USDA Natural Resources Conservation Service

Ecological site FX053A99X084
Slough (SI)

Last updated: 11/22/2023
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General information

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

MLRA notes

Major Land Resource Area (MLRA): 053A–Northern Dark Brown Glaciated Plains

The Northern Dark Brown Glaciated Plains, MLRA 53A, is a large, agriculturally and ecologically significant area. It consists of approximately 6.1 million acres and stretches 140 miles from east to west and 120 miles from north to south, encompassing portions of 8 counties in northeastern Montana and northwestern North Dakota. This region represents part of the southern edge of the Laurentide Ice Sheet during maximum glaciation. It is one of the driest and westernmost areas within the vast network of glacially derived prairie pothole landforms of the Northern Great Plains and falls roughly between the Missouri Coteau to the east and the Brown Glaciated Plains to the west. Elevation ranges from 1,800 feet (550 meters) to 3,300 feet (1,005 meters).
Soils are primarily Mollisols, but Inceptisols and Entisols are also common. Till from continental glaciation is the predominant parent material, but alluvium and bedrock are also common. Till deposits are typically less than 50 feet thick (Soller, 2001). Underlying the till is sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007). The bedrock is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur in glacial outwash channels and along major drainages, including portions of the Missouri, Poplar, and Big Muddy Rivers. Large eolian deposits of sand occur in the vicinity of the ancestral Missouri River channel east of Medicine Lake (Fullerton et al., 2004). The northwestern portion of the MLRA contains a large unglaciated area containing paleoterraces and large deposits of sand and gravel known as the Flaxville gravel.
Much of this MLRA was glaciated towards the end of the Wisconsin age, and the maximum glacial extent occurred approximately 20,000 years ago (Fullerton and Colton, 1986; Fullerton et al., 2004). Subsequent erosion from major stream and river systems has created numerous drainageways throughout much of the MLRA. The result is a geologically young landscape that is predominantly a dissected till plain interspersed with alluvial deposits and dominated by soils in the Mollisol and Inceptisol orders. Much of this area is typic ustic, making these soils very productive and generally well suited to production agriculture.
Dryland farming is the predominant land use, and approximately 50 percent of the land area is used for cultivated crops. Winter, spring, and durum varieties of wheat are the major crops, with over 48 million bushels produced annually (USDA-NASS, 2017). Areas of rangeland typically are on steep hillslopes along drainages. The rangeland is mostly native mixed-grass prairie similar to the Stipa-Agropyron, Stipa-Bouteloua-Agropyron, and Stipa-Bouteloua faciations (Coupland, 1950, 1961). Cool-season grasses dominate and include rhizomatous wheatgrasses, needle and thread, western porcupine grass, and green needlegrass. Woody species are generally rare; however, many of the steeper drainages support stands of trees and shrubs, such as green ash and chokecherry. Seasonally ponded, prairie pothole wetlands may occur throughout the MLRA, but the greatest concentrations are in the east and northeast where receding glaciers stagnated and formed disintegration moraines with hummocky topography and numerous areas of poorly drained soils.

Classification relationships

NRCS Soil Geography Hierarchy
• Land Resource Region: Northern Great Plains
• Major Land Resource Area (MLRA): 053A Northern Dark Brown Glaciated Plains

National Hierarchical Framework of Ecological Units (Cleland et al., 1997; McNab et al., 2007)
• Domain: Dry
• Division: Temperate Steppe
• Province: Great Plains-Palouse Dry Steppe Province 331
• Section: Glaciated Northern Grasslands Section 331L
• Subsection: Glaciated Northern Grasslands Subsection 331La
• Landtype association/Landtype phase: N/A

National Vegetation Classification Standard (Federal Geographic Data Committee, 2008)
• Class: Mesomorphic Shrub and Herb Vegetation Class (2)
• Subclass: Shrub and Herb Wetland Subclass (2.C)
• Formation: Temperate to Polar Freshwater Marsh, Wet Meadow and Shrubland (2.C.4)
• Division: Eastern North American Temperate & Boreal Freshwater Marsh, Wet Meadow and Shrubland (2.C.4.Nd)
• Macrogroup: Great Plains Marsh, Wet Meadow, Shrubland & Playa (2.C.4.Nd.5)
• Group: Typha spp. - Schoenoplectus americanus - Scolochloa festucacea Great Plains Freshwater Marsh (2.C.4.Nd.5.a)

EPA Ecoregions
• Level 1: Great Plains (9)
• Level 2: West-Central Semi-Arid Prairies (9.3)
• Level 3: Northwestern Glaciated Plains (42)
• Level 4: Glaciated Dark Brown Prairie (42i)
Glaciated Northern Grasslands (42j)

USFWS (Cowardin et al., 1979)
• Palustrine Persistent Emergent Semi-Permanently Flooded

Montana Riparian and Wetland Sites (Hansen et. al, 1995)
• Hardstem Bulrush Habitat Type
• Common Cattail Habitat Type

Ecological site concept

Slough is a common ecological site occurring in oxbows, relic channels, and open depressions. The distinguishing characteristics of this site are that it is located on floodplains, has a seasonal high water table less than 24 inches from the soil surface, and contains hydric soils. Soils for this ecological site are typically very deep (more than 60 inches), poorly drained, and derived from alluvium. Characteristic vegetation is broadleaf cattail (*Typha latifolia*), hardstem bulrush (*Schoenoplectus acutus*), and spikerush (Eleocharis spp.).

Associated sites

FX053A99X061	**Riparian Woodland (RW)** The Riparian Woodland ecological site is adjacent to the Slough ecological site, usually on the higher terraces where hydrophytic vegetation is not present. The site is dominated by woody species.
FX053A99X150	**Subirrigated (Sb)** The Subirrigated ecological site is adjacent to the Slough ecological site, usually on higher positions where groundwater is 24 to 40 inches from the surface. The site is dominated by facultative wetland species.
FX053A99X060	**Overflow (Ov)** The Overflow ecological site is adjacent to the Slough ecological site, usually on the highest terraces where flooding is rare or occasional and hydrophytic vegetation is not present.

Similar sites

FX053A99X150	**Subirrigated (Sb)** The Subirrigated ecological site differs from the Slough ecological site, in that it occurs on higher landscape positions. Depth to a water table is 24 to 40 inches. Obligate wetland species are rare and the site is dominated by facultative wetland species.
FX053A99X071	**Recharge Closed Depression (CdR)** The Recharge Closed Depression ecological site differs from the Slough ecological site, in that it receives its moisture primarily from surface runoff rather than groundwater discharge. It is in closed depressions on uplands rather than on floodplains. Hydroperiods are much shorter and deep marsh vegetation is rare or absent.
FX053A99X705	**Discharge Closed Depression (CdD)** The Discharge Closed Depression ecological site differs from the Slough ecological site, in that it occurs in closed depressions on uplands rather than on floodplains. Hydroperiods are much shorter and deep marsh vegetation is rare or absent.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Typha latifolia* (2) *Schoenoplectus acutus*

Legacy ID

R053AY718MT

Physiographic features

This ecological site occurs on nearly level to slightly concave areas that have water at or near the soil surface throughout the growing season. The slopes typically range from 0 to 1 percent. This site occurs on all aspects.

Table 2. Representative physiographic features

Landforms	(1) River valley > Flood plain > Open depression (2) River valley > Oxbow (3) Till plain > Drainageway > Open depression
Flooding duration	Brief (2 to 7 days)
Flooding frequency	Rare to occasional
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Occasional to frequent
Elevation	549–1,006 m
Slope	0–1%
Ponding depth	3–30 cm
Water table depth	0–61 cm
Aspect	Aspect is not a significant factor

Climatic features

The Northern Dark Brown Glaciated Plains is a semi-arid region with a temperate continental climate that is characterized by frigid winters and warm to hot summers (Coupland, 1958; Richardson and Hanson, 1977; Heidel et al., 2000). The majority of precipitation occurs as steady, soaking, frontal system rains in late spring to early summer. Summer rainfall comes mainly from convection thunderstorms that typically deliver scattered amounts of rain in intense bursts. These storms may be accompanied by damaging winds and large-diameter hail and result in flash flooding along low-order streams. Approximately 80 percent of the annual precipitation occurs during the

growing season. June is the wettest month, followed by July and May (Richardson and Hanson, 1977; Heidel et al., 2000). Average annual precipitation ranges from 11 inches (280 mm) near Richey, Montana, to 15 inches (380 mm) in the Little Muddy drainage near Williston, North Dakota, but precipitation varies greatly from year to year. On average, severe drought and very wet years occur with the same frequency, which is 1 out of 10 years (Coupland, 1958; Heidel et al., 2000). Extreme climatic variations, especially droughts, have the greatest influence on species cover and production (Coupland, 1958, 1961; Biondini et al., 1998). The frost-free period for this ecological site ranges from 90 to 130 days, and the freeze-free period ranges from 115 to 155 days.

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-130 days
Freeze-free period (characteristic range)	115-155 days
Precipitation total (characteristic range)	279-381 mm
Frost-free period (average)	110 days
Freeze-free period (average)	135 days
Precipitation total (average)	330 mm

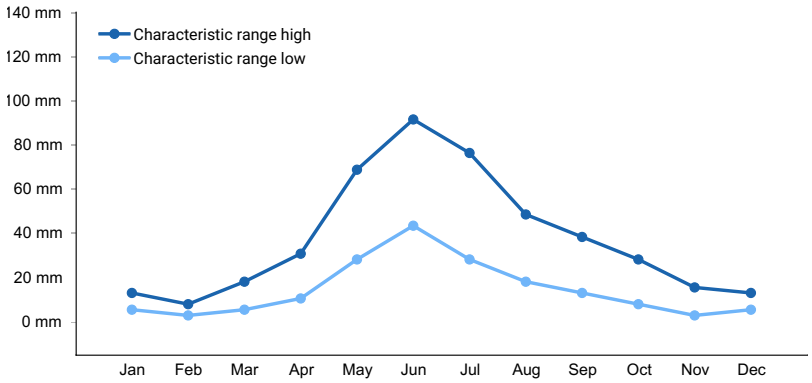


Figure 1. Monthly precipitation range

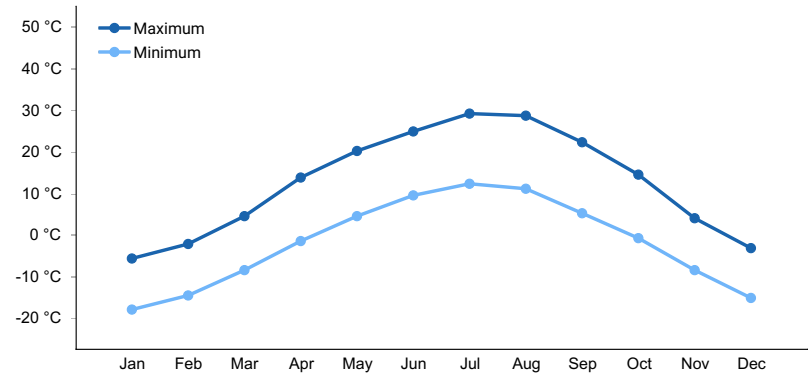


Figure 2. Monthly average minimum and maximum temperature

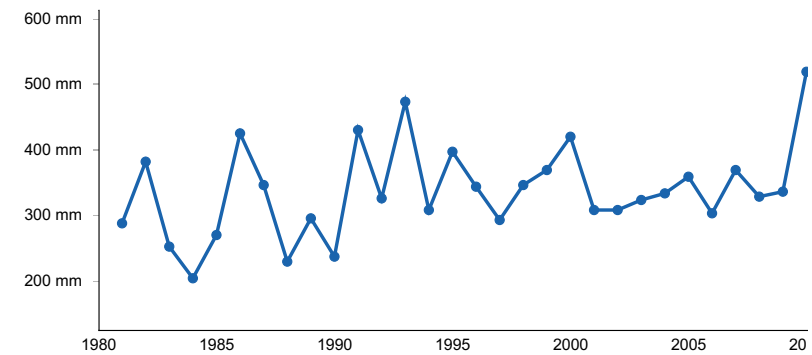


Figure 3. Annual precipitation pattern

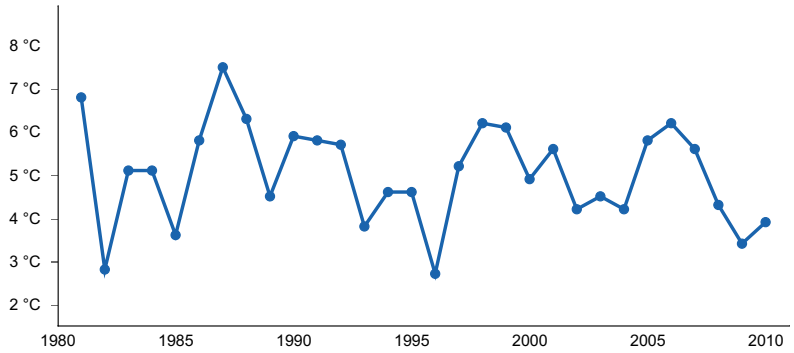


Figure 4. Annual average temperature pattern

Climate stations used

- (1) BREDETTE [USC00241088], Poplar, MT
- (2) CULBERTSON [USC00242122], Culbertson, MT
- (3) OPHEIM 10 N [USC00246236], Opheim, MT
- (4) OPHEIM 12 SSE [USC00246238], Opheim, MT
- (5) PLENTYWOOD [USC00246586], Plentywood, MT
- (6) SCOBEY 4 NW [USC00247425], Scobey, MT
- (7) SIDNEY [USC00247560], Sidney, MT
- (8) VIDA 6 NE [USC00248569], Vida, MT
- (9) WILLISTON SLOULIN INTL AP [USW00094014], Williston, ND

Influencing water features

This is a wetland site that receives additional moisture from groundwater and occasionally stream overflow. A seasonal groundwater table is present within 24 inches of the soil surface throughout most of the growing season. Typically, the ponding duration is 30 days or less, although some sites may pond water for 1 to 4 months, particularly in wet years. Ponding depth is typically 12 inches or less.

Wetland description

Palustrine Persistent Emergent Semi-Permanently Flooded

Soil features

Soils for this ecological site are typically very deep (more than 60 inches), poorly drained, and derived from alluvium. They have an aquic moisture regime, which means that the soils are saturated within 40 inches (100 cm) of the mineral soil surface for some time during the year, and a frigid soil temperature regime (Soil Survey Staff, 2014).

Soil textures in the surface horizon on this site are typically loam, silt loam, or silty clay loam; and the underlying horizons vary from loam to silty clay. All soils in this concept are endo-saturated, meaning that they receive additional moisture from groundwater, and have hydric features. Hydric features such as redox or gleying may be present in any horizon. Calcium carbonate equivalent is typically less than 15 percent in the upper 5 inches of soil. Soil pH classes are neutral to strongly alkaline in the surface horizon and slightly alkaline to strongly alkaline in the subsurface horizons. Typically, the upper 20 inches of soil does not contain coarse fragments.

Table 4. Representative soil features

Parent material	(1) Alluvium–igneous, metamorphic and sedimentary rock
Surface texture	(1) Loam (2) Silt loam (3) Silty clay loam
Drainage class	Poorly drained to very poorly drained

Soil depth	152–183 cm
Calcium carbonate equivalent (0-12.7cm)	0–15%
Electrical conductivity (0-10.2cm)	0–8 mmhos/cm
Sodium adsorption ratio (0-10.2cm)	0–15

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 Slough provisional ecological site in MLRA 53A consists of four vegetative states: The Historic Reference State (1), the Contemporary Reference State (2), the Invaded State (3), and the Hydrologically Altered State (4). Plant communities associated with the Slough ecological site evolved under the combined influences of climate, fire, grazing, and hydrology. Extreme climatic variability results in frequent droughts, which can have great influence on the relative contribution of species cover and production (Coupland, 1958, 1961; Biondini et al., 1998).

The historic ecosystem experienced periodic lightning-caused fires with estimated fire return intervals of 6 to 25 years (Bragg, 1995). Historically, Native Americans also set periodic fires. The majority of lightning-caused fires occurred in July and August, whereas Native Americans typically set fires during spring and fall to correspond with the movement of bison (Higgins, 1986). Generally, fires were less frequent on the Slough ecological site than on adjacent drier sites, however, early reports indicate that fires did occur in wetlands (Higgins, 1986). The Slough ecological site is resilient to fire and the most significant effects of fire were most likely removing excess litter accumulations and triggering resprouting and reseeding of cattail and hardstem bulrush (Esser, 1995; Gucker, 2008).

Native grazers also shaped these plant communities. American bison (Bison bison) were the dominant historic grazer, but pronghorn (Antilocapra americana), elk (Cervus canadensis), and deer (Odocoileus spp.) were also common. Grasshoppers and periodic outbreaks of Rocky Mountain locusts (Melanoplus spretus) also played an important role in the ecology of these communities (Lockwood, 2004).

Hydrology is a crucial dynamic on this site. The site receives water primarily from groundwater and is generally connected hydrologically with an adjacent stream. During the spring, the site can also be flooded by stream overflow. The duration of ponding, or hydroperiod, dramatically influences the vegetation of the site. Typically, the hydroperiod for this site is considered semi-permanent, meaning the site is inundated for 6 to 9 months. Over the short term, the hydroperiod is relatively stable, but climatic variation over the long term creates the hydrological fluctuation necessary for maintaining plant species diversity. Typically, wet-drought climatic cycles occur every 10 to 20 years during which the hydroperiod may vary from seasonally ponded (1 to 4 months) to permanently ponded.

Plant communities on the Slough ecological site are very complex. Much of the dynamics of this site are still under investigation and are not fully understood. Frequently, sites contain multiple plant community zones corresponding to the hydroperiod for that portion of the site. The seasonally ponded communities (1.1, 2.1) occur during drought years. The hydroperiod is 1 to 4 months and the site supports shallow marsh vegetation. Periods of average precipitation will transition the site to the semi-permanently ponded communities (1.2, 2.2). In these conditions, the hydroperiod increases to 6 to 9 months and the site begins supporting deep marsh vegetation. The open water communities (1.3, 2.3) occur primarily during periods of above average precipitation. The hydroperiod for these communities is typically over 9 months, and is sufficient for establishing a significant amount of aquatic vegetation. Further study is needed to fully describe all major species and plant community dynamics.

Most, if not all, extant examples of this site have some degree of alteration; either hydrologically or vegetatively. Major dams, irrigation projects, and water impoundment have had significant effects on the hydrology of this site. Major dams regulate river flows, resulting in more constant flows and less seasonal variation in the water table. Irrigation, particularly flood irrigation, raises water tables and further reduces seasonally variations. Impoundment of

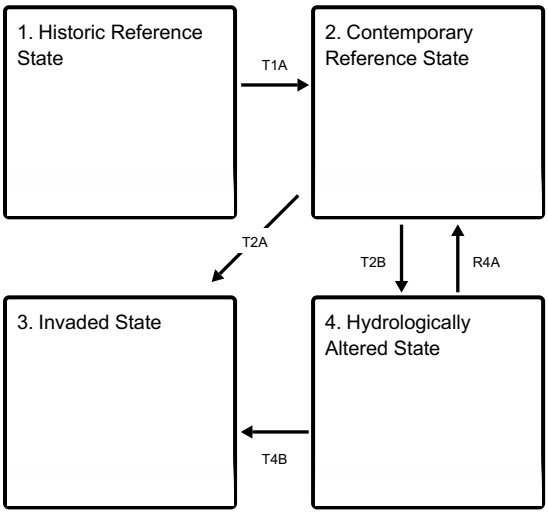
water increases inundation periods as well as ponding depths. These hydrological alterations have had significant impacts on the Slough ecological site, especially along the Missouri River.

Non-native perennial grasses, such as Kentucky bluegrass (*Poa pratensis*), are widespread throughout the Great Plains (Toledo et al., 2014) and have the potential to colonize the drier portions of this site. Wetter portions of the site may be affected by hydrophytic invasive species, such as reed canarygrass (*Phalaris arundinacea*), narrowleaf cattail (*Typha angustifolia*), and European common reed (*Phragmites australis* subsp. australis). Noxious weeds, such as purple loosestrife (*Lythrum salicaria*) and Eurasian watermilfoil (*Myriophyllum spicatum*), are rare but can become a major concern if left unchecked.

The state-and-transition model (STM) diagram and legend suggests possible pathways that plant communities on this site may follow as a result of a given set of ecological processes and management. The site may also support vegetative states not displayed in the STM diagram. Landowners and land managers should seek guidance from local professionals before prescribing a particular management or treatment scenario. Plant community responses vary across this MLRA due to variability in weather, soils, and aspect. The reference community phase may not necessarily be the management goal. The lists of plant species and species composition values are provisional and are not intended to cover the full range of conditions, species, and responses for the site. Species composition by dry weight is provided when available and is considered provisional based on the sources identified in the narratives associated with each community phase.

State and transition model

Ecosystem states



T1A - Introduction of non-native species (creeping bentgrass, Kentucky bluegrass, etc.)

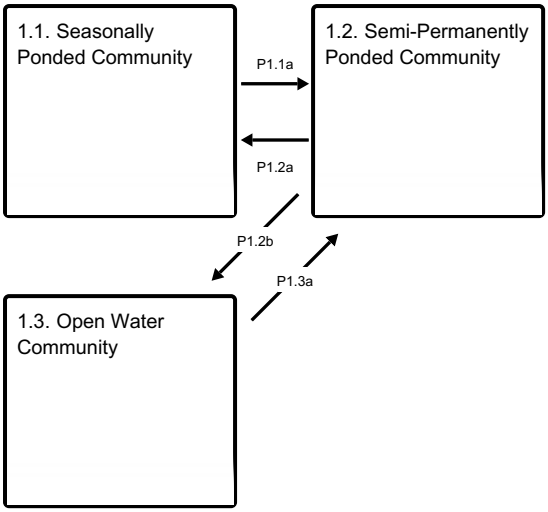
T2A - Displacement of reference species by invasive species (reed canarygrass, noxious weeds, etc.)

T2B - Alteration of hydrology by dams, dikes, irrigation, etc.

R4A - Restoration of natural hydrology and species diversity (labor intensive and costly, may be unfeasible in some cases)

T4B - Displacement of reference species by invasive species (reed canarygrass, noxious weeds, etc.)

State 1 submodel, plant communities



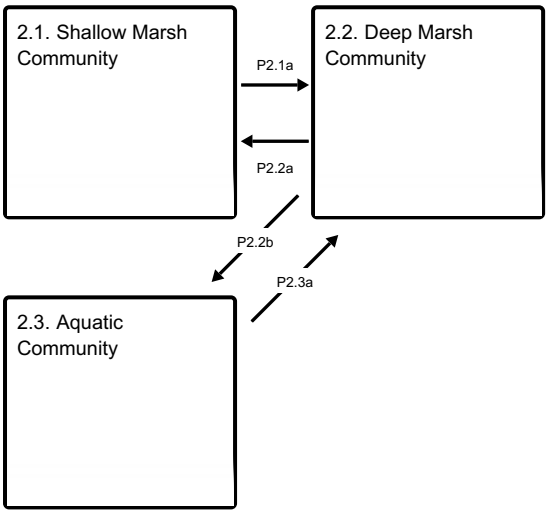
P1.1a - 2 or more years of average precipitation

P1.2a - Drought

P1.2b - 2 or more years of above average precipitation

P1.3a - 2 or more years of average precipitation

State 2 submodel, plant communities



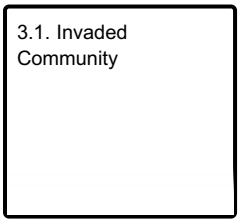
P2.1a - 2 or more years of average precipitation

P2.2a - Drought

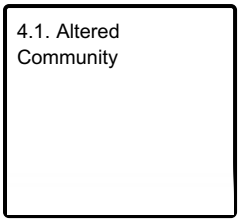
P2.2b - 2 or more years of above average precipitation

P2.3a - 2 or more years of average precipitation

State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Historic Reference State

The Historic Reference State (1) contained three community phases characterized by varying degrees of seasonal ponding. This state is considered extinct and is included here for historical reference purposes. Seasonal ponding was a key dynamic on this site and varied depending on annual precipitation patterns and groundwater inputs. Vegetation was typically characterized by zones within the site that corresponded to the hydroperiod of that particular zone. Phases usually exhibit two or more zones with the most hydrophytic vegetation in the center of the site and subsequent, drier plant communities toward the edges. Cyclical periods of drought and wet were a crucial ecological process on this site that promoted regeneration of key species such as hardstem bulrush (*Schoenoplectus acutus*) and broadleaf cattail (*Typha latifolia*). This cyclical pattern occurred, on average, every 10 to 20 years and increased stand longevity and species diversity (Luna et. al., 2010).

Community 1.1
Seasonally Ponded Community

The Seasonally Ponded Phase (1.1) occurred during drought cycles. Ponding depth and hydroperiod were reduced and the center of the site supported a sedge-spikerush dominated plant community. The fringes of the site would drawdown to bare mudflats in this stage, providing ideal conditions for germination and regeneration of cattails and bulrushes.

Community 1.2
Semi-Permanently Ponded Community

The Semi-Permanently Ponded Phase (1.2) occurred during periods of average or near average precipitation. In this phase the hydroperiod ranged from 6 to 9 months and vegetation exhibited zonation. At the center of the site, where ponding depth is greatest, a cattail-bulrush plant community occurred. The most common species in this zone were broadleaf cattail, hardstem bulrush, and common threesquare (*Schoenoplectus pungens*). A sedge-spikerush plant community was usually present around the rim of the site and common species were water sedge (*Carex aquatilis*), Nebraska sedge (*Carex nebrascensis*), and needle spikerush (*Eleocharis acicularis*). Stands of cattail and bulrush are expanding in this phase.

Community 1.3
Open Water Community

The Open Water Phase (1.3) occurred during wet climatic cycles. It was characterized by a long hydroperiod (9 months or more) and the development of open water in the center of the site. Cattail and bulrush stands declined and were limited to the fringes of the site. Aquatic species such as water knotweed (*Polygonum amphibium*), pondweed (Potamogeton spp), and duckweed (Lemna spp) were common. Species diversity in this phase declined over time until water levels were drawn down by the natural climate cycle and regeneration could occur.

Pathway P1.1a
Community 1.1 to 1.2

Two or more years of average precipitation transitioned the Seasonally Ponded Phase (1.1) to the Semi-Permanently Ponded Phase (1.2).

Pathway P1.2a

Community 1.2 to 1.1

Drought will transition the Semi-Permanently Ponded Phase (1.2) to the Seasonally Ponded Phase (1.1).

Pathway P1.2b
Community 1.2 to 1.3

Two or more years of above-average precipitation will transition the Semi-Permanently Ponded Phase (1.2) to the Open Water Phase (1.3).

Pathway P1.3a
Community 1.3 to 1.2

Two or more years of average precipitation will transition the Open Water Phase (1.3) to the Semi-Permanently Ponded Phase (1.2).

State 2
Contemporary Reference State

The Contemporary Reference State (2) contains three community phases. Seasonal ponding is a key dynamic on this site and varies depending on annual precipitation patterns and groundwater inputs. This state differs from the historical reference state in that it is influenced by nonnative plant species and has altered fire and grazing regimes. Vegetation is typically characterized by zones that correspond to the hydroperiod of that particular zone. Phases usually exhibit two or more zones with the most hydrophytic vegetation in the center of the site and subsequent, drier plant communities toward the edges. Cyclical periods of drought and wet are a crucial ecological process on this site that promotes regeneration of key species such as hardstem bulrush and broadleaf cattail. This cyclical pattern occurs, on average, every 10 to 20 years and improves stand longevity and species diversity (Luna et. al., 2010).

Community 2.1
Shallow Marsh Community

The Shallow Marsh Phase (2.1) occurs during drought cycles. Ponding depth and hydroperiod are reduced and the center of the site supports a sedge-spikerush dominated plant community. Common species are water sedge, Nebraska sedge, and needle spikerush. The fringes of the site drawdown to bare mudflats in this stage, providing ideal conditions for germination and regeneration of cattails and bulrushes.

Community 2.2
Deep Marsh Community

The Deep Marsh Phase (2.2) occurs during periods of average or near average precipitation. In this phase the hydroperiod ranges from 6 to 9 months. At the center of the depression, where ponding depth is greatest, a cattail-bulrush plant community appears. The most common species in this zone are broadleaf cattail, hardstem bulrush, and common threesquare. A sedge-spikerush plant community supporting species such as water sedge, Nebraska sedge, and needle spikerush is usually present around the rim of the site. A number of other graminoid species such as reedgrass (Calamagrostis spp), American sloughgrass (*Beckmannia syzigachne*), prairie cordgrass (*Spartina pectinata*), and rushes (Juncus spp) may also be present. Stands of cattail and bulrush are expanding and species diversity is very high in this phase.

Community 2.3
Aquatic Community

The Aquatic Phase (2.3) occurs during wet climatic cycles. It is characterized by a long hydroperiod (9 months or more) and the development of an open water area in the center of the site. The plant community is dominated by aquatic species such as water knotweed, pondweed, and duckweed. Cattail and bulrush stands are declining and limited to the fringes of the site. A number of minor species, particularly sedges and rushes, may also be present. Species diversity in this phase will decline over time until water levels are drawn down by the natural climate cycle and regeneration can occur.

Pathway P2.1a
Community 2.1 to 2.2

Two or more years of average precipitation will transition the Shallow Marsh Phase (2.1) to the Deep Marsh Phase (2.2).

Pathway P2.2a
Community 2.2 to 2.1

Drought will transition the Deep Marsh Phase (2.2) to the Shallow Marsh Phase (2.1).

Pathway P2.2b
Community 2.2 to 2.3

Two or more years of above-average precipitation will transition the Deep Marsh Phase (2.2) to the Aquatic Phase (2.3).

Pathway P2.3a
Community 2.3 to 2.2

Two or more years of average precipitation will transition the Aquatic Phase (2.3) to the Deep Marsh Phase (2.2).

State 3
Invaded State

The Invaded State (3) occurs when invasive plant species invade adjacent plant communities and displace the native species. Data suggest that native species diversity declines significantly when invasive species exceed 30 percent of the plant community. The most common concern is reed canarygrass (*Phalaris arundinacea*), which is a vigorous, productive, long-lived, perennial, sod-forming grass. Although native to North America, it may become weedy or invasive in some habitats and may displace desirable vegetation if not properly managed (USDA-NRCS, 2002). Introduced bluegrasses, such as Kentucky bluegrass (*Poa pratensis*) may also be a concern, primarily around the fringes of this ecological site. Kentucky bluegrass is widespread throughout the Northern Great Plains (Toledo et al., 2014). It is very competitive and displaces native species by forming dense root mats, altering nitrogen cycling, and having allelopathic effects on germination (DeKeyser et al., 2013). It may also alter soil surface hydrology and modify soil surface structure (Toledo et al., 2014). Other non-native species such as creeping bentgrass (*Agrostis stolonifera*) may also be common in this state. Noxious weeds are rare on the Slough ecological site, however, weeds such as purple loosestrife (*Lythrum salicaria*) and Eurasian watermilfoil (*Myriophyllum spicatum*) could become a major concern if established on this site. These species are very aggressive perennials that typically displace native species and dominate ecological function when they invade a site. Sometimes, these species can be suppressed through intensive management (herbicide, biological control, or intensive grazing management). Control efforts are unlikely to eliminate noxious weeds, but their density can be sufficiently suppressed so that species composition and structural complexity are similar to that of the Contemporary Reference State (2). However, cessation of control methods will most likely result in recolonization of the site by the noxious species.

Community 3.1
Invaded Community

Encroachment by introduced grasses, noxious weeds, and other invasive species is common. Reduced plant species diversity, simplified structural complexity, and altered biologic processes result in a state that is substantially departed from both the Reference State (1) and the Contemporary Reference State (2).

State 4
Hydrologically Altered State

The Hydrologically Altered State (4) occurs when hydrology is altered by damming, irrigation projects, or water

impoundment. Natural drought/wet cycles are reduced or eliminated and the associated variations in hydroperiod are diminished. The result is a perpetual Aquatic Phase (2.3) and a reduction in biodiversity and emergent vegetation regeneration. This state is particularly common in the river valleys where large storage reservoirs have regulated stream flows and flood irrigation has raised water tables across much of the floodplain.

Community 4.1
Altered Community

The Altered Community Phase (4.1) consists of a predominantly open water wetland with a fringe area dominated by emergent perennials such as broadleaf cattail, hardstem bulrush, and common threesquare. Stands of emergent vegetation are frequently monocultures with very little regeneration. Natural drawdown cycles necessary for regeneration are drastically reduced. A shallow marsh zone supporting sedge and spikerush species may be present but is generally very narrow. Species richness and diversity are much less than in the Contemporary Reference State (2).

Transition T1A
State 1 to 2

Introduction of non-native grass and forb species occurred in the early 20th century. The naturalization of these species in relatively undisturbed grasslands, coupled with changes in fire and grazing regimes, transitions the Reference State (1) to the Contemporary Reference State (2).

Transition T2A
State 2 to 3

The Contemporary Reference State (2) transitions to the Invaded State (3) when aggressive perennial grasses or noxious weeds displace native species. The precise triggers of this transition are not clear, but data suggest that exclusion of grazing and fire may be a contributing factor in some cases (DeKeyser et al., 2013). In addition, other rangeland health attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered.

Transition T2B
State 2 to 4

Hydrologic alteration due to dams, irrigation, impoundment, or a combination of factors will transition the Contemporary Reference State (2) to the Hydrologically Altered State (4).

Restoration pathway R4A
State 4 to 2

Restoration of natural hydrology and species diversity transitions the Hydrologically Altered State (4) to the Contemporary Reference State (2). Restoration of natural hydrology may require removal of dams or diversions, and alteration of irrigation practices. Depending on site conditions, revegetation may be required to restore species diversity. Specialized seeding techniques may be necessary as well as intensive weed control to prevent invasion of exotic species and noxious weeds. These restoration methods are labor intensive, very costly, and may be impractical, perhaps even detrimental, in some situations.

Conservation practices

Wetland Restoration
Herbaceous Weed Control

Transition T4B
State 4 to 3

The Hydrologically Altered State (4) transitions to the Invaded State (3) when aggressive perennial grasses or noxious weeds displace native species. The precise triggers of this transition are not clear, but rangeland health

attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered.

Additional community tables

Inventory data references

Only one field plot was available for this site, but data was collected from this plot for six consecutive years. These data, in conjunction with 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 this ecological site description.

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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	05/18/2024
Approved by	Kirt Walstad
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:**

17. **Perennial plant reproductive capability:**