USDA Natural Resources Conservation Service

Ecological site R116AY029MO Ponded Sinkhole Wetland

Last updated: 9/24/2020
Accessed: 04/29/2024

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.

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): 116A–Ozark Highland

The Ozark Highland constitutes the Salem Plateau of the Ozark Uplift. Elevation ranges from about 300 feet on the southeast edge of the Ozark escarpment, to about 1,600 feet in the west, adjacent to the Burlington Escarpment of the Springfield Plateau. The underlying bedrock is mainly horizontally bedded Ordovician-aged dolomites and sandstones that dip gently away from the uplift apex in southeast Missouri. Cambrian dolomites are exposed on deeply dissected hillslopes. In some places, Pennsylvanian and Mississipian sediments overlie the plateau. Relief varies, from the gently rolling central plateau areas to deeply dissected hillslopes associated with drainageways such as the Buffalo, Current, Eleven Point and White Rivers.

Classification relationships

Terrestrial Natural Community Type in Missouri (Nelson, 2010):
The reference state for this ecological site is most similar to a Pond Marsh, or Pond Shrub Swamp, or Pond Swamp.

National Vegetation Classification System Vegetation Association (NatureServe, 2010):
The reference state for this ecological site is most similar to Carex comosa - Carex decomposita - Dulichium arundinaceum - Lycopus rubellus Herbaceous Vegetation (CEGL002413).

Geographic relationship to the Missouri Ecological Classification System (Nigh & Schroeder, 2002):
This ecological site is scattered across the central portion of the Ozark Highlands Section.

Ecological site concept

NOTE: This is a “provisional” Ecological Site Description (ESD) that is under development. It contains basic ecological information that can be used for conservation planning, application and land management. After additional information is collected, analyzed and reviewed, this ESD will be refined and published as “Approved”.

Ponded Sinkhole Wetlands occur in small, scattered delineations, primarily in the central Ozark Highland counties of Howell, Texas and Shannon, in Missouri. Soils are very deep and are loamy or clayey, with periodic ponding and high water tables. The reference plant community is woodland with an overstory dominated by swamp white oak, pin oak and post oak, and a ground flora of wet-tolerant grasses and sedges.

Associated sites

F116AY011MO	**Chert Upland Woodland** Chert Upland Woodlands, and other upland and backslope ecological sites formed over dolomite, are upslope.

Similar sites

F116AY043MO	**Loamy Sinkhole Woodland** Loamy Sinkhole Woodlands are drier sinkhole ecological sites with internal drainage that does not pond water for extended periods.

Table 1. Dominant plant species

Tree	(1) *Nyssa aquatica* (2) *Quercus palustris*
Shrub	(1) *Cephalanthus occidentalis*
Herbaceous	(1) *Glyceria acutiflora* (2) *Cinna arundinacea*

Physiographic features

This site is on sinkholes with slopes of 0 to 3 percent. These sites are on nearly level to gently sloping concave upland divides and in large sinkhole basins. The site receives runoff from the adjacent uplands, and is subject to frequent ponding in the winter months.

The accompanying figure (adapted from Sturdevant et al, 2001) shows the typical landscape position of this ecological site, and landscape relationships with other ecological sites. It is within the area labeled “3” on the figure. Ponded Sinkhole Wetland sites are associated with a variety of other upland ecological sites formed over dolomite bedrock.

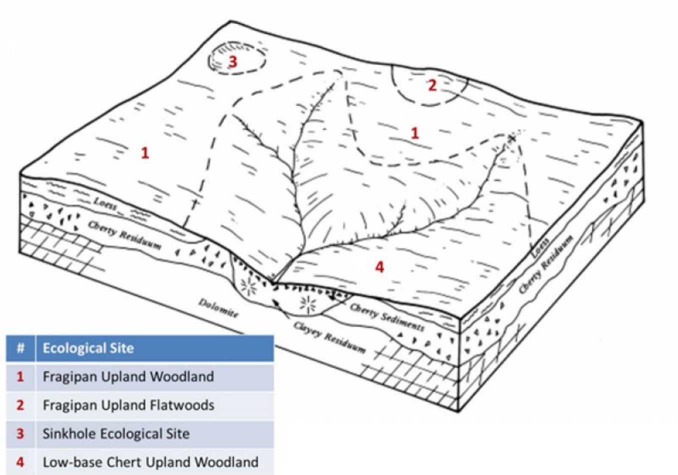


Figure 2. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Sinkhole
Flooding frequency	None
Ponding duration	Brief (2 to 7 days)
Ponding frequency	Frequent
Slope	0–3%
Water table depth	13–51 cm
Aspect	Aspect is not a significant factor

Climatic features

The Ozark Highland 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 Ozark Highland 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 crossing the MLRA from northwest to southeast.
The average annual precipitation in almost all of this area is 38 to 45 inches. Snow falls nearly every winter, but the snow cover lasts for only a few days. The average annual temperature is about 53 to 60 degrees F. The lower temperatures occur at the higher elevations in the western part of the MLRA. Mean January minimum temperature follows a stronger north-to-south 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 a northwest to southeast gradient. 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.

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. Deep sinkholes often have a microclimate significantly cooler, moister, and shadier than surrounding surfaces, a phenomenon that may result in a strikingly different ecology. 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; 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)	141-155 days
Freeze-free period (characteristic range)	176-187 days
Precipitation total (characteristic range)	1,143-1,194 mm
Frost-free period (actual range)	140-160 days
Freeze-free period (actual range)	174-190 days
Precipitation total (actual range)	1,143-1,194 mm
Frost-free period (average)	148 days
Freeze-free period (average)	181 days
Precipitation total (average)	1,168 mm

Climate stations used

- (1) WEST PLAINS [USC00238880], West Plains, MO
- (2) LICKING 4N [USC00234919], Licking, MO
- (3) BUFFALO 2N [USC00231087], Buffalo, MO

Influencing water features

This ecological site is in the basins of sinkholes. They are influenced by a seasonal high water table, due to high groundwater levels. Ponds are in some areas. The water table is typically near or at the surface in late fall through spring, receding in the summer. Ephemeral ponding may occur from seasonal high groundwater tables above the soil surface, and as a result of runoff from surrounding upslope positions. Some permanent open water may also be present.

This site is in the DEPRESSIONAL wetlands class of the Hydrogeomorphic (HGM) classification system (Brinson, 1993), and are Emergent Palustrine wetlands (Cowardin et al., 1979).

Water features associated with this upland ecological site are influenced by karst landscapes throughout the area (see diagram). Rainfall enters the groundwater system through the soil or by flowing into sinkholes and streams. Springs form where land drops low enough to meet underground water tables. Dissolution of carbonate rocks along fractures and faults has produced cave systems, sinkholes (closed and open), springs, and natural tunnels in the region. These sinkholes and losing streams can rapidly transfer water from upland recharge areas to spring outlets. The most common mechanism for groundwater recharge occurs by the relatively slow downward movement of water through soil and carbonate bedrock over a large area known as diffuse recharge, which maintains a high storage volume providing a consistent supply of water to springs. In addition to diffuse recharge, aquifers in karst terrain receive the relatively rapid transfer of water through sinkholes or losing streams connected by subsurface conduits. Surface water entering the aquifer in this fashion has very little contact with soil or rock and consequently the chemical nature of the water changes little in route. Discharge variability does not seem to be controlled by drainage area, but rather the conduit capacity of losing stream sections that can transport the entire volume of base-flow during dry periods in the year. High variability in base ?ow shows the impact of karst in the form of losing and gaining stream sections (Owen and Pavlowsky 2010).

The accompanying map depicts the distribution of these karst-related features in the state of Missouri. Relative cave density per USGS 7.5" quadrangle is depicted by shades of red, deeper red signifying a larger number of caves in the quadrangle. Stretches of losing streams are shown in yellow. Known springs are shown as blue dots. Image from Wikimedia Commons developed from the Missouri Department of Natural Resources, Division of Geology and Land Survey.

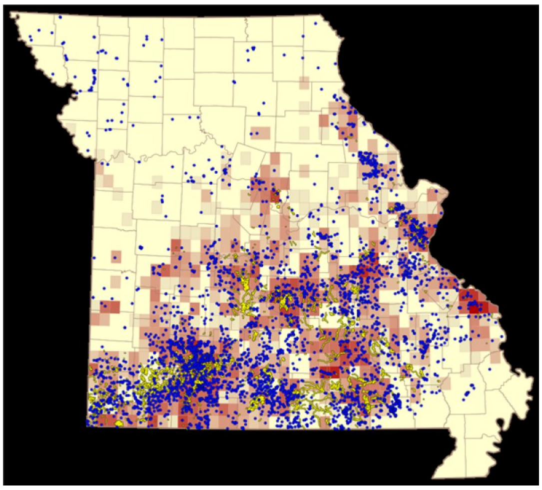


Figure 9. Distribution of karst-related features in Missouri. Image from Wikimedia Commons developed from the Missouri Department of Natural Resources, Division of Geology and Land Survey.

Soil features

These soils have no rooting restriction. The soils were formed under a mixture of herbaceous wetland and woodland vegetation. Organic matter content is variable. Parent material is colluvium. They have silt loam surface horizons, and loamy to clayey subsoils. They are affected by a seasonal high water table during the spring months and experience some ponding. Soil series associated with this site include Deible, Lowassie, Splitlimb, and Tanglenook.

The accompanying picture of the Deible series shows a clayey subsoil with dull gray colors, indicating seasonal wetness. Scale is in centimeters. Picture courtesy of John Preston, NRCS.

Figure 10. Deible series

Table 4. Representative soil features

Parent material	(1) Colluvium
Surface texture	(1) Silt loam
Family particle size	(1) Loamy
Drainage class	Poorly drained to somewhat poorly drained
Permeability class	Very slow to slow
Soil depth	183 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–8%
Available water capacity (0-101.6cm)	17.78–20.32 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)	4.5–7.3
Subsurface fragment volume <=3" (Depth not specified)	0–14%
Subsurface fragment volume >3" (Depth not specified)	0%

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 state may include wet woodlands along with wetter inclusions and associated communities, that are highly variable, ranging from pond marshes and shrub swamps with floating mats of vegetation, to swamps with an overstory of water tupelo, pin oak and other wetland trees. There are numerous plants whose occurrence in Missouri is confined to these sinkhole ponds, and many others whose next nearest locality is in the wetlands of the Mississippi Lowlands.

The wetter reference plant community phase is a ponded marsh wetland phase with water tupelo, sweet gum and green ash as common overstory species associated with these wetter sinkhole basins. Vegetation structure is variably open to closed (50 to 90 percent cover) and either uniform throughout the sinkhole basin or occurring in circular zones along the edge of deeper, open permanent water. The canopy is tall and the understory poorly developed or absent

The drier reference plant community phase is a wet sinkhole woodland with swamp white oak, pin oak and green ash as common overstory species associated with sinkhole basins. The tree canopy is medium in height (60 to 70 feet) and with an open canopy. The understory is poorly developed and the ground cover is mixed herbaceous. Grasses and sedges can dominate in open ephemeral wet areas. In contrast to the more abundant Dry Sinkhole Woodland, these units hold surface water for at least some period each year.

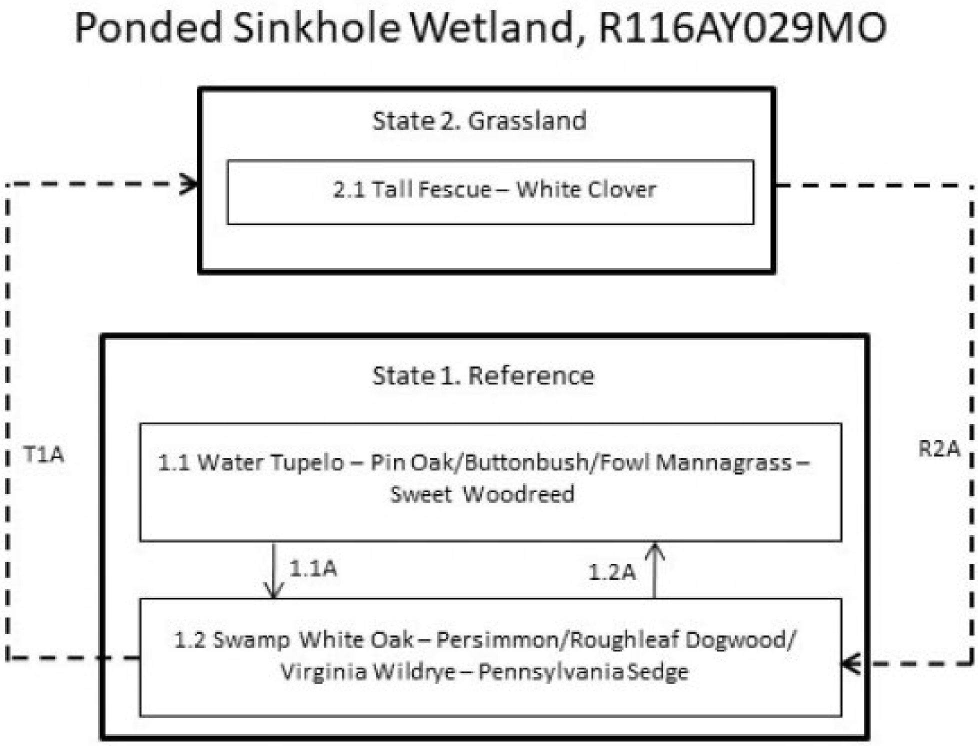
These phases are unique and valuable communities within the more common and widespread drier woodland-forest complex found in the Ozark Highlands.

The driving ecological dynamic of Ponded Sinkholes is the hydrology. This is governed by the size of the catchment, as well as the depth and configuration of the sink. Each one is unique in these respects. This depression holds water and supports plants and animals not typical of the surrounding dry Ozark woods. Unlike most dry sinkholes, this ecological site has clay lenses and peat deposits that prevent water from quickly entering cave conduits below. This allows water to pond during all but drought years. Over time, these wetlands can accumulate organic matter and silt and decrease in water depth and duration, consequently, slowly succeeding from swamp, to marsh and shrub swamp, to periodically wet woodlands.

Similar to the surrounding woodlands, fire, wind and ice played an occasional role. But fire would have been retarded by the wet conditions. Wind and ice would have influenced canopy structure of the treed sinks. Many wet sinkholes have been cleared, drained or altered by humans. Some have had berms put up to make the water deeper and more permanent for livestock. Most have had some influence of livestock.

A state-and-transition diagram is depicted 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 is likely to change as knowledge increases.

State and transition model



Code	Event/Process
T1A	Drainage; clearing; forage planting; grassland management
R2A	Abandonment (50-100 Years); organic and mineral deposits; woody invasion; reduced drainage; long term succession
1.1A	Improved internal drainage; woody invasion; long term succession; seasonal ponding
1.2A	Reduced drainage; permanent ponding; long term succession

Figure 11. State and transition diagram for this ecological site

State 1

Reference

The reference state may include wet woodlands along with wetter inclusions and associated communities, that are highly variable, ranging from pond marshes and shrub swamps with floating mats of vegetation, to swamps with an overstory of water tupelo, pin oak and other wetland trees. There are numerous plants whose occurrence in Missouri is confined to these sinkhole ponds, and many others whose next nearest locality is in the wetlands of the Mississippi Lowlands.

Community 1.1
Water Tupelo – Pin Oak/Common Buttonbush/Manna Grass – Sweet Woodreed

Figure 12. Cupola pond, a ponded sinkhole wetland ecological site - Mark Twain National Forest, Missouri; photo credit - Christy Dablemont

The reference state may include wet woodlands along with wetter inclusions and associated communities, that are highly variable, ranging from pond marshes and shrub swamps with floating mats of vegetation, to swamps with an overstory of water tupelo, pin oak and other wetland trees.

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).

Community 1.2
Swamp White Oak –Persimmon/Roughleaf Dogwood/ Virginia Wildrye – Pennsylvania Sedge

The drier reference plant community phase is a wet sinkhole woodland with swamp white oak, pin oak and green ash as common overstory species associated with sinkhole basins. The tree canopy is medium in height and with an open canopy. The understory is poorly developed, and the ground cover is mixed herbaceous. Grasses and sedges can dominate in open ephemeral wet areas.

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).

Pathway P1.1A
Community 1.1 to 1.2

Improved internal drainage; woody invasion; long term succession; seasonal ponding

Pathway P1.2A

Community 1.2 to 1.1

Reduced drainage; permanent ponding; long term succession

State 2
Grassland

Many ponded sinkholes have been altered by humans - cleared, drained and planted to cool season grasses. Some have had berms put up to make the water deeper and more permanent for livestock. Transition back to a reference phase will take many decades and substantial investment in time and money.

Community 2.1
Tall Fescue - White Clover

Community phase 2.1A activities include converting to a grassland use planted to tall fescue and white clover.

Transition T1A
State 1 to 2

Transition activities from community phase 1.2A include drainage; clearing; forage planting; grassland management

Restoration pathway R2A
State 2 to 1

Restoration activities to community phase 1.2A include abandonment (50-100 Years); organic and mineral deposits; woody invasion; reduced drainage; long term succession

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							
green ash	FRPE	*Fraxinus pennsylvanica*	Native	–	–	–	–
sweetgum	LIST2	*Liquidambar styraciflua*	Native	–	–	–	–
water tupelo	NYAQ2	*Nyssa aquatica*	Native	–	–	–	–
pin oak	QUPA2	*Quercus palustris*	Native	–	–	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
longhair sedge	CACO8	*Carex comosa*	Native	–	–
three-way sedge	DUAR3	*Dulichium arundinaceum*	Native	–	–
creeping mannagrass	GLAC	*Glyceria acutiflora*	Native	–	–
catchfly grass	LELE2	*Leersia lenticularis*	Native	–	–
Forb/Herb					
stiff marsh bedstraw	GATI	*Galium tinctorium*	Native	–	–
sessilefruit arrowhead	SARI	*Sagittaria rigida*	Native	–	–
spineless hornwort	CEEC2	*Ceratophyllum echinatum*	Native	–	–
purplestem beggarticks	BICO5	*Bidens connata*	Native	–	–
swamp smartweed	POHY2	*Polygonum hydropiperoides*	Native	–	–
common duckweed	LEMI3	*Lemna minor*	Native	–	–
Brazilian watermeal	WOBR	*Wolffia brasiliensis*	Native	–	–
Shrub/Subshrub					
common buttonbush	CEOC2	*Cephalanthus occidentalis*	Native	–	–
silky dogwood	COOB9	*Cornus obliqua*	Native	–	–
rosemallow	HILA6	*Hibiscus lasiocarpos*	Native	–	–

Table 7. Community 1.2 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
swamp white oak	QUBI	*Quercus bicolor*	Native	–	–	–	–
pin oak	QUPA2	*Quercus palustris*	Native	–	–	–	–
common persimmon	DIVI5	*Diospyros virginiana*	Native	–	–	–	–
post oak	QUST	*Quercus stellata*	Native	–	–	–	–

Table 8. Community 1.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
sweet woodreed	CIAR2	*Cinna arundinacea*	Native	–	–
inland rush	JUIN2	*Juncus interior*	Native	–	–
slender spikerush	ELTEV	*Eleocharis tenuis var. verrucosa*	Native	–	–
Pennsylvania sedge	CAPE6	*Carex pensylvanica*	Native	–	–
parasol sedge	CAUM4	*Carex umbellata*	Native	–	–
Virginia wildrye	ELVI3	*Elymus virginicus*	Native	–	–
Forb/Herb					
bluejacket	TROH	*Tradescantia ohiensis*	Native	–	–
Canadian blacksnakeroot	SACA15	*Sanicula canadensis*	Native	–	–
fourleaf milkweed	ASQU	*Asclepias quadrifolia*	Native	–	–
Shrub/Subshrub					
eastern swampprivet	FOAC	*Forestiera acuminata*	Native	–	–
possumhaw	ILDE	*Ilex decidua*	Native	–	–
roughleaf dogwood	CODR	*Cornus drummondii*	Native	–	–

Animal community

Wildlife*

Fishless sinkhole ponds provide critical breeding habitat for numerous species of salamanders, toads and frogs. This is especially important if the sinkholes are in dry upland woodlands where the closest standing water may be many miles away.

Sinkhole ponds also provide excellent foraging sites for woodland and forest bats because aquatic flying insects are abundant there.

Bird species associated with this ecological site’s reference state condition: Wood Duck, Prothonotary Warbler, Green Heron and Yellow Warbler.

Amphibians that often use sinkhole wetlands for breeding sites include the Ringed Salamander (Ambystoma annulatum), Spotted Salamander (A. maculatum), Marbled Salamander (A. opacum), Central Newt (Notophthalmus viridescens louisianensis), Dwarf American Toad (Bufo americanus charlesmithi), Cope’s Gray Treefrog (Hyla cinerea), Eastern Gray Treefrog (H. versicolor), Northern Spring Peeper (Pseudacris crucifer crucifer), Pickerel Frog (Rana palustris), Wood Frog (Rana sylvatica) and Southern Leopard Frog (R. sphenocephala).

Small mammals associated with this ecological site’s reference state condition: Muskrat (Ondatra zibethicus), Southern Bog Lemming (Synaptomys cooperi), and Mink (Mustela vison).

Sinkhole ponds are very valuable for odonates (dragonflies and damselflies), some examples include the Azure Bluet (Enallagma aspersum), Amber-winged Spreadwing (Lestes eurinus), Spatterdock Darner (Aeshna mutata) and Comet Darner (Anax longipes).

*This section prepared by Mike Leahy, Natural Areas Coordinator, Missouri Department of Conservation, 2013. References for this section: Fitzgerald and Pashley 2000a; 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 production activity.

Inventory data references

Potential Reference Sites: Ponded Sinkhole Wetland

Cupola Pond Natural Area, Mark Twain National Forest, MO
Latitude: 36.79713
Longitude: -91.08998

Tupelo Gum Pond Natural Area, Mark Twain National Forest, MO
Latitude: 36.86409
Longitude: -91.40138

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Contributors

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Approval

Nels Barrett, 9/24/2020

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Missouri Department of Conservation and Missouri Department of Natural Resources personnel provided significant and helpful field and technical support during this project.

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	04/29/2024
Approved by	Nels Barrett
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

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

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

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

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

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

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

Dominant:

Sub-dominant:

Other:

Additional:

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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):**

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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:**
