Ecological site R102BY037SD
Deep Marsh

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General information

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

MLRA notes

Major Land Resource Area (MLRA): 102B–Till Plains

The Till Plains (102B) is located within the Western Lake Section of the Central Lowland Province of the Interior Plains. It is entirely in South Dakota, encompassing 2,215 square miles (Figure 1). The elevation ranges from 1,140 to 1,880 feet. The MLRA is characterized by glaciated, nearly level to hilly plains populated by stagnation and end moraines, glacial outwash terraces, and floodplains as the major landforms. The dominant parent materials are silty drift, glacial till, glacial outwash, and alluvium. (USDA-NRCS, 2006)

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic temperature regime, a udic ustic moisture regime and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and clayey or loamy. This area is in the western area of the tall grass prairie and supports big bluestem (Andropogon gerardi), little bluestem (Schizachyrium scoparium), Indiangrass (Sorghastrum nutans), porcupine grass (Hesperostipa spartea), and green needlegrass (Nassella viridula) as the dominant native species. Cattails (Typha), prairie cordgrass (Spartina pectinate), bulrush (Cyperaceae) and reed canarygrass (Phalaris arundinacea) are commonly found on the poorly drained soils. (USDA-NRCS, 2006).

Classification relationships

Major Land Resource Area (MLRA): Till Plains (102B) (USDA-NRCS, 2006)

USFS Subregions: North Central Glaciated Plains Section (251B); Outer Coteau des Prairies (251Bb); Yankton Hills and Valleys (251Bf); Northwest Iowa Plains (251Bd); (Cleland et al., 2007).

US EPA Level IV Ecoregion: Prairie Coteau (46k); James River Lowland (46n); Loess Prairies (47a); Big Sioux Basin (46m) - (USEPA, 2013)

Ecological site concept

The Deep Marsh ecological site typically represents the central portion of a wetland basin or depression on a glaciated prairie landscape with standing water up to five feet deep, and at least some tall, emergent vegetation like cattails, bulrushes, and reeds. In most years there is at least some standing water but in drought years the basin surface may dry out to retain groundwater within one foot of the surface. Ponded water conditions and very slow permeability strongly influence the soil-water-plant relationship. Most uncultivated wetland basins in this MLRA have concentric bands of distinctly different vegetation corresponding with changes in soil and water depth.

Associated sites

R102BY001SD	**Shallow Marsh** These sites occur in a basin or closed depression. Soils are very poorly drained and the site will pond water until early summer in most years. The central concept soil series are Baltic and Worthing, but other series are included.
R102BY006SD	**Limy Subirrigated** These sites occur along the edges of drainageways. Soils are somewhat poorly drained which have a water table within two to five 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 are Davison and Wakonda, but other series are included.
R102BY010SD	**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 are Egan and Wentworth, but other series are included.

Similar sites

R102BY001SD	**Shallow Marsh** The Shallow Marsh site is in a similar landscape position, but the site ponds water until early summer in most years.

Table 1. Dominant plant species

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

Physiographic features

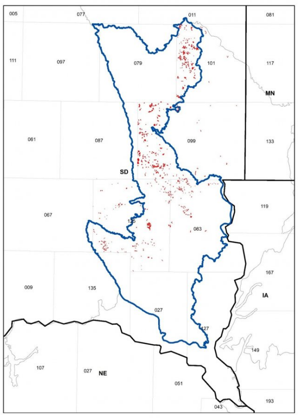

Figure 1. Site Distribution Map for the Deep Marsh site in MLRA 102B.

Table 2. Representative physiographic features

Landforms	(1) Plains > Depression
Ponding duration	Very long (more than 30 days)
Ponding frequency	Frequent
Elevation	1,140–1,880 ft
Slope	0–1%
Ponding depth	0–60 in

Water table depth	0–6 in

Climatic features

Major Land Resource Area 102B is considered to have a continental climate with 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 the location of this MLRA 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 24 to 26 inches per year. The average annual temperature is about 46°F. January is the coldest month with average temperatures ranging from about 14°F (Wentworth 2 WNW, South Dakota, to about 18°F (Canton 4 WNW, SD). July is the warmest month with temperatures averaging from about 72°F (Wentworth 2 WNW, SD), to about 73°F (Canton 4 WNW, SD). The range of normal average monthly temperatures between the coldest and warmest months is about 57°F. This large annual range attests to the continental nature of the climate of this area. 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. Green-up 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)	124-127 days
Freeze-free period (characteristic range)	138-140 days
Precipitation total (characteristic range)	26 in
Frost-free period (actual range)	123-128 days
Freeze-free period (actual range)	137-141 days
Precipitation total (actual range)	26-27 in
Frost-free period (average)	126 days
Freeze-free period (average)	139 days
Precipitation total (average)	26 in

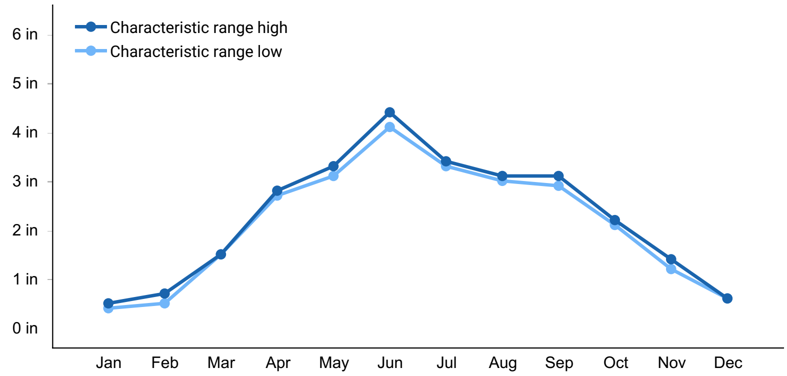

Figure 2. Monthly precipitation range

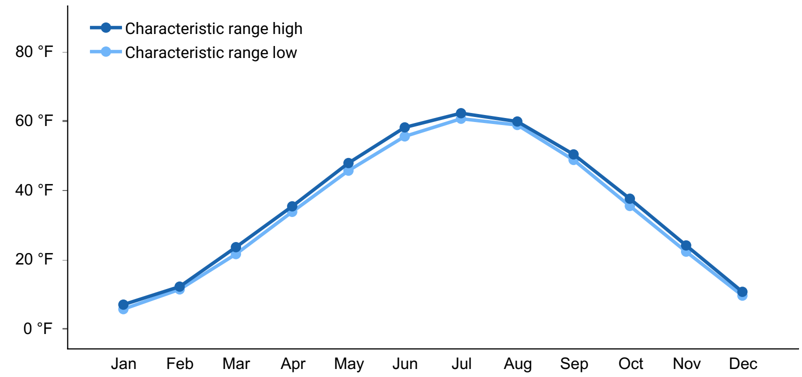

Figure 3. Monthly minimum temperature range

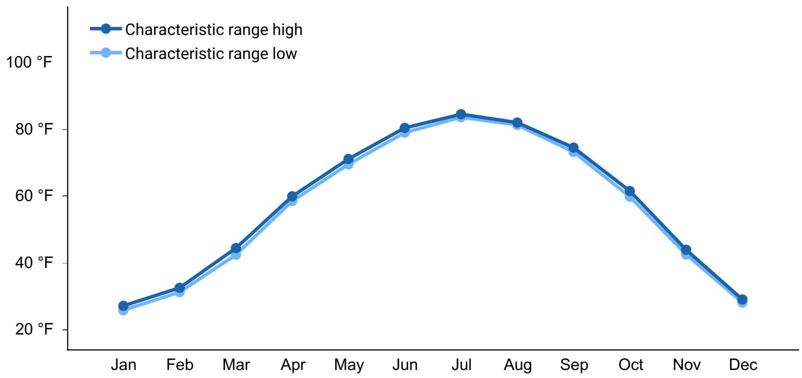

Figure 4. Monthly maximum temperature range

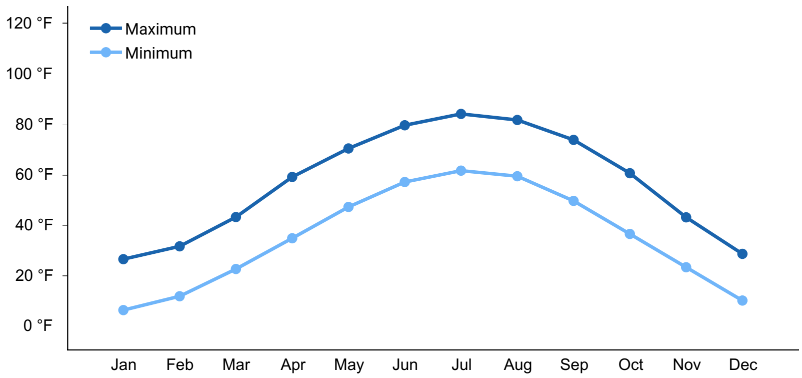

Figure 5. Monthly average minimum and maximum temperature

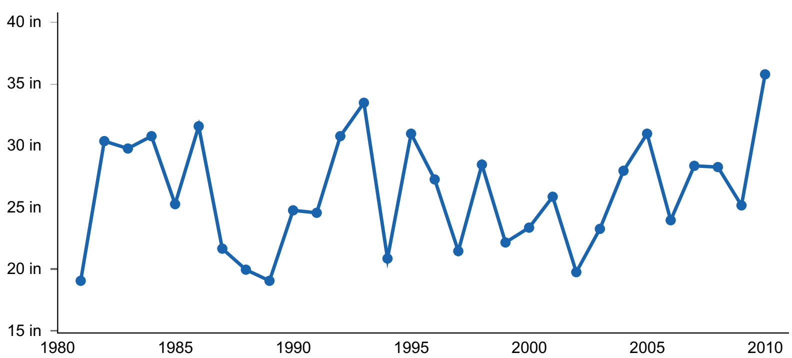

Figure 6. Annual precipitation pattern

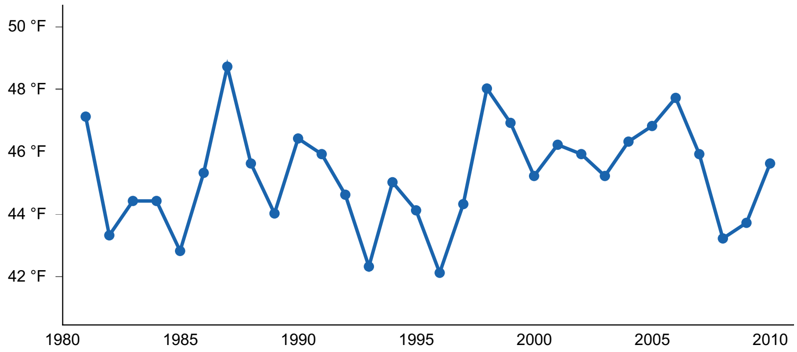

Figure 7. Annual average temperature pattern

Climate stations used

- (1) WENTWORTH 2.5 WNW [USC00399042], Wentworth, SD
- (2) MADISON 2SE [USC00395090], Madison, SD
- (3) MONTROSE 8N [USC00395738], Montrose, SD
- (4) CANTON [USC00391392], Canton, SD
- (5) CENTERVILLE 6 SE [USC00391579], Beresford, SD

Influencing water features

The Deep Marsh ecological site has a combination of physical and hydrological features that: 1) provide season-long standing water on normal years, and retain ground water within one foot of the surface in drought years 2) allows relatively free movement of water and air in the upper part of the soil, and 3) are occasionally to frequently flooded.
Wetland Description: Cowardin, et. al., 1979
System: Palustrine
Subsystem: N/A
Class: Emergent Wetland
Subclass: Semi-permanently flooded, to intermittently exposed

Soil features

The common soil features of soils in this site are the silty clay loam to clay subsoil and slopes of zero to one percent. The soils in this site are very poorly drained and formed in local alluvium. The silty clay loam surface layer is five to 20 inches thick. The soils have a very slow infiltration rate. The central concept soil series is Worthing, ponded, but others are included. 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 very slow permeability strongly influence the soil-water-plant relationship.

Table 4. Representative soil features

Surface texture	(1) Silty clay loam
Family particle size	(1) Clayey
Drainage class	Very poorly drained
Permeability class	Very slow
Soil depth	0–80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	0.11–0.23 in

Calcium carbonate equivalent (0-40in)	0–25%
Electrical conductivity (0-40in)	0–4 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	5.5–8.4
Subsurface fragment volume <=3" (0-40in)	0%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

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

The Deep Marsh Ecological Site typically represents the central portion of a wetland basin or depression on a glaciated prairie landscape with standing water up to five feet deep, and at least some tall, emergent vegetation like cattails, bulrushes, and reeds. In most years there is at least some standing water but in drought years the basin surface may dry out but retain groundwater within 1 foot of the surface. Within other classification systems this ecological site generally corresponds with Stewart and Kantrud's (1971) "Type IV wetland basin," also called a "semi-permanent pond or lake"; and with the "Palustrine Emergent Semi-permanently Flooded to Intermittently Exposed Wetland" of Cowardin, et al. (1979).
Most uncultivated wetland basins in this MLRA have concentric bands of distinctly different vegetation corresponding with changes in soil and water depth. For example, while the center of the basin supports deep marsh vegetation, it is often surrounded by a zone of shallow marsh vegetation, which is in turn surrounded by a zone of wet meadow vegetation, eventually grading outward into upland soils and vegetation. The degree of slope, type of soils, and nature of the local hydrology tend to dictate the number and width of these concentric zones of vegetation.

Given the climatic extremes of the Great Plains with precipitation that ranges from drought to deluge, Deep Marsh wetland basins undergo cycles of flooding and drawdown with corresponding changes in vegetation. These hydrologic cycles and vegetation changes have been described in detail by Stewart and Kantrud (1971), who subdivided them into four phases: 1) Normal Emergent Phase. Historically, this phase of deep marsh vegetation consisted of scattered patches of broadleaf cattail and stands of bulrushes like hardstem, slender, softstem, or prairie bulrush, interspersed with patches of open water supporting submerged or floating leaved aquatic plants like white water-crowfoot, common bladderwort, sago pondweed, water smartweed, and various duckweeds.
In wet years, the water depth in Deep Marsh basins increased and subsequently drowned out the emergent cattails and bulrushes, leading to the 2) Open-water Phase. There may still be cattails and bulrushes on the periphery of the wetland basin during this phase, but the central portion of the basin would have open water with various submerged and floating-leaved aquatic plants, like those mentioned above. With the onset of drought, the wetland basin dries up and enters the 3) Drawdown Bare-soil Phase. With the newly exposed and mostly bare soils, weedy annual and short-lived perennial plants like cockleburs, swamp ragwort, rough barnyardgrass, and foxtail barley invade the wetland basin. Prolonged drought alone (completely dry soils for two years) is also apparently enough to kill broadleaf cattail (Nelson and Dietz 1966). With the return of normal precipitation and runoff, water levels rise, inundating the standing annuals and other plants, leading to the 4) Natural Drawdown Emergent Phase. Seeds of emergent wetland plants like cattails and bulrushes are once again able to germinate and grow on any mudflats or areas of very shallow, standing water (the seeds of most emergent plant species cannot germinate in water deeper than a couple inches). After the drawdown (which also tends to kill any minnows or other aquatic animals) and reflooding, there is a pulse of nutrients from all the recently decomposing vegetation leading to an explosion of aquatic invertebrates. With the return of standing water, the germination of upland plant seeds and most emergent

plant seeds is inhibited, while the germination of submerged and floating-leaved plant seeds are stimulated. With time, the young emergent cattails and bulrushes spread by rhizomatous growth into clonal patches and the cycle repeats itself. Van der Valk and Davis (1978) suggest that these wet-dry vegetation transitions can take from five to 30 years or more to complete a full cycle.

Ecological Dynamics of Deep Marshes:
Besides the effects of wet-dry cycles, Deep Marsh habitats historically were subjected to substantial herbivory from muskrats, in particular; but also the grazing and trampling by large ungulates like bison and elk. Muskrats consume cattail and bulrush tubers as food, but also cut the stems for the construction of their mounds and dens. In most circumstances, muskrats maintain open water patches surrounding their mounds within a larger stand of cattails and bulrushes, but occasionally it is possible for muskrats to overpopulate and virtually eliminate the emergent cattails and bulrushes from a wetland basin (Errington et al. 1963). Prairie fires were a frequent phenomenon on the northern Great Plains and would burn wetland vegetation during drawdown conditions and even consume dry, dense, emergent vegetation standing over shallow water or ice (Kantrud 1986). The invasion of Deep Marsh wetlands by narrowleaf cattail and hybrid cattail, has dramatically altered the ecology of these wetland basins. Narrowleaf cattail is presumed to be an exotic species in much, if not all of North America (Stukey and Salamon 1987), and appears to have been absent from the northern Great Plains until the 1920s and 1930s based upon the absence of this species in early floristic lists for the region (Rydberg 1896, Saunders 1899, Rosco & Clements 1900, Visher 1912, 1914, McIntosh 1931, Metcalf 1931). It appears to have been introduced into the Black Hills (Hayward 1928) and eastern South Dakota (Over 1932) by the late 1920s. Once introduced, narrowleaf cattail began to hybridize with the native broadleaf cattail and formed a new, taller, more aggressive, more persistent “hybrid cattail” (Typha X glauca). Our native broadleaf cattail is killed by water depths exceeding about 64 cm when kept submerged for most of the growing season. In contrast, narrowleaf and hybrid cattail require depths exceeding 100 cm for at least one year or more before they will drown (Steenis et al. 1959, Miklovic 2000). The roots and rhizomes of cattails require oxygen to survive, and obtain most of this oxygen through the aerenchyma tissue of cattail stems and leaves. Thus, the susceptibility to drowning of all cattail species can be enhanced by cutting, grazing or burning to remove these tissues, followed by inundation (Nelson and Dietz 1966, Apfelbaum 1985).

Narrowleaf cattail is also less sensitive to salt concentrations which enables it to grow in more brackish waters than broadleaf cattail. In at least one study (Jarchow and Cook 2009), it was shown that narrowleaf cattail produced allelopathic compounds that inhibited the growth of river bulrush, suggesting yet another competitive advantage against other Deep Marsh emergent plants. The end result is that most Deep Marsh habitats are now dominated by narrowleaf and hybrid cattails and, in at least the shallower wetland basins, the cyclic rotation of vegetational phases due to drought and deluge, has been simplified if not entirely replaced by a monoculture of exotic cattails.

State and transition model

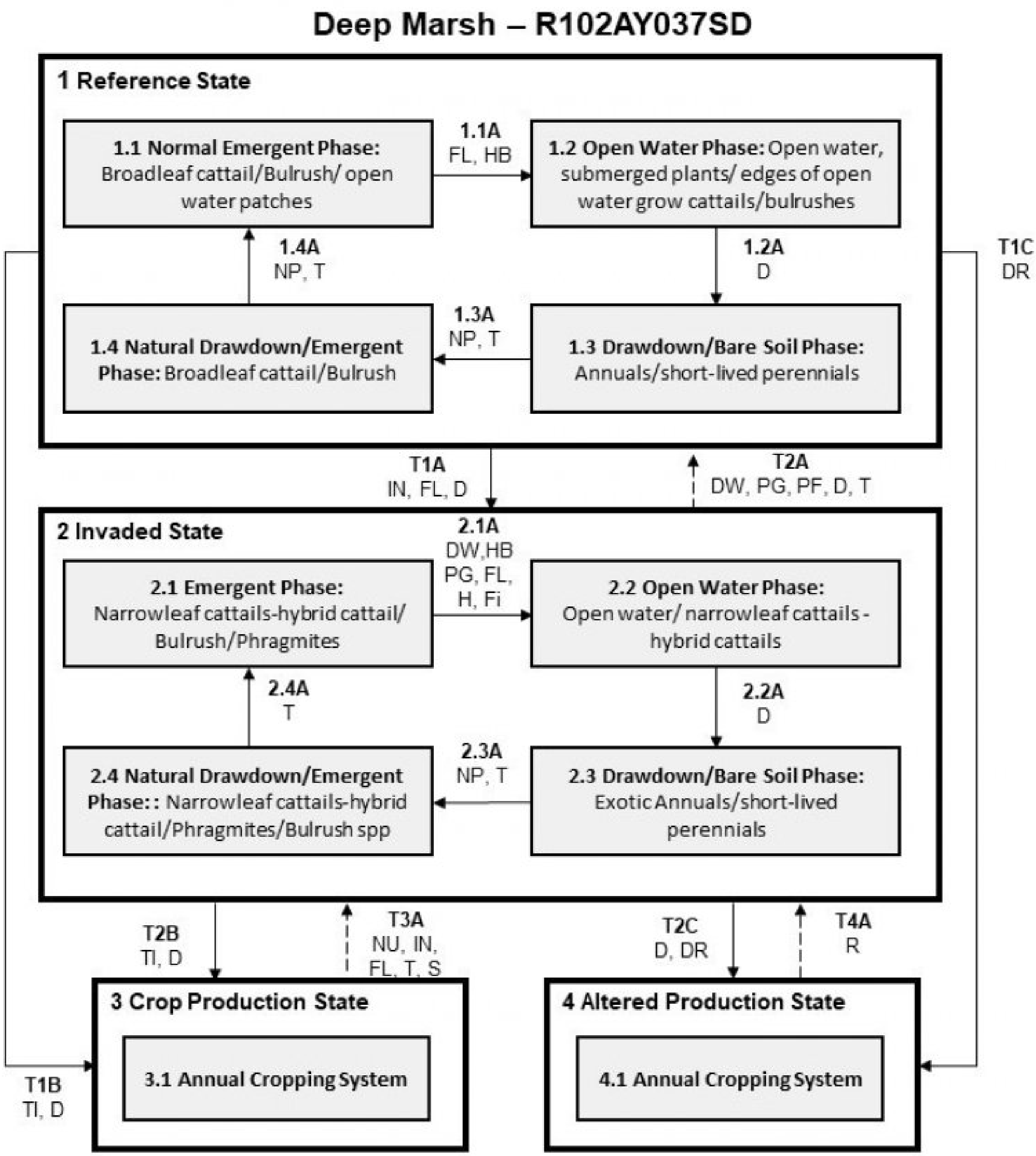

Figure 8. State-And-Transition Model of the Deep Marsh site in MLRA 102B.

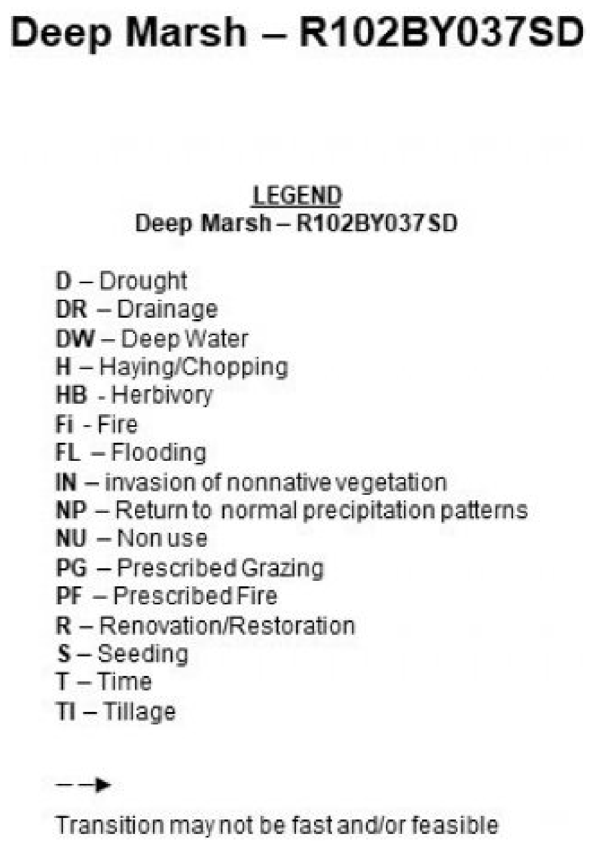

Figure 9. Legend of the Deep Marsh site in MLRA 102B.

Deep Marsh Vascular Plant Species List

USDA Common Name	Scientific Name (from USDA Plants)	USDA Plant Code	Dominant or Abundant	Comments
Emergent Grass-like Plants				
River Bulrush	Bolboschoenus fluviatilis	BOFL3		
Cosmopolitan/Prairie Bulrush	Bolboschoenus maritimus ssp. paludosus	BOMAP4	X	(Scirpus paludosus)
Common Spikerush	Eleocharis palustris	ELPA3		
American Common Reed	Phragmites australis ssp. americanus	PHAU6	Locally	Expanding native
European Common Reed	Phragmites australis ssp. australis	PHAU7		Invasive exotic
Hardstem Bulrush	Schoenplectus acutus	SCAC3	X	
Slender Bulrush	Schoenplectus heterochaetus	SCHE5		
Softstem Bulrush	Schoenoplectus			
Common Rivergrass	Scolochloa festucacea	SCFE		(Whitetop)
Broadfruit Bur-reed	Sparganium eurycarpum	SPEU		
Prairie Cordgrass	Spartina pectinata	SPPE		
Narrowleaf Cattail	Typha angustifolia	TYAN	X	Exotic
Broadleaf Cattail	Typha latifolia	TYLA	X	Native
Hybrid Cattail	Typha x glauca	TYGL	X	Exotic

Common Name	Scientific Name (from USDA Plants)	USDA Plant Code	Dominant or Abundant	Comments
Emergent Forbs				
Tufted Loosestrife	Lysimachia thyrsiflora	LYTH2		
Purple Loosestrife	Lythrum salicaria	LYSA2		Invading exotic
Hemlock Water Parsnip	Sium suave	SISU2		

Common Name	Scientific Name (from USDA Plants)	USDA Plant Code	Dominant or Abundant	Comments
Submerged or Floating-leaved Aquatic Plants				
Coon's Tail (Coontail)	Ceratophyllum demersum	CEDE4		
Turion Duckweed	Lemna turionifera	LETU2		
Shortspike Watermilfoil	Myriophyllum sibiricum	MYSI		(Northern Water-
Water Knotweed	Polygonum amphibium	POAMS		
Water Smartweed	Polygonum amphibium var. emersum	POAME		(Polygonum coccineum)
Small Pondweed	Potamogeton pusillus	POPU7		
Richardson's Pondweed	Potamogeton richardsonii	PORI2		
Flatstem Pondweed	Potamogeton zosteriformis	POZO		
Longbeak Buttercup	Ranunculus longirostris	RALO2		(White Water-
Sago Pondweed	Stuckenia pectinata	STPE15		(Potamogeton pectinatus)
Common Bladderwort	Utricularia macrorhiza	UTMA		

Figure 10. Plant List of the Deep Marsh site in MLRA 102B.

Common Name	Scientific Name (from USDA Plants)	Plant Code	Dominant or Abundant	Comments
A few of the common drawdown plants that colonize dry wetland basins				
Tumble Pigweed	Amaranthus albus	AMAL		
Spearscale	Atriplex patula	ATPA4		
Burning Bush (Kochia)	Bassia scoparia	BASC5		(Kochia scoparia)
Red Goosefoot	Chenopodium rubrum	CHRU		
Barnyardgrass	Echinochloa crus-galli	ECCR		exotic
Rough Barnyardgrass	Echinochloa muricata	ECMU2		native
Foxtail Barley	Hordeum jubatum	HOJU		

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 Europeans settling in North America. This site, in the Reference State (State 1), is dominated by cattails and grass-like vegetation. Drought and flooding are major drivers between plant community phases, while herbivory by native ungulates and other wildlife and fire played a more minor role. Invasion of non-native or hybrid cattails during the drawdown/bare soil phase will result in a transition to the Invaded State (State 2).

Community 1.1
Normal Emergent

Historically, this phase of Deep Marsh vegetation consisted of scattered patches of broadleaf cattail and stands of bulrushes like hardstem, slender, softstem, or prairie bulrush interspersed with patches of open water supporting submerged or floating leaved aquatic plants like white water-crowfoot, common bladderwort, sago pondweed, water smartweed, and various duckweeds.

Community 1.2
Open Water

The transition to an open water phase is due to increased precipitation during wet years. Flooding will drown out cattails and bulrushes in certain areas, but some will still be present on the periphery of the wetland basin during this phase. Herbivory by muskrats or other native ungulates may also help speed the transition to this state. The central portion of the basin will have open water with various submerged and floating-leaved aquatic plants, like those mentioned above.

Community 1.3
Drawdown/Bare Soil

The transition from an open water phase or normal emergent phase due to drought will result in bareground. Weedy annuals and short-lived perennials will invade the basin. Species such as cockleburs, swamp ragwort, rough barnyardgrass, and foxtail barley will replace the cattails and bulrushes.

Community 1.4
Natural Drawdown/ Emergent

The return of normal precipitation and runoff will inundate the basin, killing the annuals and other plants. Seeds of emergent wetland plants like cattails and bulrushes will be able to germinate and grow on mudflats or areas of very shallow standing water. As the water levels return to normal, cattails and bulrushes will colonize the site through rhizomatous growth and submerged and floating aquatic plants will be supported once again, leading to a transition back to the 1.1 Normal Emergent Community Phase with in the Reference State (State 1).

Pathway 1.1A
Community 1.1 to 1.2

Excessive flooding results in an open water phase with mostly submerged species, and cattails and bulrushes around the periphery of the open water. Herbivory by muskrats or other native species may also decrease the amounts of cattails and lead to open water phases as well will shift this community to the 1.2 Open Water Phase within the Reference State (State 1).

Pathway 1.2A
Community 1.2 to 1.3

Drought leads to a Drawdown phase, where open water changes to bare ground. Annuals and short-lived perennials colonization of the bare ground shifts this community to the 1.3 Drawdown/Bare Soil Phase within the Reference State (State 1).

Pathway 1.3A
Community 1.3 to 1.4

Normal precipitation and time allow cattails to recolonize certain areas and will shift this community to the 1.4 Natural Drawdown/Emergent Phase within the Reference State (State 1).

Pathway 1.4A
Community 1.4 to 1.1

Normal precipitation and time allow cattails and other vegetation to return to a normal emergent phase with areas of open water and will shift this community back to the 1.1 Normal Emergent Phase within the Reference State (State 1).

State 2
Invaded State

This state is characterized by a shift from broadleaf cattail dominance to narrowleaf (*Typha angustifolia*) and hybrid (Typha x glauca) cattail dominance – both more invasive cattail species. The transition leads to a more cattail dominated state, decreasing the amount of bulrush species present in this state and also allowing Phragmites to invade as well. This state incorporates the same drought and deluge cycles as the Reference state, but is dominated by invasive and non-native vegetation.

Community 2.1
Emergent

The Emergent phase is dominated by narrowleaf and hybrid cattails with minor amounts of bulrush. Phragmites may also invade during this state. This phase has less open water and more continuous stands of cattails.

Community 2.2
Open Water

The Open Water phase is similar to Reference State (State 1) condition except water must be deeper or cattails must be grazed, cut, or crushed down and inundated in order to reach a deep-water phase.

Community 2.3
Drawdown/Bare Soil

The transition from an open water phase to the Drawdown/*Bare Ground* phase occurs due to drought. The bare ground will be invaded by exotic weedy annuals and short-lived perennials such as barnyardgrass, foxtail barley, and chenopods.

Community 2.4
Natural Drawdown/Emergent

Once normal precipitation patterns have returned, the native wetland seedbank will try to recolonize the site with bulrushes and cattails. Windblown seeds from narrowleaf and hybrid cattails and Phragmites compete with the natives for space.

Pathway 2.1A
Community 2.1 to 2.2

Deep water, herbivory, prescribed grazing, and/or flooding lead to an open water phase. Deeper water than than the Reference State (State 1) is needed to drown out narrowleaf and hybrid cattails. Alternatives to deeper water are any combination of haying, chopping, fire, and crushing cattails followed by flooding. These management strategies will shift this community to the 2.2 Open Water Phase within the Invaded State (State 2).

Pathway 2.2A
Community 2.2 to 2.3

Drought leads to bareground, and exotic annual weeds out compete native annuals to colonize the bareground, resulting in a shift of this community to the 2.3 Drawdown/Bare Soil Phase within the Invaded State (State 2).

Pathway 2.3A
Community 2.3 to 2.4

Normal precipitation and time is needed to recolonize the basin with emergent vegetation. Native seed bank species compete with wind-blown seeds of narrowleaf cattail and Phragmites to colonize the area and will shift this community to the 2.4 Natural Drawdown/Emergent Phase within the Invaded State (State 2).

Pathway 2.4A
Community 2.4 to 2.1

Time allows cattails and other vegetation to return to a normal emergent phase with areas of open water and will shift this community back to the 2.1 Emergent Phase within the Invaded State (State 2).

State 3
Crop Production State

This state is characterized by the production of annual crops. This community phase only occurs during extreme drought years when basin is dry enough to be cropped.

Community 3.1
Annual Cropping System

This plant community developed with the use of a variety of tillage and cropping systems for the production of annual crops including corn, soybean, wheat, oats, and a variety of other crops.

State 4
Altered Production State

This state is characterized by the production of annual crops due to drainage by mechanical means. This state is highly altered and will never return to the Reference State (State 1).

Community 4.1
Annual Cropping System

This plant community developed with the use of a variety of tillage and cropping systems for the production of annual crops including corn, soybean, wheat, oats, and a variety of other crops.

Transition T1A
State 1 to 2

Invasion of non-native cattails and phragmites along with flooding and drought may lead to the Invaded State (State 2).

Transition T1B
State 1 to 3

Extended drought will dry out the site, allowing tillage and annual cropping. This leads to the Crop Production State (State 3).

Transition T1C
State 1 to 4

Drainage allows for the basin to be cropped, leading to the Altered Production State (State 4). Restoration of this state may occur, but natural pathways have been altered and site will never return to Reference State (State 1).

Restoration pathway T2A

State 2 to 1

Deep water or drought may help the Invaded phase return to a more native state within the Reference State (State 1). Narrowleaf and hybrid cattails cannot withstand deep water or drought. A combination of management strategies including prescribed grazing, and burning, may return the site to to a non-native state.

Transition T2B
State 2 to 3

Extended drought dries out the site, allowing tillage and annual cropping which facilitates transition to State 3.

Transition T2C
State 2 to 4

Drainage and drought of basin may allow for the basin to be cropped and may lead to the Altered Production State (State 4). Restoration of this state may occur, but natural pathways have been altered and site will never return to Reference State (State 1).

Restoration pathway T3A
State 3 to 2

Non-use and flooding will allow invasive water-loving plants to revegetate the site over time. Seeding with native vegetation may also speed this process.

Restoration pathway T4A
State 4 to 2

Restoration of the site by plugging ditches will return this site back to a vegetated state. The site has been altered too much to allow a restoration back to the Reference State (State 1).

Additional community tables

Other information

Ecological Site Correlation Issues and Questions:

• SD079 Lake County, SD did not use the (Bb) Baltic silty clay loam, ponded (national symbol g18p) (R102AY999SD ESD) as used in the adjoining SD101 Moody County. SD079 Lake County, SD (Mar) Worthing silty clay loam, ponded, 0 to 1 percent slopes (national symbol 2tlcj) (R55CY037SD ESD) will need to be split correlated to match SD101 Moody County, SD ESD.
• SD079 Lake County, SD did not use the (Bb) Baltic silty clay loam, ponded (national symbol gz33) (R102BY001SD ESD) as used in the adjoining SD099 Minnehaha County. SD079 Lake County, SD (Mar) Worthing silty clay loam, ponded, 0 to 1 percent slopes (national symbol 2tlcj) (R55CY037SD ESD) will need to be split correlated to match SD099 Minnehaha County, SD ESD.
• SD087 McCook County, SD did not use the (Bb) Baltic silty clay loam, ponded (national symbol gz33) (R102BY001SD ESD) as used in the adjoining SD099 Minnehaha County. SD087 McCook County, SD (Bb) Baltic silty clay loam, ponded, 0 to 1 percent slopes (national symbol g0z1) (R55CY999SD ESD) will need to be split correlated to match SD099 Minnehaha County, SD ESD.
• Reference and alternative states within the state and transition model are may not be fully documented and may require additional field sampling for refinement.

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.

Data Source Sample Period State County
None

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Contributors

Stan Boltz

Approval

Suzanne Mayne-Kinney, 2/01/2024

Acknowledgments

Contact for Lead Authors: Natural Resources Conservation Service (USDA-NRCS), Redfield Soil Survey Office, Redfield, SD & Stanton Soil Survey Office, Stanton, NE; Lance Howe (Lance.Howe@usda.gov), Soil Survey Office Leader, USDA-NRCS, Redfield, SD; Steve Winter (Steven.Winter@usda.gov), Soil Scientist, USDA-NRCS, Redfield, SD; and Greg Clark (Greg.Clark@usda.gov), Soil Survey Office Leader, USDA-NRCS, Stanton, NE.

Additional Information Acknowledgment: Emily Helms (Emily.Helms@usda.gov), State Range Management Specialist, USDA-NRCS, Huron, SD; Jason Hermann (Jason.Hermann@usda.gov), Area Rangeland Management Specialist, USDA-NRCS, Redfield, SD; Dave Ode, Botanist/Plant Ecologist (retired) State of South Dakota.

This Provisional Ecological Site concept has passed both Quality Control and Quality Assurance processes. It was officially approved for publication by David Kraft as of 11/12/2020.

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	04/24/2024
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:**