

## **Ecological site FX052X99X084 Slough (SI)**

Last updated: 7/01/2019  
Accessed: 05/12/2025

---

### **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): 052X–Brown Glaciated Plains

The Brown Glaciated Plains, MLRA 52, is an expansive and agriculturally and ecologically significant area. It consists of approximately 14.5 million acres and stretches across 350 miles from east to west, encompassing portions of 15 counties in north-central Montana. This region represents the southwestern limit of the Laurentide Ice Sheet and is considered to be the driest and westernmost area within the vast network of glacially derived prairie pothole landforms of the northern Great Plains. Elevation ranges from 2,000 feet (610 meters) to 4,600 feet (1,400 meters).

Soils are primarily Mollisols, but Entisols, Inceptisols, Alfisols, and Vertisols 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, and in some areas glacially deformed bedrock occurs at or near the soil surface (Soller, 2001). Underlying the till is sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007). It is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur along glacial outwash channels and major drainages, including portions of the Missouri, Teton, Marias, Milk, and Frenchman Rivers. Large glacial lakes, particularly in the western half of the MLRA, deposited clayey and silty lacustrine sediments (Fullerton et al., 2013).

Much of the western portion of this MLRA was glaciated towards the end of the Wisconsin age, and the maximum glacial extent occurred approximately 20,000 years ago (Fullerton et al., 2004). The result is a geologically young landscape that is predominantly a level till plain interspersed with lake plains and dominated by soils in the Mollisol and Vertisol orders. These soils are very productive and generally are well suited to dryland farming. Much of this area is aridic-ustic. Crop-fallow dryland wheat farming is the predominant land use. Areas of rangeland typically are on steep hillslopes along drainages.

The rangeland, much of which is native mixedgrass prairie, increases in abundance in the eastern half of the MLRA. The Wisconsin-age till in the north-central part of this area typically formed large disintegration moraines with steep slopes and numerous poorly-drained potholes. A large portion of Wisconsin-age till occurring on the type of the level terrain that would typically be optimal for farming has large amounts of less-suitable sodium-affected Natrustalfs. Significant portions of Blaine, Phillips, and Valley Counties were glaciated approximately 150,000 years ago during the Illinoian age. Due to erosion and dissection of the landscape, many of these areas have steeper slopes and more exposed bedrock than areas glaciated during the Wisconsin age (Fullerton and Colton, 1986).

While much of the rangeland in the aridic-ustic portion of MLRA 52 is classified as belonging to the “dry grassland” climatic zone, sites in portions of southern MLRA 52 may belong to the “dry shrubland” climatic zone. The dry shrubland zone represents the northernmost extent of the big sagebrush (*Artemisia tridentata*) steppe on the Great Plains. Because similar soils occur in both southern and northern portions of the MLRA, it is currently hypothesized that climate is the primary driving factor affecting big sagebrush distribution in this area. However the precise factors are not fully understood at this time.

Sizeable tracts of largely unbroken rangeland in the eastern half of the MLRA and adjacent southern Saskatchewan are home to the northern Montana population of greater sage grouse (*Centrocercus urophasianus*), and large portions of this area are considered to be a Priority Area for Conservation (PAC) by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service, 2013). This population is unique among sage grouse populations because many individuals overwinter in the big sagebrush steppe (dry shrubland) in the southern portion of the MLRA and then migrate to the northern portion of the MLRA, which lacks big sagebrush (dry grassland), to live the rest of the year (Smith, 2013).

Areas of the till plain near the Bearpaw and Highwood Mountains as well as the Sweetgrass Hills and Rocky Mountain foothills are at higher elevations, receive higher amounts of precipitation, and have a typical-ustic moisture regime. These areas have significantly more rangeland production than the drier aridic-ustic portions of the MLRA and have enough moisture to produce crops annually rather than just bi-annually, as in the drier areas. Ecological sites in this higher precipitation area are classified as the moist grassland climatic zone.

## **Classification relationships**

NRCS Soil Geography Hierarchy

- Land Resource Region: Northern Great Plains
- Major Land Resource Area (MLRA): 052 Brown Glaciated Plains
- Climate Zone: N/A

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: Northwestern Glaciated Plains 331D
- Subsection: Montana Glaciated Plains 331Dh
- 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 Formation (2.C.4)
- Division: *Alnus viridis* ssp. *sinuata* - *Salix boothii* / *Carex* spp. Western North American Freshwater Marsh, Wet Meadow, and Shrubland Division (2.C.4.Nb)
- Macrogroup: Arid West Interior Freshwater Marsh Macrogroup (2.C.4.Nb.1)
- Group: *Schoenoplectus* spp. - *Typha* spp. Interior Freshwater Marsh Group (2.C.4.Nb.1.a)

USFWS (Cowardin et al., 1979)

- Palustrine Persistent Emergent Semi-Permanently Flooded

Montana Riparian and Wetland Sites (Hansen et. al, 1995)

- Hardstem Bulrush Habitat Type and/or Common Cattail Habitat Type

## **Ecological site concept**

This provisional ecological site occurs in all climatic zones of MLRA 52. Figure 1 illustrates the distribution of the Slough ecological site based on current data. Current mapping does not consistently identify the Slough ecological site when it occurs as a minor component of the mapunit, therefore this map will require future revision. Slough is a limited extent ecological site occurring throughout MLRA 52. Typically, it occurs in backwater areas on floodplains such as oxbows, relic channels, and open depressions. The ponding duration is typically semi-permanent, however, it is highly variable depending on catchment size and annual precipitation. This site is typically non-saline, but may be brackish in some instances.

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) and derived from alluvium. Soil textures in the upper 4 inches are typically loam, silt loam, or silty clay loam. Soils are endosatuated, meaning they receive additional moisture from groundwater.

Characteristic vegetation is broadleaf cattail (*Typha latifolia*), hardstem bulrush (*Schoenoplectus acutus*), and spikerush (*Eleocharis* spp.).

### Associated sites

FX052X99X060	<b>Overflow (Ov)</b> 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.
FX052X99X061	<b>Riparian Woodland (RW)</b> The Riparian Woodland ecological site is adjacent to the Slough ecological site, usually on the highest terraces where hydrophytic vegetation is not present. The site is dominated by woody species.
FX052X99X150	<b>Subirrigated (Sb)</b> 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.

### Similar sites

FX052X99X150	<b>Subirrigated (Sb)</b> 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.
FX052X99X071	<b>Recharge Closed Depression (Cdr)</b> 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.
FX052X99X705	<b>Discharge Closed Depression (Cdr)</b> 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

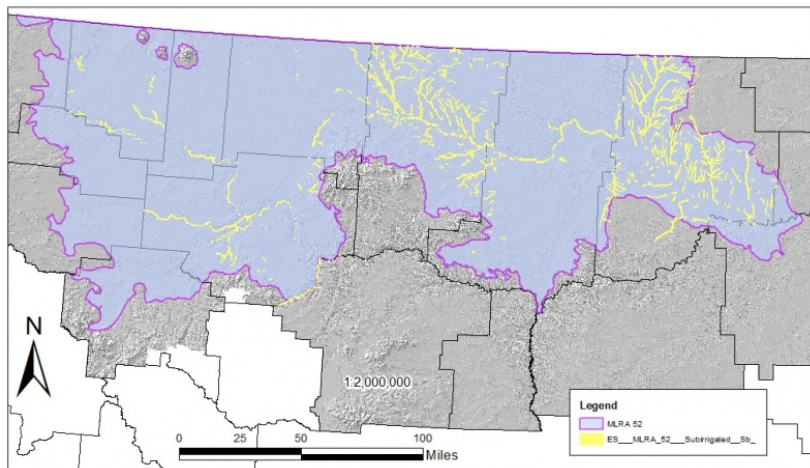
Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

### Legacy ID

R052XY084MT

### Physiographic features

Slough is an ecological site of limited extent occurring in depressions and oxbows on flood plains



**Figure 1. General distribution of the Slough ecological site by mapunit extent**

**Table 2. Representative physiographic features**

Landforms	(1) River valley > Depression (2) River valley > Oxbow (3) River valley > Flood plain
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Occasional to frequent
Elevation	610–1,402 m
Slope	0–2%
Ponding depth	0–30 cm
Water table depth	0–61 cm
Aspect	Aspect is not a significant factor

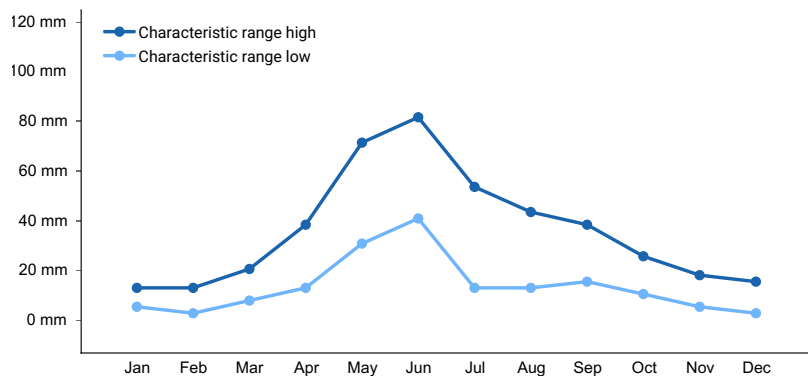
## Climatic features

The Brown Glaciated Plains is a semi-arid region with a temperate continental climate that is characterized by frigid winters and warm to hot summers (Cooper et al., 2001). The average frost-free period for this ecological site is 115 days. 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. Severe drought occurs on average in 2 out of every 10 years. Annual precipitation ranges from 10 to 17 inches, and 70 to 80 percent of this occurs during the growing season (Cooper et al., 2001). Extreme climatic variations, especially droughts, have the greatest influence on species cover and production (Coupland, 1958, 1961; Biondini et al., 1998).

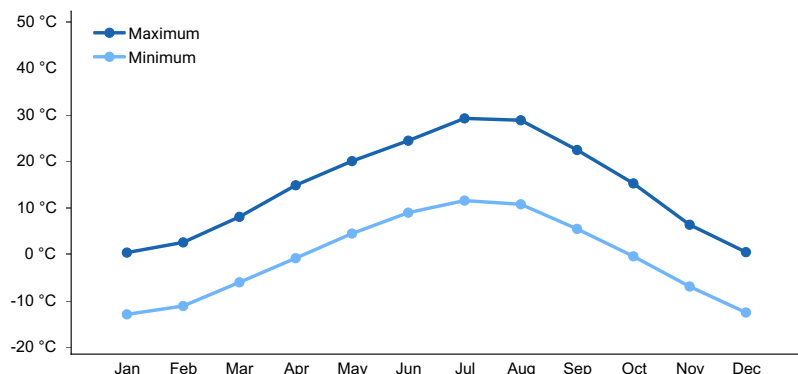
During the winter months, the western half of MLRA 52 commonly experiences chinook winds, which are strong west to southwest surface winds accompanied by abrupt increases in temperature. The chinook winds are strongest on the western boundary of the MLRA near the Rocky Mountain foothills and decrease eastward. In addition to producing damaging winds, prolonged chinook episodes can result in drought or vegetation kills due to the reaction of plants to a “false spring” (Oard, 1993).

**Table 3. Representative climatic features**

Frost-free period (average)	115 days
Freeze-free period (average)	140 days
Precipitation total (average)	330 mm



**Figure 2. Monthly precipitation range**



**Figure 3. Monthly average minimum and maximum temperature**

## Climate stations used

- (1) GERALDINE [USC00243445], Geraldine, MT
- (2) CONRAD [USC00241974], Conrad, MT
- (3) TURNER 11N [USC00248415], Turner, MT
- (4) CONTENT 3 SSE [USC00241984], Zortman, MT
- (5) GOLDBUTTE 7 N [USC00243617], Sunburst, MT
- (6) SACO 1 NNW [USC00247265], Saco, MT
- (7) CARTER 14 W [USC00241525], Floweree, MT
- (8) CHESTER [USC00241692], Chester, MT
- (9) HARLEM [USC00243929], Harlem, MT
- (10) LOMA 1 WNW [USC00245153], Loma, MT

## Influencing water features

This is a riverine wetland site that receives additional moisture from groundwater and occasionally stream overflow. Hydrology is most similar to a lotic stream hydrogeomorphic (HGM) model (Tiner, 2003). It typically occurs on low gradient or intermittent gradient reaches, although many reaches on larger streams have been dammed. Typically, the site maintains groundwater connectivity with the stream channel for the majority of the year. During spring runoff the sites receives surface overflow from the stream as well as subsurface flow. Groundwater dynamics are not well documented, but it is most likely a flow-through site or discharge site. Typically, the ponding duration is typically 6 months or more and ponding depth is typically 1 foot or more.

## Soil features

The Slough concept covers about 25,000 acres in MLRA 52. Soils that best represent the central concept for this ecological site are Bigsandy and Lallie. These soils are in the Fluvaquents great group and are characterized by a surface horizon that lacks enough organic matter to have a mollic epipedon. The Bigsandy soil is in the fine-loamy family, meaning it contains between 18 and < 35 percent clay in the particle-size control section, and has mixed mineralogy. The Lallie soil is in the fine family, meaning it contains between 35 and 60 percent clay in the particle-size control section, and has smectitic mineralogy. The parent material for these soil series is typically alluvium

deposits. These and all soils in this concept are endosaturated, meaning that they receive additional moisture from groundwater, and have hydric features. Ponding frequency varies from occasional to frequent and duration is typically long. All soils in this concept 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. These soils have 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. Hydric features such as redox or gleying may be present in any horizon. In the surface 20 inches, electrical conductivity is typically less than 4; and the sodium absorption ratio is less than 13. The surface horizon typically contains 2 to 5 percent organic matter; and moist colors vary from dark grayish brown (10YR 4/2) to black (10YR 2/1). 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. The soil depth class for this site is typically very deep (more than 60 inches). Typically, the upper 20 inches of soil does not contain coarse fragments.

**Table 4. Representative soil features**

Parent material	(1) Alluvium
Surface texture	(1) Loam (2) Silt loam (3) Silty clay loam
Drainage class	Poorly drained to very poorly drained
Soil depth	152–183 cm
Available water capacity (0-101.6cm)	12.95–18.54 cm
Calcium carbonate equivalent (0-12.7cm)	0–14%
Electrical conductivity (0-50.8cm)	0–3 mmhos/cm
Sodium adsorption ratio (0-50.8cm)	0–12
Soil reaction (1:1 water) (0-101.6cm)	6.6–9

## Ecological dynamics

The information in this ecological site description, including the state-and-transition model (STM) (Figure 2), 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 52 Dry Grassland consists of three vegetative states: The Reference State (1.0), the Invaded State (2.0), and the Hydrologically Altered State (3.0). Historically, plant communities associated with the Slough ecological site evolved under the combined influences of climate, grazing, hydrology, and fire. 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).

Hydrology is a crucial dynamic on this site. The site receives water primarily from groundwater and 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 Slough ecological site transitions between the Shallow Marsh Phase (1.1), the Deep Marsh Phase (1.2), and the Open Water Phase (1.3). Plant communities vary depending on the hydroperiod and many species require drawdown during drought cycles to regenerate and maintain diversity on the site.

Native grazers also shaped these plant communities. 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*) may have also played an important role in the ecology of these communities (Lockwood, 2004).

The historic ecosystem also experienced relatively frequent 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 are most likely removing excess litter accumulations and triggering resprouting and reseeding of cattail and hardstem bulrush (Esser, 1995; Gucker, 2008). Long-term fire suppression in the 20th century removed periodic fire from the ecosystem altogether. This practice led to an increase in litter accumulation and decreased regeneration of native species, which in some cases, may provide ideal conditions for seed germination and seedling establishment of invasive species such as Canada thistle.

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 that correspond to the depth and duration of ponding for that portion of the site. During drought cycles, the site is typically in the Shallow Marsh Phase (1.1). In this phase, the center of the depression is dominated by a sedge-spikerush plant community with an area of drawdown around the edges. This drawdown area is frequently open mud flats, which provides a medium for cattail and bulrush to reseed. Periods of average precipitation will transition the site to the Deep Marsh Phase (1.2). In this phase the ponding depth increases and the mudflats around the edges are inundated. Cattail and bulrush dominate the site, particularly in the deepest portions. A sedge-spikerush plant community may establish on the fringes where the hydroperiod is shorter and water depth is shallow as well as numerous other wetland species. The Deep Marsh Phase (1.2) supports a diverse community of hydrophytic plants. During cycles of above average precipitation, the site will transition to the Open Water Phase (1.3). Over time cattails and bulrush become decadent and die out. The site becomes open water in the center with a stand of cattail and bulrush around the fringes. Plant communities in all phases are often dynamic and diversity varies from site to site. Further study is needed to fully describe all major species and plant community dynamics.

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 seasonal 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 in the Milk River valley.

The effects of improper grazing are largely unknown on this site. Due to wetness and the lack of palatable forage, livestock use of this site is generally limited. However, livestock may utilize the site if conditions dry out sufficiently (Hansen et al., 1995). Improper grazing practices include any practices that do not allow sufficient opportunity for plants to physiologically recover from a grazing event or multiple grazing events within a given year and/or may not be providing adequate cover to prevent soil erosion over time. This may include, but is not limited to, overstocking, continuous grazing, and/or inadequate seasonal rotation moves over multiple years.

Invasive species are not common on this ecological site, but invasive species have been observed in some instances. Potential invasive species include 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 (Figure 2) 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. Land owners 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 State (1) 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

### Slough R52XY084MT

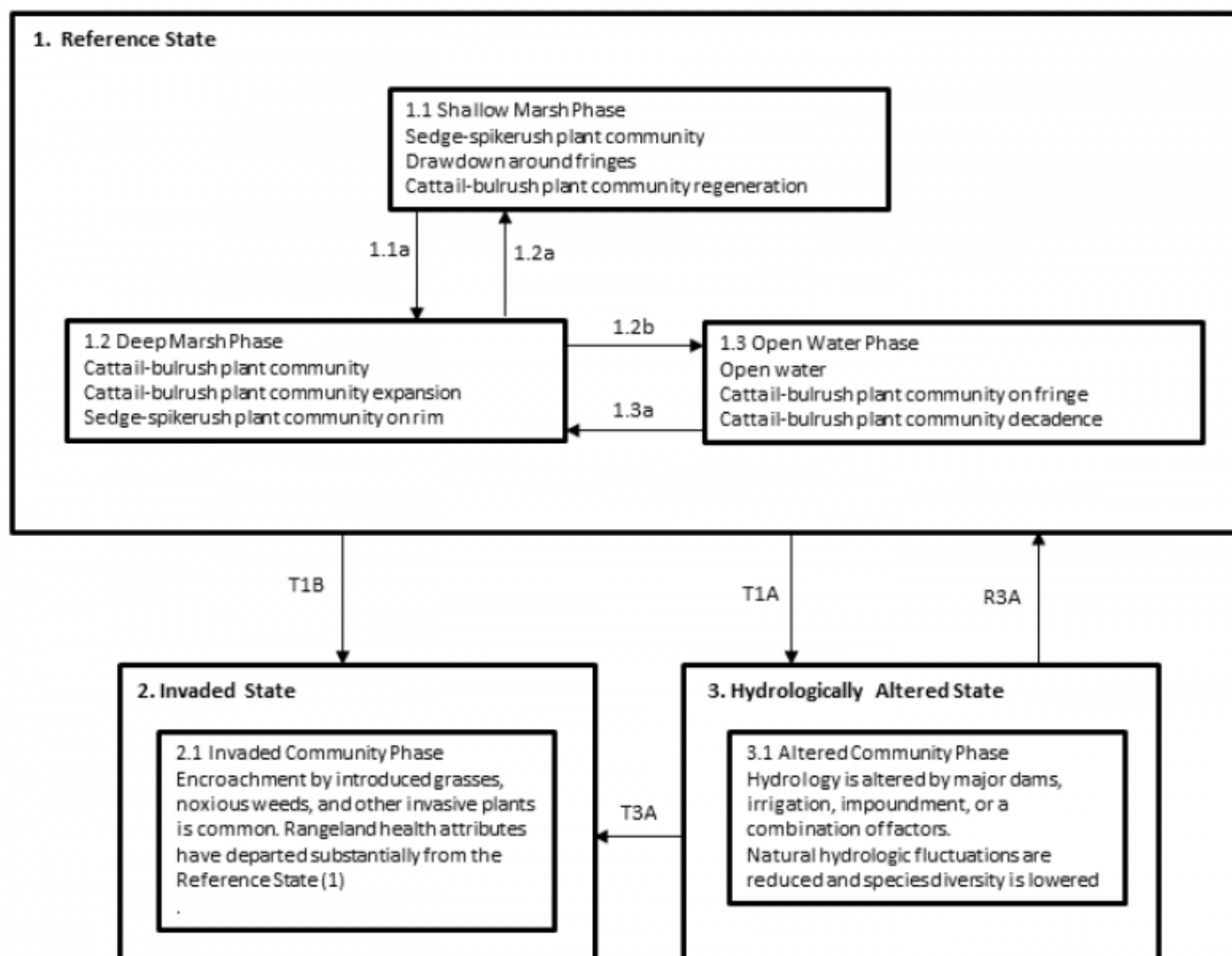


Figure 2. State-and-transition diagram



## Legend

- 1.1a 2 or more years of average precipitation
- 1.2a drought
- 1.2b 2 or more years of above average precipitation
- 1.3a 2 or more years of average precipitation
- T1A alteration of hydrology by major dams, irrigation, etc.
- T1B, T3A introduction of invasive species
- R3A restoration of natural hydrology and species diversity  
(labor intensive and costly)

Figure 2 (continued)

## State 1 Reference State

Scientific Name	Common Name	Growth Form	Duration	Nativity
<i>Achillea millefolium</i>	common yarrow	Forb	Perennial	Native
<i>Achnatherum nelsonii</i>	Columbia needlegrass	Graminoid	Perennial	Native
<i>Agoseris glauca</i>	pale agoseris	Forb	Perennial	Native
<i>Agrostis scabra</i>	rough bentgrass	Graminoid	Perennial	Native
<i>Allium geyeri</i>	Geyer's onion	Forb	Perennial	Native
<i>Allium sextile</i>	textile onion	Forb	Perennial	Native
<i>Antennaria microphylla</i>	littleleaf pussytoes	Forb	Perennial	Native
<i>Apocynum cannabinum</i>	Indianhemp	Forb	Perennial	Native
<i>Argentina anserina</i>	silverweed cinquefoil	Forb	Perennial	Native
<i>Aristida cana</i>	silver sagebrush	Shrub	Perennial	Native
<i>Aristida frigida</i>	prairie sagewort	Shrub	Perennial	Native
<i>Aristida ludoviciana</i>	white sagebrush	Forb	Perennial	Native
<i>Atriplex argentea</i>	silverscale saltbush	Forb	Annual/Biennial	Native
<i>Beckmannia cylindrica</i>	American sloughgrass	Graminoid	Annual/Biennial	Native
<i>Bouteloua gracilis</i>	blue grama	Graminoid	Perennial	Native
<i>Calamagrostis stricta</i>	northern reedgrass	Graminoid	Perennial	Native
<i>Calamovilfa longifolia</i>	prairie sandreed	Graminoid	Perennial	Native
<i>Carex aquatilis</i>	water sedge	Graminoid	Perennial	Native
<i>Carex buxbaumii</i>	Buxbaum's sedge	Graminoid	Perennial	Native
<i>Carex nebrascensis</i>	Nebraska sedge	Graminoid	Perennial	Native
<i>Carex pellita</i>	woolly sedge	Graminoid	Perennial	Native
<i>Carex praegracilis</i>	clustered field sedge	Graminoid	Perennial	Native
<i>Carex rostrata</i>	beaked sedge	Graminoid	Perennial	Native
<i>Carex spp.</i>	sedge	Graminoid	Perennial	Native
<i>Carex stipata</i>	sawbeak sedge	Graminoid	Perennial	Native
<i>Carex vesicaria</i>	blister sedge	Graminoid	Perennial	Native
<i>Chamaesyce serpyllifolia</i>	thymeleaf sandmat	Forb	Annual/Biennial	Native
<i>Chenopodium pratericola</i>	desert goosefoot	Forb	Annual/Biennial	Native
<i>Cicuta douglasii</i>	western water hemlock	Forb	Perennial	Native
<i>Cicuta maculata</i>	spotted water hemlock	Forb	Perennial	Native
<i>Collomia linearis</i>	tiny trumpet	Forb	Annual/Biennial	Native
<i>Comarum palustre</i>	purple cinquefoil	Forb	Perennial	Native
<i>Compa canadensis</i>	Canadian horseweed	Forb	Annual/Biennial	Native
<i>Danthonia spp.</i>	oatgrass	Graminoid	Perennial	Native
<i>Deschampsia cespitosa</i>	tufted hairgrass	Graminoid	Perennial	Native
<i>Distichlis spicata</i>	inland saltgrass	Graminoid	Perennial	Native
<i>Downingia laeta</i>	Great Basin calicoflower	Forb	Annual/Biennial	Native
<i>Echinacea angustifolia</i>	blacksamson echinacea	Forb	Perennial	Native
<i>Eleocharis acicularis</i>	needle spikerush	Graminoid	Perennial	Native
<i>Eleocharis palustris</i>	common spikerush	Graminoid	Perennial	Native
<i>Eleocharis rostellata</i>	beaked spikerush	Graminoid	Perennial	Native
<i>Elymus elymoides</i>	squirreltail	Graminoid	Perennial	Native
<i>Elymus trachycaulus</i>	slender wheatgrass	Graminoid	Perennial	Native
<i>Eriogonum ciliatum</i>	fringed willowherb	Forb	Perennial	Native

Figure 4. Table 5. List of plant species observed in riverine wetlands (adapted from Jones [2004]; Hansen et al. [1995])

<i>Epilobium pygmaeum</i>	smooth spike-primrose	Forb	Annual/Biennial	Native
<i>Epilobium</i> spp.	willowherb	Forb	Perennial	Native
<i>Erigeron arvensis</i>	field horsetail	Forb	Perennial	Native
<i>Erigeron glabellus</i>	streamside fleabane	Forb	Perennial	Native
<i>Erigeron</i> spp.	fleabane	Forb	Perennial	Native
<i>Gaillardia aristata</i>	common gaillardia	Forb	Perennial	Native
<i>Galium boreale</i>	northern bedstraw	Forb	Perennial	Native
<i>Galium triflorum</i>	fragrant bedstraw	Forb	Perennial	Native
<i>Gilia maritima</i>	sea milkwort	Forb	Perennial	Native
<i>Glyceria grandis</i>	American mangrass	Graminoid	Perennial	Native
<i>Glycyrrhiza lepidota</i>	American licorice	Forb	Perennial	Native
<i>Gnaphalium palustre</i>	western marsh cudweed	Forb	Annual/Biennial	Native
<i>Grindelia squarrosa</i>	curlycup gumweed	Forb	Annual/Biennial	Native
<i>Hackelia diffusa</i>	nodding stickseed	Forb	Annual/Biennial	Native
<i>Helianthella quinquevallis</i>	five-nerve helianthella	Forb	Perennial	Native
<i>Helianthella uniflora</i>	oneflower helianthella	Forb	Perennial	Native
<i>Helianthus annuus</i>	common sunflower	Forb	Annual/Biennial	Native
<i>Helianthus nuttallii</i>	Nuttall's sunflower	Forb	Perennial	Native
<i>Hesperolopia comata</i>	needle and thread	Graminoid	Perennial	Native
<i>Heterotheca villosa</i>	hairy false goldenaster	Forb	Perennial	Native
<i>Hieracium</i> spp.	hawkweed	Forb	Perennial	Native
<i>Hordeum jubatum</i>	foxtail barley	Graminoid	Perennial	Native
<i>Juncus arcticus</i> ssp. <i>littoralis</i>	Baltic rush	Graminoid	Perennial	Native
<i>Juncus</i> spp.	rush	Graminoid	Perennial	Native
<i>Koeleria macrantha</i>	prairie Junegrass	Graminoid	Perennial	Native
<i>Lemma minor</i>	common duckweed	Forb	Perennial	Native
<i>Lepidium densiflorum</i>	common pepperweed	Forb	Annual/Biennial	Native
<i>Lesquerella arenosa</i>	Great Plains bladderpod	Forb	Annual/Biennial	Native
<i>Linum lewisii</i>	prairie flax	Forb	Perennial	Native
<i>Lomatium</i> spp.	desertparsley	Forb	Perennial	Native
<i>Lycopus asper</i>	rough bugleweed	Forb	Perennial	Native
<i>Malanthemum stellatum</i>	starry false lily of the valley	Forb	Perennial	Native
<i>Mentha arvensis</i>	wild mint	Forb	Perennial	Native
<i>Muhlenbergia asperifolia</i>	scratchgrass	Graminoid	Perennial	Native
<i>Muhlenbergia richardsonii</i>	mat muhly	Graminoid	Perennial	Native
<i>Muhlenbergia</i> spp.	muhly	Graminoid	Perennial	Native
<i>Najas flexilis</i>	nodding watercress	Forb	Annual	Native
<i>Nassella viridula</i>	green needlegrass	Graminoid	Perennial	Native
<i>Navaretia intertexta</i>	needleleaf navaretia	Forb	Annual/Biennial	Native
<i>Najas flexilis</i>	yellow pond-lily	Forb	Perennial	Native
<i>Opuntia polyacantha</i>	plains pricklypear	Shrub	Perennial	Native
<i>Pascopyrum nuttallii</i>	western wheatgrass	Graminoid	Perennial	Native
<i>Pedioceltis argophyllum</i>	silverleaf Indian bread- root	Forb	Perennial	Native
<i>Plantago elongata</i>	prairie plantain	Forb	Annual/Biennial	Native
<i>Poa arida</i>	plains bluegrass	Graminoid	Perennial	Native
<i>Poa palustris</i>	fowl bluegrass	Graminoid	Perennial	Native
<i>Poa secunda</i>	Sandberg bluegrass	Graminoid	Perennial	Native
<i>Poa</i> spp.	bluegrass	Graminoid	Perennial	Native

<i>Polygonum amphibium</i>	water knotweed	Forb	Perennial	Native
<i>Polygonum erectum</i>	erect knotweed	Forb	Annual/Biennial	Native
<i>Polygonum ramotissimum</i>	bushy knotweed	Forb	Annual/Biennial	Native
<i>Polygonum</i> spp.	knotweed	Forb	Perennial	Native
<i>Potamogeton natans</i>	floating pondweed	Forb	Perennial	Native
<i>Potentilla gracilis</i>	slender cinquefoil	Forb	Perennial	Native
<i>Puccinellia nuttalliana</i>	Nuttall's alkaligrass	Graminoid	Perennial	Native
<i>Ranunculus cymbalaria</i>	alkali buttercup	Forb	Perennial	Native
<i>Ranunculus</i> spp.	buttercup	Forb	Annual/Biennial	Native
<i>Ratibida columnifera</i>	prairie coneflower	Forb	Perennial	Native
<i>Rhus trilobata</i>	skunkbush sumac	Shrub	Perennial	Native
<i>Ribes aureum</i>	golden currant	Shrub	Perennial	Native
<i>Rosa woodsii</i>	Woods' rose	Shrub	Perennial	Native
<i>Rumex aquaticus</i>	western dock	Forb	Perennial	Native
<i>Rumex salicifolius</i>	willow dock	Forb	Perennial	Native
<i>Sagittaria latifolia</i>	broadleaf arrowhead	Forb	Perennial	Native
<i>Salix amygdaloides</i>	peachleaf willow	Tree	Perennial	Native
<i>Salix exigua</i>	narrowleaf willow	Shrub	Perennial	Native
<i>Salix</i> spp.	willow	Shrub	Perennial	Native
<i>Schoenoplectus acutus</i>	hardstem bulrush	Graminoid	Perennial	Native
<i>Schoenoplectus maritimus</i>	cosmopolitan bulrush	Graminoid	Perennial	Native
<i>Schoenoplectus purpureus</i>	common threesquare	Graminoid	Perennial	Native
<i>Schoenoplectus tabernaemontani</i>	softstem bulrush	Graminoid	Perennial	Native
<i>Salvinella densa</i>	lesser spikemoss	Forb	Perennial	Native
<i>Solidago</i> spp.	goldenrod	Forb	Perennial	Native
<i>Spartina gracilis</i>	alkali cordgrass	Graminoid	Perennial	Native
<i>Spartina pectinata</i>	prairie cordgrass	Graminoid	Perennial	Native
<i>Stellaria</i> spp.	starwort	Forb	Annual/Biennial	Native
<i>Stuckenia filiformis</i>	fineleaf pondweed	Forb	Perennial	Native
<i>Suaeda calceoliformis</i>	Pursh seepweed	Forb	Annual/Biennial	Native
<i>Symphoricarpos occidentalis</i>	western snowberry	Shrub	Perennial	Native
<i>Symphoricarpos falcatus</i>	white prairie aster	Forb	Perennial	Native
<i>Symphoricarpos spathulatus</i>	western mountain aster	Forb	Perennial	Native
<i>Thermopsis rhombifolia</i>	prairie thermopsis	Forb	Perennial	Native
<i>Triglochin maritimum</i>	seaside arrowgrass	Graminoid	Perennial	Native
<i>Typha latifolia</i>	broadleaf cattail	Forb	Perennial	Native
<i>Urtica dioica</i>	stinging nettle	Forb	Perennial	Native
<i>Veronica peregrina</i>	neckweed	Forb	Annual/Biennial	Native
<i>Vicia americana</i>	American vetch	Forb	Perennial	Native
<i>Vicia</i> spp.	violet	Forb	Perennial	Native
<i>Xanthium strumarium</i>	rough cocklebur	Forb	Annual/Biennial	Native
<i>Zigadenus elegans</i>	mountain deathcamas	Forb	Perennial	Native

The Reference State (1) contains three community phases. Ecological dynamics of this state are still under investigation, therefore, this model may not cover the full range of conditions, species, and responses for the state. Seasonal ponding is a key dynamic on this site and varies depending on annual precipitation patterns and

groundwater inputs. Vegetation is typically characterized by zones within the site 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. Dominant plant species that occur on the Slough ecological site are cattail, bulrush, sedges, and spikerush (Jones, 2004; Hansen et al., 1995). Plant communities can be diverse and may contain numerous other species in addition to the dominant species. Table 5 contains a list of species that have been observed in the Reference State (1). Cyclical periods of drought and wet occur, on average, every 10 to 20 years and are a crucial ecological process on this site (Luna et. al., 2010). During these cycles the site undergoes a dry phase that promotes regeneration of key species such as hardstem bulrush and broadleaf cattail, which require open mudflats to regenerate. This cyclical pattern helps to maintain stand integrity, species diversity, and wildlife habitat. Community Phase 1.1: Shallow Marsh Phase The Shallow Marsh Phase (1.1) occurs during drought cycles. Ponding depth and hydroperiod are reduced and the center of the site supports a sedge-spikerush dominated plant community. The fringes of the site drawdown to bare mudflats in this stage, providing ideal conditions for germination and regeneration of cattails and bulrushes. Community Phase Pathway 1.1a Two or more years of average precipitation will transition the Shallow Marsh Phase (1.1) to the Deep Marsh Phase (1.2). Community Phase 1.2: Deep Marsh Phase The Deep Marsh Phase (1.2) occurs during periods of average or near average precipitation. In this phase the hydroperiod ranges from 6 to 9 months. Vegetation exhibits zonation in this phase. 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 is usually present around the rim of the site and frequently supports water sedge, Nebraska sedge, and needle spikerush. A number of minor graminoid species such as American sloughgrass, prairie cordgrass, and rushes may also be present. Stands of cattail and bulrush are expanding in this phase. Species diversity is very high in this phase. Community Phase Pathway 1.2a Drought will transition the Deep Marsh Phase (1.2) to the Shallow Marsh Phase (1.1). Community Phase Pathway 1.2b Two or more years of above-average precipitation will transition the Deep Marsh Phase (1.2) to the Open Water Phase (1.3). Community Phase 1.3: Open Water Phase The Open Water Phase (1.3) occurs during wet climatic cycles. It is characterized by a long hydroperiod (8 to 9 months) and the development of an open water area in the center of the site. Cattail and bulrush stands are declining and limited to the fringes of the site. Aquatic species such as water knotweed, pondweed, and duckweed are common. A number of minor species such as sedges, rushes, and grasses may also be present. Species diversity in this phase will decline over time until water levels are drawn down by the natural climate cycle. Community Phase Pathway 1.3a Two or more years of average precipitation will transition the Open Water Phase (1.3) to the Deep Marsh Phase (1.2). Transition T1A Hydrologic alteration due to dams, irrigation, impoundment, or a combination of factors will transition the Reference State (1) to the Hydrologically Altered State (3). Transition T1B Introduction of invasive species will transition the Reference State (1) to the Invaded State (2).

## **State 2 Invaded State**

The Invaded State (2) occurs when invasive plant species invade adjacent native plant communities. Invasive species are not common, nor are they well documented on the Slough ecological site. However, species such as reed canarygrass, narrowleaf cattail, and European common reed have been observed on this site in some instances. Left unchecked, these species can form dense stands and reduce cover and diversity of desirable species. Noxious weeds are also rare on the Slough ecological site, however, weeds such as purple loosestrife and Eurasian watermilfoil have been documented in MLRA 52 and would 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 Reference State (1). However, cessation of control methods will most likely result in recolonization of the site by the noxious species. Community Phase 2.1: Invaded Community Phase The Invaded Community Phase (2.1) occurs when encroachment by introduced grasses, noxious weeds, and other invasive plants are common. Rangeland health attributes have departed substantially from the Reference State (1).

## **State 3 Hydrologically Altered State**

The Hydrologically Altered State (3) 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 Open Water Phase (1.3) and a reduction in biodiversity and emergent vegetation regeneration. This state is particularly common in the Milk River valley where large storage reservoirs have regulated stream flows and flood irrigation has raised water tables across much of the floodplain. Community Phase 3.1: Altered Community Phase The Altered Community Phase (3.1) 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 Reference State (1). Restoration Pathway R3A Restoration of natural hydrology and species diversity transitions the Altered State (3) to the Reference State (1). 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 most situations. Transition T3A Introduction of invasive species will transition the Hydrologically Altered State (3) to the Invaded State (2).

## **Inventory data references**

No field plots were available for this site. A review of the scientific literature and professional experience was 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 current knowledge and the sources identified in this ecological site description.

## **Other references**

- Adams, B.W., et al. 2013. Rangeland plant communities for the dry mixedgrass natural subregion of Alberta. Second approximation. Rangeland Management Branch, Policy Division, Alberta Environment and Sustainable Resource Development, Lethbridge, Pub. No. T/040.
- Anderson, R.C. 2006. Evolution and origin of the central grassland of North America: Climate, fire, and mammalian grazers. *Journal of Torrey Botanical Society* 133:626-647.
- Biondini, M.E., and L. Manske. 1996. Grazing frequency and ecosystem processes in a northern mixed prairie, USA. *Ecological Applications* 6:239-256.
- Biondini, M.E., B.D. Patton, and P.E. Nyren. 1998. Grazing intensity and ecosystem processes in a northern mixed-grass prairie, USA. *Ecological Applications* 8:469-479.
- Bragg, T.B. 1995. The physical environment of the Great Plains grasslands. In: A. Joern and K.H. Keeler (eds.) *The Changing Prairie*, Oxford University Press, Oxford, pp. 49–81.
- Branson, D.H., and G.A. Sword. 2010. An experimental analysis of grasshopper community responses to fire and livestock grazing in a northern mixed-grass prairie. *Environmental Entomology* 39:1441-1446.
- Bylo, L.N., N. Koper, and K.A. Molloy. 2014. Grazing intensity influences ground squirrel and American badger habitat use in mixed-grass prairies. *Rangeland Ecology and Management* 67:247-254.
- Cleland, D.T., et al. 1997. National hierarchical framework of ecological units. In: M.S. Boyce and A. Haney (eds.) *Ecosystem Management Applications for Sustainable Forest and Wildlife Resources*, Yale University Press, New Haven, CT.
- Cooper, S.V., C. Jean, and P. Hendricks. 2001. Biological survey of a prairie landscape in Montana's glaciated plains. Report to the Bureau of Land Management. Montana Natural Heritage Program, Helena.
- Cooper, S.V. and W.M. Jones. 2003. Site descriptions of high-quality wetlands derived from existing literature sources. Report to the Montana Department of Environmental Quality. Montana Natural Heritage Program, Helena.
- Coupland, R.T. 1950. Ecology of the mixed prairie of Canada. *Ecological Monographs* 20:271-315.

- Coupland, R.T. 1958. The effects of fluctuations in weather upon the grasslands of the Great Plains. *Botanical Review* 24:273-317.
- Coupland, R.T. 1961. A reconsideration of grassland classification in the Northern Great Plains of North America. *Journal of Ecology* 49:135-167.
- Coupland, R.T., and R.E. Johnson. 1965. Rooting characteristics of native grassland species in Saskatchewan. *Journal of Ecology* 53:475-507.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. US Fish and Wildlife Service FWS/OBS, 79(31), 131.
- Crowe, E. and G. Kudray. 2003. Wetland Assessment of the Whitewater Watershed. Report to U.S. Bureau of Land Management, Malta Field Office. Montana Natural Heritage Program, Helena.
- Davis, S.K., R.J. Fisher, S.L. Skinner, T.L. Shaffer, and R.M. Brigham. 2013. Songbird abundance in native and planted grassland varies with type and amount of grassland in the surrounding landscape. *Journal of Wildlife Management* 77:908-919.
- Derner, J.D., and R.H. Hart. 2007. Grazing-induced modifications to peak standing crop in northern mixed-grass prairie. *Rangeland Ecology and Management* 60:270-276.
- Derner, J.D., and A.J. Whitman. 2009. Plant interspaces resulting from contrasting grazing management in northern mixed-grass prairie: Implications for ecosystem function. *Rangeland Ecology and Management* 62:83-88.
- Derner, J.D., W.K. Lauenroth, P. Stapp, and D.J. Augustine. 2009. Livestock as ecosystem engineers for grassland bird habitat in the western Great Plains of North America. *Rangeland Ecology and Management* 62:111-118.
- Dix, R.L. 1960. The effects of burning on the mulch structure and species composition of grasslands in western North Dakota. *Ecology* 41:49-56.
- Esser, L.L. 1995. *Schoenoplectus acutus*. In: Fire Effects Information System, U.S. Department of Agriculture, Forest Service. <http://www.fs.fed.us/database/feis/> (accessed (July 26, 2016)).
- Federal Geographic Data Committee. 2008. The national vegetation classification standard, version 2. FGDC Vegetation Subcommittee, FGDC-STD-005-2008 (Version 2), p. 126.
- Fullerton, D.S., and R.B. Colton. 1986. Stratigraphy and correlation of the glacial deposits on the Montana Plains. U.S. Geological Survey.
- Fullerton, D.S., R.B. Colton, C.A. Bush, and A.W. Straub. 2004. Map showing spatial and temporal relations of mountain and continental glaciations on the northern plains, primarily in northern Montana and northwestern North Dakota. U.S. Geologic Survey pamphlet accompanying Scientific Investigations Map 2843.
- Fullerton, D.S., R.B. Colton, and C.A. Bush. 2013. Quaternary geologic map of the Shelby 1° x 2° quadrangle, Montana: U.S. Geological Survey Open-File Report 2012–1170, scale 1:250,000.
- Galatowitsch, S.M. and A.G. Van der Valk. 1996. The vegetation of restored and natural prairie wetlands. *Ecological Applications*. 6:1 pp.102-112.
- Gilbert, M.C., P.M. Whited, E.J. Clairain Jr., and R.D. Smith. 2006. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of prairie potholes. U.S. Army Corps of Engineers Final Report, Washington, DC.
- Gucker, C. L. 2008. *Typha latifolia*. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service. <http://www.fs.fed.us/database/feis/> (Accessed 7/26/2016).

- Hansen, P.L., et al. 1995. Classification and management of Montana's riparian and wetland sites. University of Montana, Montana Forest and Conservation Experiment Station, Miscellaneous Publication No. 54.
- Heidel, B., S.V. Cooper, and C. Jean. 2000. Plant species of special concern and plant associations of Sheridan County, Montana. Report to U.S. Fish and Wildlife Service. Montana Natural Heritage Program, Helena.
- Heitschmidt, R.K., and L.T. Vermeire. 2005. An ecological and economic risk avoidance drought management decision support system. In: J.A. Milne (ed.) *Pastoral Systems in Marginal Environments*, XXth International Grasslands Congress, July 2005, p. 178.
- Henderson, A.E., and S.K. Davis. 2014. Rangeland health assessment: A useful tool for linking range management and grassland bird conservation? *Rangeland Ecology and Management* 67:88-98.
- Herrick, J.E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2009. Monitoring manual for grassland, shrubland and savanna ecosystems. U.S. Department of Agriculture, Agricultural Research Service, Jornada Experimental Range, Las Cruces, NM.
- Higgins, K.F. 1986. Interpretation and compendium of historical fire accounts in the Northern Great Plains. U.S. Fish and Wildlife Service Resource Publication 161.
- Joern, A. 2005. Disturbance by fire frequency and bison grazing modulate grasshopper assemblages in tallgrass prairie. *Ecology* 86:861-873.
- Jones, W.M. 2004. Using vegetation to assess wetland condition: a multimetric approach for temporarily and seasonally flooded depressional wetlands and herbaceous-dominated intermittent and ephemeral riverine wetlands in the northwestern glaciated plains ecoregion, Montana. Report to the Montana Department of Environmental Quality and the U.S. Environmental Protection Agency. Montana Natural Heritage Program, Helena.
- Knopf, F.L. 1996. Prairie legacies—birds. In: F.B. Samson and F.L. Knopf (eds.) *Prairie Conservation: Preserving North America's Most Endangered Ecosystem*, Island Press, Washington, DC, pp. 135-148.
- Knopf, F.L., and F.B. Samson. 1997. Conservation of grassland vertebrates. In: F.B. Samson and F.L. Knopf (eds.) *Ecology and Conservation of Great Plains Vertebrates: Ecological Studies 125*, Springer-Verlag, New York, NY, pp. 273-289.
- Laycock, W.A. 1988. History of grassland plowing and grass planting on the Great Plains. In: J.E. Mitchell (ed.) *Impacts of the Conservation Reserve Program in the Great Plains—Symposium Proceedings, September 16-18, 1987*. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.
- Laycock, W.A. 1991. Stable states and thresholds of range condition on North American rangelands. *Journal of Range Management* 44:427-433.
- Lesica, P. and P. Husby. 2006. Field Guide to Montana's Wetland Vascular Plants. Montana Wetlands Trust. Helena.
- Lockwood, J.A. 2004. Locust: The devastating rise and mysterious disappearance of the insect that shaped the American frontier. Basic Books, New York, NY.
- Luna T., C. McIntyre, and L. Vance. 2010. Emergent marsh—north american arid west emergent marsh. Montana Field Guide [http://FieldGuide.mt.gov/displayES\\_Detail.aspx?ES=9222](http://FieldGuide.mt.gov/displayES_Detail.aspx?ES=9222) (Accessed 7/26/2016).
- Madden, E.M., R.K. Murphy, A.J. Hansen, and L. Murray. 2000. Models for guiding management of prairie bird habitat in northwestern North Dakota. *American Midland Naturalist* 144:377-392.
- McIntyre, C., K. Newlon, L. Vance, and M. Burns. 2011. Milk, Marias, and St. Mary monitoring: developing a long-term rotating basin wetland assessment and monitoring strategy for Montana. Report to the United States Environmental Protection Agency. Montana Natural Heritage Program, Helena.

- McNab, W.H., et al. 2007. Description of ecological subregions: Sections of the conterminous United States [CD-ROM]. USDA Forest Service, General Technical Report WO-76B.
- Montana State College Agricultural Experiment Station. 1949. Similar vegetative rangeland types in Montana.
- Mushet, D.M., N.H. Euliss, Jr., and C.A. Stockwell. 2012. A conceptual model to facilitate amphibian conservation in the Northern Great Plains. *Great Plains Research* 22:45-58.
- Nesser, J.A., G.L. Ford, C.L. Maynard, and D.S. Page-Dumroese. 1997. Ecological units of the Northern Region: Subsections. USDA Forest Service, Intermountain Research Station, General Technical Report INT-GTR-369.
- Oard, M.J. 1993. A method of predicting chinook winds east of the Montana Rockies. 1993. *Weather and Forecasting* 8:166-180.
- Roath, L.R. 1988. Implications of land conversions and management for the future. In: J.E. Mitchell (ed.) *Impacts of the Conservation Reserve Program in the Great Plains—Symposium Proceedings*, September 16-18, 1987. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.
- Rowe, J.S. 1969. Lightning fires in Saskatchewan grassland. *Canadian Field Naturalist* 83:317-327.
- Salo, E.D., et al. 2004. Grazing intensity effects on vegetation, livestock and non-game birds in North Dakota mixed-grass prairie. *Proceedings of the 19th North American Prairie Conference*, Madison, WI.
- Semlitsch, R.D. 2000. Principles for management of aquatic-breeding amphibians. *Journal of Wildlife Management* 64:615-631.
- Shay, J., D. Kunec, and B. Dyck. 2001. Short-term effects of fire frequency on vegetation composition and biomass in mixed prairie in south-western Manitoba. *Plant Ecology* 155:157-167.
- Smith, B., and G.J. McDermid. 2014. Examination of fire-related succession within the dry mixed-grass subregion of Alberta with the use of MODIS and Landsat. *Rangeland Ecology and Management* 67:307-317.
- Smith, R.E. 2013. Conserving Montana's sagebrush highway: Long distance migration in sage-grouse. M.S. thesis, University of Montana, Missoula.
- Soil Survey Staff. 2014. *Keys to soil taxonomy*, 12th edition. USDA Natural Resources Conservation Service.
- Soller, D.R. 2001. Map showing the thickness and character of Quaternary sediments in the glaciated United States east of the Rocky Mountains. U.S. Geological Survey Miscellaneous Investigations Series I-1970-E, scale 1:3,500,000.
- Stephens, S.E., J.J. Rotella, M.S. Lindberg, M.L. Taper, and J.K. Ringelman. 2005. Duck nest survival in the Missouri Coteau of North Dakota: Landscape effects at multiple spatial scales. *Ecological Applications* 15:2137-2149.
- Tiner, R.W. 2003. *Correlating Enhanced National Wetlands Inventory Data with Wetland Functions for Watershed Assessments: A Rationale for Northeastern U.S. Wetlands*. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Region 5, Hadley, MA.  
[http://www.fws.gov/northeast/wetlands/pdf/CorrelatingEnhancedNWIDataWetlandFunctionsWatershedAssessments\[1\].pdf](http://www.fws.gov/northeast/wetlands/pdf/CorrelatingEnhancedNWIDataWetlandFunctionsWatershedAssessments[1].pdf)
- Toledo, D., M. Sanderson, K. Spaeth, J. Hendrickson, and J. Printz. 2014. Extent of Kentucky bluegrass and its effect on native plant species diversity and ecosystem services in the northern Great Plains of the United States. *Invasive Plant Science and Management* 7:543-552.
- Umbanhowar, Jr., C.E. 2004. Interactions of climate and fire at two sites in the Northern Great Plains. *Palaeogeography, Palaeoclimatology, and Palaeoecology* 208:141-152.

U.S. Department of Agriculture, Natural Resources Conservation Service. Glossary of landform and geologic terms. National Soil Survey Handbook, Title 430-VI, Part 629.02c.

[http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2\\_054242](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054242) (Accessed 13 April 2016).

U.S. Fish and Wildlife Service. 2013. Greater sage-grouse (*Centrocercus urophasianus*) conservation objectives: Final report.

Vance, L., S. Owen, and J. Horton. 2013. Literature review: Hydrology-ecology relationships in Montana prairie wetlands and intermittent/ephemeral streams. Report to the Cadmus Group and the U.S. Environmental Protection Agency. Montana Natural Heritage Program, Helena.

Vuke, S.M., K.W. Porter, J.D. Lonn, and D.A. Lopez. 2007. Geologic Map of Montana - information booklet: Montana Bureau of Mines and Geology Geologic Map 62-D.

Wilson, S.D., and J.M. Shay. 1990. Competition, fire, and nutrients in a mixed-grass prairie. *Ecology* 71:1959-1967.

With, K.A. 2010. McCown's longspur (*Rhynchophanes mccownii*). In: A. Poole (ed.) *The Birds of North America* (online), Cornell Lab of Ornithology, Ithaca. <http://bna.birds.cornell.edu/bna/species/09>.

## **Contributors**

Scott Brady  
Stuart Veith

## **Approval**

Scott Brady, 7/01/2019

## **Acknowledgments**

This provisional ecological site description could not have been completed without the contributions of Karen Newlon. She conducted an extensive literature review, which provided most of the background information for this project as well as many of the references. She also co-authored the Loamy and Thin Claypan Dry Grassland ecological sites previously prepared in MLRA 52.

A number of USDA-NRCS and USDI-BLM staff supported this project. Staff contributions are as follows:

Soil Concepts, Soils Information, and Field Descriptions  
Charlie French, USDA-NRCS  
Josh Sorlie, USDI-BLM

NASIS Reports, Data Dumps, and Soil Sorts  
Bill Drummond, USDA-NRCS  
Pete Weikle, USDA-NRCS

Peer Review and Beta Testing  
Kirt Walstad, USDA-NRCS  
Kyle Steele, formerly USDA-NRCS  
Kelsey Molloy, USDA-NRCS  
Rick Caquelin, USDA-NRCS  
Josh Sorlie, USDI-BLM  
BJ Rhodes, USDI-BLM

Editing  
Ann Kinney, USDA-NRCS  
Jenny Sutherland, USDA-NRCS



Quality Control  
Jon Siddoway, USDA-NRCS

Quality Assurance  
Stacey Clark, USDA-NRCS

## 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	
Approved by	
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:**
-