



## CALCAREOUS FENS

### *Provisional Ecological Site Description*

An Ecological Site Description (ESD) at the Provisional status represents the lowest tier of documentation that is releasable to the public. It contains a grouping of site scale, soil and ecological based units within a Major Land Resource Area (MLRA) that respond similarly to ecological processes. The ESD contains 1) enough information to distinguish it from similar and associated Ecological Sites and 2) a draft state-and-transition model capturing the ecological processes and vegetative states and plant communities as they are currently conceptualized. This Provisional Ecological Site Description is a draft, and was written exclusively by Soil Scientists.

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### General Information

**Provisional Ecological Site Name:**

**Abiotic:** Calcareous Fens

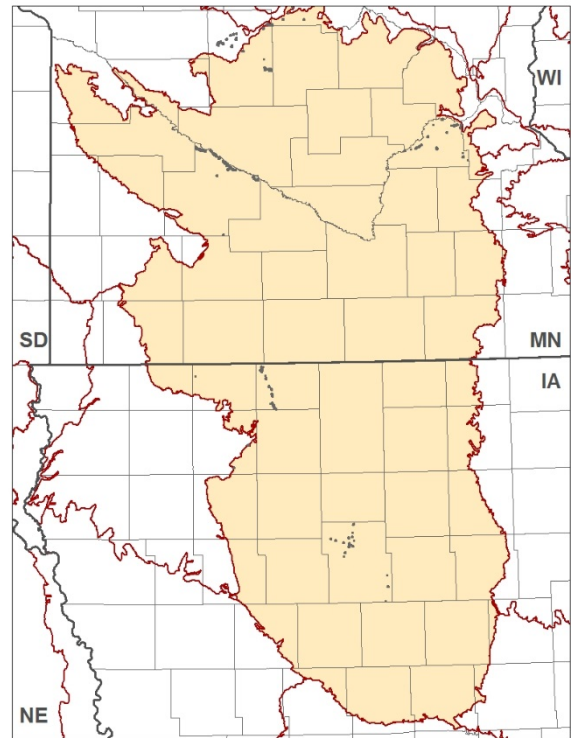
**Biotic:** Prairie Sedge -White Lady's Slipper  
*Carex prairea – Cypripedium candidum*

**Ecological Site ID:** R103XY013MN

**Hierarchical Framework Relationships:**

**Major Land Resource Area (MLRA):** Central Iowa and Minnesota Till Prairies (103) (USDA Handbook 296, 2006)

**USFS Subregions:** North Central Glaciated Plains Section (251B) and Upper Minnesota River-Des Moines Lobe (251BA) Subsections (Cleland et al. 2007)



**Figure 1.** Distribution of Calcareous Fens within MLRA 103. In many cases, data is not spatially consistent across political boundaries due to the method with which soils were mapped; e. g. county subsets.

**MLRA Notes:**

The Central Iowa and Minnesota Till Prairies (MLRA 103) is an expansive and agriculturally important region consisting of nearly 18 million acres and includes all or portions of 63 counties in southern Minnesota and northern Iowa (Figure 1). Because its southernmost extent reaches Des Moines, Iowa, the region is often referred to as the “Des Moines Lobe.” The entire area was glaciated during the most recent glaciation, the Late Wisconsin period ending approximately 12,000 years ago (Ojakangas and Matsch, 1982). These geologically young landscapes mostly are gently rolling, low relief till plains and moraines having poorly integrated drainage networks. With the exception of the glacially-scoured valleys, local relief

is less than 50 feet over most of the land area. The region is considered the southernmost ecoregion within the vast network of glacially-derived prairie pothole landforms of the northern plains. Young glacial landforms with poorly integrated drainage networks and frequent closed depressions cause nearly ubiquitous drainage issues, resulting in hydric soils covering nearly half of the land area within the MLRA. Lakes and various types of wetlands, ranging from permanently-ponded depressions to non-ponded linear slopes and gentle slopes, are abundant.

Soils are primarily Mollisols but also include Alfisols, Inceptisols, Histosols, and a small area of Vertisols. Nearly 300 soil series are mapped in the MLRA, but the top ten represent over half of the land area. The dominant parent material is calcareous fine-loamy till (18-35 percent clay) containing distinctive limestone and shale fragments (Ojakangas and Matsch, 1982). Smaller amounts of both fine till (35-60 percent clay) and coarse-loamy till (<18 percent clay) occur in the far northern and the far southern portions of the region, respectively. Other parent materials include alluvium, outwash, lacustrine sediments, and organic deposits. Areas of outwash and alluvium occur along the major rivers and streams (e.g., Minnesota River, Des Moines River, Skunk River, etc.). Ephemeral glacial lakes deposited silty and/or clayey sediments. Organic deposits occur throughout the region but are most common to the east, particularly in the higher relief landscapes lateral and end moraines.

On a continental scale, MLRA 103 is unique because it is located on the transition from prairie soils to the west and forest soils to the east. In contrast to other parts of the prairie pothole region, the ratio of precipitation to evapotranspiration is nearly equal (or higher) throughout much of the MLRA. Adequate precipitation, coupled with a predominance of fertile prairie soils, makes MLRA 103 one of the most productive agricultural regions in the world. Pre-European settlement vegetation was primarily tallgrass prairie interspersed with wet meadow and marsh communities. Oak savanna and woodland occurred on the lee sides of river valleys, lakes, and other topographic features that provided protection from fire. A large area of mixed hardwood forest also occurred in the northeast part of the MLRA, broadly coincident with the rougher topography of lateral and end moraines. Although geologically related, these lateral and end moraines are ecologically different from other portions of MLRA 103, and thus other ecological classification systems classify that area as distinct from the prairie landscapes to the west (Cleland et al., 2007; MN DNR, 2005).

#### **Provisional Ecological Site Concept:**

Calcareous Fens are a Provisional Ecological Site of low extent (<10,000 acres), occurring in a scattered set of counties in MLRA 103. Landscape positions include sloping and convex landforms which are higher than the surrounding drier mineral soils. Hydrologic interaction with adjacent ground classifies these sites as discharge wetlands. These Provisional Ecological Sites are ponded in their natural state and have a high-water table (i.e., endosaturated) with soils classified as very poorly drained. Soils are Histosols with high organic matter content that developed in areas of intense water discharge from subsurface preferential water flow.

Characteristic vegetation in the reference state includes various sedges (*Carex* L.), white lady's slipper (*Cypripedium candidum* Muhl. ex Willd.), small bladderwort (*Utricularia vulgaris*) and leafy northern green orchid (*Platanthera aquilonis*).

## Physiographic Features

The Calcareous Fens Provisional Ecological Sites are mapped in just a handful of counties in MLRA 103. These counties include Kandiyohi, Stearns, Redwood, Scott, Emmet, Webster, Dickinson, and Clay. This Provisional Ecological Site can be quite convex in shape and highly sloping for an organic/hydric soil; the slope on these can be over 20 percent.

**Table 1.** Physiographic features of Calcareous Fens.  
(Data and information presented here were obtained from the field data, GIS analysis, or the National Soil Information System, and are reflective of knowledge as of 2016.)

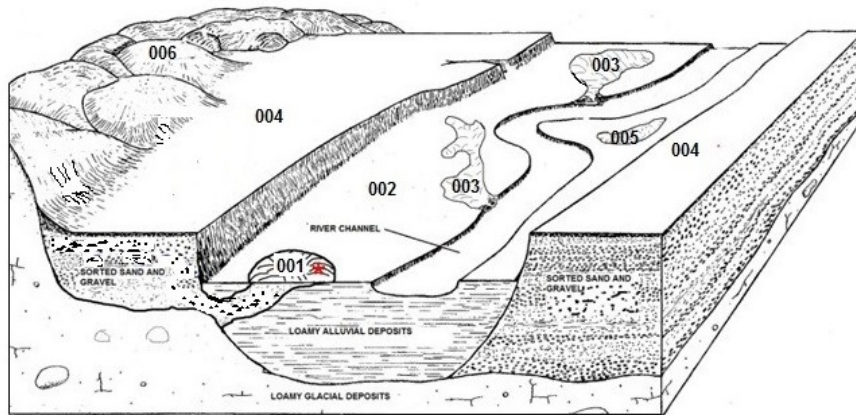
	Minimum	Maximum
<b>Elevation (ft.)</b>	689	1,837
<b>Slope (percent)</b>	0	25
<b>Water Table Depth (in.)</b>	0	50
<b>Flooding Frequency</b>	None	None
<b>Ponding Frequency</b>	None	Frequent
<b>Ponding Duration</b>	None	Long

**Landforms:** till plains, moraines, lake plains, outwash plains, but mostly river valleys

**Hillslope Positions:** Backslopes, summits, shoulders

**Slope Shape:** convex to linear (both up and across slope)

**Aspect:** Does not affect site



Code	Ecological Site Name	Representative Soil Series
001	Calcareous Fens	Klossner, Houghton, Aquolls
002	Loamy Floodplains	Spillville, Minneiska
003	Organic Floodplain Marsh	Muskego, Klossner
004	Sandy Upland Prairie	Esterville, Dickinson
005	Floodplain Marsh	Nishna, Oshawa
006	Loamy Upland Prairie	Clarion, Nicollet

**Figure 2.** Representative block diagram of Calcareous Fens and associated Ecological Sites.

## Climatic Features

The soil temperature regime of MLRA 103 is classified as “mesic” (i.e., mean annual soil temperature between 46 and 59°F). The average freeze-free period of this Ecological Site is 152 days, while the frost-free period is 123 days (Table 2). Average annual precipitation is 28.2 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 35.4 and 55.5°F, respectively. Climate data and analyses are derived from 30-year averages gathered from four National Oceanic and Atmospheric Administration (NOAA) weather stations contained within the range of this Ecological Site (Table 4). The climate ranges/values were copied from the organic marsh. These came from the Wells weather station, which is in a non-fen Muskego delineation. Due to the low extent of Calcareous Fens, and their relatively small size, no weather stations are available on one.

**Table 2.** Frost-free and freeze-free days.  
(Data were obtained from NOAA weather stations, using 30-year averages.)

	Average days
<b>Frost-free period</b> (32.5°F or greater, 90% probability)	123
<b>Freeze-free period</b> (Less than 28.5 °F, 90% probability)	152

**Table 3.** Monthly and annual precipitation and temperature for Calcareous Fen.  
(Data were obtained from NOAA weather stations within the range of this Ecological Site, using 30-year averages.)

	Monthly Moisture (Inches) and Temperature (°F) Distribution				
	-----Precipitation-----			-----Temperature-----	
	Low	Med	High	Average Low	Average High
<b>January</b>	0.37	0.58	1.12	4.9	24.1
<b>February</b>	0.18	0.41	0.78	10.7	28.9
<b>March</b>	0.81	1.57	2.25	23.0	41.3
<b>April</b>	1.33	2.98	3.98	35.2	57.3
<b>May</b>	2.30	3.73	5.35	47.9	69.7
<b>June</b>	2.53	4.35	7.15	58.2	79.3
<b>July</b>	3.39	3.89	6.50	62.4	82.7
<b>August</b>	3.07	4.37	5.99	59.8	80.2
<b>September</b>	1.30	2.31	4.08	50.2	73.2
<b>October</b>	1.32	1.84	2.93	37.5	59.7
<b>November</b>	0.77	1.27	2.38	24.4	42.5
<b>December</b>	0.50	0.94	1.13	10.5	27.5
<b>Annual</b>	-	28.2	-	35.4	55.5

**Table 4.** NOAA climate stations used for data analysis, located within the range of this Ecological Site.

Climate Station ID	Location (County)	From	To
Wells (USC00218808)	Faribault County	1981	2010

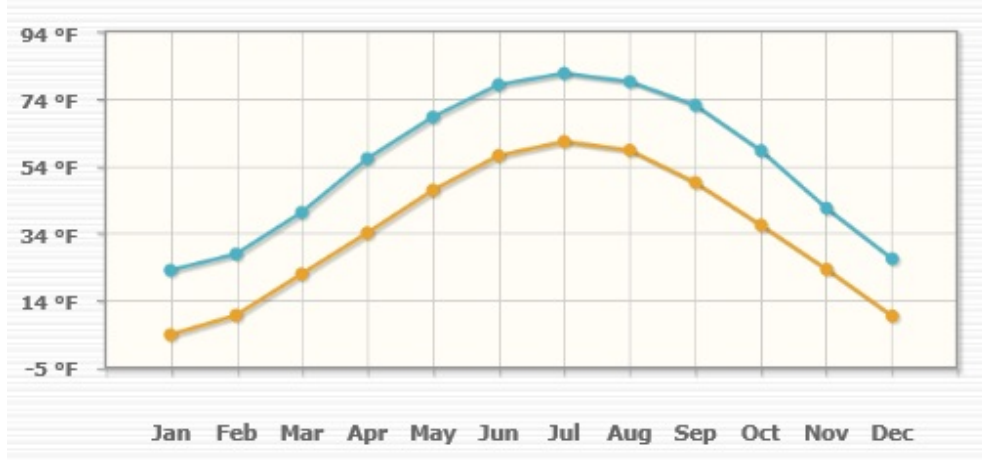


Figure 3. Monthly precipitation

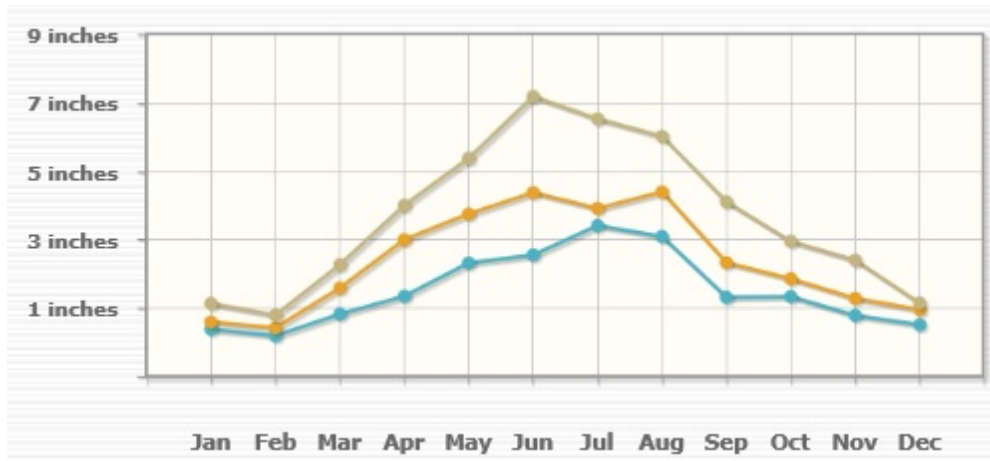


Figure 4. Monthly temperature

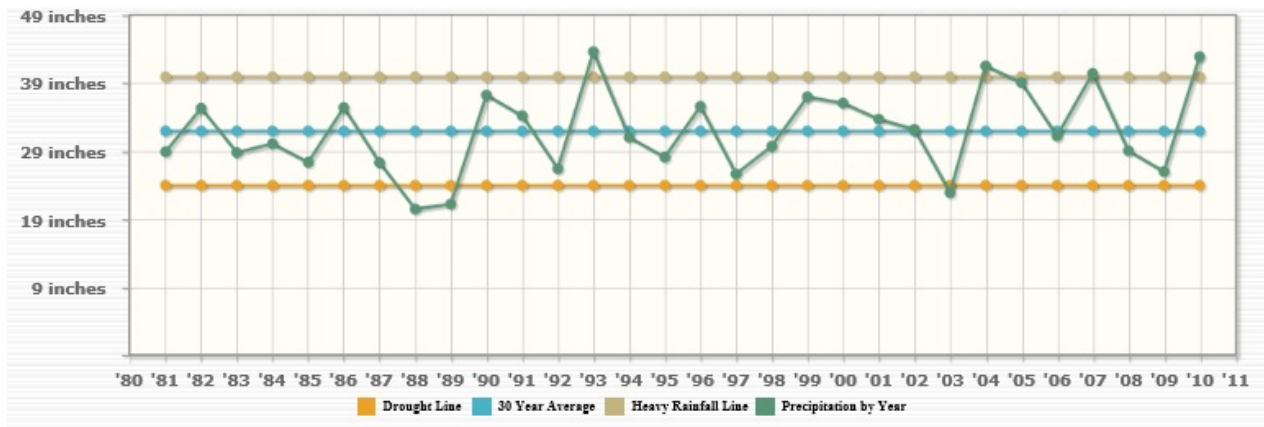


Figure 5. 30-year rainfall

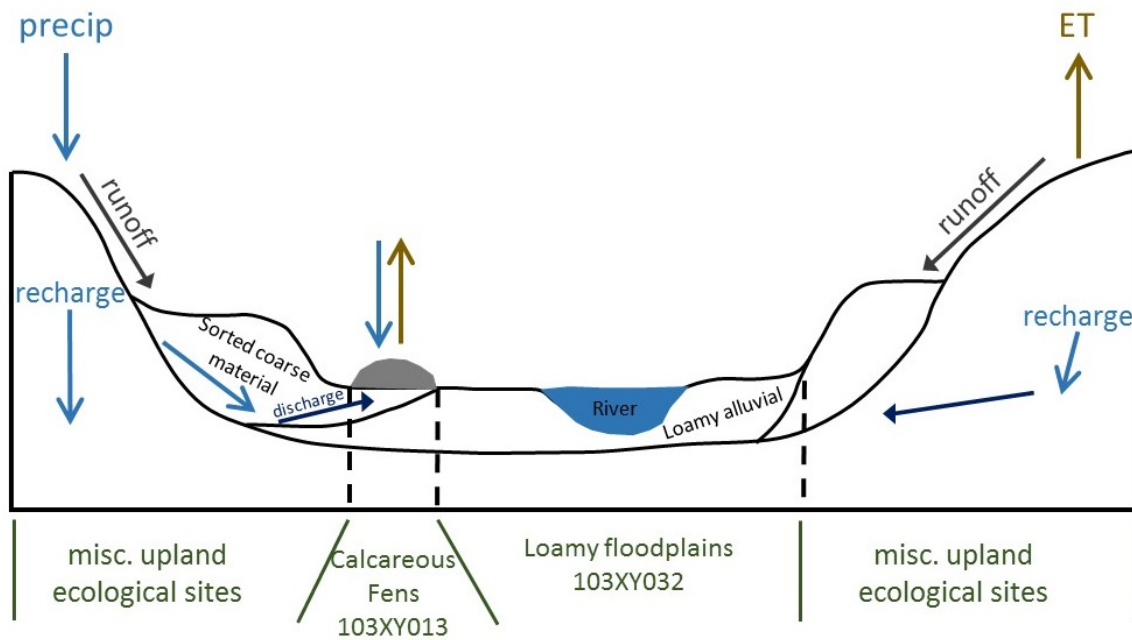
### Influencing Water Features

Calcareous Fens can receive water through precipitation and runoff, but they primarily receive water through discharge from adjacent higher elevation landforms via subsurface ground water flow. The discharge often occurs through veins of relatively coarser material. During the spring or during intense rainfall, these soils are ponded.

The soils of Calcareous Fens Provisional Ecological Sites are classified as endosatuated. The water table is typically above the soil surface during the spring months and may drop to as low as three to four feet later in the growing season during dry periods.

Because of the discharge nature of the hydrology, Calcareous Fens are as the name implies; highly calcareous due to carbonate rich groundwater being discharged to the surface. Draining these has been attempted at times, but is essentially impossible due to continual subsurface discharge of water.

This Provisional Ecological Site has a Saturated Cowardin Hydrologic classification of Palustrine, Emergent Wetland Persistent, Seasonally Saturated. It also has a (United States Army Corps of Engineers) USACE Wetland Plant Community of F; Calcareous Fens (USACE; Wetland Plants and Plant Communities of Minnesota and Wisconsin).



**Figure 6.** Hydrologic representation of a typical Des Moines Lobe (MLRA 103) Calcareous Fen and associated Ecological Sites.

## Representative Soil Features

These soils are rich in organic matter and were developed under hydrophytic vegetation and ponded conditions. Some of the soils included in this Provisional Ecological Site are taxon above family concepts, such as Haplosaprists or mineral Aquolls. Organic soils by definition have thick, dark histic horizons composed mainly of organic matter, mostly the remains of plants. Terric, Limnic and Typic Histosols are central to the Calcareous Fen Provisional Ecological Site. Terric Histosols have a mineral substratum within the range of 16-51 in (41-130cm) and Typic/Limnic Histosols have a mineral substratum below 51-in (130cm). Soil drainage class is very poorly drained. The surface texture is muck, and organic horizons above the mineral soil substratum have around 65 percent organic matter. The subsurface textural group, when present within the series control section, is classified primarily as fine-loamy (with 18 to 35 percent clay) but also includes coarse-loamy (with less than 18 percent clay) and sandy (less than 15 percent clay and 30 percent silt). Palms (more likely Klossner) is the most extensive Terric Histosol in this Provisional Ecological Site, while Houghton and Muskego are the more extensive deeper Histosols. Houghton is a Typic Haplosaprist and Muskego is a Limnic Haplosaprists.

Organic soils, such as Blue Earth which has limnic material, most often form in conditions that were ponded for long periods of time, such as in shallow lakes or ponds, but can also form on fens.

These soils were formed under saturated conditions that produced anaerobic conditions during much of the year. The anaerobic conditions inhibit the decomposition of the organic matter which accumulates to form organic soils

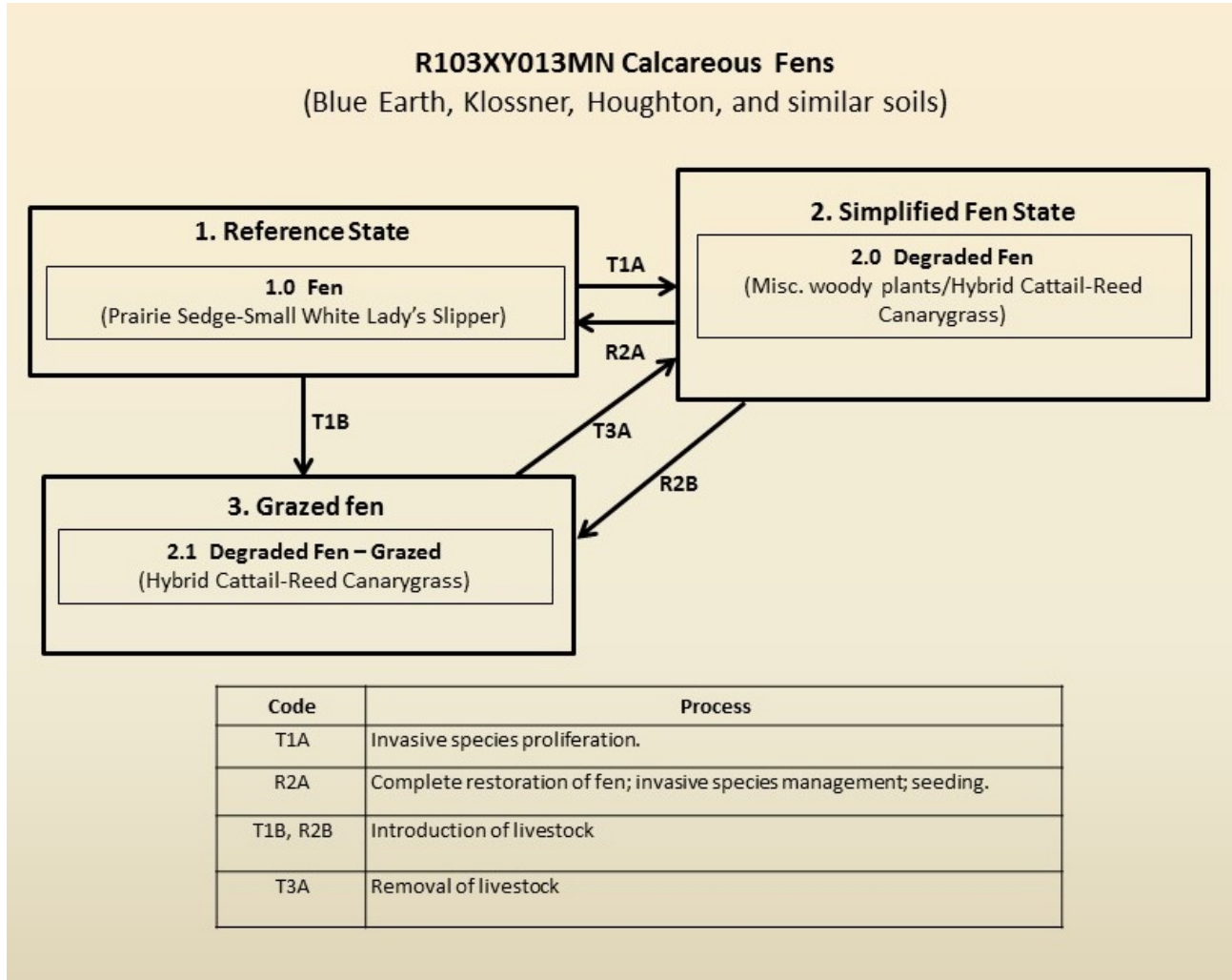
The A and/or 2C horizon, when present in soils like Klossner, typically does not represent the modal glacial till in MLRA 103, but is more representative of glaciofluvial, alluvial or slope wash materials derived from original Des Moines lobe materials. Since this Provisional Ecological Site formed at discharge areas downslope from higher elevations, and near rivers and streams, a certain amount of sediment accumulated before the organic material started to accumulate, or was present previously because of their position on a floodplain.

**Table 5.** Representative soil features of Calcareous Fens.  
 (Data and information presented here were obtained from field data or the National Soil Information System, and are reflective of knowledge as of 2016.)

	Minimum	Maximum
<b>Surface Fragments less than 3" (percent cover)</b>	0	0
<b>Surface Fragments greater than 3" (percent cover)</b>	0	0
<b>Subsurface Fragments less than 3" (percent volume)</b>	0	23
<b>Subsurface Fragments greater than 3" (percent volume)</b>	0	5
<b>Drainage Class</b>	Very poor	Very poor
<b>Permeability Class</b>	Moderately Slow	Rapid
<b>Soil Depth (in)</b>	80	80+
<b>Soil Reaction/pH (1:1 water)</b>	7.0	8.4
<b>Available Water Capacity (inches in 60")</b>	9	24
<b>Calcium carbonate equivalent (%)</b>	0	40
<b>Parent Material – Kind:</b> Limnic and/or organic materials over slope alluvium or alluvial materials		
<b>Parent Material – Origin:</b> Organic materials and/or Wisconsin age glacial materials		
<b>Surface Texture:</b> Muck		
<b>Surface Texture Modifier:</b> none		
<b>Subsurface (below organic material) Textural Group:</b> Fine-loamy, coarse-loamy, fine-silty, coarse silty		
<b>Soil Series:</b> Blue Earth, Klossner/Palms, Houghton, Histosols, Haplosaprists, Aquolls		



## States and Community Phases



**Figure 7.** State-and-transition diagram for Calcareous Fen Provisional Ecological Site.

### Ecological Dynamics

Reference plant communities are characterized as hydrophytic which are characteristic of very poorly drained, ponded conditions and high calcium carbonate conditions due to groundwater discharge.

Fire, drought, and grazing were the primary natural disturbances in pre-settlement MLRA 103 overall. Calcareous Fens may have burned during times of drought.

Most of the wetlands in MLRA 103 were drained and converted to agriculture after European settlement. Calcareous Fens are near impossible to impossible to drain due to the hydrology and their strong discharge nature, and so they tended to escape conversion to row crop agriculture. Some Calcareous Fens were invaded by non-native plant species, and could be restored with appropriate vegetation management.

### STATE 1 – REFERENCE STATE

This state identifies the condition of Calcareous Fens prior to European settlement. The Reference State is dependent upon ponding and groundwater discharge, which makes the soil water very basic in pH. The most common month for ponding in the reference state is April, but these tended to stay ponded for much longer duration than other wetlands in MLRA 103. Most woody species and upland grasses were kept from proliferating mainly by saturated conditions. Dominant species in this state include prairie sedge (*Carex prairea* Dewey ex Alph. Wood) and other various sedges, needle beaksedge (*Rhynchospora capillacea* Torr.), various forbes, small white lady's slipper (*Cypripedium candidum*).

### STATE 2 – SIMPLIFIED FEN STATE

Often, in this Ecological Site, without grazing or mechanical removal to manage vegetation, certain invasive plant species can proliferate. A variety of invasive woody plants and grasses can become established and spread, potentially converting the site to a Simplified Fen state and shading out native species. Common species in this state include narrowleaf cattail (*Typha angustifolia* L.), hybrid cattail (*Typha xglauca* Godr. (pro sp.) [*angustifolia* or *domingensis* x *latifolia*]), common reed (*Phragmites australis* (Cav.) Trin. ex Steud.), reed canarygrass (*Phalaris arundinacea* L.), and various small woody plants.

Sites in this state may be in set-aside conservation easements.

### STATE 3 – GRAZED FEN STATE

This state identifies the grazed state where the growth of woody plants is prohibited or repressed by grazing livestock. Common species in this state include narrowleaf cattail (*Typha angustifolia* L.), hybrid cattail (*Typha xglauca* Godr. (pro sp.) [*angustifolia* or *domingensis* x *latifolia*]), common reed (*Phragmites australis* (Cav.) Trin. ex Steud.), and reed canarygrass (*Phalaris arundinacea* L.).

This Provisional Ecological Site has a variable Land Capability Classification, according to the current (non-SDJR) NASIS data. 6w, 5w, 3w are among the values. This site has severe limitations for agriculture due to strong discharge hydrology. Surface water can generally not be removed. The Hydrologic Soil Group in the current NASIS data is classified as dual; A/D, B/D or C/D.

Information on Land Capability Classification and Hydrologic Soil Groups:

LCC:

[http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2\\_054226#02](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054226#02)

HSG:

[http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2\\_054223#39](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054223#39)

## Supporting Information

### Relationship to Other Established Classifications:

MN DNR Native Plant Community (MN DNR, 2005); the reference community of this Ecological Site is most similar to:

OPp93 Prairie extremely rich fen

### Associated Ecological Sites:

Ecol. Site Name	Site ID	Narrative
Sandy Floodplains	F103XY031MN	There is uncertainty whether these are prairie or forest Ecological Sites. Soils are sandy-textured Mollisols. Soil Drainage class ranges from moderately well to excessively well drained. Size of drainage area and differences in floodplain landforms may warrant further separations. Presumably these soils occur on levee positions or low, active floodplains. Flood frequency and duration have not been considered, due to perceived lack of consistency. Central concept soil series are Zumbro, Buckney, and Minneopa.
Loamy Floodplains	F103XY032MN	Extensive unit. There is uncertainty whether these are prairie or forest Ecological Sites, although it is likely most of these are forests. Both mollic and non-mollic soils are included. Soils are medium-textured and typically cumulic Mollisols. Non-mollic soils are predominately located on the Minnesota River floodplain and are calcareous, medium-textured, stratified recent alluvial materials classified as Entisols. Soil Drainage class ranges from well to somewhat poorly drained. The initial site concept is based on active floodplain; more research is needed to determine if an additional, less frequently flooded ES is needed. Size of drainage area and differences in floodplain landforms may warrant further separations. Flood frequency and duration have not been considered, due to perceived lack of consistency. Common Mollisol series are Du Page, Hanlon, Spillville, and seven others. Common Entisol series are Minneiska, Chaska, and Dorchester.
Wet Floodplains	F103XY033MN	Very extensive unit. There is uncertainty regarding historic vegetation, but since these soils are wet it may be more likely that they would be herbaceous-dominated wetlands. Mollisols and Entisols are included. Mollisols are loamy and clayey, poorly drained, and cumulic. Entisols are stratified and sometimes calcareous. Some calcareous soils are included. Size of drainage area and differences in floodplain landforms may warrant further separations. Flood frequency and duration have not been considered, due to perceived lack of consistency. Mollisol series are Colo, Coland, Havelock, Nishna, and 13 other series are included. Entisols are Chaska, Kalmarville, and Rushriver.

Floodplain Marsh	R103XY034MN	Marshes, herbaceous-dominated plant communities. Soils are fine or medium textured and very poorly drained; some are calcareous. They are classified as either Entisols or Mollisols. Sites are typically both flooded and ponded. More research is needed to determine how these soils fit into a larger floodplain landform model. Central concept soil series include Nishna, Oshawa, Mayer, and four others.
Organic Floodplain Marsh	R103XY035MN	Marshes, herbaceous-dominated plant communities. Soils are very poorly drained and derived from organic parent materials. They are classified as Typic or Terric Histosols. Sites are typically both flooded and ponded. More research is needed to determine how these soils fit into a larger floodplain landform model. Soil series include Muskego, Klossner, Boots, and Houghton.
Sandy Upland Prairies	R103XY003MN	Dry-mesic to mesic prairie. Widely-distributed unit. Soils are mostly well drained (or drier) sandy and coarse loamy outwash and loamy-mantled outwash soils located in outwash plains and valley trains along modern river valleys. Also included, but to a lesser extent, are outwash over till and eolian parent materials. Estherville, Dickinson, Dickman, and Hawick are the predominant soil series, but there are many more included (34 as of 12/14/15). Some outwash-derived Calcic Hapludolls are included in this site concept. SWP- and MW-drained soils are a small portion of this site concept, and are included because of lower AWC. Pure outwash concepts may have been over-mapped.
Loamy Upland Prairies	R103XY004MN	Mesic prairie. Widely distributed and extensive. Well to SWP-drained Mollisols formed in fine loamy till, but also including medium-textured lacustrine soils. Clarion and Nicollet are the central concept soil series, but many more are included (31 total as of 12/14/15). Areas located in the prairie-savanna transition would have included savanna/brush prairie communities historically.

**Similar Ecological Sites:**

None

**Ecological Site Correlation Issues and Questions:**

1. This Ecological Site includes Fens widely scattered over MLRA 103. It is likely that in many counties they were not mapped, but lumped with the normal, depressional organic. In other inventories, such as that of the DNR, there are many more fens than are represented in the soil survey.
2. Some of the land use interpretations in the current NASIS data seem off, such as dual hydrologic groups when this concept is impossible to nearly impossible to effectively drain for agricultural uses.
3. Palms was largely correlated out of MLRA 103 in 2013, except for the fen version. It is likely that this is Klossner (having a mineral 2A horizon rather than organic material straight into a 2C).
4. The taxon above family concepts could probably be correlated to a series upon investigation.
5. In some cases properties like pH in the NASIS data reflect more of the common depressional situations rather than the Calcareous Fen.
6. This Provisional Ecological Site was written primarily by soil scientists, and should be reviewed in depth by an ecologist.
7. Water table depths listed in NASIS are questionable, and ponding is not noted anywhere in any of the concepts' component month tables, even though ponding has been observed in the spring on these by the MLRA 103 staff.

**Other References:**

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