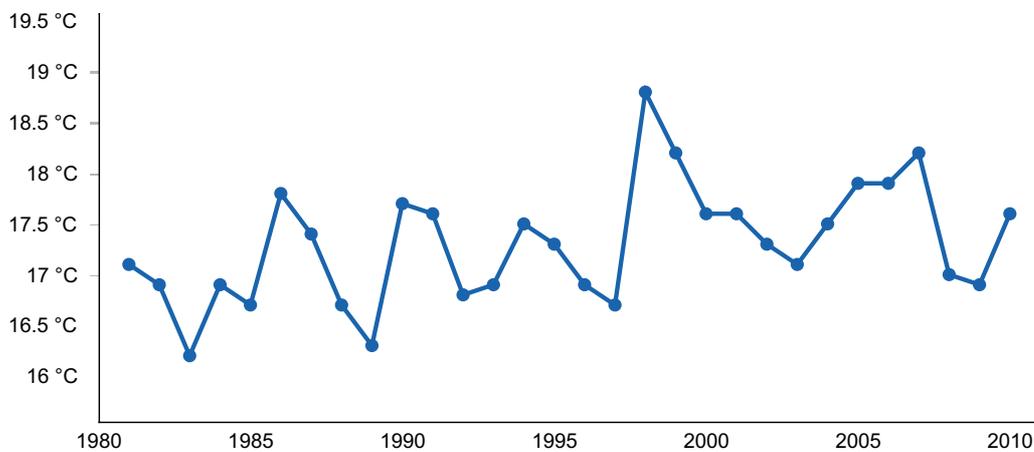
**Figure 4. Monthly maximum temperature range**



**Figure 5. Monthly average minimum and maximum temperature**



**Figure 6. Annual precipitation pattern**



**Figure 7. Annual average temperature pattern**

## Climate stations used

- (1) ST JOSEPH 3 N [USC00168163], Newellton, LA
- (2) STONEVILLE EXP STA [USC00228445], Leland, MS
- (3) TUNICA 2 N [USC00228998], Tunica, MS
- (4) CARUTHERSVILLE [USC00231364], Caruthersville, MO

## Influencing water features

These sites are influenced by the whole of the Mississippi River watershed above their current location. They are directly impacted by flooding from the river.

## Soil features

Please note that the soils listed in this section 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 131A 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 of this description to determine if another site may be a better fit for your area of interest.

The principal (or modal) soils of this site are moderately well to somewhat poorly drained that formed in silty alluvium. These soils characteristically occurs on natural levees and the undulating meander scroll ridges of the recent Mississippi River meander belt. Dominant slope gradient is between 1 and 3 percent. Permeability is slow to moderately rapid, and runoff is slow.

The dominant soils of this site include include Bruin (coarse-silty, mixed, superactive, thermic Oxyaquic Eutrudepts), Commerce (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts), and Bowdre (clayey over loamy, smectitic, thermic Fluvaquentic Hapludolls) series.

Bruin soils are moderately well drained and occurs on the higher positions of natural levees and ridges. Bruin soils have a water table below 2.5 to 4 feet in the winter and spring.

Commerce soils are somewhat poorly drained that formed in loamy alluvium and occurs on the intermediate backslope positions of natural levees and low ridges. Commerce soils can have a perched saturated zone above the clayey layers at 1.5 to 4 feet below the surface in winter through spring and also have saturated layers beneath them.

Bowdre soils are somewhat poorly drained, and occurs on slightly lower positions of natural levees and ridges. Bowdre soils have a water table that fluctuates between a depth of 1.5 to 2.0 feet during winter and spring.

Reactions in Bruin, Commerce, and Bowdre soils are slightly acid to moderately alkaline from the surface through the subsoil. A minor soil series included is Convent soils (coarse-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts) which are somewhat poorly drained. They are on similar landscape positions to Commerce, but differ by having a coarse-silty texture.

**Table 4. Representative soil features**

Parent material	(1) Alluvium
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Surface texture	(1) Clay (2) Silt loam (3) Silty clay loam (4) Very fine sandy loam
Drainage class	Somewhat poorly drained to moderately well drained
Permeability class	Slow to moderately rapid
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	14.73–22.1 cm
Calcium carbonate equivalent (Depth not specified)	0–3%
Soil reaction (1:1 water) (Depth not specified)	6.5–7.8
Subsurface fragment volume <=3" (Depth not specified)	0%
Subsurface fragment volume >3" (Depth not specified)	0%

## Ecological dynamics

This ecological site occurs within the undulating landscape between the active river and man-made levee or upland bluffs of adjacent MLRA's. Active flooding, overwash, scour and sedimentation by the Mississippi River will impact the site. These sites have been altered greatly by anthropogenic means; the hydrology, soils, and vegetation have been altered beyond what would have naturally occurred in the region. Due to these alterations by construction of flood protection levees, the ecological sites that would have occurred on these locations are no longer relevant. There will be similarities to the sites found on the protected side of the levees, however, the hydrology, sedimentation and erosion have overshadowed all other ecological processes.

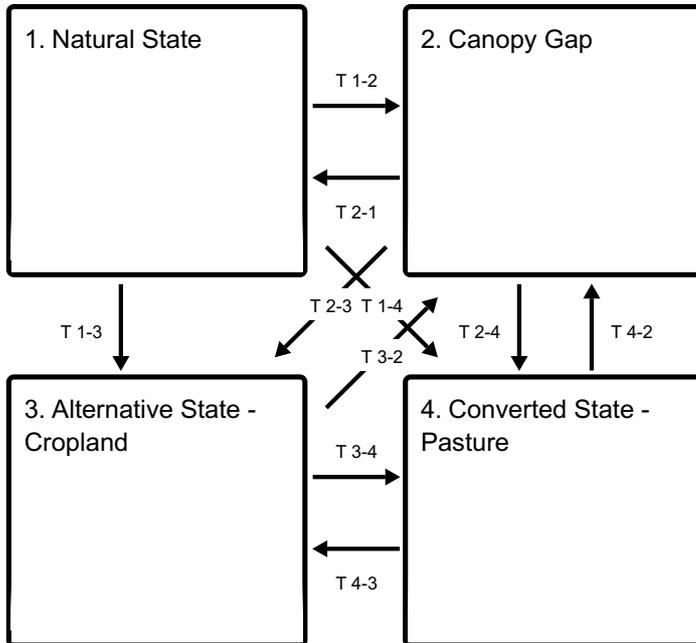
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Mississippi River levee system and is distinguished from similar landforms that are protected from current flooding by constructed levees or natural features.

## State and transition model

### Ecosystem states



**T 1-2** - Wind or water Force causing canopy gaps.

**T 1-3** - Establish and manage crop rotation

**T 1-4** - Establish desired forage species and manage for grassland.

**T 2-1** - Regeneration of natural species.

**T 2-3** - Establish and manage crop rotation

**T 2-4** - Establish desired forage species and manage for grassland.

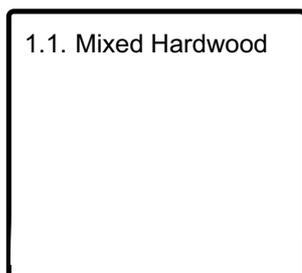
**T 3-2** - Plant or natural regeneration of woody and/or herbaceous species.

**T 3-4** - Establish desired forage species and manage for grassland.

**T 4-2** - Plant or natural regeneration of woody and/or herbaceous species.

**T 4-3** - Establish and manage crop rotation.

### State 1 submodel, plant communities



## State 1 Natural State

### Dominant plant species

- Nuttall oak (*Quercus texana*), tree
- willow oak (*Quercus phellos*), tree
- sweetgum (*Liquidambar styraciflua*), tree
- sugarberry (*Celtis laevigata*), tree
- American elm (*Ulmus americana*), tree
- cherrybark oak (*Quercus pagoda*), tree

## **Community 1.1**

### **Mixed Hardwood**

On low ridges - nuttall oak (*Quercus texana*), willow oak (*Quercus phellos*), sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), american elm (*Ulmus americana*), and understory including giant cane (*Arundinaria gigantea*) and possumhaw (*Ilex decidua*). On the higher elevation portions of this site cherrybark oak (*Quercus pagoda*) may be found.

## **State 2**

### **Canopy Gap**

This state consists of forest canopy openings that are created by catastrophic disturbances, allowing sunlight to reach understory strata and ground surfaces. Depending on local conditions and disturbance regime and intensity, a continuum or range of successional stages and community structure (physiognomy) is represented. Provisionally, this state includes seral stages ranging from recent disturbances that consist mainly of sparse herbaceous cover over mostly bare soil to the regeneration of woody species among a dense herbaceous cover (early stand initiation stage) to the initial stem exclusion stage where woody growth overtops and shades out the herbaceous stratum. In future ecological site development efforts, multiple community phases that describe the composition and progression from one stage to the next may be warranted for specifying management strategies and actions. The nature of the batture area makes it difficult to get slower growing species tall enough to withstand the deeper flood waters during regeneration. They can be planted and survive only to be lost in the next flood event. It is difficult to get some species back in this area once they are gone from an area.

## **State 3**

### **Alternative State - Cropland**

This site is an undulating landscape, so it is variably suited for crop production due to potential wetness and different soil textures, this will present inconsistencies in production across a field. The site can be managed as cropland; however, production is impacted by the potential for flooding. This site will be the highest local elevation and will be the last to flood and it may be utilized by wildlife and livestock as refuge from rising floods, which could damage or destroy crop production. A form of crop field that is found in irregular shapes and sizes on the landscape in the Batture region are wildlife food plots. This site is suited for this landuse and can be productive. Careful planning considerations should be

made when utilizing Batture areas for crop production. Extreme and innovative practices may be needed at times for management. Access, water management, and wildlife impacts are considerations that require careful planning and multiple techniques in any given crop cycle. Irrigation may be warranted at one time or part of a field while at another time or part of the field river flooding may be destroying the crop, so multiple techniques are required to address these concerns. The potential for river flooding is ever present and monitoring forecasts and river stages will be required to plan for impacts. Construction and maintenance of additional hydrologic control systems may be warranted, depending on local conditions. Even with control, production could still be below expectation or may only be possible on an irregular basis.

## **State 4**

### **Converted State - Pasture**

Pasture or grassland is characterized by a monoculture or mixture of forage species planted or established from naturalized species and is managed for forage production or herbaceous ground cover. This site can be utilized for forage production, however there are limitations. Maintenance of the hydrologic control systems may be needed to maintain production. Wet conditions will reduce forage production and limit the ability of livestock to graze. When alluvial sites are utilized for forage production, wetness and/or flooding must be monitored to prevent the loss of livestock or forage crop. Additionally, adjacent higher elevation or protected areas may be needed for storage of harvested forage or holding of livestock when wet or flooded conditions occur. The potential for flooding will limit the forage species that can or should be established on the site. When sites flood, the addition of sediment or erosion of the surface may destroy some perennial forages and will impact future productivity. Conditions for establishing forage crops are site-specific and all available site data should be analyzed to determine species, management, and usage for forage production.

### **Transition T 1-2**

#### **State 1 to 2**

Wind or water force causing canopy gaps.

### **Transition T 1-3**

#### **State 1 to 3**

This transition occurs when a decision is made to clear, establish and manage crops on the site.

### **Transition T 1-4**

#### **State 1 to 4**

This transition occurs when a decision is made to clear, establish and manage forages or

herbaceous vegetation on the site.

**Transition T 2-1**  
**State 2 to 1**

Regeneration of natural species.

**Transition T 2-3**  
**State 2 to 3**

This transition occurs when a decision is made to clear, establish and manage crops on the site.

**Transition T 2-4**  
**State 2 to 4**

This transition occurs when a decision is made to clear, establish and manage forages or herbaceous vegetation on the site.

**Transition T 3-2**  
**State 3 to 2**

Plant or natural regeneration of woody and/or herbaceous species to return the site to forested conditions.

**Transition T 3-4**  
**State 3 to 4**

This transition occurs when a decision is made to establish and manage forages or herbaceous vegetation on the site.

**Transition T 4-2**  
**State 4 to 2**

Plant or natural regeneration of woody and/or herbaceous species to return the site to forested conditions.

**Transition T 4-3**  
**State 4 to 3**

This transition occurs when a decision is made to establish and manage crops on the site.

**Additional community tables**

## Other references

- Aslan, A. and W.J. Autin. 1999. Evolution of the Holocene Mississippi River floodplain, Ferriday, Louisiana: Insights on the origin of fine-grained floodplains. *Journal of Sedimentary Research* 69: 800-815.
- Aslan, A., W. J. Autin, and M. D. Blum. 2005. Causes of river avulsion: insights from the late Holocene avulsion history of the Mississippi River, USA. *Journal of Sedimentary Research*, 75(4), 650-664.
- Autin, W.J., S.F. Burns, B.J. Miller, R.T. Saucier, and J.I. Snead. 1991. Quaternary geology of the Lower Mississippi Valley. p. 547-582. In R.B. Morrison (Editor). *Quaternary Nonglacial Geology: Conterminous U.S.* Geological Society of America. *The Geology of North America*, Volume K-2. Boulder, CO.
- Autin, W. J. 1996. Pleistocene stratigraphy in the southern Lower Mississippi Valley. *Engineering Geology*, 45(1), 87-112.
- Blum, M.D., M.J. Guccione, D.A. Wysocki, P.C. Robnett, and E.M. Rutledge. 2000. Late Pleistocene evolution of the lower Mississippi River valley, southern Missouri to Arkansas. *Geological Society of America Bulletin*, 112(2), 221-235.
- Broadfoot, Walter M. 1976. Hardwood suitability for and properties of important midsouth soils. Res. Pap. SO-127. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 84 p.
- Brown, D. A., V. E. Nash, A. G. Caldwell, L. J. Bartelli, R. C. Carter, and O. R. Carter. 1970. A monograph of the soils of the southern Mississippi River Valley alluvium. *Southern Cooperative Series Bulletin*, 178, 112.
- Chapman, S.S, G.E. Griffith, J.M. Omernik, J.A. Comstock, Beiser, M.C., 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).
- Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. *US Fish and Wildlife Service FWS/OBS*, 79(31), 131.
- Cowdrey, A. E. 1977. *Land's End: A history of the New Orleans District. US Army Corps of Engineers, and Its Lifelong Battle with the Lower Mississippi and Other Rivers Wending Their Way to the Sea.*
- Daigle, J.J., G.E. Griffith, J.M. Omernik, P.L. Faulkner, R.P. McCulloh, et al. 2006. Ecoregions of Louisiana (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,000,000).

- Elliott, D.O. 1932. The Improvement of the Lower Mississippi River for Flood Control and Navigation. Volume 1. U.S. Waterways Experiment Station, Vicksburg, MS.
- Ezell, A.W. 2016. Evaluating high-graded hardwood stands. Publication-Cooperative Extension Service, Mississippi State University (USA).
- Fisk, H. N. 1944. Geological investigation of the alluvial valley of the lower Mississippi River: US Dept. Army, Mississippi River Comm.
- Foti, T., C. Klimas, J. Pagan, and A. Keister. 2011. Potential natural vegetation of the Mississippi Alluvial Valley: Tensas Basin, Northeastern Louisiana. U.S. Fish and Wildlife Service, Lower Mississippi Valley Joint Venture; Vicksburg, MS.
- Gardiner, E. S., and J. M. Oliver. 2005. Restoration of bottomland hardwood forests in Lower Mississippi Aluvial Valey, USA. In: Stanturf, JA; Madsen, P. eds. Restoration of boreal and temperate forests. Restoration of bottomland hardwood forests in the Lower Mississippi Alluvial Valley, USA Boca Raton, FL: CRC Press. 235-251.
- Grigar, J., J.L. Hatfield, and R. Reeder, 2018. Transitional no-till: What is it and how does it differ from 'true'no-till?. *Crops and Soils* 51, no. 6:28–36.
- Kemp, K. 2000. The Mississippi Levee System and the Old River Control Structure. Available online: <http://www.tulane.edu/~bifleury/envirobio/enviroweb/FloodControl.htm>. Accessed 11/2018
- Klimas, C.V. 1988. Forest vegetation of the leveed floodplain of the lower Mississippi River. Lower Mississippi River Environmental Program Report 11. US Army Corps of Engineers. Vicksburg, Mississippi.
- Klimas, C., J. Pagan, T. Foti, and B. Tirpak. 2011. Potential natural vegetation of the Mississippi Alluvial Valley: Yazoo Basin, Mississippi. U.S. Fish and Wildlife Service, Lower Mississippi Valley Joint Venture; Vicksburg, MS.
- Lentz, G. H. 1928. Summary of First Year's Hardwood Investigations in Louisiana. US Forest Service and Louisiana Division of Forestry
- Lentz, G. H. 1929. Summary of First Year's Hardwood Investigations in Louisiana. *Journal of Forestry*, 27(5), 486-494.
- McKnight, J.S., D.D. Hook, O.G. Langdon, and R.L. Johnson. 1981. Flood tolerance and related characteristics of trees of the bottomland forests of the southern United States. In *Developments in Agricultural and Managed Forest Ecology*. 11, pp. 29-69. Elsevier. [https://www.srs.fs.usda.gov/pubs/ja/1980/ja\\_1980\\_mcknight\\_001.pdf](https://www.srs.fs.usda.gov/pubs/ja/1980/ja_1980_mcknight_001.pdf) (accessed 12 Oct. 2018)

[NCDC] National Climatic Data Center. 2018. Climate of Mississippi. Available [https://www.ncdc.noaa.gov/climate normals/clim60/states/Clim\\_MS\\_01.pdf](https://www.ncdc.noaa.gov/climate normals/clim60/states/Clim_MS_01.pdf). (Accessed: 22 May 2018).

Putnam, J. A., and H. Bull. 1932. The trees of the bottomlands of the Mississippi River Delta Region. US Department of Agriculture, Forest Service, Southern Forest Experiment Station, Occasional Paper, 27, 207.

Rittenhour, T.M., M.D. Blum, and R.J. Goble. 2007. Fluvial evolution of the Lower Mississippi River Valley during the last 100 k.y. glacial cycle: Response to glaciation and sea-level change. *Geological Society of America Bulletin* 119(5-6): 586-608.

Rogers, D. 2005. Evolution of the levee system along the Lower Mississippi River. University of Missouri-Rolla: Rolla, MO, USA.  
<https://web.mst.edu/~rogersda/levees/Evolution%20of%20the%20Levee%20System%20Along%20the%20Mississippi.pdf>. Accessed 10/2018.

Saucier, R. T. 1974. Quaternary geology of the lower Mississippi Valley (No. 6). Arkansas Archeological Survey.

Saucier, Roger T. 1994. Geomorphology and Quaternary Geologic History of the Lower Mississippi Valley, Volumes I & II. U.S. Army Corps of Engineers, Vicksburg, MS. (Available online: <http://biotech.law.lsu.edu/climate/mississippi/saucier/saucier.htm>)

Schumm, S. A., and W. J. Spitz. 1996. Geological influences on the Lower Mississippi River and its alluvial valley. *Engineering Geology*, 45(1-4), 245-261.

Shen, Z., T.E. Tornqvist, W.J. Autin, Z.R.P. Mateo, K.M. Straub, and B. Mauz. 2012. Rapid and widespread response of the Lower Mississippi River to eustatic forcing during the last glacial-interglacial cycle. *Geological Society of America Bulletin* 124(5-6): 690-704.

Smith, R.D. and C. Klimas. 2002. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of selected regional wetland subclasses, Yazoo Basin, Lower Mississippi River Alluvial Valley. ERDC/EL TR-02-4, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Theriot, R. F. 1992. Flood tolerance of plant species in bottomland forests of the southeastern United States. Ph.D. diss. University of Florida. Available online: <http://ufdc.ufl.edu//AA00003281/00001>

Turner, S., J. Welch, and N. Musso. 2010. The Atchafalaya National Heritage Area, Selected Level 0 Cultural Landscape Assessments. Suzanne Turner Associates LLC. Available online: <http://www.atchafalaya.org/ckfinder/userfiles/files/CLA-Final.pdf>

Tye, R. S., and J. M. Coleman. 1989. Depositional processes and stratigraphy of fluvially dominated lacustrine deltas: Mississippi delta plain. *Journal of Sedimentary Research*, 59(6).

[USACE] U.S. Army Corps of Engineers. 2004. Louisiana Coastal Area Comprehensive Coastwide Ecosystem Restoration Study. U.S. Army Corps of Engineers, New Orleans, LA. Available online: <https://www.lca.gov/Library/ProductList.aspx?Prodtype=0&folder=1118>.

[USACE] United States Army Corps of Engineers. 2017. The Mississippi Drainage Basin. U.S. Army Corps of Engineers, New Orleans District Website. Available: <https://www.mvn.usace.army.mil/Missions/Mississippi-River-Flood-Control/Mississippi-River-Tributaries/Mississippi-Drainage-Basin/> (Accessed: 2017).

[USACE] U.S. Army Corps of Engineers. Atchafalaya Basin Project, Brochure, <http://www.mvn.usace.army.mil/Portals/56/docs/PAO/Brochures/AtchafalayaBasinProject.PDF> (accessed 12 Oct. 2018)

[USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. *US Department of Agriculture Handbook*, 296.

[USDA, SCS] USDA, Soil Conservation Service. 1968. Soil Survey Interpretations for Woodland in the Southern Mississippi Valley Alluvium Area of LA MS AR TN MO and KY, Progress Report.

[USDA-NRCS] United States Department of Agriculture, Natural Resources Conservation Service. 2022. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. *U.S. Department of Agriculture, Agriculture Handbook* 296.

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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	03/28/2026
Approved by	Charles Stemmans
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:**

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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):

---

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):**

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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:**

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