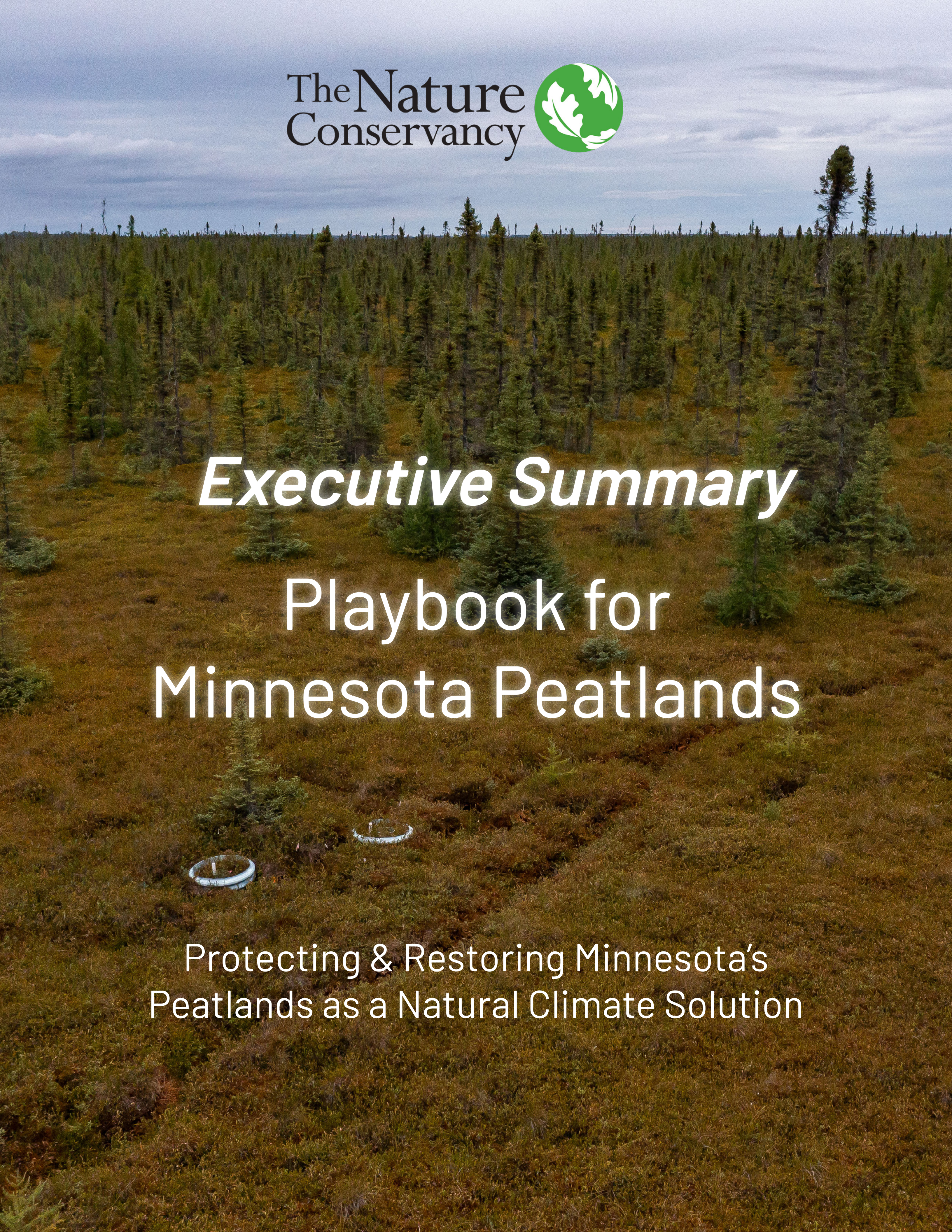
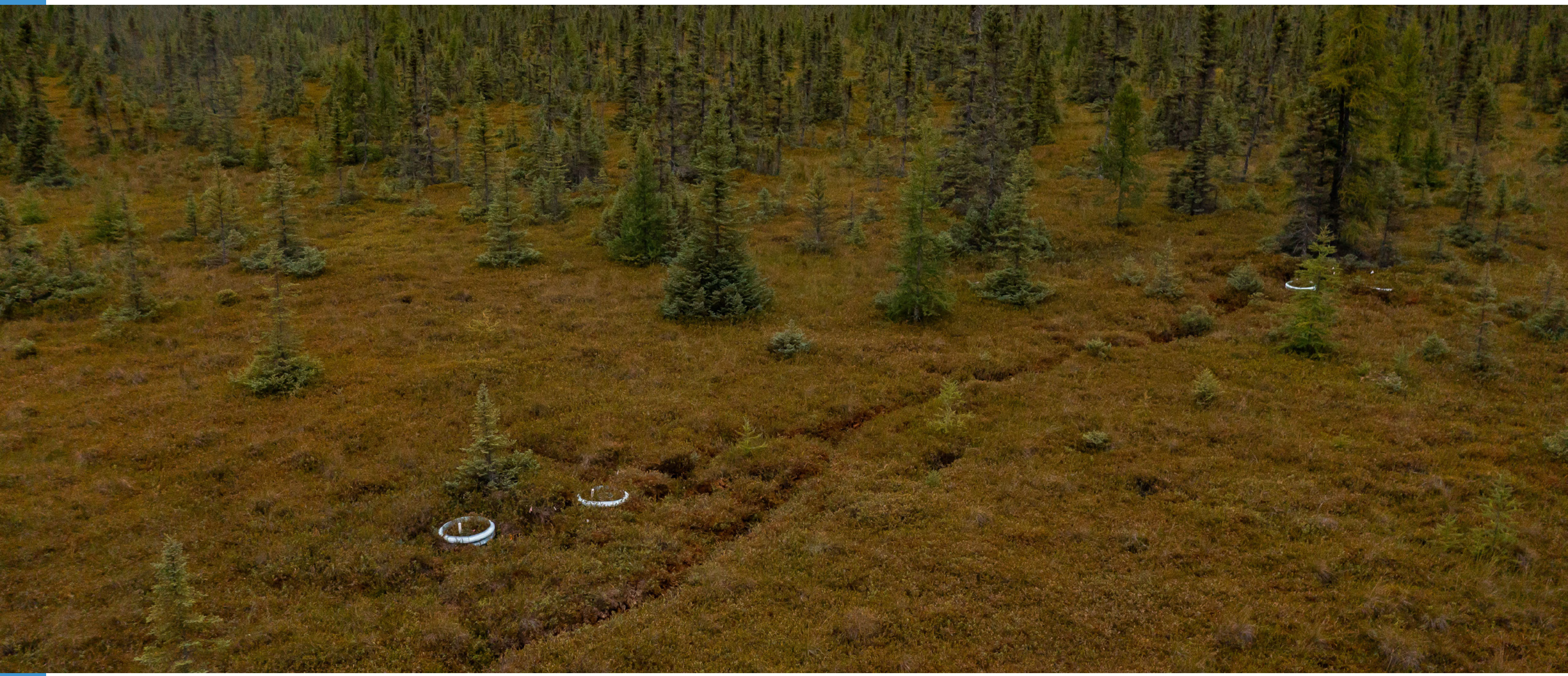


Executive Summary

Playbook for Minnesota Peatlands

Protecting & Restoring Minnesota's Peatlands as a Natural Climate Solution



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Introduction

Natural ecosystems are key to the climate and carbon cycle. They have a critical role to play in achieving climate mitigation goals in the short-term (i.e., by 2050). This is especially true of peatlands, a type of carbon-rich wetland ecosystem estimated to store more than 30% of the world's terrestrial soil carbon while occupying just 3% of the land surface. Most of this carbon is stored below ground in deep, organic-matter-rich peat soil layers.

With at least 6 million acres, Minnesota contains more peatlands than any other of the contiguous 48 United States. Peatlands cover more than 10% of the state by area and the top 1 meter of soil alone accounts for at least 40% of Minnesota's stored soil carbon.

However, historical drainage and conversion of peatlands to cropland and other land uses has disturbed the carbon balance of Minnesota's peatlands, converting them in many cases from a long-term sink to a source of atmospheric carbon. Largescale ditching efforts over the past 100 years have lowered water levels in peatlands, causing degradation of the peat and leading to net greenhouse gas emissions from these landscapes.

Restoration, conservation, and land management activities can increase carbon storage and reduce carbon/greenhouse gas emissions (GHG) from peatlands to help mitigate global average temperature rise.

Given the critical role that protecting and restoring peatlands plays in the global carbon cycle, The Nature Conservancy (TNC) of Minnesota, North Dakota, and South Dakota is working with partners to develop a strategy to protect and restore peatlands in Minnesota as an important component of an overall climate change mitigation strategy.

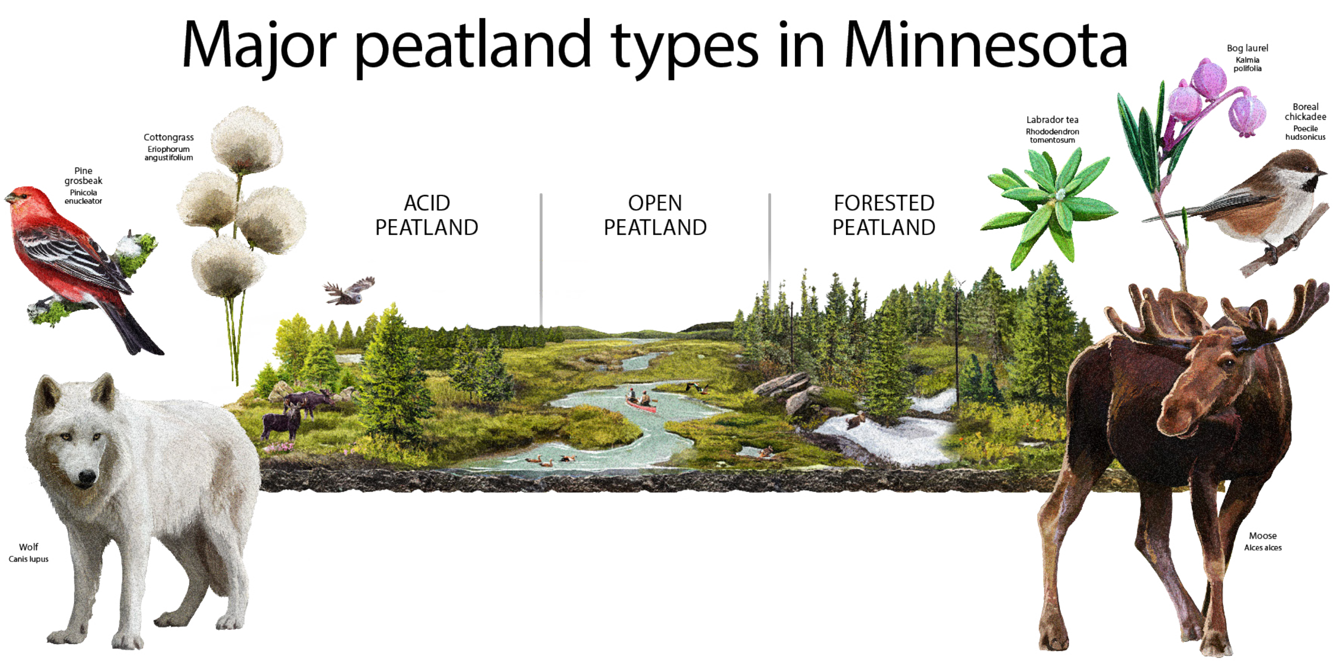
Background: Minnesota's peatlands

Peat is partially decayed plant material that accumulates in soil under moist and often cool climates, where waterlogged conditions prevent microbes from breaking down dead plant material and leaves. In the process, the carbon dioxide (CO2) that plants remove from the atmosphere becomes sequestered underground so long as waterlogged conditions are maintained. While all peatlands are wetlands, not all wetlands are peatlands. A peatland is typically defined as a wetland that accumulates peat, or partially decayed plant matter. Peatlands are also generally referred to as fens, bogs, and swamps, though peatland definitions can vary widely (Lourenco et al., 2022).

Minnesota's peatlands predominantly developed over the past 6,000–8,000 years, when cool, wet climate periods combined with poor drainage in the depressions left behind by Ice Age glaciers combined to create conditions favorable to peat formation. Until the late 19th century, much of the region's landscape was dominated by wetlands of various types including bogs, fens, marshes, swamps, and wet prairies. Indigenous people valued the peatlands as intact ecosystems that furnished them with food, medicines, furs, and other necessities. However, when European settlers moved into the landscape, they viewed these poorly drained areas as wastelands, and made massive drainage investments to make land available for "productive" agriculture and forestry uses. In support of this project, the federal government passed a series of Swamp Acts starting in the 19th century to encourage draining wetlands throughout the Great Lakes States (Dahl and Allord, 1996).

State and local governments in Minnesota took up the charge in earnest throughout the early 1900s, dredging long trenches and using explosives to drain millions of acres of wetlands. While not everyone supported these large-scale drainage efforts, as much as 90% of historic wetlands in southern and western Minnesota were drained. Drainage in northern peatlands was less economically successful and less extensive, but ditching still contributes to significant peatland degradation today.

Today, based on publicly available geographic data layers, we estimated that more than 41,000 miles of streams in Minnesota have been altered or modified in some way. Of this, at least 7,000 miles directly intersect areas with peat soils. Restoring peatland hydrology in those areas has the potential to generate both climate benefits and restore more natural waterways.



Peatland Drainage and Carbon

Peatland ecology is largely shaped by hydrology—the patterns governing water quality, water chemistry, water flow, and water table dynamics. Disrupting these dynamics has had profound impacts on peat accumulation, landforms, vegetation, and carbon. As shown in Figure 1, ditches dug through peatlands lower the water table, exposing previously saturated peat layers to air, which accelerates oxidation (decomposition) of organic matter and the release of CO2 and other greenhouse gases to the atmosphere (Krause et al., 2021).

Although many of these ditches are no longer actively used to support agriculture or forestry, they continue to drain water out of peatlands. If left unrestored, they will continue to contribute to peatland degradation.

Ongoing carbon stock losses from partially drained peatlands in Minnesota have been estimated at ~38,000 metric tons (MT) per year (Krause et al., 2021), **equivalent to adding about 32,500 gasoline powered vehicles to the roads, or burning 154,773,500 pounds of coal.**

Some estimates in the literature suggest that re-wetting peat could potentially save even more carbon per year. Re-wetting drained peatlands may also provide additional carbon sequestration benefits.

Given the critical importance of Minnesota's extensive peatlands, The Nature Conservancy in MN, ND, SD is actively working to develop, refine and implement a comprehensive 3-pronged peatland strategy:

1. Protect carbon stocks remaining in intact peatlands
2. Re-wet partially drained peatlands to avoid additional carbon loss and restore the carbon sink
3. Restore fully drained peat wetlands based on potential for multiple benefits.

This "Playbook", developed over the past 4 years represents the first iteration of our analysis of opportunities and feasibility.

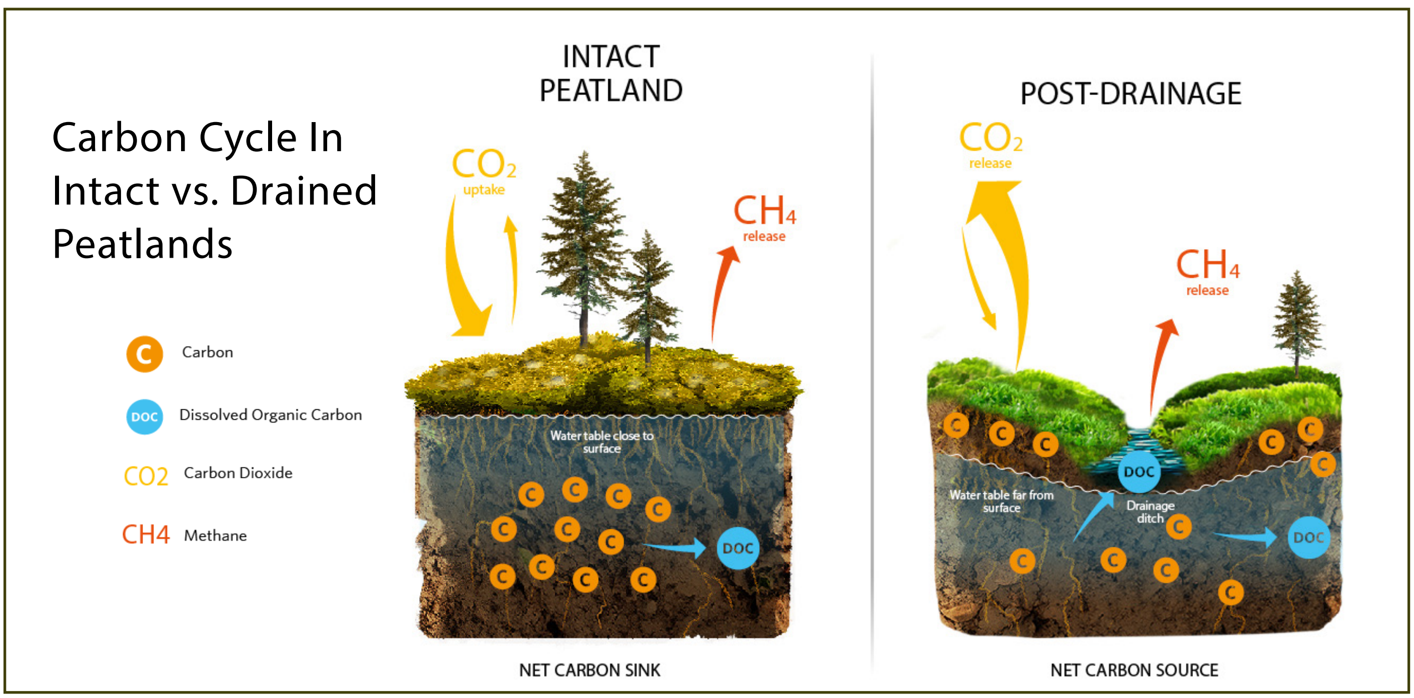


Figure 1. Intact peatlands are net sinks for carbon. By lowering the water table, drainage allows Carbon stored in the peat to be exposed to air. This ultimately leads to increased CO2 emissions while having variable impacts on methane (CH4) production.

Quantifying the benefits of and exploring opportunities for peatland restoration

Although peatlands can be identified, mapped, and/or classified by a variety of attributes (soil types, plant communities, hydrogeomorphic wetland categories, etc.), a single complete statewide coverage map of drained and remaining peatlands did not exist prior to this project.

To map physical and biological characteristics of peatlands, we compiled publicly available geospatial data layers such as soil properties, topography, wetland inventories, historical and current vegetation, existing and potential native plant communities. To assess drainage impacts, we used public data layers identifying altered watercourses and public ditches, and assessed where peat soils are most likely being impacted by drainage ditches and other hydrologic alterations. Combining land cover with ownership data, we mapped and summarized the extent of intact, drained, and partially-drained peat area by major ownership and administrative categories.

To view a web-based tool developed concurrently by the Minnesota Board of Water and Soil Resources (BWSR), using many of these same data layers, see the Potentially Restorable Peatlands Mapping Tool http://bit.ly/4hyum8Q.

We also interpreted soil data layers to estimate peatland carbon stocks by ownership, peatland type, and drainage conditions. We then combined estimates of drained and partially-drained peatland extent with estimates of avoided carbon stock loss and carbon sequestration rates derived from the literature to estimate the potential climate mitigation impacts associated with different peatland protection and restoration strategies.

Photograph © Mark Godfrey

Land ownership and administration

Of the 7.8 million acres of land identified as having peat soils, roughly 4.5 million (about 60%) are in public ownership.

The majority of these peatland areas are state-owned, particularly in northern Minnesota. They are managed under a variety of different state administrative and surface interest categories, depending on how they were acquired and for what purposes they have most recently been designated. These varied designations and management interests have important implications for strategy and opportunities for carbon management.

Of these state-owned or administered lands, the areas with the highest acreage on peat soils include State Forest lands, School Trust lands, Consolidated Conservation lands, and Wildlife Management Areas.

Drained peatlands in private ownership

More that 3 million acres with peat soils are in private ownership across the state, with many of those acres drained and converted for agriculture or other uses. In its 2018 statewide inventory, Minnesota Pollution Control Agency (MPCA) estimated emissions from fully drained peat soils as the fourth highest source of emissions, just after light trucks. Using updated land cover layers intersected with the histosol layer, we estimated approximately 475,000 acres of peat soils in cropland or pasture.

Climate Change Mitigation Potential

Academic literature confirms a strong link between re-wetting drained peatlands and increasing the water table to long-term reductions in CO2 emissions, but also a short-term increase in methane (CH4) emissions. Estimating which has a stronger impact can be difficult because of variation in carbon fluxes with time and across landscapes. However, general evidence indicates the long-term benefits of CO2 reduction outweigh the short-term impacts from CH4 emission and that re-wetting peatlands will result in a net carbon sink.

Based on updated estimates of the extent of histosol soils and other high carbon stock soil types statewide, we estimated the climate mitigation potential for restoration of farmed peatlands at nearly 582,000 Mt CO2e per year. For partially-drained peat impacted by altered drainage channels, we estimate the total statewide potential climate mitigation benefits of restoration at more than 500,000 Mt of carbon per year. Restoration and re-wetting on public land alone would be 282,000 Mt.

Re-wetting of partially-drained northern temperate peatlands represents a significant natural climate solution (NCS) pathway in Minnesota due to the presence of high remaining carbon stocks, the ongoing threat of degradation from legacy drainage, and net positive greenhouse gas dynamics of restoring ditched peat.

Feasibility and Scaling Up

Many factors affect the feasibility of peatland restoration, including ecological type, biophysical and landscape setting, technical complexity, and social, economic, institutional, and governance practices.

Biophysical factors affecting the feasibility of peatland restoration include vegetation, hydrology, chemistry, restoration size, ditch properties, hydrologic complexity, level of peat degradation, time since drainage and/or maintenance, and size of the ditches. These factors can also affect costs and economic feasibility.

Peatland restoration projects can range from relatively inexpensive options, such as passive ditch abandonment, to more costly interventions such as ditch plugging and active seeding of peat to ensure full restoration. Cost and feasibility are also affected by land values, opportunity cost, and impacts to adjacent properties, both real and perceived. Large-scale projects are typically considered more economical because of fixed costs for equipment mobilization, design, and planning. However, they may also may involve ecological complexity and social complexity (e.g. more landowners impacted).

A majority of funding for peatland restoration is currently provided through federal, state, and

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local sources. At the federal level, the Inflation Reduction Act has provided some opportunities for securing funding for peatland restoration.

At the state level, support includes funding for a Department of Natural Resources (DNR) pilot restoration program, a state Legislative-Citizen Commission on Minnesota Resources (LCCMR) grant awarded to the University of Minnesota for research on northern peatlands, and the Minnesota Board of Water and Soil Resources (BWSR) new Reinvest in Minnesota (RIM) program for peatland restoration on private lands. There is also an opportunity to move support for peatland protection and restoration forward through the state's Climate Action Framework. Additionally, wetland mitigation is well-established in Minnesota as a regulatory mechanism that funds wetland restoration, including some peatlands.

There is also significant opportunity to engage directly on potential ditch abandonment projects with county drainage authorities seeking to reduce the long-term maintenance burden of public drainage systems on taxpayers, local, and state government.

Carbon financing in Minnesota is in the early stages, but could also play a role in funding peatland restoration projects. Initial assessments show the largest restoration opportunity areas are on state-owned lands, but that based on the high cost and complexity of peatland restoration in Minnesota, most projects interested in using carbon finance to fund restoration would also need significant outside financial investments (i.e. grant funding or private philanthropic support).

Institutional and sociopolitical feasibility factors are also critically important to consider in peatland restoration. Many potential restoration sites involve a complex matrix of federal, county, and state lands subject to different management goals, statutory obligations, administrative policies, and sources and mechanisms for funding or financing for restoration. Because drainage has long been viewed in much of Minnesota as essential for economic development of land, restoration often represents a major cultural shift in thinking about the value of wetland ecosystems. Landowners and communities will need assurances that projects will not negatively impact their own lands or property values, that the changes will result in net benefits, and/or that benefits and costs will be fairly distributed.

Conclusion

As the largest natural terrestrial carbon storage ecosystem, peatlands represent a critical component of Natural Climate Solutions needed to reduce atmospheric carbon emissions and achieve climate mitigation goals.

Minnesota has more peatland area and carbon stocks than any of the other lower 48 states. However, legacy effects of historic drainage combined with climate changes already underway represent a major threat to Minnesota's remaining peatland carbon stocks; therefore, peatlands have an outsize role to play as part of Minnesota's portfolio of NCS strategies. By protecting intact peatlands, as well as re-wetting and restoring drained and degraded peatlands, we can protect existing stocks and reduce or even reverse the loss of stored carbon by restoring peatlands. Though the potential role of wetlands in climate change mitigation is complex, evidence continues to suggest that the restoration and protection of peatlands has a critical role to play in climate mitigation.

Read the full report:
nature.org/mnpeatlands

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Questions? Collaboration? Get in touch with us at minnesota@tnc.org or visit nature.org/minnesota

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