USDA Natural Resources
Conservation Service

Ecological site R115XB018MO
Limestone/Dolomite Protected Cliff

Last updated: 12/30/2024
Accessed: 04/07/2026

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): 115X–Central Mississippi Valley Wooded Slopes

This MLRA is characterized by deeply dissected, loess-covered hills bordering well defined valleys of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers and their tributaries. It is used to produce cash crops and livestock. About one-third of the area is forested, mostly on the steeper slopes. This area is in Illinois (50 percent), Missouri (36 percent), Indiana (13 percent), and Iowa (1 percent) in two separate areas. It makes up about 25,084 square miles (64,967 square kilometers).

Most of this area is in the Till Plains section and the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The Springfield-Salem plateaus section of the Ozarks Plateaus province of the Interior Highlands occurs along the Missouri River and the Mississippi River south of the confluence with the Missouri River. The nearly level to very steep uplands are dissected by both large and small tributaries of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers. The Ohio River flows along the southernmost boundary of this area in Indiana. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to undulating. Karst topography is common in some parts along the Missouri and Mississippi Rivers and their tributaries. Well-developed karst areas have hundreds of sinkholes, caves, springs, and losing streams. In the St. Louis area, many of the karst features have been obliterated

by urban development.

Elevation ranges from 90 feet (20 meters) on the southernmost flood plains to 1,030 feet (320 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters) but can be 50 to 150 feet (15 to 45 meters) in the steep, deeply dissected hills bordering rivers and streams. The bluffs along the major rivers are generally 200 to 350 feet (60 to 105 meters) above the valley floor.

The uplands in this MLRA are covered almost entirely with Peoria Loess. The loess can be more than 7 feet (2 meters) thick on stable summits. On the steeper slopes, it is thin or does not occur. In Illinois, the loess is underlain mostly by Illinoian-age till that commonly contains a paleosol. Pre-Illinoian-age till is in parts of this MLRA in Iowa and Missouri and to a minor extent in the western part of Illinois. Wisconsin-age outwash, alluvial deposits, and sandy eolian material are on some of the stream terraces and on dunes along the major tributaries. The loess and glacial deposits are underlain by several bedrock systems. Pennsylvanian and Mississippian bedrock are the most extensive. To a lesser extent are Silurian, Devonian, Cretaceous, and Ordovician bedrock. Karst areas have formed where limestone is near the surface, mostly in the southern part of the MLRA along the Mississippi River and some of its major tributaries. Bedrock outcrops are common on the bluffs along the Mississippi, Ohio, and Wabash Rivers and their major tributaries and at the base of some steep slopes along minor streams and drainageways.

The annual precipitation ranges from 35 to 49 inches (880 to 1,250 millimeters) with a mean of 41 inches (1,050 millimeters). The annual temperature ranges from 48 to 58 degrees F (8.6 to 14.3 degrees C) with a mean of 54 degrees F (12.3 degrees C). The freeze-free period ranges from 150 to 220 days with a mean of 195 days.

Soils The dominant soil orders are Alfisols and, to a lesser extent, Entisols and Mollisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, excessively drained to poorly drained, and loamy, silty, or clayey.

The soils on uplands in this area support natural hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak and eastern redcedar grow on some sites. The soils on flood plains support mixed forest vegetation, mainly American elm, eastern cottonwood, river birch, green ash, silver maple, sweetgum, American sycamore, pin oak, pecan, and willow. Sedge and grass meadows and scattered trees are on some low-lying sites. (United States Department of Agriculture, Natural Resources Conservation Service, 2022)

LRU notes

The Central Mississippi Valley Wooded Slopes, Western Part consists of deeply dissected, loess-covered hills bordering the Missouri and Mississippi Rivers as well as floodplains and terraces of these rivers. The Northern boundary runs along the South

Fabius River valley separating it from the broad rounded interfluves of the northern till plain. A major physiographic feature within the LRU (Land Resource Unit) includes the Lincoln Hills region. The Lincoln Hills extend along the Mississippi River in Missouri, starting about 40 miles (64 kilometers) northwest of St. Louis and extending north to Hannibal. The Lincoln Hills partially escaped the most recent glaciation in the region during the Pleistocene. In geology and biology, they resemble the rugged and forested hills of the Ozark Highlands (MLRA 116A) more than the rolling plains of northern Missouri. The underlying limestone bedrock has formed bluffs, glades, caves, springs, and sinkholes. Elevation ranges from about 420 feet (128 meters) along the Mississippi River near Cape Girardeau, Missouri to about 830 feet (253 meters) near Clarksville along the Mississippi River upstream from St. Louis. High ridges near Hillsboro, Missouri can reach over 1,000 feet (305 meters). Underlying bedrock is mainly Ordovician-aged dolomite and sandstone, with Mississippian-aged limestone north of the Missouri River. Loess caps both stream and glacial outwash terraces along the major rivers along with Pre-Illinoisan till near the edges of the area.

Classification relationships

Major Land Resource Area (MLRA) (USDA-NRCS, 2022):
115X–Central Mississippi Valley Wooded Slopes

Terrestrial Natural Community Type in Missouri (Nelson, 2010):
The reference state for this ecological site is most similar to a Moist Limestone/Dolomite Cliff.

National Vegetation Classification System Vegetation Association (NatureServe, 2010):
The reference state for this ecological site is most similar to Limestone - Dolostone Midwest Moist Cliff Sparse Vegetation (CEGL002292).

Geographic relationship to the Missouri Ecological Classification System (Nigh & Schroeder, 2002):
This ecological site occurs primarily in Land Type Associations of the following Subsections:
Outer Ozark Border
Mississippi River Hills

Ecological site concept

Limestone/Dolomite Protected Cliffs occupy northerly and easterly aspects, and are mapped in complex with the Limestone/Dolomite Exposed Cliff ecological site. These sites are north of the Missouri River, often on cliffs adjacent to floodplains. They are typically associated with Limestone/Dolomite Glade/Woodland ecological sites. Soils are very shallow to limestone or dolomite. The reference plant community consists of scattered small trees, shrubs, grasses, forbs, and ferns, occupying cracks and ledges in the cliff face.

Associated sites

F115XB003MO	**Deep Loess Protected Backslope Forest** Deep Loess Protected Backslope Forests are typically upslope from this ecological site
R115XB009MO	**Shallow Limestone/Dolomite Upland Glade/Woodland** Shallow Limestone/Dolomite Glade/Woodlands are typically associated with this ecological site.

Similar sites

R115XB019MO	**Limestone/Dolomite Exposed Cliff** Limestone/Dolomite Exposed Cliffs are similar but on south and west aspects.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Fraxinus quadrangulata*
Shrub	(1) *Hydrangea arborescens* (2) *Staphylea trifolia*
Herbaceous	(1) *Aquilegia canadensis* (2) *Asplenium rhizophyllum*

Physiographic features

This site is on cliffs. It is on protected aspects (north, northeast, and east), which receive significantly less solar radiation than the exposed aspects. The site generates runoff to adjacent, downslope ecological sites, and in places receives runoff from upslope summit and shoulder sites. This site does not flood.

The following figure (adapted from Young et al., 2003) shows the typical landscape position of this ecological site, and landscape relationships with other ecological sites in the uplands adjacent to the Missouri River. The site is within the area labeled “3”, on cliffs with northerly and easterly aspects. They are typically associated with Shallow Limestone/Dolomite Glade/Woodland ecological sites, included within the area labeled “3”. Deep Loess sites often directly upslope, and are included within the area labeled “1”.

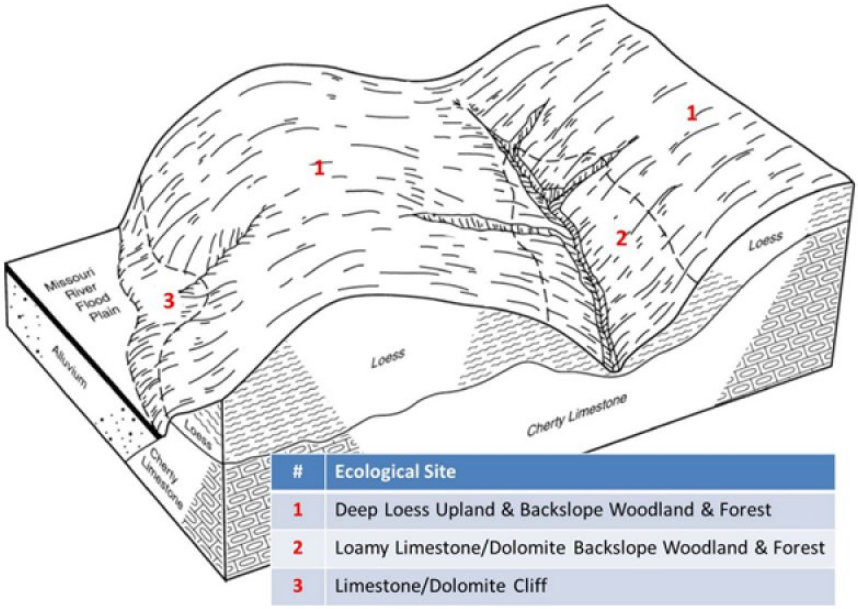


Figure 2. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Cliff
Runoff class	Very high
Flooding frequency	None
Elevation	152–335 m
Slope	9–70%
Water table depth	152 cm
Aspect	NW, N, NE, E

Climatic features

The Central Mississippi Valley Wooded Slopes, Western Part has a continental type of climate marked by strong seasonality. In winter, dry-cold air masses, unchallenged by any topographic barriers, periodically swing south from the northern plains and Canada. If they invade reasonably humid air, snowfall and rainfall result. In summer, moist, warm air masses, equally unchallenged by topographic barriers, swing north from the Gulf of Mexico and can produce abundant amounts of rain, either by fronts or by convectional processes. In some summers, high pressure stagnates over the region, creating extended droughty periods. Spring and fall are transitional seasons when abrupt changes in temperature and precipitation may occur due to successive, fast-moving fronts separating contrasting air masses.

The Central Mississippi Valley Wooded Slopes, Western Part experiences regional differences in climates, but these differences do not have obvious geographic boundaries. Regional climates grade inconspicuously into each other. The basic gradient for most

climatic characteristics is along a line diagonally crossing the MLRA from northwest to southeast. Both mean annual temperature and precipitation exhibit gradients along this line.

The average annual precipitation in most of this area is 38 to 48 inches. The average annual temperature is 53 to 57 degrees F. Mean January minimum temperature follows the northwest-to-southeast gradient. However, mean July maximum temperature shows hardly any geographic variation in the MLRA. Mean July maximum temperatures have a range of only two or three degrees across the area.
Mean annual precipitation varies along the same gradient as temperature. Seasonal climatic variations are more complex. Seasonality in precipitation is very pronounced due to strong continental influences. June precipitation, for example, averages three to four times greater than January precipitation. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter.

During years when precipitation comes in a fairly normal manner, moisture is stored in the top layers of the soil during the winter and early spring, when evaporation and transpiration are low. During the summer months the loss of water by evaporation and transpiration is high, and if rainfall fails to occur at frequent intervals, drought will result. Drought directly affects plant and animal life by limiting water supplies, especially at times of high temperatures and high evaporation rates.

Superimposed upon the basic MLRA climatic patterns are local topographic influences that create topoclimatic, or microclimatic variations. In regions of appreciable relief, for example, air drainage at nighttime may produce temperatures several degrees lower in valley bottoms than on side slopes. At critical times during the year, this phenomenon may produce later spring or earlier fall freezes in valley bottoms. Higher daytime temperatures of bare rock surfaces and higher reflectivity of these unvegetated surfaces may create distinctive environmental niches such as glades and cliffs. Slope orientation is an important topographic influence on climate. Summits and south-and-west-facing slopes are regularly warmer and drier than adjacent north- and-east-facing slopes. Finally, the climate within a canopied forest is measurably different from the climate of a more open grassland or savanna areas.

Source: University of Missouri Climate Center - http://climate.missouri.edu/climate.php; accessed June 2012

Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin, United States Department of Agriculture Handbook 296 - http://soils.usda.gov/survey/geography/mlra/

Table 3. Representative climatic features

Frost-free period (characteristic range)	154-173 days
Freeze-free period (characteristic range)	187-208 days

Precipitation total (characteristic range)	1,067-1,143 mm
Frost-free period (actual range)	147-176 days
Freeze-free period (actual range)	182-213 days
Precipitation total (actual range)	1,041-1,168 mm
Frost-free period (average)	163 days
Freeze-free period (average)	198 days
Precipitation total (average)	1,092 mm

Climate stations used

- (1) ELSBERRY 1 S [USC00232591], Elsberry, MO
- (2) COLUMBIA U OF M [USC00231801], Columbia, MO
- (3) COLUMBIA RGNL AP [USW00003945], Columbia, MO

Influencing water features

Cliff aspect and local seepages result in a variability of site moisture conditions. North- and east-facing cliffs are typically moister than south- and west-facing cliffs because of reduced wind and reduced direct exposure to the sun. Moisture can be locally present on cliff faces due to local groundwater seepage along the cliff face or surface flow across the cliff face during rain events or snow melt. The site generates runoff to adjacent, downslope ecological sites, and in places receives runoff from upslope summit and shoulder sites.

Soil features

These soils are underlain with limestone and/or dolomite bedrock at less than 20 inches. The soils have dark, organic-rich surface horizons. Parent material is limestone and dolomite residuum. These soils are loamy or clayey, and are skeletal, with high amounts of limestone/dolomite gravel, channers and flagstones. They are not affected by seasonal wetness. Soil series associated with this site include Gasconade.

Table 4. Representative soil features

Parent material	(1) Residuum–limestone and dolomite
Surface texture	(1) Gravelly silty clay loam (2) Very gravelly clay loam (3) Extremely gravelly loam
Family particle size	(1) Loamy
Drainage class	Well drained to somewhat excessively drained

Permeability class	Very slow to slow
Depth to restrictive layer	10–51 cm
Soil depth	10–51 cm
Surface fragment cover <=3"	15–55%
Surface fragment cover >3"	5–60%
Available water capacity (0-101.6cm)	2.54–5.08 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.1–7.8
Subsurface fragment volume <=3" (Depth not specified)	5–40%
Subsurface fragment volume >3" (Depth not specified)	5–60%

Ecological dynamics

Information contained in this section was developed using historical data, professional experience, field reviews, and scientific studies. The information presented is representative of very complex vegetation communities. Key indicator plants, animals and ecological processes are described to help inform land management decisions. Plant communities will differ across the MLRA because of the naturally occurring variability in weather, soils, and aspect. The Reference Plant Community is not necessarily the management goal. The species lists are representative and are not botanical descriptions of all species occurring, or potentially occurring, on this site. They are not intended to cover every situation or the full range of conditions, species, and responses for the site.

The reference community is characterized by vertical rock cliffs and by stress tolerant trees and shrubs, ferns, lichens and mosses. These sites have large expanses of bare rock, with a variety of plants occupying cracks and minor ledges across the cliff face. Protected cliffs are normally more vegetated than exposed sites. Some harbor rare plants that are relicts from the colder climate of the Pleistocene.

Limestone/Dolomite Protected Cliffs can be above talus slopes or terraces, and are often below loess or chert forests and woodlands. When present, trees are stunted and the herbaceous vegetation is generally sparse. Cliff faces with visible seep zones and cool

shaded habitats often support ferns, liverworts, mosses, algae, and fungi.

Soils are generally absent but do occur on cliff edges, ledges, and rock terraces and support higher densities of forbs and ferns. Microhabitats associated with cliffs are often ephemerally wet, becoming dry in summer. Shading on north and east facing aspects coupled with adjacent taller trees at the cliff bases keep the cliff face cooler.

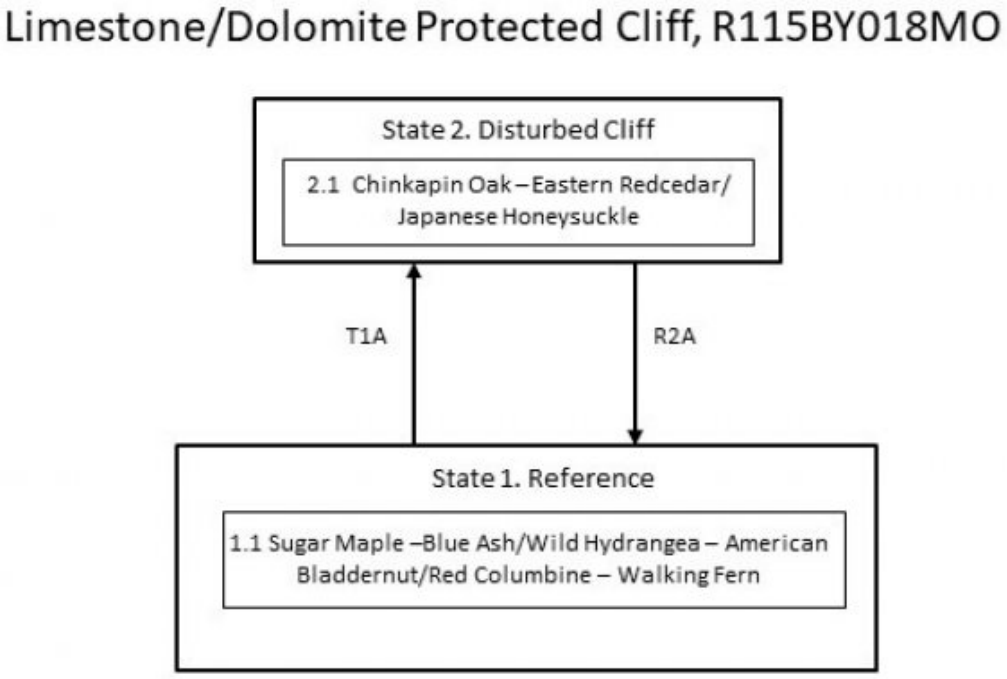
Protected cliffs are normally more vegetated than exposed cliffs. Vegetation structure is influenced by drought stress (cliff edge), wind, and storm damage and damage by falling rocks. Weathering results in the gradual exfoliation of limestone/dolomite along the cliff face, which adds to the instability of the ecological site, reducing dependable habitat for plant establishment. As portions of the bedrock slough off, they form talus slopes along the base of cliffs and expose fresh, bare rock substrates along the cliff face. Windthrow of canopy trees along the cliff escarpment is common due to the thin soils, unstable substrate, and high wind activity. Windblown trees along ledges and at the base of the cliff provide localized areas for soil accumulation.

A state-and-transition model follows. Detailed descriptions of each state, transition, plant community, and pathway follow the model. This model is based on available experimental research, field observations, professional consensus, and interpretations. It may change as knowledge increases.

Ecological Site Correlation Issues and Questions:

OSD information for this ecological site indicates that Gasconade map units are limestone derived but Clinkenbeard map units can be either limestone or dolomite derived. The Gasconade-Rock outcrop map unit (60103) associated with this ecological site may need to be more accurately named Limestone Protected/Exposed Cliff rather than its existing naming, with map unit 60009 remaining Limestone/Dolomite Protected Cliff or Limestone/Dolomite Exposed Cliff. Further field review is needed.

State and transition model



Code	Event/Activity/Process
T1A	Exotic plant invasion; woody encroachment; Human disturbances: rock climbing, rappelling
R2A	Woody removal; site protection and monitoring

Figure 9. State and transition diagram for this ecological site

State 1
Reference

The reference plant community is characterized by rock shelves, vertical rock cliffs and by stress tolerant trees, shrubs, ferns, lichens and mosses. These sites have large expanses of bare rock, with a variety of plants occupying cracks and minor ledges across the cliff face. When present, trees are stunted and the herbaceous vegetation is generally sparse.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- blue ash (*Fraxinus quadrangulata*), tree
- wild hydrangea (*Hydrangea arborescens*), shrub
- American bladdernut (*Staphylea trifolia*), shrub
- red columbine (*Aquilegia canadensis*), other herbaceous
- walking fern (*Asplenium rhizophyllum*), other herbaceous

Community 1.1
Sugar Maple –Blue Ash/Wild Hydrangea – American Bladdernut/Columbine – Walking Fern

This is the only phase associated with this state at this time. See the corresponding state narrative for details. The plant species list is based on field surveys and commonly occurring species listed in Nelson (2010).

Forest overstory. The Overstory Species list is based on field surveys and commonly occurring species listed in Nelson (2010).

Forest understory. The Understory Species list is based on field surveys and commonly occurring species listed in Nelson (2010).

State 2
Disturbed Cliff

This state has experienced significant exotic plant invasion, such as Japanese honeysuckle. Repeated trampling by human rock climbing and rappelling activities destroy the structure and composition of the reference plant communities. In addition, woody encroachment through these disturbances is also occurring.

Dominant plant species

- chinquapin oak (*Quercus muehlenbergii*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- Japanese honeysuckle (*Lonicera japonica*), other herbaceous

Community 2.1
Chinkapin Oak – Eastern Redcedar/ Japanese Honeysuckle

This is the only phase associated with this state at this time. See the corresponding state narrative for details.

Transition T1A
State 1 to 2

This transition is the result of exotic plant invasion, woody encroachment, and human disturbances such as rock climbing and rappelling.

Restoration pathway R2A
State 2 to 1

This transition is the result of woody removal, site protection and monitoring.

Additional community tables

Table 5. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	–	–	–	–
blue ash	FRQU	*Fraxinus quadrangulata*	Native	–	–	–	–
white ash	FRAM2	*Fraxinus americana*	Native	–	–	–	–
sugar maple	ACSA3	*Acer saccharum*	Native	–	–	–	–
eastern redcedar	JUVI	*Juniperus virginiana*	Native	–	–	–	–
northern red oak	QURU	*Quercus rubra*	Native	–	–	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
sideoats grama	BOCU	*Bouteloua curtipendula*	Native	–	–
bristleleaf sedge	CAEB2	*Carex eburnea*	Native	–	–
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	–
Forb/Herb					
waxyleaf meadow-rue	THRE	*Thalictrum revolutum*	Native	–	–
zigzag goldenrod	SOFL2	*Solidago flexicaulis*	Native	–	–
orange coneflower	RUFUU	*Rudbeckia fulgida var. umbrosa*	Native	–	–
red columbine	AQCA	*Aquilegia canadensis*	Native	–	–
wrinkleleaf goldenrod	SORU2	*Solidago rugosa*	Native	–	–
Fern/fern ally					
walking fern	ASRH2	*Asplenium rhizophyllum*	Native	–	–
bulblet bladderfern	CYBU3	*Cystopteris bulbifera*	Native	–	–
ebony spleenwort	ASPL	*Asplenium platyneuron*	Native	–	–
purple cliffbrake	PEAT2	*Pellaea atropurpurea*	Native	–	–
Shrub/Subshrub					
fragrant sumac	RHAR4	*Rhus aromatica*	Native	–	–
wild hydrangea	HYAR	*Hydrangea arborescens*	Native	–	–
American bladdernut	STTR	*Staphylea trifolia*	Native	–	–
Nonvascular					
rim lichen	LEMU60	*Lecanora muralis*	Native	–	–
false Russell's fishscale lichen	PSPS3	*Psora pseudorussellii*	Native	–	–

Table 7. Community 2.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	–
Indiangrass	SONU2	*Sorghastrum nutans*	Native	–	–
sideoats grama	BOCU	*Bouteloua curtipendula*	Native	–	–
Forb/Herb					
Missouri orange coneflower	RUMI	*Rudbeckia missouriensis*	Native	–	–

Animal community

Wildlife

Only a few animals are highly associated with cliff natural communities due to their unique structural conditions.

Bird species associated with this ecological site's reference state condition: Turkey Vulture, Eastern Phoebe, American Kestrel, Northern Rough-winged Swallow, Cliff Swallow, and Barn Swallow.

North-facing cliffs that are wet and moist may have numerous lungless salamander (Family Plethodontidae) species and pickerel frogs (Rana palustris).

Small mammals likely associated with this ecological site's reference state condition: Eastern Woodrat (Neotoma floridana) and Peromyscus species.

As with most natural communities, many invertebrate groups are represented on cliff natural communities including snails, spiders, insects, centipedes, millipedes and protistan microbe communities. Funnel-web and aerial web spiders are two groups well represented on cliff natural communities. Colonies of microcaddisflies and midgeflies are some of the invertebrate groups that occur on seep-type habitats created by the movement of thin sheets of water over the rock surface. Terrestrial snails are often abundant in the talus slopes that develop at the base of protected limestone/dolomite cliffs.

(This section prepared by Mike Leahy, Natural Areas Coordinator, Missouri Department of Conservation, 2013. References for this section: Fitzgerald and Pashley 2000b; Heitzman and Heitzman 1996; Jacobs 2001; Johnson 2000; Pitts and McGuire 2000; Schwartz and others 2001)

Other information

Forestry

Management: This ecological site is not recommended for traditional timber management activity

Inventory data references

Potential Reference Sites: Limestone/Dolomite Protected Cliff

No reference sites were field sampled due hazardous site issues.

Other references

Fitzgerald, J.A. and D.N. Pashley. 2000a. Partners in Flight bird conservation plan for the Ozark/Ouachitas. American Bird Conservancy.

Fitzgerald, J.A. and D.N. Pashley. 2000b. Partners in Flight bird conservation plan for the Dissected Till Plains. American Bird Conservancy.

Heitzman, J.R. and J.E. Heitzman. 1996. Butterflies and moths of Missouri. 2nd ed. Missouri Department of Conservation, Jefferson City.

Jacobs, B. 2001. Birds in Missouri. Missouri Department of Conservation, Jefferson City.

Johnson, T.R. 2000. The amphibians and reptiles of Missouri. 2nd ed. Missouri Department of Conservation, Jefferson City.

Kost, M.A., D.A. Albert, J.G. Cohen, B.S. Slaughter, R.K. Schillo, C.R. Weber, and K.A. Chapman. 2007. Natural Communities of Michigan: Classification and Description. Michigan Natural Features Inventory, Report No. 2007-21, Lansing, MI.

NatureServe, 2010. Vegetation Associations of Missouri (revised). NatureServe, St. Paul, Minnesota.

Nelson, Paul W. 2010. The Terrestrial Natural Communities of Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Nelson, Paul W and Douglas Ladd. 1980. “Preliminary report on the identification, distribution and classification of Missouri glades”.

Nigh, Timothy A., and Walter A. Schroeder. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation, Jefferson City, Missouri.

Pitts, D.E. and W.D. McGuire. 2000. Wildlife management for Missouri landowners. 3rd ed. Missouri Department of Conservation, Jefferson City.

Schwartz, C.W., E.R. Schwartz and J.J. Conley. 2001. The wild mammals of Missouri. University of Missouri Press, Columbia and Missouri Department of Conservation, Jefferson City.

United States Department of Agriculture – Natural Resource Conservation Service (USDA-NRCS). 2006. 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. 682 pgs.

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.

University of Missouri Climate Center - http://climate.missouri.edu/climate.php; accessed June 2012

Young, Fred J., Caryl A. Radatz, and Curtis A. Marshall. 2003. Soil Survey of Boone County, Missouri. U.S. Dept. of Agric. Natural Resources Conservation Service.

Contributors

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Missouri Department of Conservation and Missouri Department of Natural Resources personnel provided significant and helpful field and technical support in the development of this ecological site.

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	04/07/2026
Approved by	Suzanne Mayne-Kinney
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):**

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:

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17. **Perennial plant reproductive capability:**
