USDA Natural Resources Conservation Service

Ecological site R108XC510IA
Till Backslope Seepage Meadow

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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.

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): 108X–Illinois and Iowa Deep Loess and Drift

The Illinois and Iowa Deep Loess and Drift, West-Central Part (MLRA 108C) encompasses the eastern portion of the Southern Iowa Drift Plain and the Lake Calvin basin of the Mississippi Alluvial Plain landforms (Prior 1991). It lies entirely in one state (Iowa), containing approximately 9,805 square miles (Figure 1). The elevation ranges from approximately 1,110 feet above sea level (ASL) on the highest ridges to about 505 feet ASL in the lowest valleys. Local elevation difference is mainly 10 to 20 feet. However, some valley floors can range from 80 to 200 feet, while some upland flats and valley floors only range between 3 and 6 feet. The MLRA is underlain by Pre-Illinoian glacial till, deposited more than 500,000 years ago and since undergone extensive erosion and dissection. In the northern half of the area the till thickness ranges from 150 to 350 feet and grades to less than 150 feet thick in the southern half. The till is covered by a mantle of Peoria Loess on the hillslopes and Holocene alluvium in the drainageways. Paleozoic bedrock, comprised of limestone, shale, and mudstones, lies beneath the glacial material (USDA-NRCS 2006).

The vegetation in the MLRA has undergone drastic changes over time. Spruce forests dominated the landscape 30,000 to 21,500 years ago. As the last glacial maximum peaked 21,500 to 16,000 years ago, they were replaced with open tundras and parklands. The end of the Pleistocene Epoch saw a warming climate that initially prompted the return of spruce forests, but as the warming continued, spruce trees were replaced by deciduous trees (Baker et al. 1990). Not until approximately 9,000 years ago did the vegetation transition to prairies as climatic conditions continued to warm and subsequently dry. Between 4,000 and 3,000 years ago, oak savannas began intermingling within the prairie landscape, while the more wooded and forested areas maintained a foothold in sheltered areas. This prairie-forest transition ecosystem formed the dominant landscapes until the arrival of European settlers (Baker et al. 1992).

Classification relationships

USFS Subregions: Central Dissected Till Plains (251C) Section, Central Dissected Till and Loess Plain (251Cc), Mississippi River and Illinois Alluvial Plains (51Cf), Southeast Iowa Rolling Loess Hills (251Ch) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Rolling Loess Prairies (47f), Upper Mississippi Alluvial Plain (72d) (USEPA 2013)

National Vegetation Classification – Ecological Systems: North-Central Interior Floodplain (CES202.694) (NatureServe 2015)

National Vegetation Classification – Plant Associations: *Carex pellita* – Carex spp. – Schoenoplectus tabernaemontani Fen (CEGL002041) (Nature Serve 2015)

Biophysical Settings: Central Interior and Appalachian Shrub-Herbaceous Wetland Systems (BpS 4214930) (LANDFIRE 2009)

Natural Resources Conservation Service – Iowa Plant Community Species List: Fen, Central Tallgrass (USDA-NRCS 2007)

Iowa Department of Natural Resources: Seep (INAI 1984)

Iowa Wetland Types: Southern Iowa Drift Plain Seeps (Runkel and Roosa 2014)

Ecological site concept

Till Backslope Seepage Meadows are located within the blue areas on the map (Figure 1). They occur on upland hillslopes. The soils are Mollisols that are somewhat poorly to poorly-drained and deep, formed in a gray paleosol that formed in glacial till. A shallow perched water table results in saturated soil conditions throughout most of the year.

The historic pre-European settlement vegetation on this ecological site was dominated by highly-diverse hydrophytic herbaceous vegetation. Green bulrush (Scirpus atrovirens Willd.) and fox sedge (Carex vulpinoidea Michx.) are the dominant species of Till Backslope Seepage Meadows. Other monocots likely to be present include spikerushes (Eleocharis R. Br.), rushes (Juncus L.), sedges (Carex L.), and broadleaf cattails (Typha latifolia L.) (Pearson and Leoschke 1992; Runkel and Roosa 2014). Other vascular plants typical of an undisturbed plant community associated with this ecological site include white turtlehead (Chelone glabra L.), crested woodfern (Dryopteris cristata (L.) A. Gray), and yellow marsh marigold (Caltha palustris L.) (Pearson and Leoschke 1992; Drobney et al. 2001; Runkel and Roosa 2014). Consistent groundwater saturation is the primary disturbance factor that maintains this site, while occasional fire and drought are secondary disturbances (LANDFIRE 2009).

Associated sites

R108XC503IA	**Loess Upland Prairie** Loess parent material that is not shallow to the water table and occurs higher on the hillslope including Killduff, Nira, Osco, Otley, Port Byron, Tallula, and Tama soils
R108XC509IA	**Till Backslope Prairie** Glacial till parent material that is not shallow to the water table and occurs lower on the hillslope including Adair and Shelby soils

Similar sites

R108XC515IA	**Ponded Upland Depression Sedge Meadow** Ponded Upland Depression Sedge Meadows occur on broad upland flats, are ponded, and are DEPRESSIONAL wetlands
R108XC516IA	**Wet Loess Upland Flat Prairie** Wet Loess Upland Flat Prairies occur on broad upland flats and are MINERAL SOIL FLAT wetlands
R108XC519IA	**Wet Upland Drainageway Prairie** Wet Upland Drainageway Prairies occur on upland drainageways and are SLOPE: topographic, flow-through wetlands

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Scirpus atrovirens* (2) *Carex vulpinoidea*

Physiographic features

Till Backslope Seepage Meadows occur on upland hillslopes (Figure 2). They are situated on elevations ranging from approximately 623 to 1499 feet ASL. The site does not experience flooding, but rather is continuously saturated due to groundwater discharge moving laterally throughout the soil and discharging as sidehill seeps.

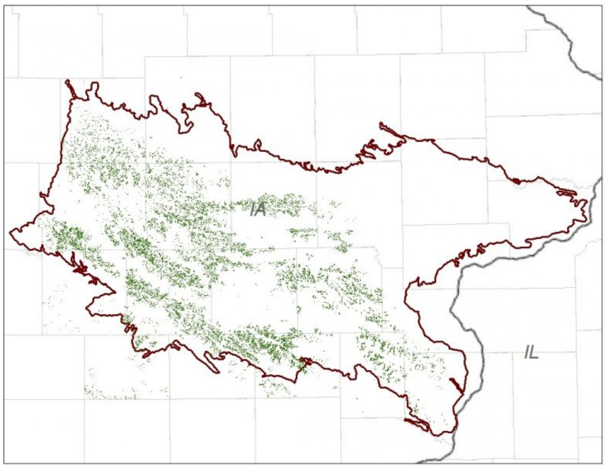


Figure 2. Figure 1. Location of Till Backslope Seepage Meadow ecological site within MLRA 108C.

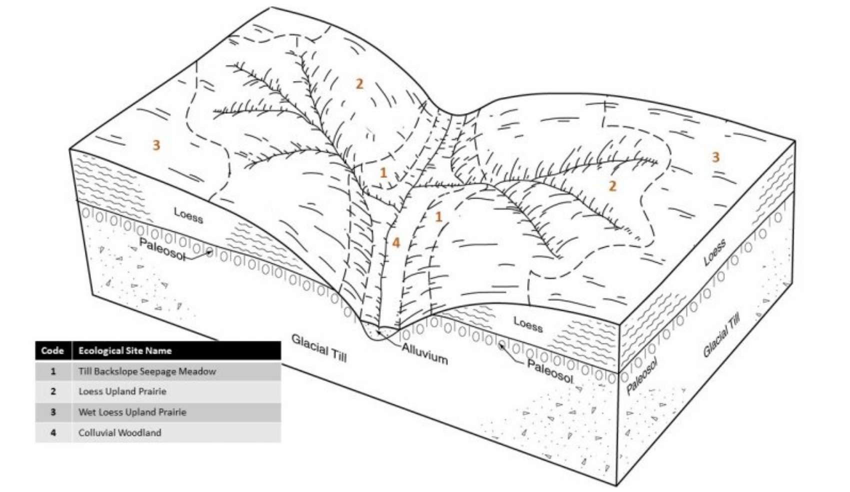


Figure 3. Figure 2. Representative block diagram of Till Backslope Seepage Meadow and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Convex
Slope shape up-down	(1) Convex
Landforms	(1) Upland > Hillslope
Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None
Elevation	623–1,499 ft
Slope	5–18%
Water table depth	0–12 in
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The Illinois and Iowa Deep Loess and Drift, West-Central Part falls into the hot humid continental climate (Dfa)

Köppen-Geiger climate classification (Peel et al. 2007). In winter, dry, cold air masses periodically shift south from Canada. As these air masses collide with humid air, snowfall and rainfall result. In summer, moist, warm air masses from the Gulf of Mexico migrate north, producing significant frontal or convective rains. Occasionally, hot, dry winds originating from the Desert Southwest will stagnate over the region, creating extended droughty periods in the summer from unusually high temperatures. Air masses from the Pacific Ocean can also spread into the region and dominate producing mild, dry weather in the autumn known as Indian Summers (NCDC 2006).

The soil temperature regime of MLRA 108C is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south one travels. The average freeze-free period of this ecological site is about 180 days, while the frost-free period is about 162 days (Table 2). The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is approximately 38 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 38 and 60°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from five National Oceanic and Atmospheric Administration (NOAA) weather stations contained within the range of this ecological site (Table 4).

Table 3. Representative climatic features

Frost-free period (characteristic range)	132-142 days
Freeze-free period (characteristic range)	162-171 days
Precipitation total (characteristic range)	36-38 in
Frost-free period (actual range)	126-150 days
Freeze-free period (actual range)	148-178 days
Precipitation total (actual range)	36-38 in
Frost-free period (average)	138 days
Freeze-free period (average)	165 days
Precipitation total (average)	37 in

Climate stations used

- (1) FAIRFIELD [USC00132789], Fairfield, IA
- (2) NEWTON [USC00135992], Newton, IA
- (3) WILLIAMSBURG 3SE [USC00139067], Williamsburg, IA
- (4) OSKALOOSA [USC00136327], Oskaloosa, IA
- (5) GRINNELL 3 SW [USC00133473], Grinnell, IA

Influencing water features

Till Backslope Seepage Meadows are classified as a SLOPE: stratigraphic, groundwater influenced, discharge, herbaceous wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as a Palustrine, Persistent, Emergent, Continuously Saturated wetland under the National Wetlands Inventory (FGDC 2013). Groundwater discharge from a perched water table is the main source of water for this ecological site (Smith et al. 1995). Infiltration is very slow to slow (Hydrologic Group C and D) for undrained soils, and surface runoff is high to very high (Figure 5).

Primary wetland hydrology indicators for an intact Till Backslope Seepage Meadow may include: A2 High water table and A3 Saturation. Secondary wetland hydrology indicators may include: C2 Dry-season water table and D5 FAC-neutral test (USACE 2010).

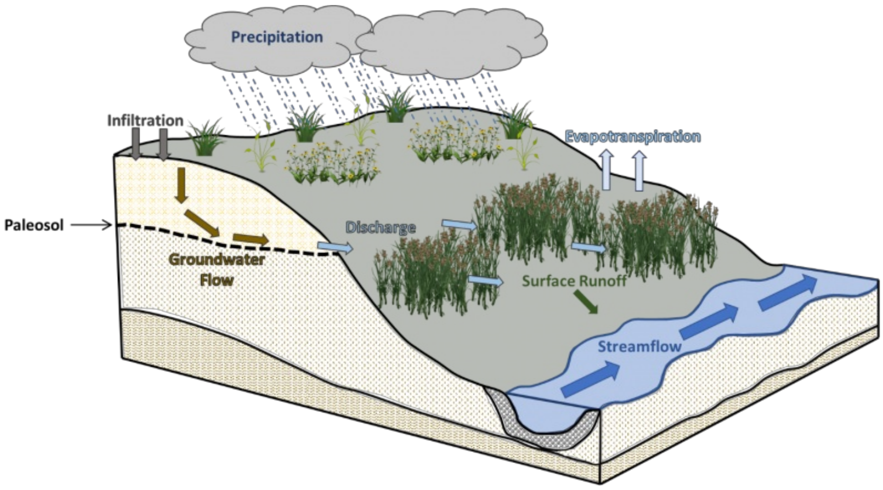


Figure 10. Figure 5. Hydrologic cycling in Till Backslope Seepage Meadow ecological site.

Soil features

Soils of Till Backslope Seepage Meadows are in the Mollisols order, further classified as Aquertic Argiudolls, Aquic Argiudolls, Typic Argiaquolls, Typic Endoaquolls, and Vertic Argiaquolls with very slow to slow infiltration and high to very high runoff potential. The soil series associated with this site includes Clarinda, Clearfield, and Lamoni (Figure 6). The parent material is a gray paleosol that formed in glacial till, and the soils are somewhat poorly to poorly-drained and deep. A shallow perched water table results in saturated soil conditions throughout most of the year. Soil pH classes are strongly acid to moderately alkaline (Table 5).

Soil map units in this ecological site, if not drained, may meet the definition of hydric soils and are listed as meeting criteria 2 of the hydric soils list (77 FR 12234).

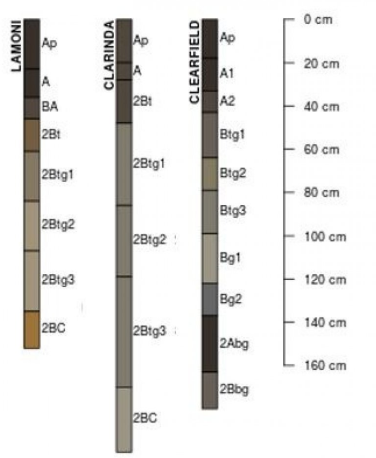


Figure 11. Figure 6. Profile sketches of soil series associated with Till Backslope Seepage Meadow.

Table 4. Representative soil features

Parent material	(1) Till
Surface texture	(1) Silt loam (2) Silty clay loam (3) Silty clay (4) Fine sandy loam (5) Sandy loam
Family particle size	(1) Fine
Drainage class	Poorly drained to somewhat poorly drained

Permeability class	Very slow
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	2–3 in
Calcium carbonate equivalent (Depth not specified)	0–30%
Soil reaction (1:1 water) (Depth not specified)	5.1–84
Subsurface fragment volume <=3" (Depth not specified)	0–6%
Subsurface fragment volume >3" (Depth not specified)	0–2%

Ecological dynamics

The information in this Ecological Site Description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

The MLRA lies within the transition zone between the eastern deciduous forests and the tallgrass prairies. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in turn are able to support prairies, savannas, woodlands, and forests. Till Backslope Seepage Meadows form an aspect of this vegetative continuum. This ecological site occurs on upland hillslopes on somewhat poorly to poorly-drained soils. A shallow perched water table results in saturated soil conditions throughout most of the year. Species characteristic of this ecological site consist of hydrophytic herbaceous vegetation.

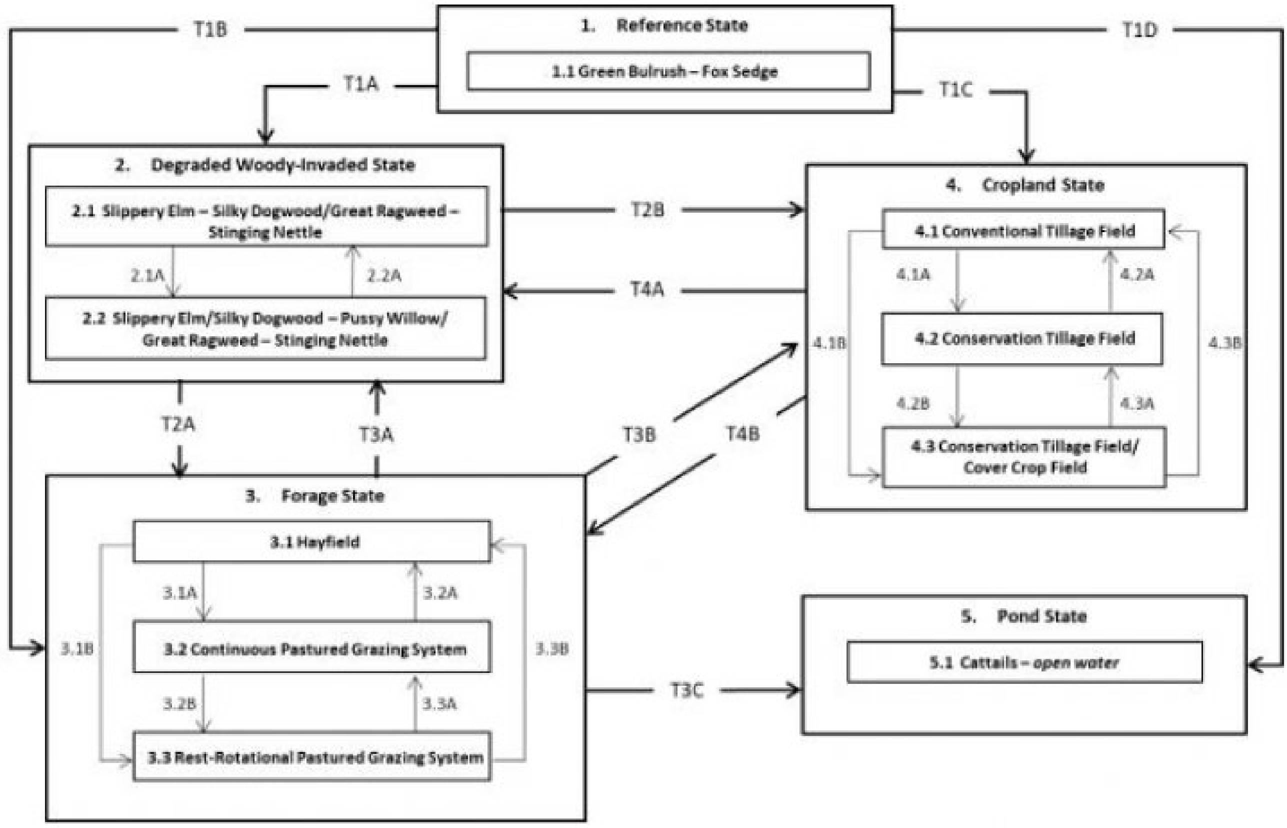
Till Backslope Seepage Meadows are dependent on consistent groundwater discharge. These conditions are present where surface slopes intersect a perched water table, allowing the groundwater to slowly seep from the hillside (Richardson and Brinson 2001; Dixon 2014). While water levels may fluctuate throughout the year, they generally remain at or near the soil surface (LANDFIRE 2009). The near-constant anaerobic conditions maintain the herbaceous wetland plant community and prevent woody species from encroaching.

Drought and fire have also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the somewhat poorly to poorly-drained soils have favored the proliferation of plant species tolerant of such conditions. Drought can also slow the growth of plants and result in dieback of certain species. Occasional fires reduced plant litter and aided in preventing declines in species richness. Drought coupled with fire would keep woody plants from encroaching (LANDFIRE 2009).

Today, Till Backslope Seepage Meadows have been greatly reduced as sites have been converted to agricultural production lands or converted to ponds. Sites that have not been directly altered show evidence of indirect anthropogenic influences from hydrologic alterations, fire suppression, and non-native species invasion (Pearson and Leoschke 1992). These land conversions and alterations to the natural groundwater flow are considered to be irreversible, making restoration an improbability. The state-and-transition model that follows provides a detailed description of each state, community phase, pathway, and transition. This model is based on available experimental research, field observations, literature reviews, professional consensus, and interpretations.

State and transition model

R108CY510IA Till Backslope Seepage Meadow



Code	Process
T1A, T3A, T4A	Changes to natural hydroperiod and/or land abandonment
2.1A	Natural succession following continuing landscape alterations
2.2A	Limited woody species removal
T1B, T2A, T4B	Cultural treatments are implemented to increase forage quality and yield
3.1A	Mechanical harvesting is replaced with domestic livestock and continuous grazing
3.1B	Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing
3.2A, 3.3B	Tillage, forage crop planting, and mechanical harvesting replace grazing
3.2B	Implementation of rest-rotational grazing
3.3A	Implementation of continuous grazing
T1C, T2B, T3B	Agricultural conversion via tillage, seeding, and non-selective herbicide
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row cropping
T1D, T3C	Native vegetation removal and impoundment or excavation

State 1
Reference State

The reference plant community is categorized as a groundwater-fed slope wetland community, dominated by hydrophytic herbaceous vegetation. The one community phase within the reference state is dependent on consistent groundwater seepage to maintain the plant community. Drought and occasional fires have more localized impacts in the reference state, but do contribute to overall species composition, diversity, cover, and productivity.

Community 1.1
Green Bulrush – Fox Sedge

Sites in this reference community phase are dominated by hydrophytic herbaceous vegetation. Green bulrush and fox sedge are dominant monocots on the site, but other frequently encountered species include woolly sedge (*Carex pellita* Muhl. ex Willd.), bluejoint (*Calamagrostis canadensis* (Michx.) P. Beauv.), spikerushes, and rushes. Forb species richness is often very high in these unique communities and typically includes many species with high conservative values, e.g., white turtlehead, stiff cowbane (Oxylpolis rigidior (L.) Raf.), Riddell's goldenrod (*Oligoneuron riddellii* (Frank ex Riddell) Rydb.), and closed bottle gentian (*Gentiana andrewsii* Griseb.) (Pearson and Leoschke 1992).

State 2
Degraded Woody-invaded State

The expansion of ruderal woody and herbaceous species into Till Backslope Seepage Meadows can arise due to a complex interaction of fire suppression, hydrological alterations, and edge effects. Subsurface water reduction from agricultural tiling, ditching, or off-site development in conjunction with the removal of periodic fires allows woody species to encroach, casting shade on the native plant community and altering the natural light regime. In addition, edge effects can arise from indirect land management practices (e.g., cropping, herbicide drift) on directly adjacent sites that lead to a transition in the herbaceous species composition to taller, ruderal species (Pearson and Leoschke 1992; NatureServe 2015).

Community 2.1
Slippery Elm – Silky Dogwood/Great Ragweed – Stinging Nettle

This community phase represents the initial changes to the natural community following hydroperiod alterations and adjacent land management actions. Reduction in the water table allows woody species, such as slippery elm (*Ulmus rubra* Muhl.), silky dogwood (*Cornus obliqua* Raf.), and pussy willow (*Salix discolor* Muhl.), to establish a significant shrub cover. The herbaceous layer shifts to disturbance-tolerant, opportunistic species including great ragweed (*Ambrosia trifida* L.), stinging nettle (*Urtica dioica* L.), Canada lettuce (*Lactuca canadensis* L.), common milkweed (*Asclepias syriaca* L.), and common evening primrose (*Oenothera biennis* L.). Non-native invasive species, including reed canarygrass (*Phalaris arundinacea* L.), redtop (*Agrostis gigantea* Roth), and Kentucky bluegrass (*Poa pratensis* L.), begin to encroach as well (Pearson and Leoschke 1992).

Community 2.2
Slippery Elm/Silky Dogwood – Pussy Willow/Great Ragweed

Stinging Nettle – Sites falling into this community phase represent the natural succession as a result of continuing changes to the hydroperiod and adjacent lands. Slippery elm can mature into a tree canopy, and silky dogwood and pussy willow continue to form the dominant shrubs. The herbaceous layer continues to be simplified and inhabited by ruderal and non-native species.

Pathway 2.1A
Community 2.1 to 2.2

Natural succession as a result of continuing landscape changes.

Pathway 2.2A
Community 2.2 to 2.1

Limited woody species removal.

State 3
Forage State

The forage state arises when the site is converted to a farming system that emphasizes domestic livestock production, known as grassland agriculture. Tree removal, fire suppression, periodic cultural treatments (e.g., clipping, drainage, soil amendment applications, planting new species and/or cultivars, mechanical harvesting) and grazing by domesticated livestock transition and maintain this state (USDA-NRCS 2003). Early settlers seeded non-native species, such as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass (*Poa pratensis* L.), to help extend the grazing season (Smith 1998). Over time, as lands were continuously harvested or grazed by herds of cattle, these species were able to spread and expand across the landscape, reducing the native species diversity and ecological function.

Community 3.1
Hayfield

Sites in this community phase consist of forage plants that are planted and mechanically harvested. Mechanical harvesting removes much of the aboveground biomass and nutrients that feed the soil microorganisms (Franzluebbers et al. 2000; USDA-NRCS 2003). As a result, soil biology is reduced leading to decreases in nutrient uptake by plants, soil organic matter, and soil aggregation. Frequent biomass removal can also reduce the site's carbon sequestration capacity (Skinner 2008). This phase may not be prevalent on this ecological site due to the high soil moisture making it difficult to run large equipment across it.

Community 3.2
Continuous Pastured Grazing

This community phase is characterized by continuous grazing where domestic livestock graze a pasture for the entire season. Depending on stocking density, this can result in lower forage quality and productivity, weed invasions, and uneven pasture use. Continuous grazing can also increase the amount of bare ground and erosion and reduce soil organic matter, cation exchange capacity, water-holding capacity, and nutrient availability and retention (Bharati et al. 2002; Leake et al. 2004; Teague et al. 2011). Smooth brome, Kentucky bluegrass, and white clover (*Trifolium repens* L.) are common pasture species used in this phase. Their tolerance to continuous grazing has allowed these species to dominate, greatly reducing the native species diversity to only low palatability, disturbance-tolerant species.

Community 3.3
Periodic-rest Pastured Grazing

This community phase is characterized by periodic-rest grazing where the pasture has been subdivided into several smaller paddocks. Subdividing the pasture in this way allows livestock to utilize one or a few paddocks, while the remaining area is rested allowing plants to restore vigor and energy reserves, deepen root systems, develop seeds, as well as allow seedling establishment (Undersander et al. 2002; USDA-NRCS 2003). Periodic-rest pastured grazing includes deferred periods, rest periods, and periods of high intensity – low frequency, and short duration methods. Vegetation is generally more diverse and can include orchardgrass (*Dactylis glomerata* L.), timothy (Phleum pretense L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.). The addition of native prairie species can further bolster plant diversity and, in turn, soil function. This community phase promotes numerous ecosystem benefits including increasing biodiversity, preventing soil erosion, maintaining and enhancing soil quality, sequestering atmospheric carbon, and improving water yield and quality (USDA-NRCS 2003).

Pathway 3.1A
Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock utilizing continuous grazing.

Pathway 3.1B
Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock utilizing periodic-rest grazing.

Pathway 3.2A
Community 3.2 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.2B

Community 3.2 to 3.3

Periodic-rest grazing replaces continuous grazing.

Pathway 3.3B
Community 3.3 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.3A
Community 3.3 to 3.2

Continuous grazing replaces periodic-rest grazing.

State 4
Cropland State

The cropland state is the dominant land condition throughout the MLRA today. Agricultural tile drains used to lower the water table and the continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) have effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn and soybeans are the dominant crops for the site, and oats (Avena L.) and alfalfa (*Medicago sativa* L.) may be rotated periodically. These areas are likely to remain in crop production for the foreseeable future.

Community 4.1
Conventional Tillage Field

Sites in this community phase typically consist of monoculture row-cropping maintained by conventional tillage practices. They are cropped in either continuous corn or corn-soybean rotations. The frequent use of deep tillage, low crop diversity, and bare soil conditions during the non-growing season negatively impacts soil health. Under these practices, soil aggregation is reduced or destroyed, soil organic matter is reduced, erosion and runoff are increased, and infiltration is decreased, which can ultimately lead to undesirable changes in the hydrology of the watershed (Tomer et al. 2005).

Community 4.2
Conservation Tillage Field

This community phase is characterized by periodically alternating crops and utilizing various conservation tillage methods to promote soil health and reduce erosion. Conservation tillage methods include strip-till, ridge-till, vertical-till, or no-till planting operations. Strip-till keeps seedbed preparation to narrow bands less than one-third the width of the row where crop residue and soil consolidation are left undisturbed in-between seedbed areas. Strip-till planting may be completed in the fall and nutrient application either occurs simultaneously or at the time of planting. Ridge-till uses specialized equipment to create ridges in the seedbed and vegetative residue is left on the surface in between the ridges. Weeds are controlled with herbicides and/or cultivation, seedbed ridges are rebuilt during cultivation, and soils are left undisturbed from harvest to planting. Vertical-till operations employ machinery that lightly tills the soil and cuts up crop residue, mixing some of the residue into the top few inches of the soil while leaving a large portion on the surface. No-till management is the most conservative, disturbing soils only at the time of planting and fertilizer application. Compared to conventional tillage operations, conservation tillage methods can improve soil ecosystem function by reducing soil erosion, increasing organic matter and water availability, improving water quality, and reducing soil compaction.

Community 4.3
Conservation Tillage with Cover Crop Field

This community phase applies conservation tillage methods as described above as well as adds cover crop practices. Cover crops typically include nitrogen-fixing species (e.g., legumes), small grains (e.g., rye, wheat, oats), or forage covers (e.g., turnips, radishes, rapeseed). The addition of cover crops not only adds plant diversity but also promotes soil health by reducing soil erosion, limiting nitrogen leaching, suppressing weeds, increasing soil organic matter, and improving the overall soil ecosystem. In the case of small grain cover crops, surface cover and water infiltration are increased, while forage covers can be used to graze livestock or support local wildlife. Of the three community phases for this state, this phase promotes the greatest soil sustainability and improves ecological functioning within a row crop operation.

Pathway 4.1A
Community 4.1 to 4.2

Tillage operations are greatly reduced, crop rotation occurs on a regular interval, and crop residue remains on the soil surface.

Pathway 4.1B
Community 4.1 to 4.3

Tillage operations are greatly reduced or eliminated, alternating crops occurs on a regular interval, crop residue remains on the soil surface, and cover crops are planted following crop harvest.

Pathway 4.2A
Community 4.2 to 4.1

Intensive tillage is utilized, and monoculture row-cropping is established.

Pathway 4.2B
Community 4.2 to 4.3

Cover crops are implemented to minimize soil erosion.

Pathway 4.3B
Community 4.3 to 4.1

Intensive tillage is utilized, cover crops practices are abandoned, monoculture row-cropping is established, and crop rotation is reduced or eliminated.

Pathway 4.3A
Community 4.3 to 4.2

Cover crop practices are abandoned.

State 5
Pond State

Ponds may be regularly encountered throughout the MLRA, having been impounded or excavated for a variety of reasons including watering livestock, creating waterfowl habitat, and establishing fisheries (Pearson and Leoschke 1992). Through excavation, the native vegetation is removed, and groundwater seepage can rapidly fill the exposed area and transition the diverse seepage meadow into an open water habitat. Over time, sediments may accumulate along the edges of the pond where emergent vegetation, introduced by wind or wildlife, can germinate and establish.

Community 5.1
Cattail – open water

This community phase is characterized mostly by open water. Along the shallow edges of the water, a limited diversity of emergent vegetation may establish. Cattails (Typha L.) and bulrushes (Scirpus L., Bolboschoenus (Asch.) Palla) are the most commonly encountered species. Other emergent and aquatic species reported from the MLRA include American water plantain (*Alisma subcordatum* Raf.)), pondweed (Potamogeton L.), and winged loosestrife (*Lythrum alatum* Pursh) (Runkel and Roosa 2014).

Transition T1A
State 1 to 2

Changes to the natural hydroperiod and edge effects from adjacent land uses transition this site the degraded woody-invaded state (2).

Transition T1B
State 1 to 3

Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition T1C
State 1 to 4

Installation of drain tiles, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Transition T1D
State 1 to 5

Removal of natural vegetation and excavation transition the site to the pond state (5).

Transition T2A
State 2 to 3

Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition T2B
State 2 to 4

Installation of drain tiles, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Transition T3A
State 3 to 2

Land is abandoned and left fallow; natural succession by opportunistic and non-native species transition this site the disturbed state (2).

Transition T3B
State 3 to 4

Installation of drain tiles, tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Transition T3C
State 3 to 5

Removal of natural vegetation and excavation transition the site to the pond state (5).

Transition T4A
State 4 to 2

Agricultural production abandoned and left fallow; natural succession by opportunistic and non-native species transition this site to the degraded state (2).

Transition T4B
State 4 to 3

Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Additional community tables

Inventory data references

No field plots were available for this site. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in ecological site description.

Other references

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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	05/11/2025
Approved by	Suzanne Mayne-Kinney
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):**

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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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:**
