USDA Natural Resources Conservation Service

Ecological site R116BY040MO
Ponded Sinkhole Wetland

Last updated: 10/07/2020
Accessed: 04/26/2024

General information

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

MLRA notes

Major Land Resource Area (MLRA): 116B–Springfield Plain

The Springfield Plain is in the western part of the Ozark Uplift. It is primarily a smooth plateau with some dissection along streams. Elevation is about 1,000 feet in the north to over 1,700 feet in the east along the Burlington Escarpment adjacent to the Ozark Highlands. The underlying bedrock is mainly Mississippian-aged limestone, with areas of shale on lower slopes and structural benches, and intermittent Pennsylvanian-aged sandstone deposits on the plateau surface.

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 occurs primarily within the Spring River Prairie/Savanna Dissected Plain Land Type Association.

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 scattered karst areas, primarily in the southern Springfield Plain. Soils are very deep and loamy throughout, with periodic ponding and high-water tables. The reference plant community is a wetland with an open overstory dominated by red maple, pin oak, and green ash and an understory of wet-tolerant grasses and sedges.

Associated sites

F116BY003MO	**Chert Upland Woodland** Chert Upland Woodlands and other ecological sites formed over limestone surround these sites.
F116BY004MO	**Low-Base Chert Upland Woodland** Low-base Chert Upland Woodlands and other ecological sites formed over limestone surround these sites.

F116BY005MO	**Low-Base Loamy Upland Woodland** Low-base Loamy Upland Woodlands and other ecological sites formed over limestone surround these sites.

Similar sites

F116BY018MO	**Loamy Sinkhole Woodland** Loamy Sinkhole Woodlands are sinkholes but are dry and more wooded.

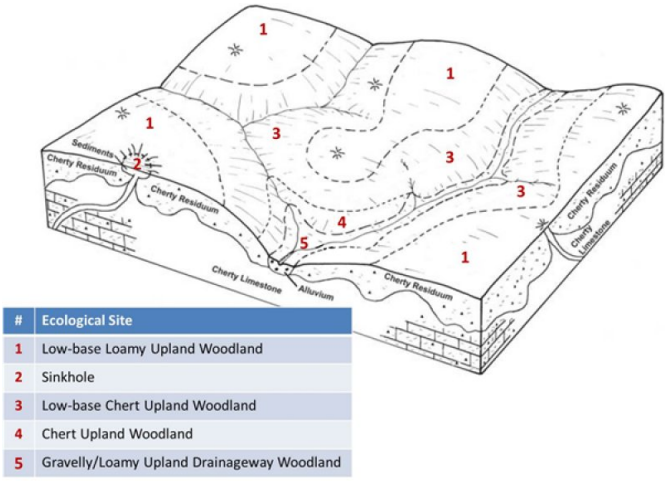
Table 1. Dominant plant species

Tree	(1) *Acer rubrum*
Shrub	(1) *Cephalanthus occidentalis*
Herbaceous	(1) *Carex*

Physiographic features

This site is on sinkholes with slopes of 0 to 3 percent. The site receives runoff from the adjacent uplands, and is subject to frequent seasonally ponding.

The following figure (adapted from Gregg and Woodward, 2006) shows the typical landscape position of this ecological site, and landscape relationships with other ecological sites. It is within the area labeled “2”, as well as in smaller sinkholes as shown on the figure. Sinkhole sites are associated with limestone, so adjacent ecological sites are typically underlain by limestone such as the sites shown in the figure.



#	Ecological Site
1	Low-base Loamy Upland Woodland
2	Sinkhole
3	Low-base Chert Upland Woodland
4	Chert Upland Woodland
5	Gravelly/Loamy Upland Drainageway Woodland

Figure 1. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Sinkhole
Flooding frequency	None
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Frequent
Slope	0–3%
Water table depth	17–18 in
Aspect	Aspect is not a significant factor

Climatic features

The Springfield Plain 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 Springfield Plain experiences few regional differences in climates. The average annual precipitation in this area is 41 to 45 inches. Snow falls nearly every winter, but the snow cover lasts for only a few days. The average annual temperature is about 55 to 58 degrees F. The lower temperatures occur at the higher elevations. Mean July maximum temperatures have a range of only one or two degrees across the area.
Mean annual precipitation varies along a west to east 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 (average)	169 days
Freeze-free period (average)	191 days
Precipitation total (average)	50 in

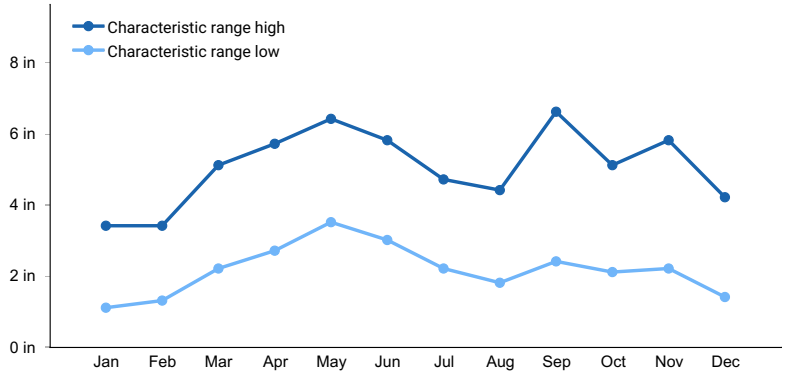


Figure 2. Monthly precipitation range

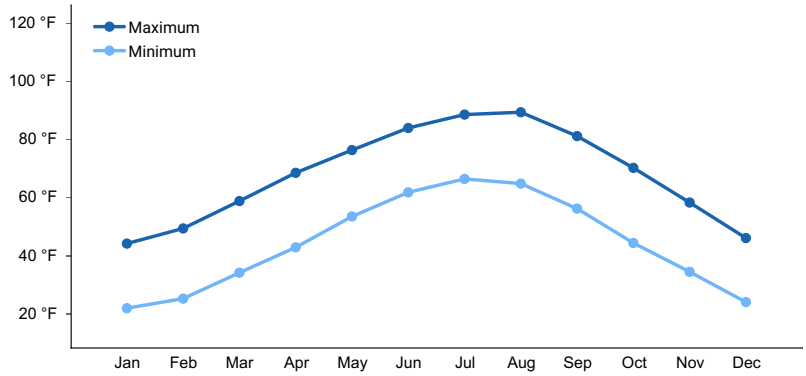


Figure 3. Monthly average minimum and maximum temperature

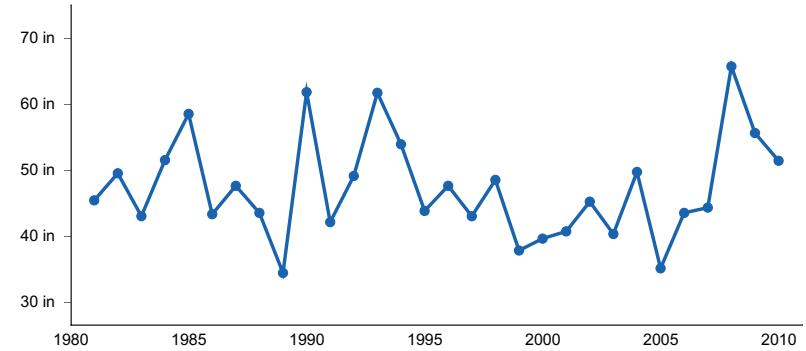


Figure 4. Annual precipitation pattern

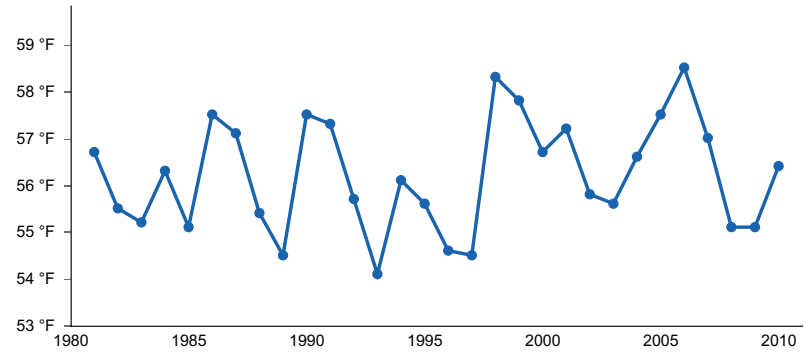


Figure 5. Annual average temperature pattern

Climate stations used

- (1) CASSVILLE RANGER STN [USC00231383], Cassville, MO
- (2) NEOSHO [USC00235976], Neosho, MO
- (3) BILLINGS 1SW [USC00230657], Billings, 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. Ponding occurs 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.

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).

Soil features

These soils have no rooting restriction. The soils were formed under woodland vegetation, and have thin, light-

colored surface horizons. Parent material is colluvium. They have silt loam surface horizons, and loamy subsoils. They are affected by a seasonal high water table and ponding during the spring months. Soil series associated with this site include Sowcoon.

Table 4. Representative soil features

Parent material	(1) Colluvium
Surface texture	(1) Silt loam
Family particle size	(1) Loamy
Drainage class	Somewhat poorly drained
Permeability class	Very slow
Soil depth	72 in
Surface fragment cover <=3"	1–2%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	7–8 in
Calcium carbonate equivalent (0-40in)	0%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	4.5–6.5
Subsurface fragment volume <=3" (Depth not specified)	1–36%
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 plant community is a wetland with scattered pin oak, red maple and green ash as overstory species associated with sinkhole basins. The tree canopy, when present, is medium in height (60 to 70 feet) and open. 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 more abundant Loamy Sinkhole Woodlands, these units hold surface water for at least some period each year. These sites are unique and valuable communities within the more common and widespread woodland-forest complex.

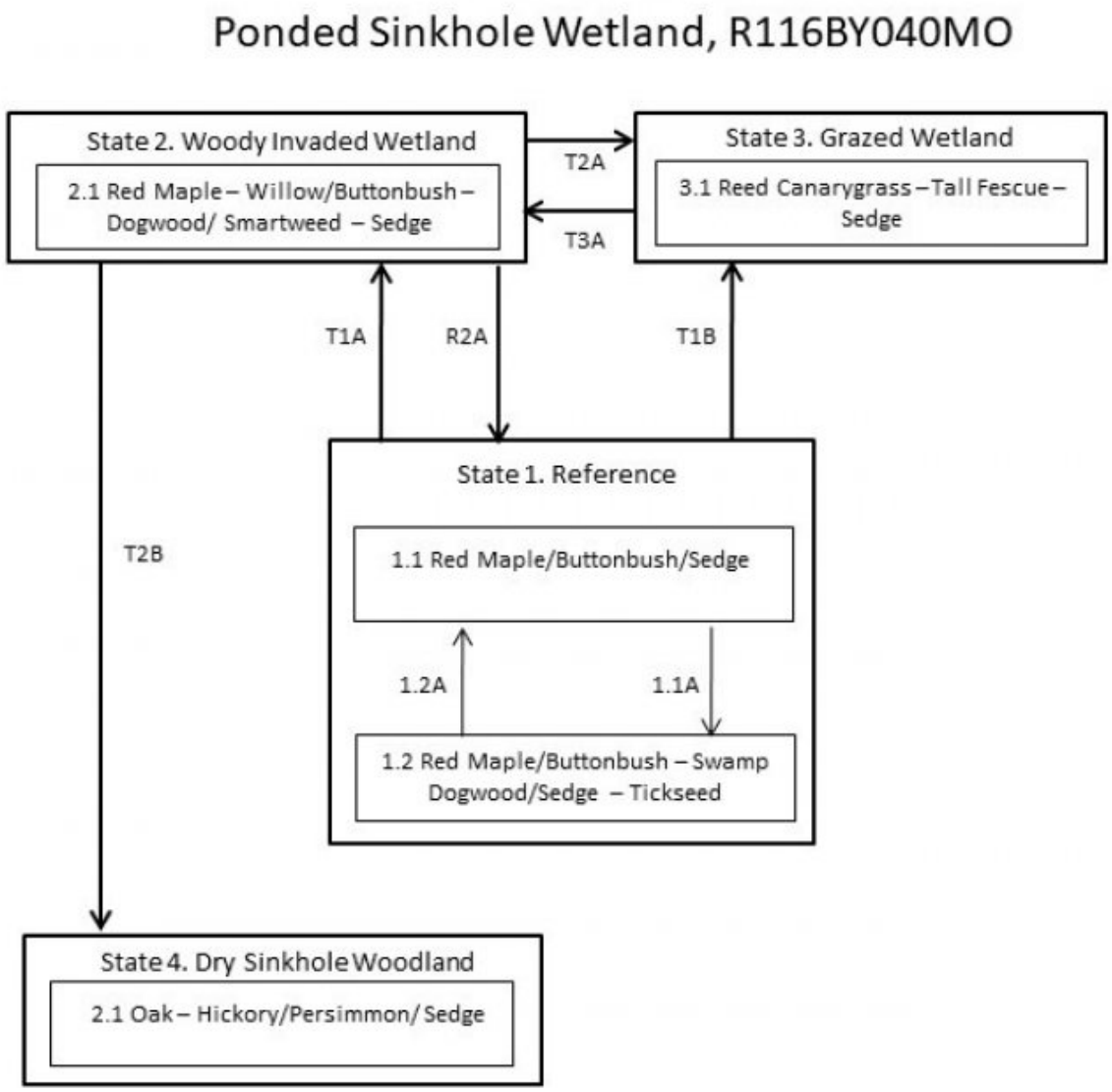
The driving ecological dynamic of Ponded Sinkhole Wetlands is the hydrology. This is governed by the size of the catchment, as well as the depth and configuration of the sink. Each one is unique in these respects. Over time, these wetlands can accumulate organic matter and silt and decrease in water depth and duration, consequently, slowly succeeding from swamp, to marsh and shrub swamp, to periodically wet woodlands.

Like 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 wooded sinks. Many wet sinks 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 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.

State and transition model



Code	Event/Activity/Process
T1A	Woody invasion; reduced ponding
T1B	Woody removal; drainage activities; grazing;
T3A	Grazing cessation; woody invasion
T2A	Woody removal; grazing
T2B	Excessive silting; no ponding; open sinkhole
1.1A	Decreased ponding
1.2A	Increased ponding
R2A	Woody reduction; restore natural hydrology and ponding

Figure 6. State and transition diagram for this ecological site

State 1

Reference

This state is typical of wet sinkhole wetlands that experience full horizon saturation (endosaturation) for extended periods during the growing season. Long duration ponding regimes are common during many years. Two phases can occur that will transition back and forth depending on ponding water levels. Shorter ponding intervals with periods of open water will increase woody species such willow, dogwoods and other woody species. When ponding and flooding intervals lengthen woody species will decrease. This state may include 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 red maple and green ash 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
Red Maple/Buttonbush/Sedge

Forest overstory. The Overstory Species list is based on field reconnaissance as well as commonly occurring species listed in Nelson 2010; names and symbols are from USDA PLANTS database.

Forest understory. The Understory Species list is based on field reconnaissance as well as commonly occurring species listed in Nelson 2010; names and symbols are from USDA PLANTS database.

Dominant resource concerns

- Ponding and flooding
- Seasonal high water table

Community 1.2
Red Maple/Buttonbush – Swamp Dogwood/Sedge – Tickseed

Dominant resource concerns

- Ponding and flooding
- Seasonal high water table

Pathway P1.1A
Community 1.1 to 1.2

Decreased ponding

Pathway P1.2A
Community 1.2 to 1.1

Increased ponding

State 2
Woody Invaded Wetland

During extended dry periods or excessive silting in from upland sites, the reference state may become drier and may transition to a woody invaded wetland state. The drier site conditions allow woody seed germination to occur and over time allow a denser canopy to form. Many hydric species may also decrease. If wetter conditions return this state can be restored to a reference state by reducing woody cover. Sites that have transitioned to this state through excessive silting may be very difficult to restore to a reference state.

Dominant resource concerns

- Seasonal high water table
- Plant structure and composition
- Terrestrial habitat for wildlife and invertebrates
- Aquatic habitat for fish and other organisms

Community 2.1
Red Maple – Willow/Buttonbush – Dogwood/ Smartweed – Sedge

State 3
Grazed Wetland

Many wet sinks have been cleared, drained or otherwise altered by humans. Some have had berms put up to make the water deeper and more permanent for livestock activity and use. Most have had some influence of livestock during some period of recent time.

Dominant resource concerns

- Seasonal high water table
- Nutrients transported to ground water
- Plant productivity and health
- Plant structure and composition
- Terrestrial habitat for wildlife and invertebrates
- Aquatic habitat for fish and other organisms
- Feed and forage imbalance

Community 3.1
Reed Canarygrass – Tall Fescue – Sedge

State 4
Dry Sinkhole Woodland

Some wet sinkholes will transition to this state through excessive siltation and or removal of the sinkhole plug that drains the previously wet sinkhole. This transition to a woodland community can take many years (25 to 50 years) to complete.

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Plant productivity and health
- Plant structure and composition
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates
- Aquatic habitat for fish and other organisms

Community 4.1
Oak – Hickory/Persimmon/ Sedge

Transition T1A
State 1 to 2

Woody invasion; reduced ponding

Transition T1B
State 1 to 3

Woody removal; drainage activities; grazing

Restoration pathway R2A
State 2 to 1

Woody reduction; restore natural hydrology and ponding

Transition T2A
State 2 to 3

Woody removal; grazing

Transition T2B
State 2 to 4

Excessive silting; no ponding; open sinkhole

Transition T3A
State 3 to 2

Grazing cessation; woody invasion

Additional community tables

Table 5. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
pin oak	QUPA2	*Quercus palustris*	Native	–	0–20	–	–
red maple	ACRU	*Acer rubrum*	Native	–	0–20	–	–
green ash	FRPE	*Fraxinus pennsylvanica*	Native	–	0–20	–	–
common persimmon	DIVI5	*Diospyros virginiana*	Native	–	0–20	–	–
black willow	SANI	*Salix nigra*	Native	–	0–20	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
cypressknee sedge	CADE6	*Carex decomposita*	Native	–	5–20
three-way sedge	DUAR3	*Dulichium arundinaceum*	Native	–	5–20
sweet woodreed	CIAR2	*Cinna arundinacea*	Native	–	5–20
inland rush	JUIN2	*Juncus interior*	Native	–	5–20
slender spikerush	ELTEV	*Eleocharis tenuis var. verrucosa*	Native	–	5–20
longhair sedge	CACO8	*Carex comosa*	Native	–	5–20
broadwing sedge	CAAL3	*Carex alata*	Native	–	5–20
broadleaf cattail	TYLA	*Typha latifolia*	Native	–	5–20
Forb/Herb					
taperleaf water horehound	LYRU	*Lycopus rubellus*	Native	–	5–20
small beggarticks	BIDI	*Bidens discoidea*	Native	–	5–20
swamp loosestrife	DEVE	*Decodon verticillatus*	Native	–	5–20
rosemallow	HILA6	*Hibiscus lasiocarpos*	Native	–	5–20
least duckweed	LEMI6	*Lemna minuta*	Native	–	5–20
Shrub/Subshrub					
common buttonbush	CEOC2	*Cephalanthus occidentalis*	Native	–	5–20
silky dogwood	COOB9	*Cornus obliqua*	Native	–	5–20

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 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: Ponded Sinkhole Wetland

Murphy Pond in Christian County, Missouri
No reference sites were sampled

Other references

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Contributors

Doug Wallace
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Approval

Nels Barrett, 10/07/2020

Acknowledgments

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	10/06/2020
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:

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:**
