USDA Natural Resources Conservation Service

Ecological site R102AY038SD
Calcareous Fen

Last updated: 8/20/2024
Accessed: 09/27/2024

General information

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

MLRA notes

Major Land Resource Area (MLRA): 102A–Rolling Till Prairie

The Rolling Till Prairie (102A) is located within the Central Feed Grains and Livestock Land Resource Region. It spans 3 states (Minnesota 58 percent, South Dakota 42 percent, and small part in North Dakota), encompassing over 16,000 square miles (Figure 1). The elevation ranges from approximately over 2,000 feet above sea level (ASL) on the Prairie Coteau in Northeastern South Dakota to about 1,000 feet ASL on lowlands. The dominate landform in this area are stagnation moraines, end moraines, glacial outwash plains, terraces, and flood plains. The area is dominated by till covered moraines. The stagnation moraines are gently undulating to steep and have many depressions and poorly defined drainages. Small outwash areas are adjacent to the watercourses. The Cretaceous Pierre Shale underlies the till in the most of the area. Precambrian rocks also occur at depth. Granite is quarried near Milbank, South Dakota and outcrops of Sioux Quartzite are common. (USDA-NRCS 2006).

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to very poorly drained. This area supports true prairie vegetation characterized by big bluestem (Andropogon gerardii), little bluestem (Schizachyrium scoparium), porcupinegrass (Hesperostipa spartea), and green needlegrass (Nassella viridula). Prairie cordgrass (*Spartina pectinata*) commonly grows in wet areas. (USDA-NRCS 2006).

Classification relationships

Major Land Resource Area (MLRA): Rolling Till Prairie (102A) (USDA-NRCS 2006)

USFS Subregions: North Central Glaciated Plains Section (251B); Upper Minnesota River-Des Moines Lobe Subsection (251Ba); Outer Coteau des Prairies Subsection (251Bb); Northwest Iowa Plains Subsection (251Bd); Minnesota and Northeast Iowa Morainal-Oak Savannah Section (222M); Alexandria Moraine-Hardwood Hills Subsection (222Ma) (Cleland et al. 2007).

US EPA Level IV Ecoregion: Tewaukon/Big Stone Stagnation Moraine (46e), Prairie Coteau (46k), Prairie Coteau Escarpment (46l), Big Sioux Basin (46m), Minnesota River Prairie (46o), Des Moines Lobe (47b) , Lake Agassiz Plains (48d), Alexandria Moraines and Detroit Lakes Outwash Plain (51j) (USEPA 2013)

Ecological site concept

The Calcareous Fen ecological site represents a highly calcareous organic soil area which can be located on hillsides, lake/pond shorelines, and mounds on glacial outwash channels. Calcareous fens develop under very localized and uncommon hydrogeologic conditions where there are upwellings or lateral flows of mineral rich groundwater. Unlike many terrestrial ecological sites, calcareous fens do not have a single, uniform plant community. Instead, they are a wetland complex typically comprised of different structural parts each with its own plant community or vegetation zone.

Associated sites

R102AY002SD	**Linear Meadow** These sites occur in drainageways or along the edges of closed depressions. Soils are poorly and very poorly drained which have a water table within 0 to 2 feet of the soil surface that persists longer than the wettest part of the growing season typically until the month of August. The central concept soil series are Vallers and Colvin, but other series are included.
R102AY006SD	**Limy Subirrigated** These sites occur along the edges of drainageways. Soils are somewhat poorly drained which have a water table within 2 to 5 feet of the soil surface that persists longer than the wettest part of the growing season typically until the month of August. Soils will effervesce with acid at or near the surface. The central concept soil series is Cubden, Hamerly, McKranz, but other series are included.
R102AY010SD	**Loamy** These sites occur on upland areas. The soils are well drained and have less than 40 percent clay in the surface and subsoil. The central concept soil series is Barnes, Forman, and Poinsett, but other series are included.
R102AY012SD	**Thin Upland** These sites occur on uplands. Soils are well drained and will effervesce with acid at or near the surface. The central concept soil series is Buse, Hattie, Langhei, and Zell, but other series are included.

Similar sites

R102AY039SD	**Shallow Peatland** The Open Peatland organic soils are not calcareous at or near the surface.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Carex prairea* (2) *Schoenoplectus pungens*

Physiographic features

The Calcareous Fen ecological site is located in depressions and fens on moraines and lake plains. These sites have 0-2 percent slope.

Table 2. Representative physiographic features

Landforms	(1) Ground moraine
Runoff class	Very low to negligible
Ponding duration	Very long (more than 30 days)
Ponding frequency	Frequent
Elevation	1,000–2,000 ft
Slope	0–2%
Ponding depth	0–6 in
Water table depth	0 in
Aspect	Aspect is not a significant factor

Climatic features

MLRA 102A is considered to have a continental climate – cold winters and relatively hot summers, low to moderate humidity, light rainfall, and much sunshine. Extremes in temperature may also abound. The climate is the result of this MLRA's location near the geographic center of North America. There are few natural barriers on the Northern

Great Plains and air masses move freely across the plains and account for rapid changes in temperature.

Annual precipitation typically ranges from 21 to 27 inches per year. The average annual temperature is about 43°F. January is the coldest month with average temperatures ranging from about 5°F (Mahnomen 1 W, Minnesota (MN)), to about 14°F (Tracy, MN). July is the warmest month with temperatures averaging from about 69°F (Mahnomen 1 W, MN), to about 73°F (Tracy, MN). The range of normal average monthly temperatures between the coldest and warmest months is about 62°F. This large annual range attests to the continental nature of this area's climate. Hourly winds are estimated to average about 11 miles per hour (mph) annually, ranging from about 13 mph during the spring to about 10 mph during the summer. Daytime winds are generally stronger than nighttime and occasional strong storms may bring brief periods of high winds with gusts to more than 50 mph.

Growth of cool-season plants begins in early to mid-March, slowing or ceasing in late June. Warm-season plants begin growth about mid-May and continue to early or mid-September. Greenup of cool-season plants may occur in September and October when adequate soil moisture is present.

Table 3. Representative climatic features

Frost-free period (characteristic range)	118-127 days
Freeze-free period (characteristic range)	141-148 days
Precipitation total (characteristic range)	24-28 in
Frost-free period (actual range)	105-129 days
Freeze-free period (actual range)	135-155 days
Precipitation total (actual range)	24-28 in
Frost-free period (average)	121 days
Freeze-free period (average)	144 days
Precipitation total (average)	26 in

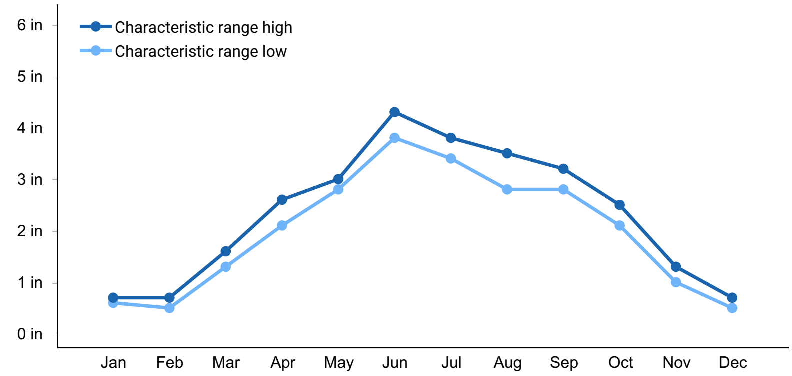


Figure 1. Monthly precipitation range

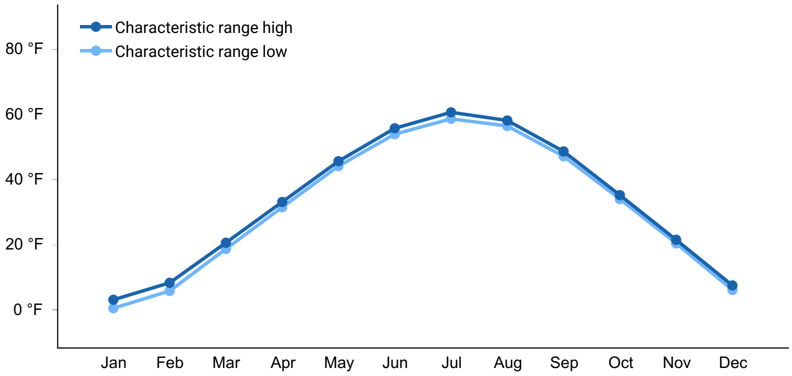


Figure 2. Monthly minimum temperature range

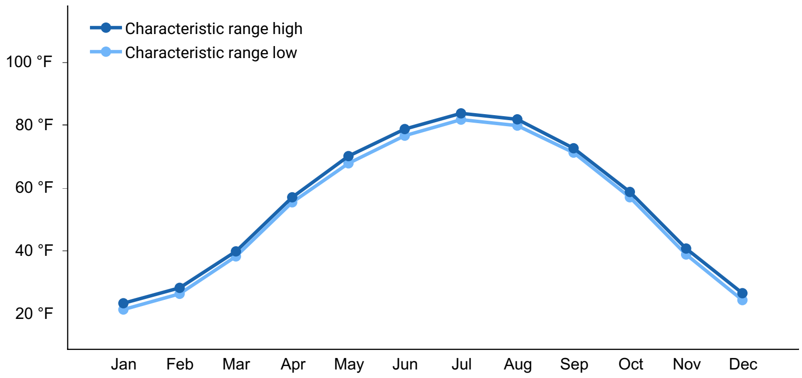


Figure 3. Monthly maximum temperature range

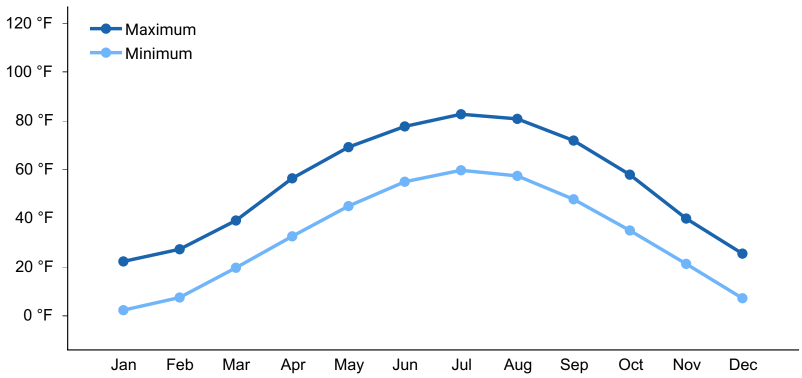


Figure 4. Monthly average minimum and maximum temperature

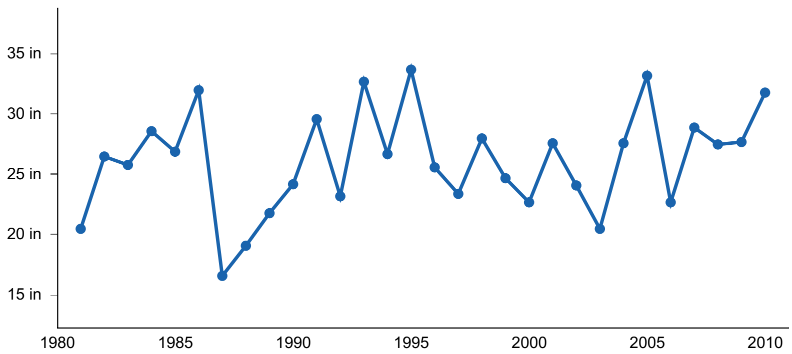


Figure 5. Annual precipitation pattern

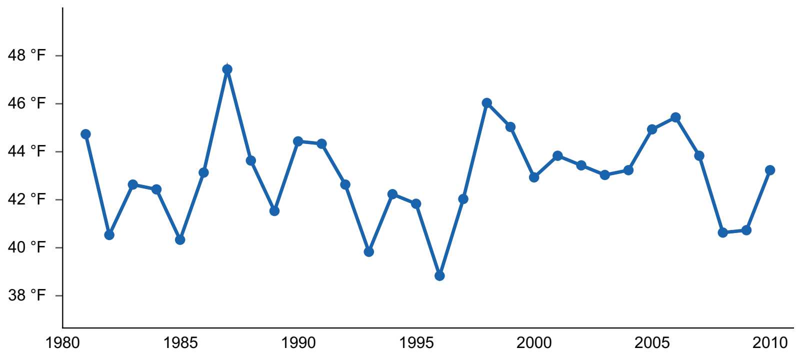


Figure 6. Annual average temperature pattern

Climate stations used

- (1) TYLER [USC00218429], Tyler, MN
- (2) BENSON [USC00210667], Benson, MN
- (3) BROOKINGS 2 NE [USC00391076], Brookings, SD

- (4) BROWNS VALLEY [USC00211063], Beardsley, MN
- (5) CLEAR LAKE [USC00391777], Clear Lake, SD
- (6) GLENWOOD 2 WNW [USC00213174], Glenwood, MN
- (7) MELROSE [USC00215325], Melrose, MN
- (8) MILBANK 4 NW [USC00395536], Milbank, SD
- (9) MORRIS WC EXP STN [USC00215638], Hancock, MN
- (10) ROY LAKE [USC00397326], Lake City, SD
- (11) SISSETON [USC00397742], Sisseton, SD
- (12) SUMMIT 1 W [USC00398116], Summit, SD

Influencing water features

Ponded water conditions and calcareous organic material strongly influences the soil-water-plant relationship. Very localized and uncommon hydrogeologic conditions where there are upwellings or lateral flows of mineral rich groundwater provides the framework for organic soil production and wetland plant communities.

Wetland description

Under the Cowardin wetland classification system this site falls into the Palustrine Emergent Wetland.

Soil features

The common soil features of soils in this site are the calcareous mucky peat subsoil. The soils in this site are very poorly drained and formed in organic deposits within glacial moraines. The peat (fibric material) organic surface layer is 8 to 12 inches thick. The saturated hydraulic conductivity is very high to high and a constant positive water potential is at the surface in all months of the year. A crust consisting of calcium carbonate, manganese, and iron about 1 to 5 inches thick is common in some areas. The soils show no evidence of rills, wind scoured areas, or pedestalled plants. The soil surface is stable and intact. Subsurface soil layers are nonrestrictive to water movement and root penetration. These soils are not susceptible to water erosion. Ponded water conditions and calcareous organic material strongly influences the soil-water-plant relationship. This site is represented by the Seelyeville soil series.

Table 4. Representative soil features

Parent material	(1) Organic material
Surface texture	(1) Peat (2) Mucky peat
Drainage class	Very poorly drained
Permeability class	Slow to moderately slow
Depth to restrictive layer	72 in
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	11.4–14.9 in
Calcium carbonate equivalent (0-40in)	0–60%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Soil reaction (1:1 water) (0-40in)	6.6–7.8
Subsurface fragment volume <=3" (0-40in)	0–5%

Subsurface fragment volume >3" (0-40in)	0–2%

Ecological dynamics

Unlike many terrestrial ecological sites, calcareous fens do not have a single, uniform plant community. Instead, they are a wetland complex typically comprised of different structural parts each with its own plant community or vegetation zone. Calcareous fens develop under very localized and uncommon hydrogeologic conditions where there are upwellings or lateral flows of mineral rich groundwater. On a glacial landscape, these rare hydrogeologic conditions are generally limited to three topographic locations: hillsides, lake/pond shorelines, and mounds on glacial outwash channels (Amon et al. 2002). These groundwater discharge sites support wetland plants whose root materials do not decompose because they are constantly suspended in cold, anoxic water. Peat deposits typically range from a few feet thick to over 10 feet thick representing thousands of years of accumulation (Malterer et al. 1988, Miner and Ketterling 2003, Yu et al. 2003).

Groundwater minerals consist primarily of calcium and other carbonates which are held in suspension until the water is discharged at the surface whereby these carbonates precipitate out of solution and form layers or deposits of marl (calcium rich mud or mudstone) and tufa (porous, crunchy rock of calcium carbonate). A typical fen complex consists of a small, circular or linear discharge zone often with a floating mat of vegetation. Below the discharge zone are often marl flats or slopes with relatively short, sparse vegetation interrupted by small pools of standing water. This transitions into a border zone or zones of wetland vegetation typically with a sharp or gradual transition from organic substrates to the mineral soils of more common, surrounding wetland or upland vegetation.

Discharge zone vegetation (often a floating mat) is relatively species poor and often dominated by coarse sedges and cattails, e.g. water sedge (*Carex aquatilis*), and broadleaf cattail (*Typha latifolia*), whereas the marl flat zone is typically very species rich and dominated by shorter, finer leaved graminoids, e.g. common threesquare (*Schoenoplectus pungens*), needle beaksedge (*Rhynchospora capillacea*), prairie sedge (*Carex prairea*), spiked muhly (*Muhlenbergia glomerata*), and marsh arrowgrass (*Triglochin palustris*). Marl flats also have an abundance of calcium loving and distinctive forbs, e.g. grass of Parnassus (*Parnassia glauca*), Ontario lobelia (*Lobelia kalmii*), lesser fringed gentian (*Gentianopsis virgata*), and northern bog aster (*Symphyotrichum boreale*). A floating-leaved aquatic plant – the lesser bladderwort (*Utricularia minor*) is frequently found in the tiny pools of water that occur throughout the marl flat zone, as is stonewart (Chara spp.) which, although it looks like a submerged aquatic vascular plant, is actually a multicelluar algae.

Below or outside of the marl flat may be border zones of wetland vegetation. These may vary from wet meadow types dominated by fine-stemmed grasses and sedges, e.g. bluejoint (*Calamagrostis canadensis*), or prairie cordgrass (*Spartina pectinata*); to deep marsh vegetation of cattails and bulrushes, or the water may converge into a stream channel along the downslope edge of the marl flat with riparian vegetation including shrubs.

In a study of Midwestern fens across 11 states, including South Dakota, Amon, et al. (2002) concluded that calcareous fens could best be distinguished from other wetland types by 4 characteristics: 1) they are dependent upon mineral rich groundwater discharge which moves through and saturates the root zone for most of the year; 2) unlike ponded wetlands, they do not experience flooding or long term inundation; 3) they develop organic soils, not from sphagnum mosses, but from fibrous roots and brown mosses, and develop carbonate deposits like marl and tufa; 4) they have botanically diverse plant communities dominated by non-emergent graminoids.

In one respect, calcareous fens are extremely stable, undisturbed environments. Only a continuously saturated, anoxic environment could allow the accumulation of peat deposits of 3 to 10 feet thick typical of many calcareous fens. Given the vagarity of the climate on the Great Plains including long term droughts, it is even more remarkable that such permanent and stable saturated conditions have persisted even on such a small scale as these fens. By the same token, these calcareous fens are embedded in a landscape where bison were abundant and prairie fires were frequent. Because of the soft, saturated peaty substrates and floating mats of vegetation fens are somewhat dangerous to large animals who may break through and become bogged down and eventually die in these fens. It seems likely that given alternative water holes, bison and elk would have avoided these boggy traps. Likewise, while prairie fires would have burned across the surface, the perpetually saturated nature of a fen precludes the damage or consumption of the peaty substrates. The fens that did dry up, would have been consumed by fire.

Most calcareous fens are small in size, rarely more than a few acres, which makes them especially vulnerable to hydrologic alteration, ground or surface water pollution, excessive trampling by livestock, invasion by exotic plant species, and easily damaged by herbicide drift or direct application of herbicides. While many calcareous fens discharge water that ultimately ends up in natural streams or ponds (which provide readily accessible water for livestock), some fens have dispersed flows into wetlands. Many such fens have been altered by ditching, damming or excavating for stock ponds. Ditching drains the water away from the root zone making those substrates unsuitable for wetland plants. Without constant saturation, the peat and organic soil begins to oxidize and decompose.

The hydrology of calcareous fens is complicated and difficult to quantify (Thompson et al. 1992, Almendinger and Leete 1998). Clearly these fens depend upon a reliable quantity and quality of groundwater discharge. Ditching alters the hydrology at the fen itself, but the hydrology can also be altered at the recharge end of the aquifer. Gravel mines can remove substantial portions of a near surface aquifer that feeds a fen or alter the recharge zone of such an aquifer. Large irrigation, municipal, or industrial wells can remove enough water from an aquifer to interrupt, if not totally dry up a fen. A relevant example comes from a proposed expansion the Lincoln-Pipestone Rural Water System in southwestern Minnesota. The original proposal called for increased pumping from the “Burr Well Field,” a series of wells located on an aquifer called the “Burr Unit of the Prairie Coteau Aquifer.” This Burr Unit was later mapped out to be an aquifer that, in aerial extent, measured more than 6 miles long and 4 miles wide, with a water-bearing sand and gravel lens that varied from 50 to 95 feet thick, underlain by 159 feet of clay and overlain by 50 to 100 feet of glacial till (Plank et al. 1998). At least six calcareous fen complexes were documented in the vicinity of this Burr Unit. By monitoring the hydraulic pressure at four of these fens while pumping from the aquifer, it was established that at least three of these fens were hydrologically connected to the Burr Unit and were negatively affected by substantial pumping from this Burr Unit aquifer (Plank et al. 1998).

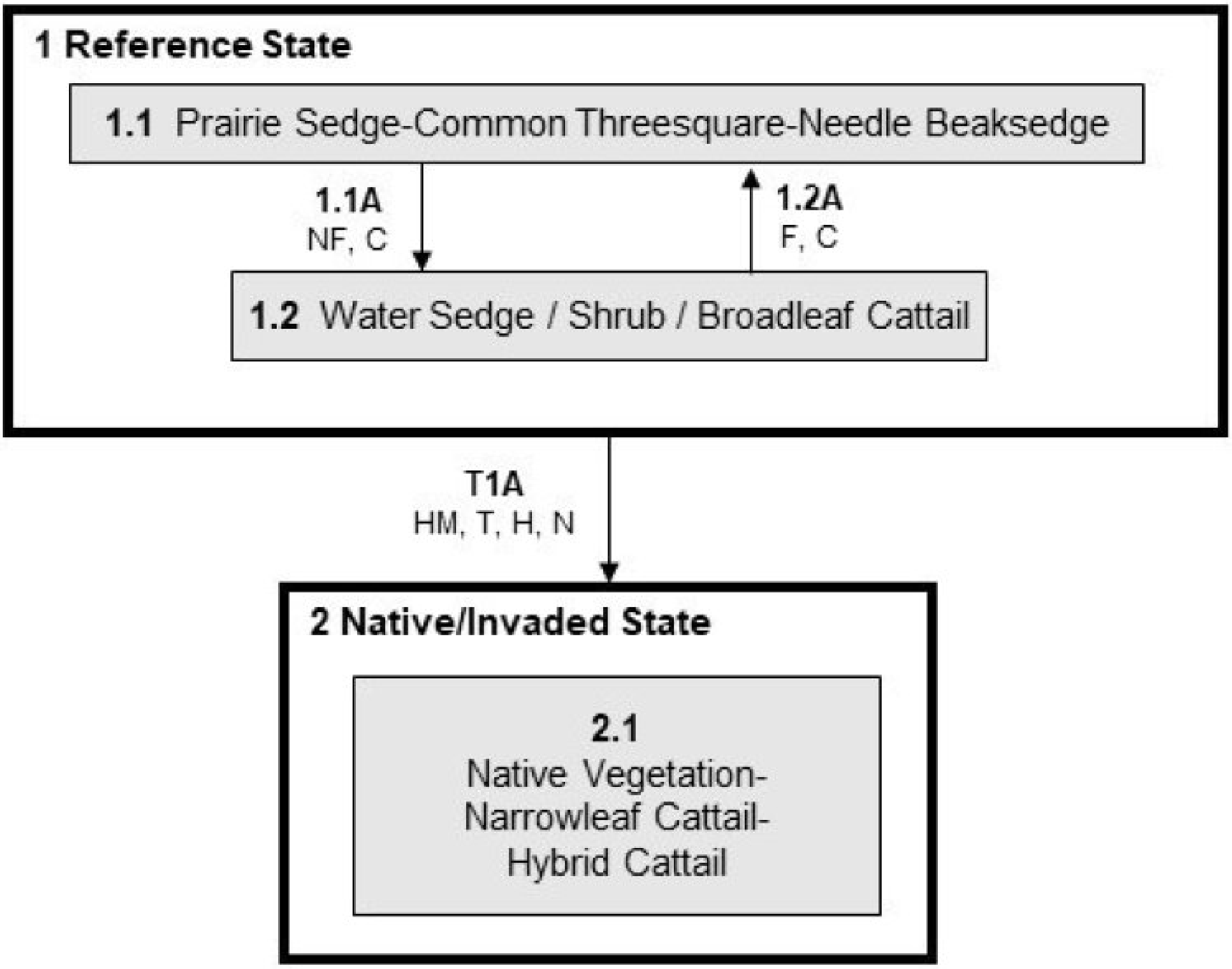
Likewise, the water chemistry of fens is complicated and has not been entirely explained. For example, what causes the plants of the marl flat zone to be rather short and sparse? One theory is that the high calcium content causes phosphorus to precipitate out of solution into chemical forms that are not available to plants, thereby resulting in a nutrient poor condition that limits the growth of taller, more robust vegetation (Amon, et al. 2002). While these nutrient relationships remain mostly untested, it seems likely that the contamination of aquifers that supply water to calcareous fens could significantly alter the native flora and fauna of these habitats. Ground water recharge areas that are located in cropland or urban areas would seem especially vulnerable to increased levels of nutrients like nitrogen and phosphorus.

Like grassland ecological sites, calcareous fens support a diverse plant community that includes increaser and decreaser species based upon their palatability to livestock. Unfortunately, livestock preference of many fen plant species have not been determined.

It is clear that intensive livestock use can alter the surface hydrology of calcareous fen when cattle trample narrow ditches through the shallower peat mats as they trail through the fen. This has the effect of ditching and presumably lowers the water table in at least those portions of the fen so affected.

State and transition model

Calcareous Fen – R102AY038SD (1/17/2020)



<u>LEGEND</u>
Calcareous Fen – R102AY038SD

C – Climate variation
F – Fire
H – Herbicide use
HM – Hydrologic manipulation
N – Nutrient loading
NF – No fire
T – Trampling

Code	Process
T1A	Hydrologic manipulation, trampling, herbicide use, nutrient loading
1.1A	No fire, climate variation
1.2A	Fire, climate variation

State 1
Reference State

This state represents what is believed to show the natural range of variability that dominates the dynamics of the ecological state prior to European settlement. This site, in the Reference State (State 1), is a complex community with different vegetation zones. The marl flat zones are dominated by prairie sedge, common threesquare, and needle beaksedge. Below or outside of the marl flat may be border zones of wetland vegetation. These may vary from wet meadow types dominated by fine-stemmed grasses and sedges, e.g. bluejoint, or prairie cordgrass; to deep marsh vegetation of cattails and bulrushes, or the water may converge into a stream channel along the downslope edge of the marl flat with riparian vegetation including shrubs. The discharge zone is typically dominated by water sedge and broadleaf cattail. Climatic variation, disturbance, and fire are drivers between community phases, while herbivory plays a very minor role as these areas are typically avoided by large ungulates. Invasion of non-native cattails may occur if the hydrology of the site is manipulated through ditching, draining, or excavating, nutrient loading, herbicide use, and/or trampling by livestock. Invasion may also occur due to changes in water pH. This will result in a transition to the Native/Invaded State (State 2).

Dominant plant species

- sageleaf willow (*Salix candida*), shrub
- redosier dogwood (*Cornus sericea*), shrub
- meadow willow (*Salix petiolaris*), shrub
- prairie sedge (*Carex prairea*), grass
- common threesquare (*Schoenoplectus pungens*), grass
- needle beaksedge (*Rhynchospora capillacea*), grass
- spiked muhly (*Muhlenbergia glomerata*), grass
- marsh arrowgrass (*Triglochin palustris*), grass
- water sedge (*Carex aquatilis*), grass
- broadleaf cattail (*Typha latifolia*), grass
- grass of Parnassus (*Parnassia*), other herbaceous
- Ontario lobelia (*Lobelia kalmii*), other herbaceous
- lesser fringed gentian (*Gentianopsis virgata*), other herbaceous
- northern bog aster (*Symphyotrichum boreale*), other herbaceous

Community 1.1
Prairie Sedge-Common Threesquare-Needle Beaksedge (Marl flat zone)

This area of the fen complex is dominated by marls (calcium rich mud or mudstone) and tufa (porous, crunchy rock of calcium carbonate). The zone is typically very species rich and dominated shorter, finer leaved graminoids such as prairie sedge, common threesquare, and needle beaksedge. Other graminoids that could occur on this site include spiked muhly and marsh arrowgrass. This vegetation zone also has an abundance of calcium-loving, distinctive forbs such as grass of Parnassus, Ontario lobelia, lesser fringed gentian, and northern bog aster. This zone is also interrupted by tiny pools of water that support floating aquatic plants such as lesser bladderwort and muticelluar algae like stonewart.

Community 1.2
Water Sedge/Shrub/Broadleaf cattail (Discharge zone)

The Discharge zone vegetation is often found on a floating mat of organic material. This zone is often species poor and dominated by coarse sedges and cattails such as water sedge (*Carex aquatilis*), and broadleaf cattail (*Typha latifolia*). Shrub vegetation may include sageleaf willow (*Salix candida*), redosier dogwood (*Cornus sericea*), and meadow willow (*Salix petiolaris*).

Pathway 1.1A
Community 1.1 to 1.2

Climatic variation, no fire and/or lack of disturbance will shift this community to the 1.2 Water Sedge/Shrub/Broadleaf Cattail (Discharge zone) plant community phase.

Pathway 1.2A
Community 1.2 to 1.1

Climatic variation, fire and/or disturbance will shift this community to the 1.2 Prairie Sedge-Common Threesquare-Needle Beaksedge (Marl flat zone) within the Reference State (State 1).

State 2
Invaded State

The Native/Invaded State is characterized by a shift from native species to inclusion of invasive cattail species such as narrowleaf (*Typha angustifolia*) and hybrid cattail (Typha x glauca) due to hydrologic manipulation from ditching, draining, or excavating, nutrient loading, herbicide use, and/or trampling by livestock. The various forms of manipulation result in a lowered water table, which allows peat and organic soils to decompose in absence of saturation. This altered site provides an environment for non-natives and exotics to invade.

Dominant plant species

- narrowleaf cattail (*Typha angustifolia*), grass
- hybrid cattail (*Typha ×glauca*), grass
- common reed (*Phragmites australis*), grass
- redtop (*Agrostis gigantea*), grass
- prairie sedge (*Carex prairea*), grass
- common threesquare (*Schoenoplectus pungens*), grass
- needle beaksedge (*Rhynchospora capillacea*), grass
- spiked muhly (*Muhlenbergia glomerata*), grass
- marsh arrowgrass (*Triglochin palustris*), grass
- purple loosestrife (*Lythrum salicaria*), other herbaceous
- grass of Parnassus (*Parnassia*), other herbaceous
- Ontario lobelia (*Lobelia kalmii*), other herbaceous
- lesser fringed gentian (*Gentianopsis virgata*), other herbaceous
- northern bog aster (*Symphyotrichum boreale*), other herbaceous

Community 2.1
Native Vegetation-Narrowleaf Cattail-Hybrid Cattail

This community phase is still a complex of native and invasive vegetation. Native vegetation will still include species such broadleaf cattail, prairie sedge, and water sedge, but also will include invasive species such as narrowleaf cattail, hybrid cattail, common reed, purple loosestrife, redtop (*Agrostis gigantea*), and others.

Transition T1A
State 1 to 2

Hydrological manipulation such as ditching, draining, or excavating, nutrient loading from the watershed, herbicide use and/or trampling by livestock may all lead to this shift in plant community. Invasion of nonnative cattails, common reed (*Phragmites australis*), and invasive forbs such as purple loosestrife (*Lythrum salicaria*) leads to a Native/Invaded State (State 2).

Additional community tables

Inventory data references

There is no NRCS clipping data and other inventory currently available for this site. Information presented here has been derived using field observations from range-trained personnel. Those involved in developing this site include: Stan Boltz, Range Management Specialist, NRCS; and Dave Ode, Botanist/Plant Ecologist (retired) State of South Dakota.

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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	09/27/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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

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:**