MINNESOTA'S WILDLIFE ACTION PLAN 2025-2035

CONSERVING HABITATS AND BIODIVERSITY

NON-FORESTED WETLANDS

DEPARTMENT OF NATURAL RESOURCES

NONGAME WILDLIFE PROGRAM

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Non-forested Wetlands

Habitat Description

This chapter describes a set of wetland plant communities dominated by herbaceous plants or low-growing woody plant species (shrubs). Non-forested wetlands are found throughout Minnesota and consist of several major types: marshes, wet meadows, fens and bogs. Like all wetlands, non-forested wetlands occur on sites that are flooded or saturated at least seasonally, if not much of the year. Because of periodic or permanent water inundation, soils in these habitats often become anaerobic. Many dominant plants in wetland communities are tolerant of persistent water levels and have stems, leaves and roots that contain intercellular air spaces (aerenchyma) that store oxygen and diffuse it from above-water structures to roots during waterlogged conditions. See also the Coniferous Forest Wetland sub-chapter and the DNR's Wetlands website.

Marshes occur on frequently inundated sites. These communities are typically inundated by nutrient-rich water. They include emergent marshes and open marshes. Emergent marshes are dominated by vascular plants, such as cattails (*Typha* spp.), that can survive indefinitely with their roots and lower stem submerged and their aerial shoots above water. In addition to cattails, emergent marshes are characterized by perennial emergent plants, such as bulrushes (*Scirpus* spp.) and arrowheads (*Sagittaria* spp.), mixed with annual forbs during low-water periods when substrates are exposed, and with floating-leaved and submergent aquatic plants in settings with persistent standing water. Emergent plants provide important habitat for a variety of wetland bird species. Plants with floating leaves, such as water lilies, dominate open marshes, which are sometimes classified as aquatic communities.

Photo: Fen, Maplewood State Park, Amy Kendig

Variation in species composition over time occurs in response to changes in hydrological conditions. See also the Marsh System summaries for the Laurentian Mixed Forest Province, Eastern Broadleaf Forest Province and the Prairie Parkland and Tallgrass Aspen Parklands Provinces.

Wet meadows are graminoid-dominated wetlands that are subjected to periodic relatively brief inundation and drawdowns during the growing season. The dominant graminoids are broad-leaved species such as lake sedge (*Carex lacustris*), tussock sedge (*C. stricta*), and bluejoint (*Calamagrostis canadensis*). Peak water levels are persistent enough to prevent trees from becoming established. However, there may be little or no standing water present during much of the growing season. As a result, the substrate surface alternates between aerobic and anaerobic conditions. Any organic matter that accumulates over time is usually oxidized during periodic drawdowns and may even burn during severe droughts. Soils range from mineral soils to muck and peat. Because surface water is derived from runoff, stream flow, or groundwater, it is approximately neutral (pH 6.0–8.0) and has high mineral and nutrient content. Wet meadows are present statewide on the fringes of wetland basins, along streams and drainageways, in drained beaver ponds, at higher elevations of shallow bays and as semi-floating mats along sheltered lake shorelines. Wet meadows can grade into lowland shrub communities (called carrs) where water levels are lower and less persistent. See also the Wet Meadow/Carr System summaries for the Laurentian Mixed Forest Province, Eastern Broadleaf Forest Province, and the Prairie Parkland and Tallgrass Aspen Parklands Provinces.

Peatlands cover more than six million acres (or approximately 10% of the state), primarily in northern Minnesota, and are a defining feature of its natural landscape (see Minnesota Scientific and Natural Areas Patterned Peatlands).

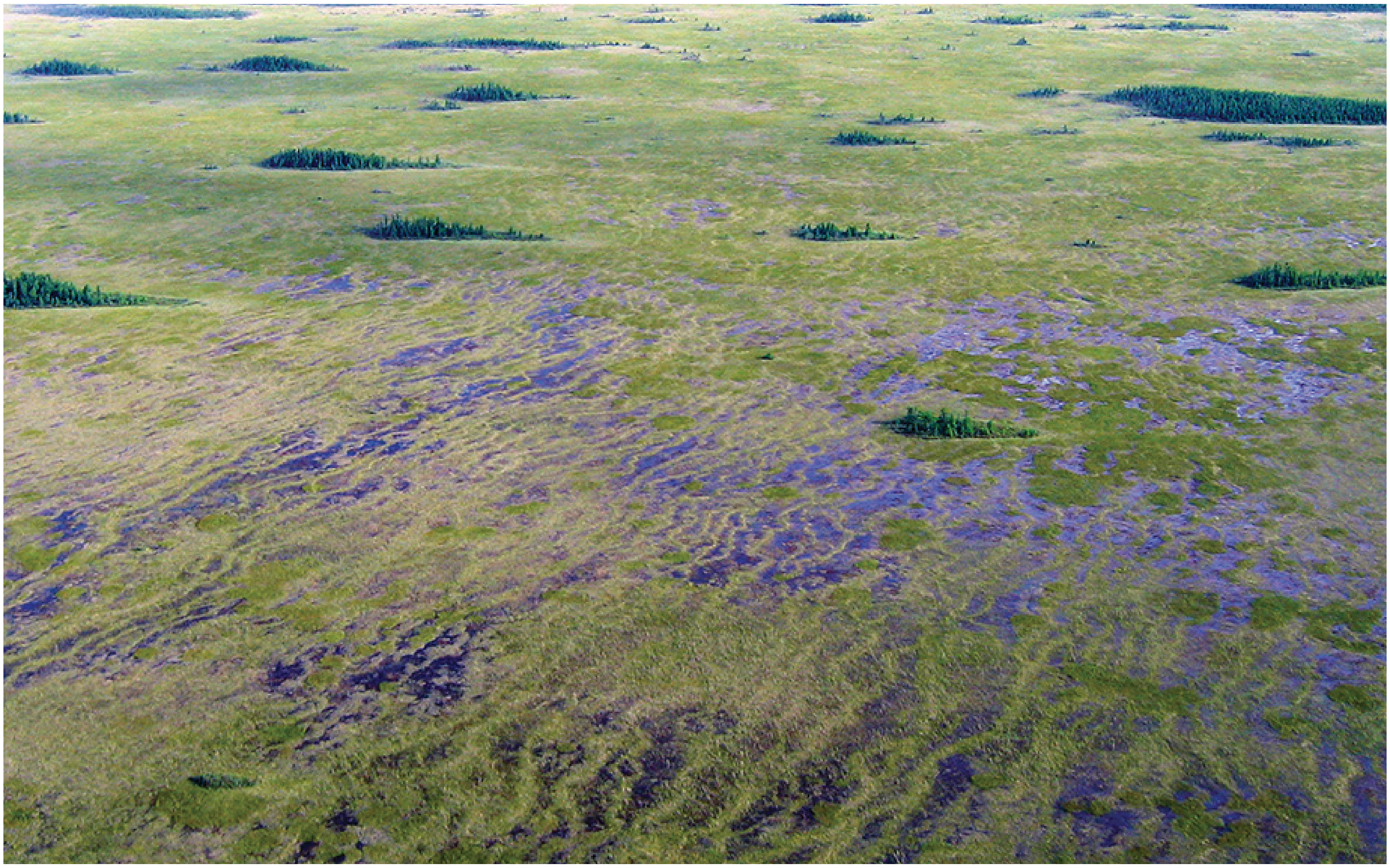

Photo: Red Lake Peatland Scientific and Natural Area, Erika Rowe

These wetlands formed over thousands of years through the slow accumulation of partially decomposed plant material in saturated, low-oxygen conditions. Peatlands may be dominated by mosses such as sphagnum moss (*Sphagnum* spp.) or other plants such as sedges (*Carex* spp.). Some peatlands are forested, primarily by black spruce (*Picea mariana*) and tamarack (*Larix laricina;* also see Conifer Forest Wetland sub-chapter). The resulting deep organic soils, or peat, sequester and store vast amounts of carbon and support unique hydrologic functions, including flood attenuation, water filtration and baseflow regulation (read more about the DNR's Peatland Resilience Initiative). Minnesota's peatlands are broadly categorized into bogs and fens, distinguished primarily by their hydrology and nutrient availability. In 2024, the DNR published a mapping resource entitled Potentially Wet Histosols in Minnesota to display the extent of peatlands across the state.

Bogs receive water only from precipitation. Over time, accumulating sphagnum moss raises the peat surface above the surrounding groundwater table, resulting in acidic (pH < 5.5), nutrient-poor conditions. These environments limit species diversity and are often dominated by black spruce (see Coniferous Forest Wetland sub-chapter) and acid-tolerant sphagnum species. Bogs are most prevalent in northern Minnesota, particularly within the Laurentian Mixed Forest Province, where cool temperatures and high precipitation enable extensive peat development. See also the acid peatland system summaries for the Laurentian Mixed Forest Province, the Eastern Broadleaf Forest Province, and the Prairie Parkland and Tallgrass Aspen Parklands Provinces.

Fens receive mineral-rich groundwater, resulting in more neutral pH conditions (5.6–7.5) and higher concentrations of nutrients such as calcium and magnesium. Fens are divided into forested rich peatlands (see Coniferous Forest Wetland sub-chapter) and open rich peatlands, depending on their vegetation structure. Open rich peatlands are graminoid- or low-shrub dominated communities characterized by sedges (*Carex* spp.), brown mosses, and minerotrophic *Sphagnum* species. These environments favor sun-loving, shade-intolerant species that thrive in wet, nutrient-poor but mineral-rich conditions. Species such as buckbean (*Menyanthes trifoliata*), tufted bulrush (*Scirpus cespitosus*) and Kalm's lobelia (*Lobelia kalmii*) are commonly found in these systems. Adaptations such as aerenchyma tissue allow these plants to survive in saturated soils, while others, like tufted bulrush, form hummocks that lift the plant above anaerobic conditions. Open rich peatland communities are widespread in the Laurentian Mixed Forest Province, where abundant precipitation, cool climate, and poorly drained glacial basins support sustained peat development. However, these communities also extend into the Eastern Broadleaf Forest and Prairie Parkland and Tallgrass Aspen Provinces provinces, where they are typically found near the southern and western margins of the peatland range. In these warmer, more evaporative regions, open rich peatlands are restricted to floating mats or areas with sufficient groundwater input to maintain saturation throughout the growing season.

Calcareous fens are a rare type of fen that develops in areas with particularly high calcium content, often where calcareous glacial till or limestone bedrock is present. These systems support a number of plant Species in Greatest Conservation Need, including highly specialized and rare species such as twig rush (*Cladium mariscoides*) and hairlike beak rush (*Rhynchospora capillacea*), as well as grass of Parnassus (*Parnassia* spp.), a calciphilic (calcium loving) indicator species. Calcareous fens are predominantly located in western and southern Minnesota, including the Minnesota River Valley and parts of the southeastern karst region, where conditions favor calcium-rich groundwater discharge (see also the DNR's Calcareous Fens webpage and Calcareous Fens overview sheet).

Photo: Calcareous fen, Skandia Wildlife Management Area, Megan Benage

Habitat Map

To depict non-forested wetland habitat (see Figure 3.15), we compiled spatial data from several sources: DNR's Native Plant Communities, National Wetland Inventory for Minnesota and Midwest Terrestrial Habitat System created by the USFWS Midwest Landscape Initiative (for more information, see Habitat Map Methods in Chapter 3. Habitats). We note included sub-types below; underlined items have links to online descriptions.

Associated Native Plant Community Classes by Ecological Systems

Marsh (MR)

MRn83 Northern Mixed Cattail Marsh (PDF)

MRn93 Northern Bulrush-Spikerush Marsh (PDF)

MRu94 Lake Superior Coastal Marsh (PDF)

MRp83 Prairie Mixed Cattail Marsh (PDF)

MRp93 Prairie Bulrush-Arrowhead Marsh (PDF)

Wet Meadow / Carr (WM)

WMn82 Northern Wet Meadow/Carr (PDF)

WMs83 Southern Seepage Meadow/Carr (PDF)

WMs92 Southern Basin Wet Meadow/Carr (PDF)

WMp73 Prairie Wet Meadow/Carr (PDF)

Open Rich Peatland (OP)

OPn81 Northern Shrub Shore Fen (PDF)

OPn91 Northern Rich Fen (Water Track) (PDF)

OPn92 Northern Rich Fen (Basin) (PDF)

OPn93 Northern Extremely Rich Fen (PDF)

OPp91 Prairie Rich Fen (PDF)

OPp93 Prairie Extremely Rich Fen (PDF)

Acid Peatland (AP)

APn90 Northern Open Bog (PDF)

APn91 Northern Poor Fen (PDF)

National Wetlands Inventory

From the National Wetland Inventory for Minnesota (NWI) Layer we included these Simplified Plant Community Class types: Shallow Marsh, Deep Marsh, Seasonally Flooded/Saturated Emergent Wetland, Shrub Wetland, Open Bog and Shallow Open Water Aquatic Community.

Midwest Terrestrial Habitat System

From the Midwest Terrestrial Habitat System we included these groups: Eastern North American Boreal-Subboreal Alkaline Fen, Midwest Prairie Alkaline Fen, Eastern North American Freshwater Marsh, Eastern North American Ruderal Meadow & Shrubland and Eastern Ruderal Wet Meadow & Marsh.

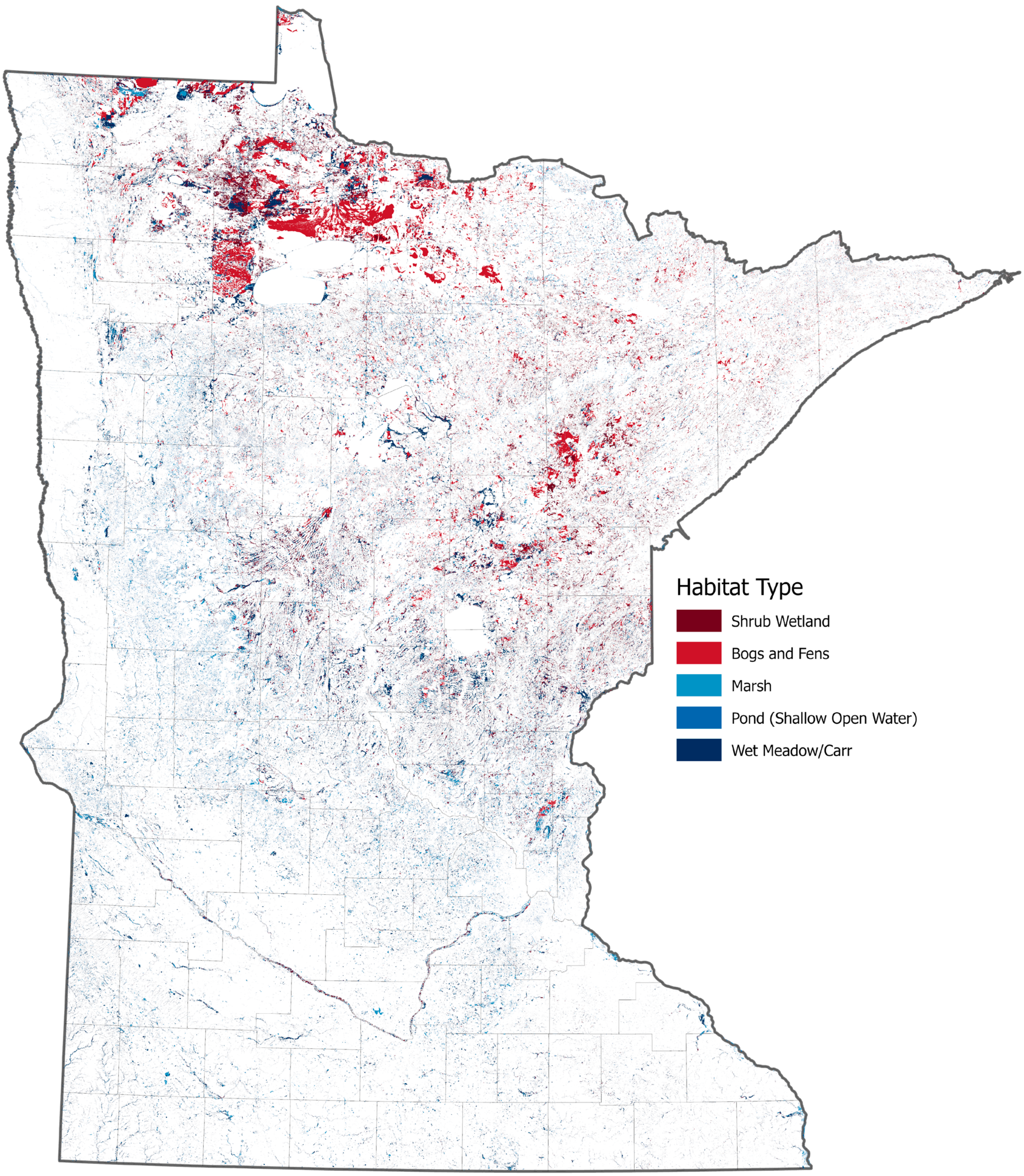

Figure 3.15. A map depicting Non-forested Wetland habitat in Minnesota, including DNR Native Plant Community Classes in the Ecological Systems of Marsh, Wet Meadow/Carr, Open Rich Peatland and Acid Peatland, as well as several types from the National Wetland Inventory for Minnesota and Midwest Terrestrial Habitat System (see narrative).

Conservation Overview

Wetlands provide a number of ecological benefits to the landscapes in which they are found, including erosion control, flood control, groundwater recharge and discharge, water quality, recreation, habitat for rare plant and animal species, and economic and cultural value.

Prior to European settlement, Minnesota's wetlands covered about 18.5 million acres, accounting for nearly 35 percent of the state's landscape (Phillips, 1997). Since then, approximately half of those wetlands have been lost, primarily through conversion and drainage for agriculture, urban development and other land use changes, leaving just over 10 million acres of wetland today (Haga, 2015). Losses have been most severe in southern and western Minnesota, where up to 95 percent of original wetlands have vanished. Northern wetland complexes remain relatively intact and high-quality (Minnesota Pollution Control Agency, 2025). Although Minnesota's 1991 Wetland Conservation Act has largely limited acreage losses, overall wetland quality continues to face threats from invasive species, altered hydrology and nutrient loading (Marohn, 2024). While there are new additions to wetland acreage in Minnesota, replacement wetlands can lack the diversity and complexity of natural wetlands (Whigham, 1999). Of particular note are peatlands, one of Minnesota's most ecologically significant landscapes. Historically, peatlands were considered as unproductive and unusable land, and European settlers drained them for conversion to agriculture and forestry uses (The Nature Conservancy, 2025). Peat was also harvested for fuel and horticultural use, and in the 1970s and 1980s, proposals emerged to develop peat as an energy resource (Keirstead, 1992). However, most of these plans were abandoned due to economic, environmental and regulatory concerns, coupled with increasing recognition of the ecological importance of peatlands.

Today, peatlands are valued for the many ecosystem services they provide. They are globally significant carbon sinks, storing vast amounts of carbon and helping to regulate greenhouse gases. When disturbed or drained, however, peatlands can become major sources of carbon dioxide and methane emissions. Ecologically, they support unique plant and animal communities adapted to wet, acidic, nutrient-poor conditions, including carnivorous plants, rare orchids, boreal birds and several SGCN. Peatlands also play an important role in hydrology, storing and slowly releasing water to moderate flood risks and maintain base flows, while filtering sediments and nutrients to improve water quality (Bonn et al., 2016). Their relative intactness also makes them likely refuges for species as climate conditions shift.

Recognizing their ecological value, Minnesota has taken steps to conserve peatlands through legislation and land protection. The Minnesota Peatland Protection Act of 1991 established a system for identifying and safeguarding high-quality peatland ecosystems, including the designation of Scientific and Natural Areas (SNAs) such as the Red Lake and Lost River peatlands. Many peatlands are now managed under state or federal ownership, with careful consideration given to land use, restoration potential and climate resilience. These efforts reflect the growing understanding that peatlands are not only biologically rich and hydrologically important but also essential in mitigating climate change.

Calcareous fens are one of Minnesota's rarest and most ecologically unique wetland types, which supports an assemblage of specialized and often endangered plant and animal species, many of which are found nowhere else in the state (Walker et al., 2023). Historically, calcareous fens were more common across Minnesota's landscape, particularly in the western and southern regions where glacial activity and underlying calcareous bedrock created suitable conditions (see also Calcareous Fens). However, their extent has been dramatically reduced since European settlement due to agricultural drainage, groundwater pumping and development (Bart, 2011). Their location on flat or gently sloping lands made them attractive for conversion to cropland, and many were drained or filled before their ecological importance was fully understood. In the 20th century, some fens were also affected by excavation for peat or marl and by groundwater withdrawals that altered the delicate hydrology required to sustain fen ecosystems (Prince, 1997).

Today, calcareous fens are recognized as exceptionally valuable and fragile ecosystems. Minnesota's 1991 Wetland Conservation Act specifically protected calcareous fens stating that they cannot be filled, drained, or degraded, by any activity unless under an approved management plan where mitigation is sought (MN Statue 103G.223). They are home to a diversity of rare and state-endangered plant species, such as the flowering plant valerian (*Valeriana edulis*), sterile sedge (*Carex sterilis*), hair-like beak rush (*Rhynchospora capillacea*), and slender reedgrass (*Calamagrostis stricta*), as well as rare orchids, mosses, and invertebrates including many SGCN (see Calcareous Fens). Because they are groundwater-fed, calcareous fens are especially sensitive to changes in hydrology and land use, including groundwater withdrawals from nearby municipal, industrial, or agricultural wells (Bart, 2022). Their ecological function depends on maintaining stable, clean and abundant groundwater flow, which not only sustains fen vegetation but also buffers downstream water bodies against sedimentation and nutrient overload. The DNR identifies and maintains a list of over 200 documented calcareous fens, and active efforts are in place to monitor, research and protect these critical habitats (see also Calcareous Fens).

Climate Profile for Non-forested Wetlands

We provide information on anticipated future climate effects in non-forested wetland habitat types from two reports created by the U.S. Geological Survey Midwest Climate Adaptation Science Center in support of State Wildlife Action Plans. All content in this section is derived from these reports: "Effects of Climate Change on Midwestern Ecosystems: Eastern North American Temperate Freshwater Marsh, Wet Meadow and Shrubland" (Ratcliffe et al., 2025a) and "Effects of Climate Change on Midwestern Ecosystems: Bogs and Fens" (Ratcliffe et al., 2025b).

The primary stressor for marsh and wet meadow/carr wetlands is fluctuating hydrology. There is anticipated more frequent and severe flooding driven by increased spring precipitation in more frequent extreme events. In addition, summer and fall droughts will likely be more frequent, driven by higher temperatures and evapotranspiration demands.

Projected changes in annual temperatures in the Mixed Wood Plains ecoregion of central Minnesota for the late century (2070-2099) are 6 – 11 degrees F over historical (1971-2000), depending on emissions and using the mean of 20 climate models (Table 2 in Ratcliffe et al., 2025a). Spring precipitation is projected to rise 25% over historical conditions by end of century (Table 4 in Ratcliffe et al., 2025a). The frequency of 30-yr droughts is projected to be as much as 917% over historical rates by end of century (Table 5 in Ratcliffe et al 2025a).

Marshes (from the North American Freshwater Marsh section of Ratcliffe et al., 2025a)

Marshes are adapted to fluctuating hydrology, typically with plants suited for various inundation levels in zones within them. However, shallow marshes may be sensitive to water deficits.

- **Habitat Structure** - Flooding may increase nutrient inputs and sediment deposition from adjacent developed or agricultural areas, increasing eutrophication, the distribution of invasive species and altering habitat structure through scouring and deposition. Increased drought phases may accelerate decomposition, carbon dioxide release and mineralization during dry periods.

- **Community Composition** – Due to the increased incidence of flooding as well as drought, the particulars of which species will be favored under future climate conditions is likely quite site-specific. More frequent, severe drought may favor facultative wetland species rather than obligate and promote meadow and shrub species more typical of drier-adapted communities. Wild rice (*Zizania palustris*) marshes may be particularly vulnerable to hydrological change, because as annuals they can be easily uprooted during flooding or outcompeted under both flooding and drought.
- **Problematic Species** – Prolonged flooding and increased nutrient loads may favor species such as reed canarygrass (*Phalaris arundinacea*), European common reed (*Phragmites australis ssp. australis*) and cattails (*Typha* spp.).

Wet Meadow/Carr (from the Midwest Wet Prairie, Wet Meadow, and Shrub Swamp of Ratcliffe et al., 2025a)

These wetlands are typically shallow, seasonally or intermittently flooded wetlands. Their hydrology is largely reliant on precipitation and snowmelt, and increased evapotranspiration rates driven by higher temperatures may exacerbate their vulnerability to drying.

- **Habitat Structure** - Flooding may increase nutrient inputs and sediment deposition from adjacent developed or agricultural areas, increasing eutrophication, the distribution of invasive species and terrestrialization. Increased drought phases may reduce wetland habitat extent through drying soils. Frequent shifting of soil between aerobic and anaerobic states may slow decomposition, denitrification and plant nutrient uptake during saturation and accelerate decomposition, carbon dioxide release and mineralization during drought.
- **Community Composition** – Given the projected increase in both flooding and drought, the plants that will be favored under future climate conditions will likely vary considerably from site to site. Flood-tolerant species may become more dominant. Drought may facilitate dominance by annuals and rhizomatous graminoids, shifting communities toward shrubs and graminoids typical of drier-adapted communities.
- **Problematic Species** – Prolonged flooding and increased nutrient loads may favor species such as reed canarygrass, European common reed and cattails. Warming trends may also create conditions favorable to expansion of invasive taxa from more southern regions.

Bogs (acid peatlands) – (from the Eastern North American Boreal-Subboreal Bog and Acidic Fen section of Ratcliffe et al., 2025b)

In the Northern Forest ecoregion of northeastern Minnesota, projected changes in annual temperature by end of century (2070-2099) are 6 – 11 degrees higher than historic (1970-2000), depending on the carbon emissions level and using the mean of 20 climate models (see Table 9 in Ratcliffe et al. 2025b). Rainfall projections include greater expected winter and spring rain and more summer drought. Less summer rainfall paired with higher temperatures is projected to raise the vapor pressure deficit (VPD) 32-66% by end of century (2070-2099) over historic (1970-2000), depending on emissions levels, using the mean of models (Table 11 in Ratcliffe et al., 2025b).

Anticipated climate change effects:

- **Habitat Structure** - Higher VPD corresponds with rapid evaporation and water loss from plants and soils and reduced water table levels. When water levels drop, peat becomes more exposed to oxygen, and this leads to accelerated aerobic decomposition and release of nutrients including carbon. Sustained heat and lack of moisture can hurt the productivity of Sphagnum moss (*Sphagnum* spp.) and diminish its dominance (Bu and others, 2011; Norby and others, 2019 in Ratcliffe et al. 2025b). Drier conditions lead to peat subsidence, compaction and cracking, which reduces water retention, limits hydraulic conductivity, and increases probability of wildfire (Ratcliffe et al. 2025b).

- **Community Composition** – climate changes, particularly increased temperatures that enhanced nutrient availability and extended growing seasons, are anticipated to be unfavorable for black spruce, tamarack and sphagnum moss species, while being more favorable for ericaceous shrubs such as highbush blueberry (*Vaccinium corymbosum*), bog rosemary (*Andromeda polifolia*) and small cranberry (*Vaccinium oxycoccos*) (Ratcliffe et al., 2025b).
- **Problematic Species** – Increased nutrient availability and longer growing seasons create more favorable conditions for species such as glossy buckthorn (Frangula alnus), reed canarygrass, common reed and cattails.
- **Pests and pathogens** – In general, climate change may increase populations and facilitate spread of pests and pathogens, as well as decreasing the fitness of dominant species, making them more susceptible to outbreaks, such as tamarack (*Larix laricina*) being vulnerable to eastern larch beetle (*Dendroctonus simplex*) and black spruce (*Picea mariana*) to spruce budworm (*Choristoneura fumiferana*) (Bellemin-Noël and others, 2021; McKee and others, 2022; Ren and others, 2020 in Ratcliffe et al., 2025b).

Fens – (from Midwest Prairie Alkaline Fen section in Ratcliffe et al. 2025b)

Anticipated climate change effects:

- **Habitat Structure** – warming paired with reduced summer rainfall creates water deficits that can lower water tables and expose peat to oxygen, increasing decomposition and releasing nutrients and carbon. Drier conditions lead to peat subsidence, compaction and cracking, which reduces water retention, limits hydraulic conductivity and increases probability of wildfire. These changes could reduce conditions for fen-adapted specialists while making these habitats more available to more generalist forbs and graminoids.
- **Community Composition** – more frequent water deficits from drought may create difficult growing conditions for some species such as spikerushes (*Eleocharis* species) and grass of parnassus (*Parnassia glauca*), while favoring more deep-rooted plants and facilitate encroachment by woody shrubs and trees. Longer growing seasons and enhanced nutrient availability will shift competitive dominance by fen specialist forbs and mosses while creating conditions more favorable to ericaceous shrubs and graminoids.
- **Problematic Species** – Longer growing seasons along with increased nutrient availability may facilitate conditions favorable for species such as glossy buckthorn (Frangula alnus), reed canarygrass, common reed and cattails.
- **Pests and pathogens** – Pest and pathogen pressure is anticipated to increase directly through higher pest and pathogen populations and indirectly through heightened host susceptibility due to temperature and water deficit related stress.

Species in Greatest Conservation Need

Non-forested wetlands provide primary or secondary habitat for 97 animal Species in Greatest Conservation Need (SGCN) and 51 plant SGCN (see Table 3.14). Primary habitats are those that species rely on and use most consistently, and the loss or degradation of which would most greatly affect the species. Secondary habitats are used by species less frequently.

Animals with more general habitat requirements were associated with multiple habitats, while specialists were associated with fewer. Primary and secondary habitat associations were distinguished for vertebrate and some invertebrate animals but not for insects, which are shown in 'total'. Plants were only associated with a single primary habitat for each species. Detailed tables associating each of the SGCN with each of the 15 habitats can be found in Appendix D for animals and Appendix E for plants.

Non-forested wetlands provide habitat for one-third of the 130 terrestrial vertebrate SGCN identified in the 2025-2035 SWAP (36%; 47 species). Thirty of these SGCN are bird species, and the 30 birds utilizing these wetlands comprise 38% of the 79 avian SGCN. The 51 plant SGCN found in this habitat constitute 12% of the 448 that are designated as SGCN. Examples of some of the SGCN and their significance are described below; state-listed species are linked to their account in the Rare Species Guide.

Table 3.14. Numbers of Species in Greatest Conservation Need associated with Non-forested Wetlands as either primary or secondary habitat.

Species Group	Primary Habitat	Secondary Habitat	Total
Amphibians	4	1	5
Birds	18	12	30
Mammals	3	3	6
Reptiles	1	5	6
Bees	-	-	20
Beetles	-	-	1
Butterflies	-	-	6
Dragonflies and damselflies	-	-	7
Moths	-	-	14
Mussels	0	1	1
Spiders	1	0	1
Plants	51	-	51
Total	**78**	**22**	**148**

Amphibians

Non-forested Wetlands are a rich and important habitat for amphibian SGCN. Five of the seven amphibian SGCN are found in this habitat. It is especially critical for four species: Blanchard's cricket frog (*Acris blanchardi*), spotted salamander (*Ambystoma maculatum*), pickerel frog (*Lithobates palustris*) and eastern newt (*Notophthalmus viridescens*). As noted in the Riparian and Floodplain Forest chapter which also provides critical habitat, the cricket frog is found right along the water's edge; open areas with muddy shorelines and dense emergent vegetation are preferred. They reside near water throughout the summer, but during dry conditions they may seek out wetter conditions elsewhere. Crayfish burrows or small openings along the bank of a wetland or river provide sites for hibernation. Less than 2 inches in size, their breeding call is similar to that of yellow rails and Virginia rails, making visual identification or expert verification via audio recording essential. A state endangered species, Blanchard's cricket frogs have a limited range in portions of central, southeast and southwestern Minnesota as of 2025.

Photo: Blanchard's cricket frog, USFWS

Spotted salamanders (*Ambystoma maculatum*), a state Special Concern species, also have a very limited distribution in the state, restricted to two east-central counties: Carlton and Pine. Found in forests with seasonal ponds or in shallow emergent wetlands that do not contain predatory fish to ensure successful reproduction. Mature, close-canopy forests that provide sufficient shade and organic soils with woody debris for foraging are important habitat features.

Pickerel frogs are also found in Riparian Forests and Floodplains as well as open non-forested wetlands, preferring the edges of ponds, small rivers and streams that flow through wooded areas or open habitats (Moriarty & Hall, 2014). The wetlands they use are typically on a valley floor near a river or stream, are permanent, and are never far from forested habitats. They rarely venture far from the water's edge or from nearby wet meadows. Winter months are spent hibernating in their water habitats. Pickerel frogs are restricted to the far southeastern corner of the state; county records are available from Goodhue, Fillmore, Houston, Mower, Olmsted, and Winona counties (Moriarty & Hall, 2014). Eastern newts have a much wider state distribution in Minnesota than other amphibian SGCN. They can be found temporary or permanent wetlands throughout deciduous and coniferous forests across the eastern half of the state. A rich, organic understory with abundant leaf litter and woody debris is required (Moriarty & Hall, 2014). They are known to be very active during warm, rainy days and hide under the leaf litter when it is drier.

The fifth amphibian found in open wetlands is the Great Plains Toad (*Anaxyrus cognatus*). It is more prominent in prairies and other grasslands but can also be found in shallow wetlands during the breeding season. They are not especially selective about their wetland breeding sites; they also utilize any shallow pool of water, including low, ephemeral sites in agricultural fields that form following a heavy rainstorm.

Birds

Yellow rails (*Coturnicops noveboracensis*) and Nelson's sparrows (*Ammodramus nelsoni*) are almost entirely restricted to rich fens and wet meadows. Permanent water depth during the nesting season ranging from a few centimeters to about 25-30 centimeters seems critical to occupancy. A canopy of dead sedges (previous years' growth) is a key habitat feature. Nelson's sparrows often utilize isolated shrubs or small clumps of cattails as singing perches. However, neither species is found in cattail-dominated wetlands, or wetlands with dense shrub cover. Sedge wetlands of acid peatlands, with dense sphagnum mosses or ericaceous shrubs, are also avoided.

Sedge wrens (*Cistothorus stellaris*) and LeConte's sparrows (*Ammospiza leconteii*) are also found in wet meadows and rich fens, but will utilize mesic upland grasslands with dense, tall grasses. Wilson's phalaropes (*Phalaropus tricolor*) have similar habitat requirements, but typically require at least small patches of shallow, open water within fens, wet meadows, or upland grasslands. Northern harriers (*Circus hudsonius*) and short-eared owls (*Asio flammeus*) may occupy the same sedge-dominated habitats as well as open acid peatlands, marshes, shrub swamps, and upland grasslands.

Photo: Wilson's phalarope, Bob Dunlap

Emergent marshes provide key habitat for king rails (*Rallus elegans*), common gallinules (*Gallinula chloropus*), Franklin's gulls (*Leucophaeus pipixcan*), black terns (*Chlidonias niger*), Forster's terns (*Sterna forsteri*), least bitterns (*Botaurus exilis*) and American bitterns (*Botaurus lentiginosus*). Each of these species have slightly different microhabitat requirements. In general, a vital habitat characteristic is a moderate to high degree of interspersion of emergent vegetation and open water. Dense cattail stands without accessible open water are avoided by all of these species. Exposed bare soil, floating mats of vegetation, or muskrat house provide important nesting and loafing sites, particularly for Franklin's gulls, black terns and Forster's terns. Common gallinules often utilize areas of open water with water lilies within hemi-marshes. Least and American bitterns are restricted to marsh vegetation, typically foraging at the vegetation-open water interface. While least bitterns are largely restricted to cattails (as well as patches of phragmites), American bitterns will also occupy shrub swamps, wet meadows and sometimes acid peatlands.

Another group of wetland-dependent SGCN birds utilize the open water and/or shorelines of non-forested wetlands, particularly emergent marshes, as well as lakes (also see Lakes sub-chapter). This includes ducks, grebes, and common loon (*Gavia immer*). Common terns (*Sterna hirundo*) and American white pelicans (*Pelecanus erythrorhynchos*) forage in/over open water but nest on shorelines (typically islands). Black-crowned night herons (*Nycticorax nycitcorax*) forage at wetland edges or shoreline, but nest colonially in trees or sometimes marshes. Buff-breasted sandpipers (*Calidris subruficollis*) utilize very short vegetation, often associated with wetlands.

Mammals

Northern bog lemmings (*Synaptomys borealis*) are limited to lowland conifer forests and open peatlands in extreme northern Minnesota; they have been shown to disappear from peatlands altered by human activities. Little is known about the species. Current populations are believed to be isolated relics of a larger population that occurred much farther south when glaciers advanced during the Pleistocene epoch. Fewer than 12 records have been documented in Minnesota since the species was first found in Lake County in 1932. Those records have been limited to open bogs, shrub carrs, and black spruce swamps. Since the Eastern heather vole (*Phenacomys ungava*) was first documented in Lake County in 1940, fewer than 20 specimens have been collected in Cook, Lake, and St. Louis Counties. Like the northern bog lemming it also prefers lowland conifer forests and open peatlands but may be found in upland fire-dependent habitats as well. Proximity to water and the presence of boulders, coarse woody debris, and ericaceous plants appear to be important habitat components. Larger species typical of conifer wetlands include the SGCN snowshoe hare (*Lepus americanus*), Canada lynx (*Lynx canadensis*).

Franklin's ground squirrel (*Poliocitellus franklinii*) is strongly associated with prairie, other grasslands, and savanna habitats. However, the grasslands it selects usually include wooded banks and gullies for its underground burrows (Missouri DNR). The species is declining throughout its range and is under consideration for federal status.

Reptiles

Where they have access to them, Blanding's turtles (*Emydoidea blandingii*) have been documented using bogs and fens as well as open wetland complexes that are adjacent to sandy uplands for nesting. For example, adult females have been tracked to fens prior to and following nesting; both to hydrate and to forage. Potentially, hatchlings may seek the deep muck for protection. Shallow waters with abundant aquatic vegetation are preferred. Ephemeral wetlands are utilized in spring and early summer, while deeper marshes and backwater pools are utilized in both the summer and winter. In southwestern Minnesota, meandering streams and rivers, fens, prairie marshes, backwaters and oxbows are important aquatic habitats, and upland habitats include adjacent agricultural lands. In addition to Blanding's turtle, four snakes may also be found in or near open non-forested wetlands: plain hog-nosed snake (*Heterodon nasicus*), Eastern hog-nosed snake (*Heterodon platirhinos*), smooth greensnake (*Opheodrys vernalis*) and gopher snake (*Pituophis catenifer*).

Invertebrates

Many insects both terrestrial and aquatic are associated with Non-forested Wetlands, including 50 SGCN. Please see the Aquatic Invertebrates and Terrestrial Invertebrates sub-chapters for more information.

Plants

Minnesota's peatlands provide refuges for several endangered, threatened, or special concern plant species in the state, including linear-leaved sundew (*Drosera linearis*), English sundew (*Drosera anglica*), coastal sedge (*Carex exilis*), twig rush (*Cladium mariscoides*), bog rush (*Juncus stygius var. americanus*), sooty colored beak-rush (*Rhynchospora fusca*) and montane yellow-eyed grass (*Xyris montana*) (see also Minnesota Scientific and Natural Areas Patterned Peatlands).

Marshes and wet meadow are habitat for rare species including: sweet-smelling Indian plantain (*Hasteola suaveolens*), marginated rush (*Juncus marginatus*), auricled twayblade (*Listera auriculata*), sea milkwort (*Lysimachia maritima*), autumn fimbry (*Fimbristylis autumnalis*), neat spikerush (*Eleocharis nitida*), smooth-sheathed sedge (*Carex laevivaginata*), upswept moonwort (*Botrychium ascendens*), stream parsnip (*Berula erecta*), yellow bartonia (*Bartonia virginica*) and great Indian plantain (*Arnoglossum reniforme*).

Climate Spotlight: Zigzag Darner

This profile is excerpted from "Effects of Climate Change on Midwestern Ecosystems: Temperate Flooded and Swamp Forest" published by the Midwest Climate Adaptation Science Center (Ratcliffe et al. 2025c).

The zigzag darner (*Aeshna sitchensis*) is a boreal species of Odonata [dragonfly] found in northern Minnesota, Wisconsin, and Michigan (DuBois and others, 2004). While little is known about the direct effects of climate change on zigzag darners, research on other Odonata (e.g., dragonfly and damselfly) species has documented climate-driven changes such as advanced phenology, altered development time, pigmentation changes, behavioral adjustments in time spent basking and other activities and shifts in geographic distribution (Hassall and Thompson, 2008; Zeuss and others, 2014). Additionally, higher temperatures may increase Odonata sensitivity to environmental stressors, including insecticides and other pollutants (Ishiwaka and others, 2024; Sirois-Delisle and Kerr, 2022). As generalist aquatic predators, larval Odonata are unlikely to be directly affected by changes in prey phenology (Hassall and Thompson, 2008). However, rising temperatures may alter their ability to capture prey. One study found that at higher temperatures, zigzag darner larvae showed decreased activity, while their prey, wood frog (*Lithobates sylvaticus*) tadpoles, became more active (Hayden and others, 2015). However, this relationship is complex, as the number of larval attacks also increased with temperature.

Zigzag darners breed in cool-water bogs and fens with little to no emergent vegetation. In the Great Lakes region, these habitats are vulnerable to climate-driven changes in water temperature, ice-cover and water-level fluctuations (DuBois and others, 2004; DuBois and others, 2018; Magee and others, 2021). This species prefers small pools that often dry during summer (DuBois and others, 2004), but increasing rainfall variability, with cycles of drought and deluge, may lead to more frequent early drying or pool connections to larger water bodies, reducing suitable breeding habitat. Maintaining and restoring boreal, cool-water bogs and fens will be essential to zigzag darner persistence under warming temperatures and variable precipitation patterns. Additionally, because warming temperatures often amplify other environmental stressors, management strategies may include reducing exposure to toxins, such as insecticides (Ishiwaka and others, 2024) and copper (Hayden and others, 2015).

Photo: Zigzag darner, Jeff Fischer

Primary Stressors in this Habitat

Throughout Minnesota, habitats have been lost and degraded due to pressures associated with human settlement, subsistence, livelihoods and recreation. Indeed, habitat loss or alteration remains the primary threat to most, if not all, SGCN. In this section, we identify key "stressors" that may continue to contribute to habitat degradation and loss. The list is adapted from a globally recognized threats lexicon developed by the International Union for the Conservation of Nature (Salafsky et al., 2024). For additional details, see the "Stressors" section in Chapter 1: Species in Greatest Conservation Need.

It is important to note that some of the factors listed as "stressors" can also be used to advance conservation goals. Broad terms such as "fire management" reflect the dual nature of these factors as they may function as stressors in some contexts (e.g. catastrophic wildfire following a prolonged period of fire suppression) while serving as valuable conservation tools in others (e.g., appropriately planned and applied prescribed fire).

Information about a subset of primary stressors specifically affecting this habitat is included below, followed by a set of conservation actions addressing those stressors.

Development

Pressure for urban and exurban development puts pressure on wetlands, both directly, such as in the Anoka Sandplain, and indirectly in the use and alteration of groundwater hydrology, which is particularly detrimental to groundwater-fed wetlands such as calcareous fens.

Crop Production

Wetlands in general and calcareous fens in particular are affected by agricultural practices either by direct use, chemical inputs such as fertilizers or pesticides, or by changes to the flow of groundwater to the wetlands, such as by installation of wells or drain tile, which once disrupted, is essentially not possible to reinstate and causes extirpation of the wetland.

Open wetlands, particularly seasonal and temporary wetlands, have been lost from the landscape due to being able to be farmed in some years, in some cases through the placement of drain tile, conversion of these to farmland reduces rich, seasonally available habitat for migratory waterfowl and shorebirds.

Livestock Management

Large livestock facilities create runoff that can affect receiving waters and the habitats that many species depend upon. They can also affect groundwater resources and surface waters depending on the source of water being used.

Mining and Quarrying

Mining and quarrying operations can threaten wetlands directly with insufficient buffers and indirectly through changes in hydrology, including effects to the level or flow of water in the water table.

Although the drainage of peatlands for agricultural use has been the primary cause of peatland loss in Minnesota, peat mining, where layers of peat are removed for horticultural use as a soil amendment and potting medium, can be a unique stress to some coniferous forested wetland communities. Peat mining leases cover a very small percentage of state managed peatlands (0.23% in 2025). All peat mining permits in the state, whether on public or private land, require reclamation and reestablishment of surface vegetation once operations cease. However, the peat layers once removed are not readily replaceable, as it takes hundreds to thousands of years for peat to form again.

Wind and Solar Energy Infrastructure

Siting of solar development can affect wetland hydrology and associated communities.

Roads, Trails, and Railroads

The development of roads and trails can disrupt wetlands directly and indirectly by changing hydrology, both above and below ground in the aquifer, including in some cases the flow of cold groundwater into wetlands. Road and railroad herbicide application along existing right of ways affects sensitive plant communities like calcareous fens.

Utility Corridors

Powerlines present a risk to waterfowl when situated between feeding and roosting areas. This is especially true for lines near lakes, rivers and wetlands. Less agile birds, such as trumpeter swans are particularly susceptible to collision with overhead lines located near waterbodies (APLIC, 2012). Utility corridor herbicide application for maintenance has affected calcareous fen communities.

Gas pipelines can fragment wetlands habitats and disrupt groundwater hydrology.

Recreation

Recreational use can contribute to altered hydrology through soil compaction as well as the introduction of non-native invasive species to recreational sites with wetlands by inadvertently bringing in seeds on footwear or gear.

Dams and Water Management

Water impoundments and surface water diversions can disrupt the upwelling of groundwater that maintains fen and open rich peatlands unique chemistry and hydrology. For wet meadows and sedge-dominated systems, dams and irrigation can elevate water levels which favor invasive or more water-tolerant species like cattails (*Typha* spp.) and reed canary grass (*Phalaris arundinacea*) (Apfelbaum & Sams, 1987; Boers et al., 2007). Water impoundments reduce the natural variability in flow and moisture regimes, potentially degrading habitat for species dependent on specific hydrologic conditions such as nesting birds, amphibians and rare wetland invertebrates (Winter & Woo, 1990).

Invasive Species (Problematic Non-native Species)

Numerous invasive plant species with detrimental effects are present in Minnesota wetlands. For example, purple loosestrife (*Lythrum salicaria* L.), invasive cattail (*Typha angustifolia* L., *Typha x glauca*) and invasive common reed (*Phragmites australis australis (Cav.) Trin. ex Steud.)* are all associated with habitat declines for birds, homogenization and dominance of wetland plant communities, and modification of wetland soil and nutrient cycling. In addition to these emergent plants, multiple submerged species including curlyleaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) have effects including increasing internal phosphorus loading and outcompeting native plant species, respectively. Human mediated movement of species means that in addition to the current distribution of invasive species, there is a persistent risk of additional introductions of invasive species. Hybridization of native and invasive species is an additional concern, with hybrid cattail and hybrid Eurasian watermilfoil both wetland examples of species with documented hybrid vigor (hybrids are superior competitors relative to parent strains) and hybrid Eurasian watermilfoil having documented herbicide tolerance.

The invasive subspecies of Phragmities (*Phragmites australis subsp. australis*) is a tall densely growing perennial grass that can be found in wetlands, shorelines, wet ditches, and other wet areas. The species can rapidly spread through seed, stolons, rhizomes and stem fragments, forming dense stands that alter wetland hydrology, lower plant diversity and reduce habitat quality for invertebrates, fish and waterbirds. There is a native subspecies of Phragmites that can be difficult to distinguish from its invasive counterpart. This makes it difficult to estimate the distribution of the invasive species throughout the state. Source: Minnesota Aquatic Invasive Species Research Center (MAISRC)

Problematic Native Species

Reed canary grass (*Phalaris arundinacea*) is a hardy, aggressive, cool-season grass that can form dense, monotypic stands in wetlands. Despite recent research suggesting that reed canary grass found in Minnesota is predominantly native, it can outcompete other native wetland species, posing challenges for wetland restoration and mitigation efforts. Source: University of Minnesota Extension (Reed canary grass).

Water-borne Pollution

Nonpoint source pollution, including phosphorus, nitrogen, sediment, bacteria and other contaminants generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. As runoff flows, it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, groundwater and estuaries (EPA NPS Webpage). These nonpoint source pollutants represent the largest combined contribution (an estimated 86%) to the state's water pollution (MPCA Water Quality Initiatives). Water quality measured by nutrients and contaminants has been shown to decline with higher agricultural or urban development in the watershed. Some key effects include excess algal growth, reduced plant diversity and reduced diversity in fish and invertebrate communities (DNR Water quality non-point sources).

Changes in Temperature related to Climate

Minnesota has experienced a clear warming trend over the past century. Between 1895 and 2020, average statewide temperatures increased by 3.0 degrees Fahrenheit (°F; Climate Trends). This warming has become more pronounced in recent decades and during the winter months. Since 1985, average winter temperatures in Minnesota have risen by 5.4°F, with average winter low temperatures increasing even more significantly by 6.8°F (Climate Change in Minnesota). These changes have led to a shortened season of snow cover and a reduction in lake ice duration by 10-14 days over the past 50 years (Minnesota Pollution Control Agency & Minnesota Department of Commerce, 2025). Furthermore, these shifts in thermal regimes are ecologically significant. Many species are adapted to narrow temperature ranges, and such rapid changes can result in increased thermal stress, the spread of invasive species, and heightened disease and pathogen risks (Ratcliffe et al., 2025).

Looking ahead, this warming trend is expected to continue. By mid-century (2040-2059), Minnesota's average annual temperature is projected to rise by an additional 3.8 - 4.5 °F, depending on future greenhouse gas emissions scenarios (Liess et al., 2022; Climate Change in Minnesota). Climate change does not act in isolation, interacting with invasive species dynamics, land-use change, and shifts in water quality and quantity, compounding ecological effects (He et al., 2019; Finch et al., 2021). Also, projected temperature increases are likely to affect ecosystems unevenly. For example, peatlands are sensitive to changes in temperature and hydrology and may experience reduced capacity to provide critical ecosystem services such as carbon and water storage. For additional context and resources, refer to the Climate Adaptation section in Chapter 6: Implementation.

Changes in Precipitation and Hydrology related to Climate

From 1895 to 2020, Minnesota's average annual precipitation increased by 3.4 inches (Climate Trends). The state has also seen a notable rise in the frequency and intensity of heavy precipitation events. Since 2000, very heavy rains (6 inches or more in a single day) have occurred two to three times more frequently than during the 20th century (Williams-Sether & Sanocki, 2025; NOAA National Centers for Environmental Information State Climate Summaries 2022: Minnesota). These extreme events have led to a corresponding increase in flooding, which can disrupt ecosystems, human infrastructure and water quality (Williams-Sether & Sanocki, 2025).

Future projections indicate continued increases in annual precipitation, especially during the winter and spring months, which are likely to exacerbate flooding risks. The same climate models also forecast an increase in late summer drought events, underscoring the variability and unpredictability of hydrologic patterns under a changing climate (Climate Change in Minnesota). By mid-century (2040-2059), average annual precipitation is projected to increase by up to 1.2 inches, depending on emissions scenario (Liess et al. 2022; Climate Change in Minnesota). This seemingly counterintuitive pattern — wetter winters and springs, punctuated by hotter, drier late summers — has profound implications for water availability, wetland health, soil stability and species dependent on seasonal hydrologic cycles (Runkle et al., 2022). For more information and resources for climate-adapted management strategies, see the Climate Adaptation Section in Chapter 6: Implementation.

Priority Habitat Conservation Strategies

To implement the Habitat Goal of this Plan, five strategies were identified:

Strategy 1. Protect, buffer, and connect high quality habitats to optimize biodiversity, SGCN, and landscape benefits, particularly across the Conservation Action Network.

Strategy 2. Restore, enhance, and maintain lands and waters to benefit SGCN, biodiversity, and ecosystem resilience

Strategy 3. Collaborate with conservation partners and landowners to enhance conservation delivery, particularly in the Conservation Action Network and Conservation Opportunity Areas

Strategy 4. Monitor SGCN, native plant communities, habitats, and ecosystems for changes through time including responses to natural disturbances, conservation actions, and climatic conditions

Strategy 5. Connect to develop, innovate, incentivize, and disseminate evidence-based habitat management practices to benefit SGCN habitat management practices to benefit SGCN

Examples of conservation actions are grouped below under these five strategies and tagged with icons for the stressor(s) that they address. Some of these actions are widely in place as best practices while others may be more novel. Some actions will combine multiple strategies, in which case we present it under the one it fits best. Also note that some strategies, such as Strategy 3, collaborating with partners, could truly be applied to all actions to most broadly and effectively implement them. Other actions, such as those related to monitoring, might be difficult to relate to a specific stressor, in which case they are marked as not applicable (NA).

Potential Conservation Actions for Non-forested Wetlands

Strategy 1. Protect, buffer, and connect high quality habitats to optimize biodiversity, SGCN, and landscape benefits, particularly across the Conservation Action Network.

Stressor	Action
	Protections for rare calcareous fens are in place. However, early project planning is needed to limit the installation of new wells in aquifers that support them and to site projects such as mining far enough from fens so that groundwater is not affected. Consider acquiring lands where calcareous fens occur, along with a buffer area, to protect them and their hydrology.
	Preserve and prevent loss or degradation of all types of nonforested wetlands, especially in the Eastern Broadleaf Forest and Prairie Parkland provinces. Focus on protecting wetlands larger than 10 hectares (25 acres) and wetland complexes. Enforce wetland protection regulations (“no-net loss”).
	Consider ways to reduce the effects of pipelines. Also develop clearer rules around pipelines for human and environmental safety, including for CO2 pipelines. Protect calcareous fens within utility easements such as by restricting the use of herbicides in favor of mechanical maintenance using low ground pressure equipment.

Stressor	Action
	Ensure mining operations stay above and do not affect the water table, to protect the hydrology of calcareous fens.
	Ensure mining and quarrying operations and solar and wind development operate with sufficient buffers and provide sufficient mitigation for any damage to wetlands. Increase incentives to avoid all wetlands, including wet meadows.

Strategy 2. Restore, enhance, and maintain lands and waters to benefit SGCN, biodiversity, and ecosystem resilience

Stressor	Action
	Restore large wetland complexes, with attention to the habitat features required by SGCN.
	Maintain vegetated buffers comprised of locally native vegetation adjacent to waterways. Avoid or reduce mowing, burning, grazing or chemical application on these buffers. Support and promote state and federal programs incentivizing buffers and other best practices for lakes, streams, wetlands and ponds.
	Control non-native and hybrid cattails to promote a diversity of plants. Minimize the spread of invasive plants in nonforested wetlands (e.g., purple loosestrife, Phragmites). Mitigate effects and manage potential invasive species dominance in affected areas.
	Reverse ditching and try to restore hydrology to drained peatlands.
	Implement bridges and boardwalks to prevent damage to wetlands from recreational use.

Strategy 3. Collaborate with conservation partners and landowners to enhance conservation delivery, particularly in the Conservation Action Network and Conservation Opportunity Areas.

Stressor	Action
	Avoid creating impoundments that flood wet meadows, except during wetland restoration projects.
	Farmed wetlands can be restored, with resources such as provided through the Natural Resource Conservation Service, or in cooperation with Soil and Water Conservation Districts or Minnesota Board of Water and Soil Resources. This can be particularly helpful when fields are too wet for planting or for crops to come in properly, which is happening more frequently with heavier and more prolonged spring rain events and with projections of even greater spring rainfall in the coming years.

	Increase early coordination with counties and local governmental units in the early pre-planning stages to ensure avoidance of wetlands. Review and comment on plant seed mixes for restoration actitvities.
	Restrict the use of herbicides or establish buffers along utility easements and road and railroad right of ways near calcareous fens. In these areas mechanical vegetation management is prefered using low ground pressure equipment or operating in frozen groundn conditions.

Strategy 4. Monitor SGCN, native plant communities, habitats, and ecosystems for changes through time including responses to natural disturbances, conservation actions, and climatic conditions.

Stressor	Action
NA	Wetlands identification, mapping, and monitoring are ongoing in several projects, with current focus on less well-known wetlands such as vernal pools (see Vernal Pools sub-chapter) and calcareous fens. Also see Chapter 4: Monitoring.

Strategy 5. Connect to develop, innovate, incentivize, and disseminate evidence-based habitat management practices to benefit SGCN

Stressor	Action
	To reduce the effects of agriculture, mining and development on wetlands (in particular, calcareous fens), several actions are needed: technical support to identify and study hydrological contexts, information about tiling and groundwater depletions that may affect calcareous fen hydrology, sharing of information with local governments and entities including counties and Soil and Water Conservation Districts, and political support to address tough conservation issues.
	Education and outreach to promote soil and hydrological management among agricultural producers and other water consumers to reduce soil and chemical runoff, noting buffer rules, listening to barriers and finding solutions and taking advantage of financial incentives, including discussions of hydrology associated with drain tiles.
	Increase awareness of importance of peatlands, recognize relative abundance in Minnesota compared to other states, explain the importance of restoring previously degraded peatlands, and consider reducing a demand for peat. Increase awareness about anticipated stress from warming and effects it could have on our state's ability to store carbon and changes that may need to be made in the timing of management activities and the amount of area needed to be set-aside.

Case Study: Peatlands Resilience Initiative

Minnesota's Peatland Resilience Initiative, led by the DNR, aims to sustain and restore the state's vast peatland ecosystems, over 7 million acres or roughly 10% of Minnesota's land area, recognizing their critical role in carbon storage, water regulation, and wildlife habitat. Peatlands accumulate partially decomposed plant material under saturated conditions, creating some of the deepest organic soils in the world and storing carbon for millennia. As the second most peat-rich state in the continental U.S. after Alaska, Minnesota's peatlands are vital for both regional biodiversity and global climate mitigation.

Under the initiative, the DNR is advancing a science-based strategy to protect peatlands within Minnesota's Climate Action Framework. Central actions include mapping deep organic soils and wetlands to identify priority areas, developing criteria for conserving or restoring peatland sites, and executing demonstration projects. One such effort evaluates restoration at Winter Road Lake Peatland SNA to quantify changes in greenhouse gas fluxes and mercury export, thereby measuring ecological as well as climate benefits. This is complemented by a demonstration project with the Office of School Trust Lands aimed at safeguarding peatlands while maintaining sustainable economic benefits.

Beyond carbon storage, sequestration, and emissions reduction benefits, the initiative supports additional co-benefits, including improved flood water storage and filtration, reduced mercury and sediment loading in water bodies and enhanced wildlife habitat for peatland-dependent species. Restoration work focuses on increasing hydration to drained peatlands on state lands, often by raising water levels, to reestablish saturated conditions crucial for peat accumulation and ecosystem resilience.

Photo: Fen, Red Lake Wildlife Management Area, Eric Ogdahl

By integrating mapping and prioritization, cross-agency collaboration, targeted restoration, and rigorous monitoring, the Peatland Resilience Initiative provides a strategic, climate-forward model for peatland conservation. It aligns ecological restoration with climate mitigation goals, establishing Minnesota as a leader in leveraging natural landscapes to address the challenges of a warming world.

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