The Natural History and Ecological Assessment of Joe's Pond-Morrisville, Vermont

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Sponsored by the University of Vermont Natural Areas Program

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An Ode to the Pond

Joe's Pond-Morrisville is the University of Vermont's (UVM) newest delight, ready to be explored.

Driving north out of Stowe on Route 100, open farmland rolls along the side of the road. Corn, grazing pasture, and hay fields eventually meet the soft, rounded spines of the Green Mountains to the west and Mount Elmore to the east; a picture of human land use history and natural history in Vermont. You'll take it in and you may, like I have, feel like you know this place you're driving through. You know the folks who have lived here and changed the landscape, and let it grow back, and changed it again. And you'll have watched it and studied it and loved it.

From the road you see the forest—the birches, maples, beeches, and hemlocks. But from the bending roads, something secret is hidden from you. Through the forests and pastures and along the roads are rivers. The rivers and streams carry the Water, sacred, who holds metals and nutrients, calcium and potassium and magnesium, electrically charged, and oxygen, that the life giver, which together attach themselves to soil particles. And from soil to plant roots to new plant shoots and leaves and flowers to fruits to feed the animals who die and decompose and release their nutrients back into the Water. The Water, who holds the fertilized runoff from the pastures and the roads and the roofs and the parking lots and, shuffles the pollutants away from their sources. From the road you see the forest, the birches, maples, beech, and hemlocks. Between the rivers and the roads and the forests and the farmland are the forgotten heroes of ecological sustainability: the wetlands. To know Vermont, you must know its wetlands.

Tucked away from sight of Route 100 in Morrisville, just north of Paine's Tree Farm, is a wetland complex that has been accumulating carbon since the last Ice Age, about fifteen thousand years ago. These wetlands are peatlands, with deep organic soil that you can plunge a stick ten, twenty, even thirty feet into with ease. From the road, you can't see the soft majesty of an open canopy in the center of a forest. The tall, scraggly spruces that create a ring around a *Sphagnum* carpeted arena for weird carnivorous plants to grow, birds to sing and swoop to taste blueberries and cranberries and chokeberries, damsel flies and moths to rest and mate and soak up the sun.

Molly, Valcour, Andromeda, Percy', and Morristown Bogs straddle Route 100. Just downstream of all of them is Joe's Pond-Morrisville, not a bog but a *fen*! So well hidden that only its past owners, a few neighbors of the site, some avid botanizers and birders, and the folks of Stowe Land Trust, who monitor it for the easement on it, have explored its paths. Its quiet water somehow pales the whoosh of the occasional eighteen-wheeler along 100. The constant breeze along its shore gives kingfisher and cedar waxwing and broad-winged hawks an aerial current to glide through. A fen in a landscape dotted with bogs, this striking Natural Area provides the students of UVM, the residents of the area, the plants, the animals, and the fungi a strange and special place to grow.

It is my pleasure to invite you in the pages ahead to get to know Joe's Pond-Morrisville. To revel in its beauty, ponder its history, and consider its future.

Acknowledgements, aka; an Ode to the People

What a privilege to have gotten to spend a year devoted to Joe's Pond. Thank you to Brendan Fischer and the Natural Areas Program team for providing me with this opportunity, and supporting the vision I had for this project. And thank you to Ron Stancliff for donating the land to UVM. Thank you to my academic committee—Grace Glynn, Lauren Sopher, Jill Bubier, and Cathy Paris—for taking the time to carefully review this report with me and chatting through hypotheses and interpretations with me over the last year. Thank you to the many people I was able to drag out to Joe's Pond over the field season, including my committee, and my apologies (though perhaps not sincere) if you fell into the fen. It was a rite of passage. With each new visitor, I came without any plan other than to follow where their curiosities led us, and each time we saw something completely new to me at the site. Thank you to Catherine Wessel, Lorry Martinez, Rachel Stafford, and Jacob DeAlto for assisting me with the more laborious field work. Thank you to my fellow Long Eared Owls (Cohort AO) and the rest of the FN community that surrounded me in the halls of Jeffords over the last two years. Thank you to my family for supporting my venture into grad school wholeheartedly, and for celebrating each step of the process with me. Thank you to my partner and fellow FN, Matthias, for being the sound board for my theories, my anxieties, my successes, and everything in between.

I am not the first person to fall in love with and take time to get to know Joe's Pond, as thousands of years of humans have come before us on this land. I am so grateful to have been the first in a new generation of students of the land to get to know this place.

Executive Summary

Joe's Pond-Morrisville is a 26-acre parcel composed of mixed uplands and wetlands, located in Morrisville in Lamoille County, Vermont, just east of Route 100 on Stancliff Road. This property was donated to the University of Vermont Natural Areas Program in January 2025 by its previous owners, Ronald and Judith Stancliff, making it the eleventh UVM Natural Area. The property has had a conservation easement with Stowe Land Trust (SLT) since 2005. The parcel surrounds, but does not include, Joe's Pond, the namesake of the site, around its northern side.

Prior to the acquisition by the Natural Areas Program, the only formal studies of the site had been routine conservation management surveys by SLT to ensure easement requirements were met. In 2025, the Natural Areas Program hired me, Emily DeAlto, a graduate student in the UVM Field Naturalist Program, to complete an ecological assessment of the site, including a general inventory of the flora and fauna; an investigation into the natural history of the site; an assessment of the potential educational and research opportunities of the site; and baseline management recommendations for the wetlands and uplands.

In my study, I found a total of eight natural communities, including two aquatic natural communities that I described for the first time (aquatic natural communities are not treated in Wetland, Woodland, Wildland; Thompson et al., 2019). The uplands were predominantly Hemlock-Northern Hardwood Forest, a typical matrix natural community for the region. The wetlands were mixed peatlands, including Poor Fen, Intermediate Fen, and a beaver-influenced peatland swamp. I found one Vernal Pool in the upland woods, though there was no evidence of amphibians within it during my field season. I also found six rare (S2) or uncommon (S3) plant species, all within the wetlands. Populations of four of these species—few-nerved cottongrass (*Eriophorum tenellum*; S1S2), white-fringed bog-orchid (*Platanthera blephariglottis*; S2), rose pogonia (*Pogonia ophioglossoides*; S3), and tuberous grass-pink (*Calapogon tuberosus*; S3)—are tracked by Vermont Fish and Wildlife Department (VTFWD) in the nearby peatlands of Morristown Bog and Valcour Bog and along the main inlet to the pond. These new observations of the species at Joe's Pond-Morrisville add to our knowledge of the distributions and habitat components of these species in the state. I submitted Element Occurrence (EO) reports for all rare and uncommon species observed throughout the site, adding to the ecological importance of this new resource for UVM and for the state of Vermont.

The wetlands, composed almost entirely of rare (S2) fen peatland natural community types in Vermont (Sorenson et al., 2018), were the main focus of my investigation into the natural history of the site. Based on historic aerial imagery, I hypothesized that the current conditions of the peatland natural communities are quite different than they had been even eighty years ago, mainly due to influence by beavers. This hypothesis prompted me to dive deeper into the current ecology and paleoecology of the peatlands.

To investigate the current ecology of the peatland natural communities, I used a transect along the three natural communities to measure pH, electrical conductivity, total dissolved solids (nutrients), temperature, and depth to water table throughout the field season. Multivariate data analyses confirmed that there was a significant shift in the environmental conditions, specifically pH and water table fluctuations, that was correlated with the changes in vegetation along the transect. The data also confirmed that the three natural communities were composed of different plant species.

I used palaeoecological methods, including peat depth measurements across the entire wetland complex within the site and macrofossil analysis of a peat core taken from one of the transect sample points, to piece together a story of the formation of these peatlands since the last Ice Age. I found that the peatlands have likely formed by a combination of infilling (the process of peat growing out into an open water system) and paludification (the encroachment of wetlands into uplands) processes. At least three major shifts in the site's hydrology have occurred since its original establishment as a peatland, transitioning from open water to marshy fen conditions to a swamp dominated by woody species to today's open *Sphagnum* and sedgy fen conditions. Paludification likely initiated most recently when the beaver dam, located on the outlet of the pond, was built in the 1950s and raised the water level in the wetland area. There may have been other periods of paludification, but further study would be needed to investigate this.

The wetlands at the site, and the greater wetland complex they are a part of, are of very high quality in terms of their functions and values for Vermont's human and non-human communities. I used the Vermont Rapid Assessment Method for Wetlands (VRAM) to measure and report their ecological importance, as well as to provide a baseline assessment of the functionality of these wetlands and an example to be used at other wetland systems owned and stewarded by the UVM Natural Areas Program. The results of the VRAM showed that the wetlands within the UVM property and the larger wetland complex they're within are reference wetlands, meaning they can be used as a standard against which other wetlands can be compared.

Importantly, the current hydrology of the wetlands at Joe's Pond-Morrisville is supported by a 50-meter beaver dam that lies across the pond outlet. Several smaller dams are also upstream of the pond. The large dam was first built in the 1950s, changing the peatlands from forested to open by drowning out the trees present at the time and likely from the beavers taking down many of the other trees present. Beavers were active during the 2025–2026 field seasons, hinting that the dam may still be being maintained to some degree. Should the dam be abandoned or broken, the conditions at this site could change dramatically, though this should not be taken to mean that the quality of the wetlands or the site would be diminished. This would only be a part of the natural succession of beaver pond wetlands in Vermont.

Management recommendations are minimal, as the site is in high quality conditions as it is, with very few invasive species, well maintained trails, and low-impact use of these rare and uncommon features. This new Natural Area can play an important role in the protection of our state’s natural heritage, and our world’s climate resiliency as peatlands are globally important reservoirs of carbon. Joe’s Pond-Morrisville offers a wealth of educational and research opportunities. In particular, the wetlands are an incredible resource for students, and this study provides a baseline for investigating the natural history of this place.

Project Introduction and Guide to this Report

Figure 1: Overview of Joe's Pond-Morrisville.

The University of Vermont Natural Areas Program stewards over 2,400 acres of land across Vermont as "monitoring hubs where research, education, and stewardship activities take place." This newest 26-acre parcel, Joe's Pond-Morrisville, was ripe for achieving the program's goals, especially for a wetland lover like me. The site had not been formally explored in depth by anyone at the time of acquisition, so the Natural Areas Program requested that I use this Field Naturalist Project to conduct an ecological assessment of the site and identify educational and research opportunities that this new resource would afford the university. The following is the result of my efforts to achieve this goal.

Site Background

Joe's Pond-Morrisville (so named to distinguish it from the Joe's Pond in Danville, Vermont) is an ecological gem of the Lamoille River Valley, located in Morrisville, Lamoille County, Vermont. It can be accessed via Stancliff Road, from Route 100, and is near the headwaters of Bedell Brook, a tributary of the Lamoille River (**Figure 2**). It had been owned by the Stancliff family since 1912 and personally stewarded by Ron and Judith Stancliff since 1994. In 2005, Ron and Judith put a conservation easement on the parcel, which is held by Stowe Land Trust. In January of 2025, Ron and Judith donated the property to the University of Vermont (UVM) Natural Areas Program, making it the eleventh UVM Natural Area. The property is 26 acres in total, comprised of 14 acres of upland mixed hardwood and softwood forest, and 6.5 acres of mixed wetlands. The remaining 4.5 acres make up the right-of-way from Stancliff Road, which is an open field. The wetlands within the property are almost entirely peatlands, and surround an open water lake, called Joe's Pond, hereinafter "the pond". The pond itself is not contained within the property and is instead owned by the Town of Morrisville. The wetland area is a part of a larger wetland mosaic that includes Valcour Bog to the immediate south and Morristown Bog Natural Area to the southwest (**Figure 2**). Molly Bog, located southwest of this wetland complex and west of Laporte Road (Route 100), is another UVM Natural Area (**Figure 2**).

Project Objectives and Structure

This Field Naturalist masters' project, hereinafter referred to as "the Project", is the first in-depth study of the site, to our knowledge. The Project is an ecological assessment of Joe's Pond-Morrisville Natural Area sponsored by the UVM Natural Areas Program. The Project includes investigations into the site's natural history; its existing ecology, including a baseline biological inventory and natural community mapping; and outlining management and educational recommendations. This project report is split into five chapters:

1. Ecological Assessment of Joe's Pond-Morrisville
2. The Peatlands of Joe's Pond-Morrisville
3. Assessment of the Functions and Values of the Wetlands Using the Vermont Rapid Assessment Method for Wetlands (VRAM)
4. Management Recommendations
5. Educational and Further Research Opportunities.

The first chapter is meant to give an overview of the conditions of the site found during the field season and desktop review. It is the "layer cake" of the site, a method used by naturalists to describe the features of a landscape from the ground up, from bedrock to surficial geology to soils to plants to animals and more. The second chapter focuses on the wetlands at Joe's Pond-Morrisville. The wetlands are peatlands, meaning that their soil is made up of undecomposed or partially decomposed organic material, which gives us a way to peer into the potential ten-thousand-year history of this site through palaeoecological research. I also investigate the current biological, hydrological, and chemical conditions within the peatlands in this chapter. The third chapter is an assessment of the function of these wetlands both ecologically and for our human world through ecosystem services by using the VRAM. The fourth chapter is a brief one, with recommendations of potential research and educational opportunities that the site offers, to fulfill the Natural Areas Program's goals of using these lands for field research purposes. The last chapter includes baseline management recommendations for the site, based on my observations of the current conditions.

Each chapter is structured slightly differently due to their different goals. Chapters 1 and 2 are both styled in typical scientific format, though Chapter 1 has more style and voice than Chapter 2, especially in the Natural Communities descriptions, as I am trying to evoke the feeling of being in this beautiful place through more detailed and descriptive language. Chapter 2 is split into three parts, with the first two parts having their own methods, results, and discussion, and then part three brings the information from these two parts together in an overall interpretation. Chapter 3 follows the style and structure of the VRAM protocol. Chapters 4 and 5 are less formally structured, with general recommendations and insights from my observations. The overall structure was organized this way such that each chapter could stand on its own, should someone be only interested in one section of the research. The report is also generally written to be approachable to a wide audience (though Chapter 2 is probably the most technical) with an overall goal being to foster the appreciation for this site and the opportunity it afforded me to follow my passions and interests.

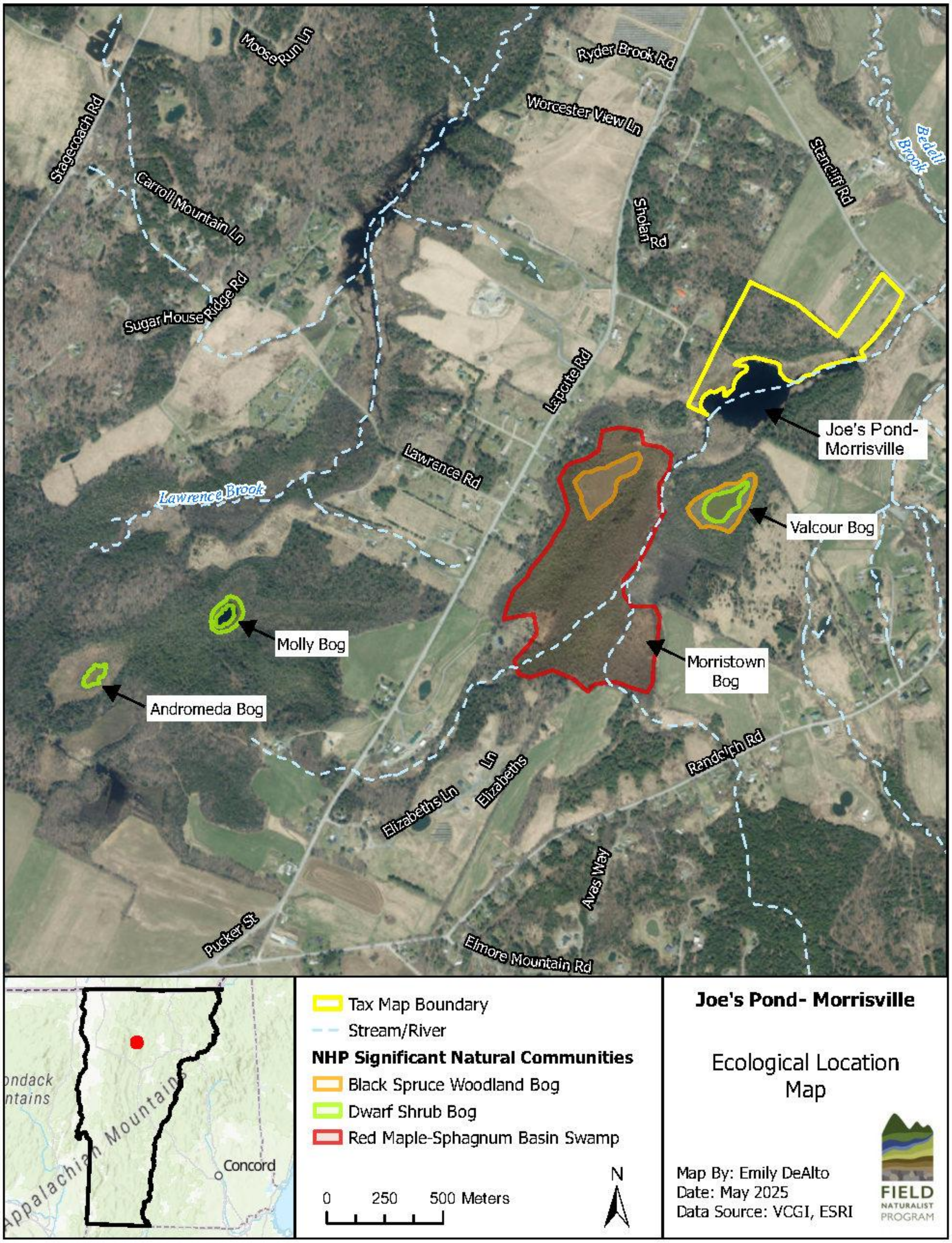


Figure 2: Ecological Location Map showing Joe's Pond-Morrisville as part of a larger wetland complex.

Chapter I: Ecological Assessment of Joe’s Pond-Morrisville

Introduction

This first chapter is an investigation into the “layer cake” of Joe’s Pond-Morrisville, an ecological assessment of the site from its deep subsurface geology to its soils, vegetation, fauna, and every layer between. This background information is critical to understanding the pieces, patterns, and processes that have shaped this landscape to become what it looks like today as we follow along its old logging roads, bound along its quaking peat mat, and paddle across its calm water. I begin with a desktop review of the site, including bedrock and surficial geology, soils, and hydrology, and follow with field surveys to increase our understanding of this new Natural Area. Using the relevé survey method, I delineated eight natural community types, including four wetland types, two upland types, and two aquatic types. I also observed six plants rated as uncommon (S3) or rare (S1, S1S2) in Vermont, three of which had been observed and tracked by VTFW in nearby areas over the last forty years. By building the story of this Natural Area from the ground up, we can better understand its management needs, educational opportunities, and ecological value in the context of the region and greater landscape.

Methods

I assessed the background of Joe’s Pond-Morrisville and its current ecology in two stages: Desktop Review/Analysis and Field Survey. Desktop analysis was completed prior to the field surveys, predominantly in the late winter to early spring of 2025. Field methods were completed predominantly between May and August of 2025.

Desktop Review/Analysis

I used data downloaded from the Vermont Center for Geographic Information (VCGI) Open Geodata Portal and other sources to complete a desktop review of the existing and historical site conditions. Data from the following sources and layers were reviewed:

- VCGI (data downloaded in June 2025)
    - Surficial Geologic Map of Vermont, 1970
    - Bedrock Geologic Map of Vermont, 2011
    - Vermont National Wetlands Inventory (NWI)
    - Vermont Significant Wetlands Inventory (VSWI) Class layer
    - Vermont NWI Data Review Draft (2025)
    - River Main Stem Water Bodies
    - VT Significant Natural Communities

    - Wildlife Management Units
    - 2023 Digital Elevation Model (DEM) LiDAR
- Natural Resources Conservation Service (NRCS) Web Soil Survey, 2025
- US National Agriculture Imagery Program (NAIP)
- Federal Emergency Management Agency (FEMA) Floodplain Hazard Layer

Field Survey Methods

Relevés

Natural community surveys followed the relevé protocol used by the Minnesota Natural Heritage and Nongame Research Program (Minnesota DNR, 2013). I selected relevé plots using a combination of information from the desktop survey and meanders (Wisconsin Department of Natural Resources, n.d.) around the site to identify areas of interest. I noted changes in slope, canopy cover, soils, and surficial deposits when identifying areas of interest.

I completed relevé plots in each natural community type that I observed, while also attempting to account for variation in natural community expression, which I had noticed in my preliminary meanders. Relevé plots were all square shaped; relevés in the uplands and woodland/swamp wetlands were 20x20 meter plots, and those in the open canopy wetlands were 10x10 meter plots. I set the plot size after conducting surveys in each overall community type (forest, swamp wetland, open wetland), increasing the plot size until I did not increase the number of species encountered by more than 10% with an increase in plot size (Minnesota DNR, 2013). The relevé sheets can be found in **Appendix A**. I dug soil pits at each relevé plot using either a drain spade or a soil auger. I described soil horizons, including information on their depth, soil texture (NRCS, 2022), color (Munsell Color [Firm], 2010), pH (using Lovibond soil pH test kit), and coarse fragments. At each relevé plot, I measured the diameter at breast height (DBH) of either a representative sample of trees or all the trees, depending on feasibility, in order to estimate the age classes of the trees. Lastly, I noted all plant species encountered in the plot. I keyed out plant species in the field predominantly using the *New Flora of Vermont* (Gilman, 2015) and *New England Wildflower Society's Flora Novae Angliae* (Hanes, 2011) when a second key was needed. The *Flora of the Northeast* (Magee and Harry Ahles, 2007) was also used. Sedges and grasses were keyed out using *Guide to Sedges of the Northern Forest* (Jenkins, 2019) and *Guide to Grasses of the Northern Forest* (Jenkins and Engstrom, 2022), respectively. I noted species distribution within the plot, such as dominance, rarity, or if a species was only found within a specific microhabitat type within the plot. Other characteristics noted in the relevés included ground cover of *Sphagnum* spp*.,* exposed rock, and standing water; height of leaf litter and moss hummocks, when appropriate; plot location within the natural community (near or far from the boundary); evidence of disturbance; aspect; and topographic context.

Natural community mapping (Field Survey and Desktop Analysis)

A natural community is "an interacting assemblage of organisms, their physical environment, and the natural processes that affect them" (Thompson et al., 2019). Natural community mapping is a land classification system that uses the physical and biological features of an area to describe the existing community assemblage with the overall goal of developing a greater understanding of Vermont's natural heritage resources. By delineating the study area into natural community types, the maturity and functionality of these communities can be inferred by comparing the species richness and diversity found to that expected of the most mature version of each natural community type. Beyond visual encounter surveys, more specific information, such as which species are dominant or codominant within vegetation layers, what species are the least abundant throughout the community, and the presence of uncommon or rare species, can strengthen the understanding of the community composition.

The natural communities concept has some caveats, especially when considering the dynamic nature of natural communities. However, mapping the current natural communities found at Joe's Pond-Morrisville offers a baseline understanding of the biotic and abiotic conditions present, providing a basis for management decisions for the future. This mapping effort also gave me a foundation for my understanding of the site's natural history and helped to inspire the research that is described in the following chapters, specifically in the wetlands.

Information from the relevés and the desktop review was used to map the boundaries of the natural communities. I also used ArcGIS Field Maps to delineate some of the natural community lines while in the field for more precise lines if I could not see the transition clearly in my desktop review. I used classifications from *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont, 2nd Edition* (herein after referred to as "WWW"; Thompson et al., 2019). Given the relatively small size of the site, natural community mapping could be conducted at a fine scale, so I created some variants of officially described natural community types from WWW to best reflect the conditions seen during the relevés.

Inventory

I completed the general inventory using a meander survey method, noting all species encountered throughout the season in the inventory. No specific transects were created for the purpose of inventory, other than the relevé plots. One bird count survey was completed on July 8th and relevé inventories were completed throughout the season. Whenever I encountered a rare or uncommon species, I made detailed notes of its occurrence on the site to be shared with the Natural Heritage Inventory. The Element Occurrence (EO) reports to be submitted to the Natural Heritage Inventory can be found in **Appendix B**.

I paid particular attention to inventorying all vascular plant species (as well as a few bryophytes) and bird species encountered. Any other animal species that could be identified quickly and accurately or identified by other iNaturalist users were added to the inventory. *Sphagnum* mosses were not keyed to species, though samples were taken of the species encountered.

Results of the Desktop Review and Field Survey

Geology

Bedrock Geology

The bedrock found within the Joe's Pond-Morrisville study area consists entirely of the Ottauquechee Formation, carbonaceous phyllite member (**Figure 3**). This formation is described as gray-to-black phyllites, with inclusions of graphite, pyrite, and massive granular quartzites (Springston et al., 2000). Phyllites are a low-to-medium grade metamorphized rock, somewhere between slate (low metamorphization) and schist (medium metamorphization). These rocks are likely of Cambrian origin (Ratcliff et al., 2011). Outcroppings are not present on the site; bedrock was never encountered during the site survey. This is almost certainly the result of surficial processes that have shaped the landscape more recently, burying the bedrock.

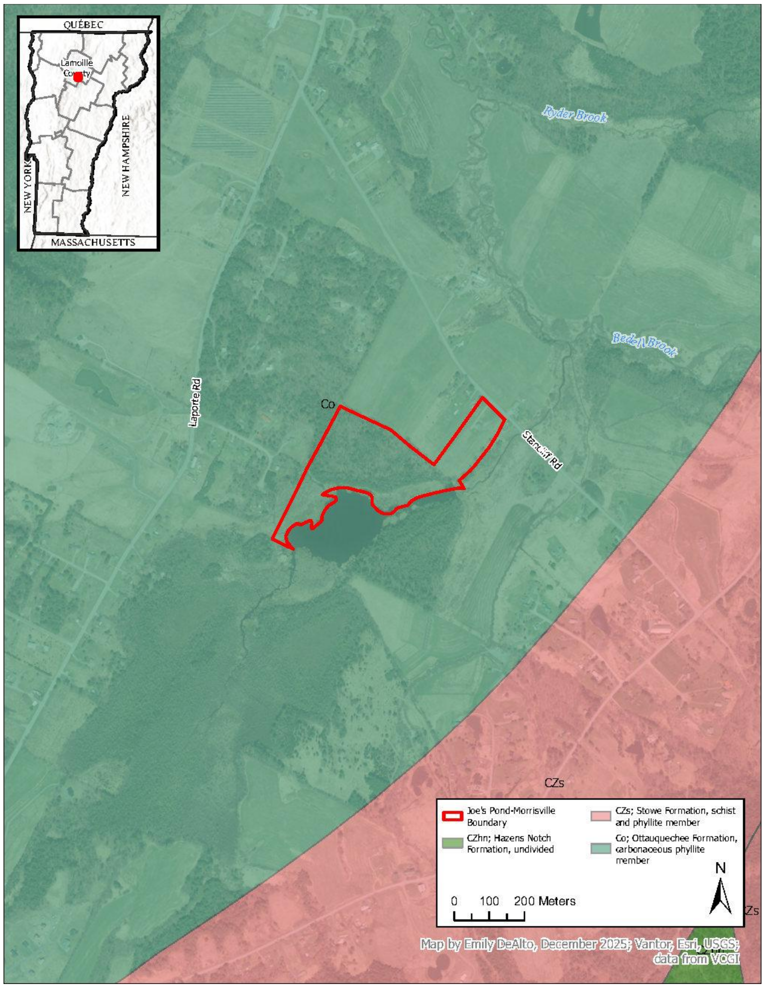
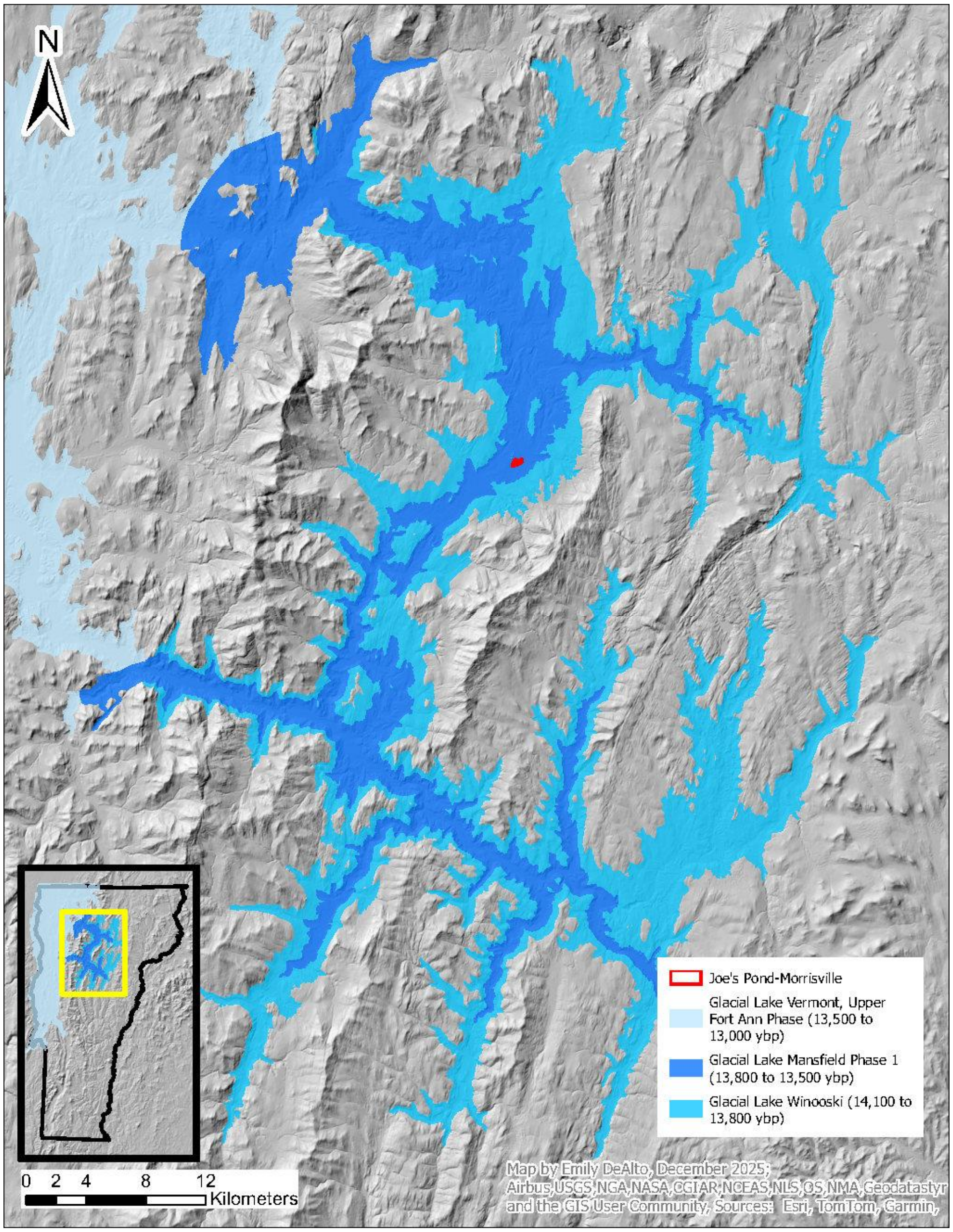


Figure 3: Bedrock Geology Map

Surficial Geology and Glacial Lakes

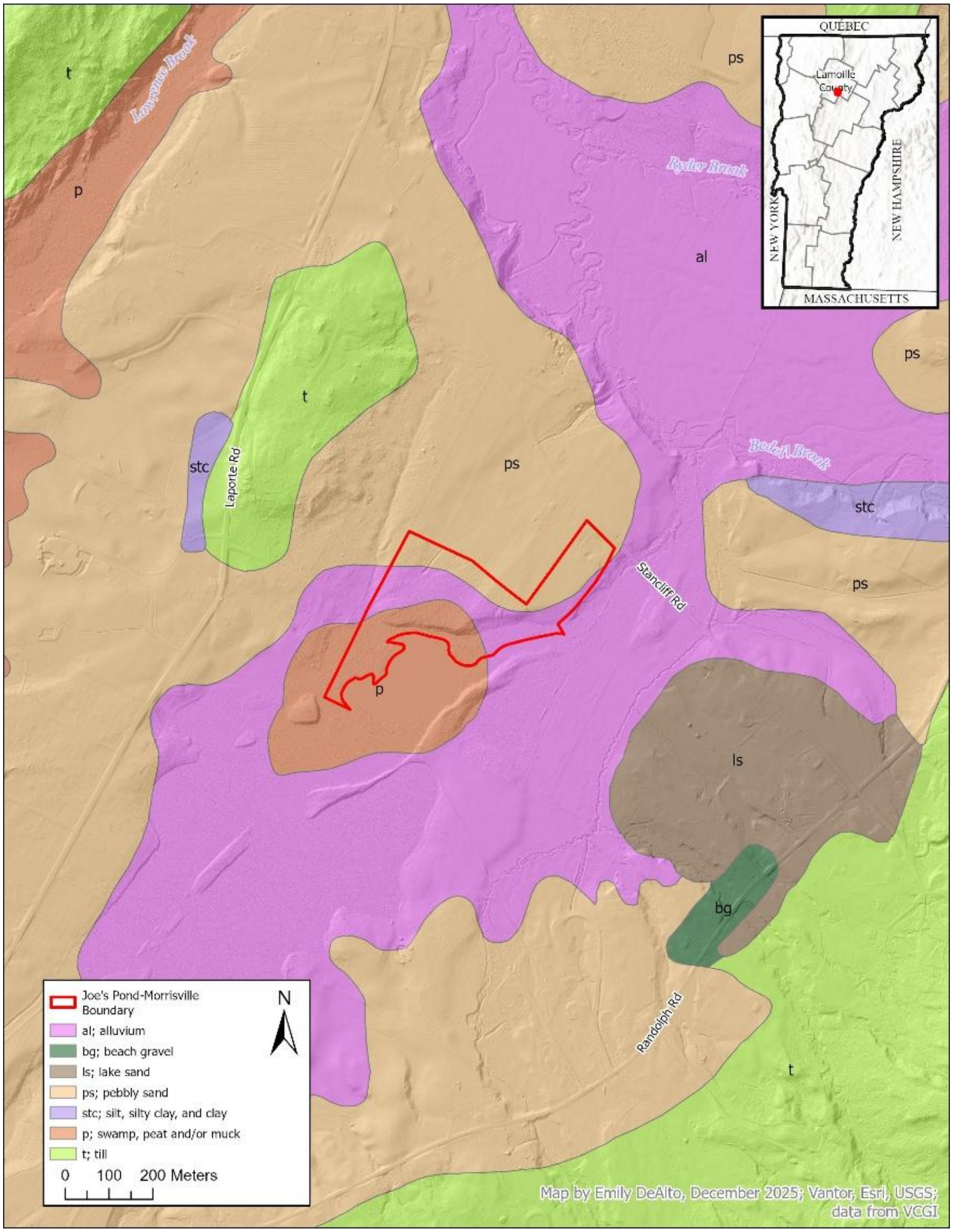


Map by Emily DeAlto, December 2025; Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyr and the GIS User Community, Sources: Esri, TomTom, Garmin,

Figure 4: Glacial Lakes Map

More important to the formation of the forests and wetlands within and surrounding the site is the surficial geology that buries the bedrock below. Depth to bedrock of soils is beyond 183cm for the soil series found on site (NRCS, 2022), thus the surficial geology likely has a greater influence than the bedrock on pH, nutrients, and other influential characteristics for biodiversity.

The site is within the boundaries of the ancient glacial lakes Winooski (13,800 years-before-present [ybp]) and Mansfield (13,500 ybp), which formed as a result of glacial Lake Winooski partially draining as the ancient ice sheet melted (**Figure 4**). The existing surficial geology is heavily influenced by the surficial processes that occurred during and after this last era of glaciation. The wettest portions of the site, including the pond, lie upon “swamp, peat, and/or muck” of pluvial origin (**Figure 5**). Pluvial sediments are sediments deposited during periods of increased precipitation rate, such as during the last Ice Age (VTANR, 2004).



Map by Emily DeAlto, December 2025; Vantor, Esri, USGS; data from VCGI

Figure 5: Surficial Geology Map

The areas surrounding the pond and extending into the wetlands to the northeast and southwest of the study area are classified as postglacial fluvial, recent alluvium, meaning they are deposits, typically fine sands or silts, left by flowing streams after the most recent glaciation (VTANR, 2004). Other nearby areas mapped as postglacial alluvium follow paths similar to the existing streams present on the site, extending north towards the Lamoille River, suggesting that the wetland complex was once a part of a larger river system during the melting of the glaciers, formation of glacial lakes, and eventual draining of those lakes. These deposits are also modern, meaning they are found in active stream channels and occasionally flooded low terraces (VTANR, 2004). The final surficial feature found in the study area is glaciolacustrine pebbly sand deposits, which are found in the uplands on the site's northeast border (Doll, 1970). These glaciolacustrine sediments are derived from glacial lake deposits, from the Burlington ice sheet as it melted and moved northwestward (VTANR, 2004).

While not shown on the 1970 Surficial Geology of Vermont map, there is also an esker just upstream (south) of the site, west of Valcour Bog, along the east side of the unnamed tributary that feeds into Joe's Pond-Morrisville. This feature can be seen in detail **Appendix C**, as well as in **Figure 5** as a thin, raised line just southeast of the site. An esker is a long, narrow ridge composed of water-lain deposits, in this case sand, formed in a tunnel or ice cave at the base of the retreating Burlington ice sheet (VTANR, 2004). These tunnels indicate the direction of glacial melt flow as the glacier retreated, again supporting the hypothesis that the wetland complex was once a part of a larger river system or floodplain.

Lastly, there is a steep slope within the study area on the northern edge of the pond. This steep slope may also be a glacial remnant, formed in a similar way to the esker to the south as sediment was deposited by the retreating glaciers. The local topography, including these steep slopes and a large depression where the pond and wetlands are, might have led to the formation and accumulation of the saturated, organic soils that cover the depression today.

Soils

The NRCS Web Soil Survey lists four soil types within the study area:

- Adams loamy sand, 3-8% slopes
- Colton-Duxbury complex, 2-8% slopes
- Borohemists, deep
- Rumney fine sandy loam 0-3% slopes, frequently flooded

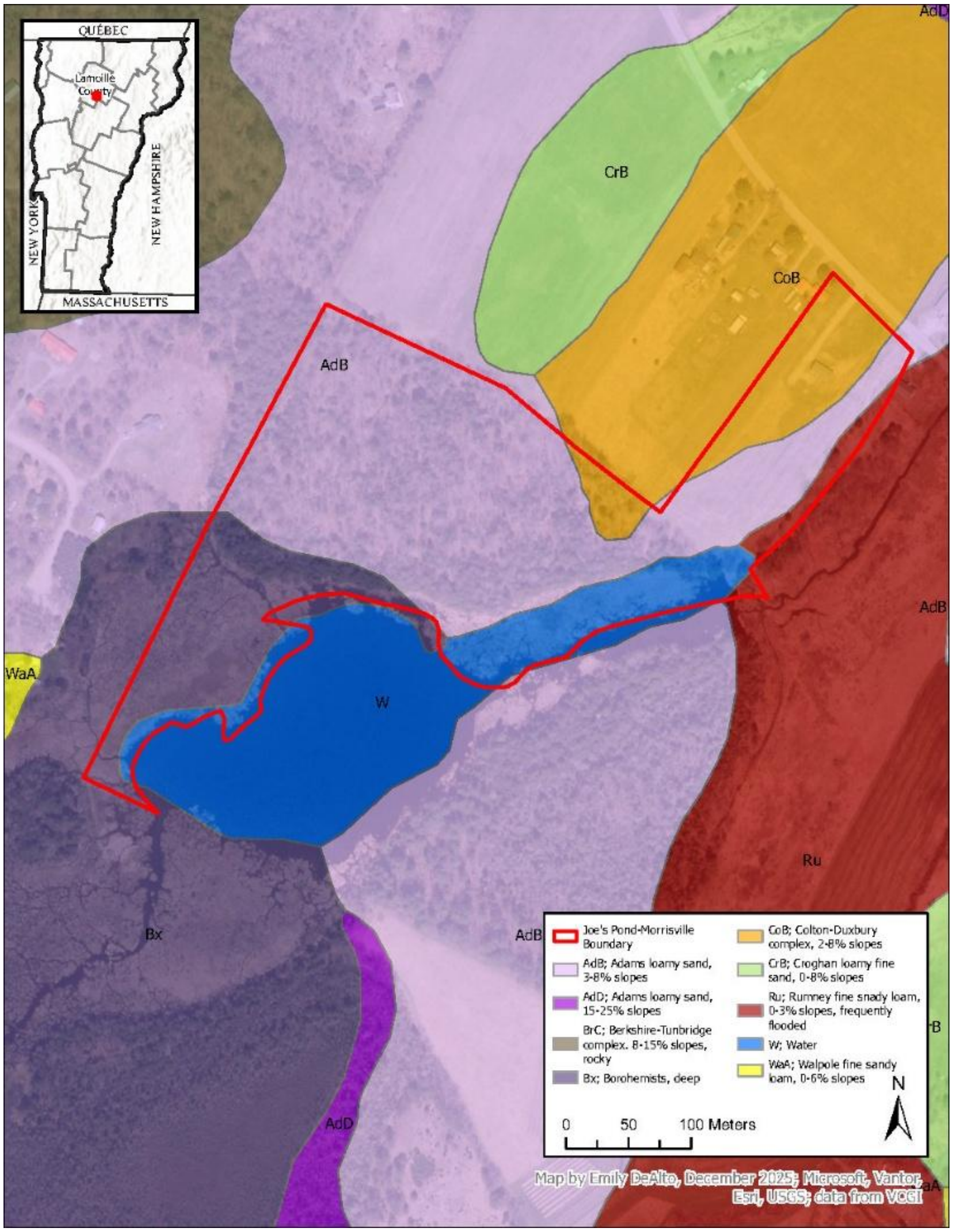


Figure 6: Soils Map

The Adams series and Colton-Duxbury complex are usually non-hydric, upland soils, while the Borohemists and Rumney series are usually hydric, wetland soils (**Figure 6**). Borohemists are poorly drained, hydric soils often found in swamps and bogs. At Joe's Pond-Morrisville this soil series can be found wherever peatlands occur. The Rumney series is typically found in recent alluvium and floodplains, and at Joe's Pond-Morrisville is found north of the large beaver dam outlet (NRCS, 2022).

Soil sampling during the relevés confirmed that the uplands are primarily composed of Adams loamy sand. There was some variation in the soil horizons, however, with some areas being clear examples of typical Adams loamy sand, and others looking more like jumbled till. The pH of the upland soil varied throughout the uplands but was generally acidic in the O Horizon (pH 4.5) and increased within the A and B horizons to pH 5-5.5. Most of the variation in soils was found on the steep slope north of the pond, where slumping and irregular erosion may be mixing the horizons more irregularly than on the flatter areas of the uplands. Soil pits in the wetlands confirmed that the wetland soil is organic in most places. Along the edges of the pond, however, there were some deposits of gleyed (with a greenish or bluish-gray color, indicative of prolonged saturation) silt with pH of 6, suggesting that some enrichment from groundwater may be seeping into the wetlands along the edges of the steep slope. Whenever silt was encountered in soil pits on the steep slope, the pH was equivalently high—near 6.5—compared to the rest of the upland soil. The acidic soils are typical for the natural communities present, especially with hemlock being a dominant species in the canopy.

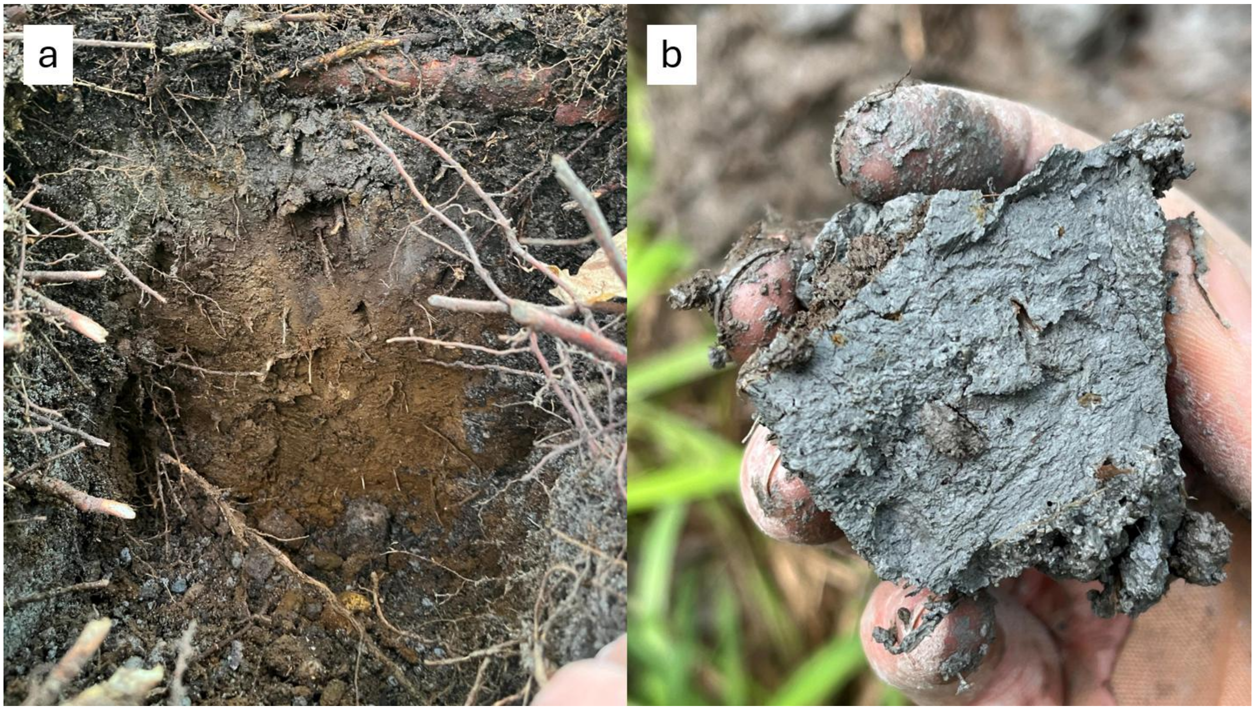
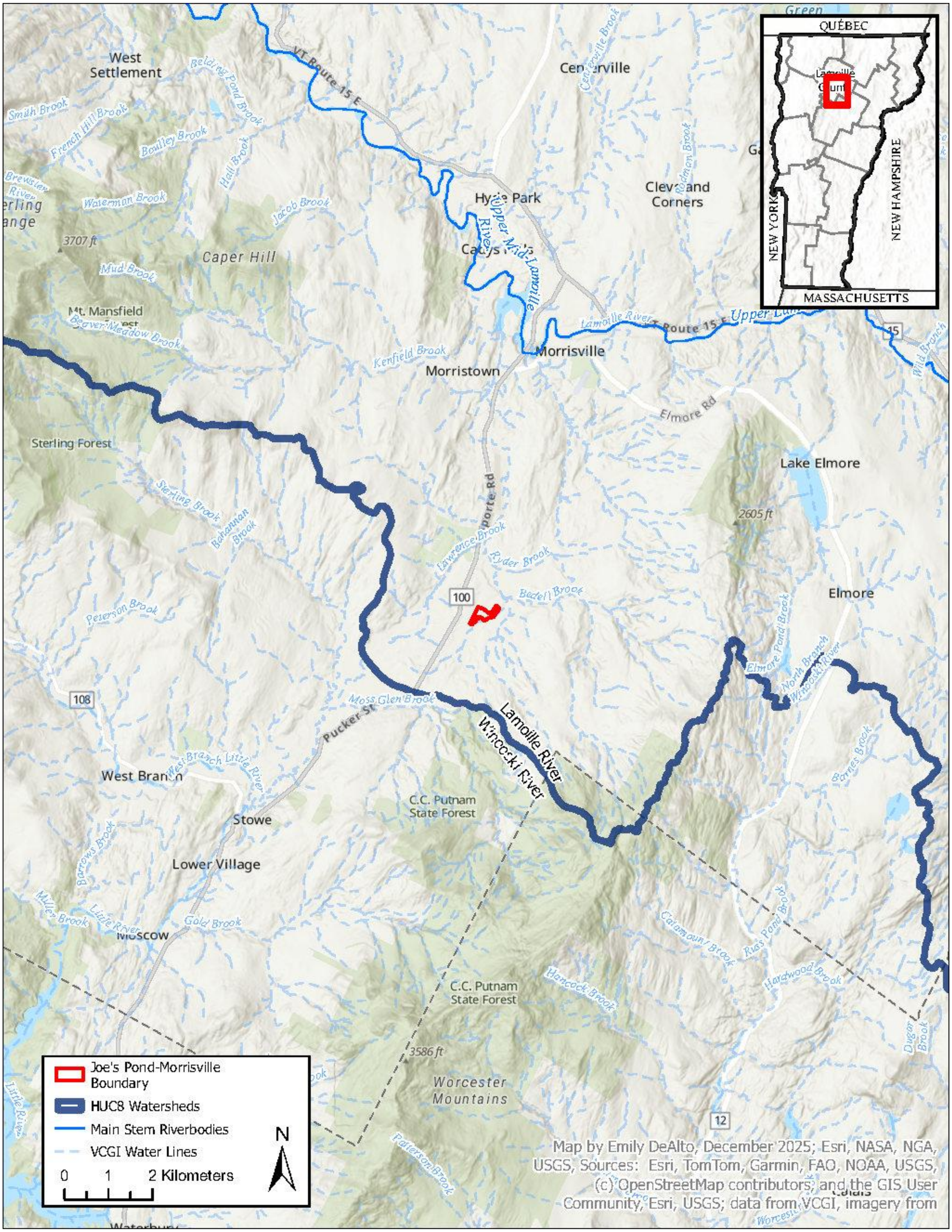


Figure 7: Soils at Joe's Pond-Morrisville. a) Typical Adams loamy sand soil. b) Hydric soils found on the edge of the wetlands and bottom of the steep slope. Note the grey/gley, reduced color and presence of redoximorphic features, suggesting this soil is hydric. The pH of the soil here was 6-6.5.

Hydrology

The study area is within the Lamoille River watershed, hydrologic unit code 8 (HUC8) 04150405 (**Figure 8**). It is just upstream (north) of the headwaters of this major watershed, on the divide between the Lamoille River and Winooski River watersheds. Water from the site flows into Bedell Brook, then Ryder Brook, and eventually into the Lamoille River. The study area is not within a FEMA mapped floodplain.



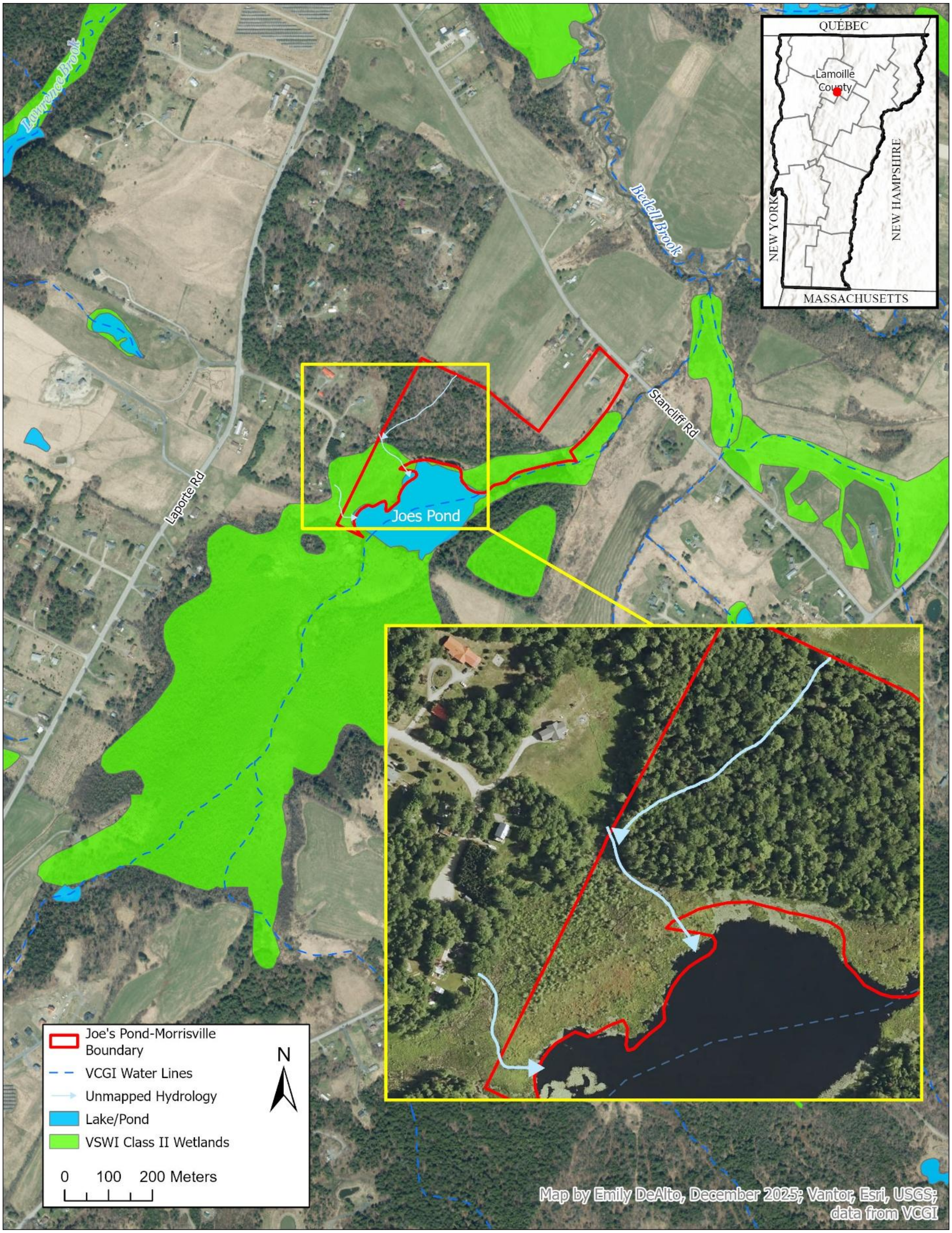
Map by Emily DeAlto, December 2025; Esri, NASA, NGA, USGS, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Esri, USGS; data from VCGI, imagery from

Figure 8: Watershed Context

There is one open body of water within the study area, the namesake, Joe's Pond (**Figure 10**). Review of the VSWI and NWI shows that the site is part of a wetland complex of adjacent wetlands that extends beyond the site to the south and east. While a formal wetland delineation was not completed, inventory map data indicate that wetlands are present throughout the site, comprising 6.5 of the 26 total acres, about 25% of the site, including the ROW (**Figure 10**). There are three inlets to Joe's Pond-Morrisville. The first is the main inlet, which is shown in **Figure 10** in the VCGI Water Lines. Two other inlets are also on either side of the main peat mat, not shown in the desktop review, but mapped during my field survey. These smaller additional inlets are shown in the zoom map within **Figure 10**.

The two inlets flow from rural residences offsite, on Joe's Pond Road. These both generally flow from northwest to southeast. A fourth inlet fed into the northern of the two smaller inlets via an underground drain that carries flows from the open field north of the parcel. This drain system can be seen in the zoom map within **Figure 10,** flowing from northeast to southwest.

Figure 9: The third inlet to Joe's Pond-Morrisville, which flows directly from 151 Joe's Pond Road. Crossing this inlet is the main access point to the main peat mat area.



Map by Emily DeAlto, December 2025; Vantor, Esri, USGS; data from VCGI

Figure 10: Site Hydrology and Wetlands

The Dam/Beaver Activity

A 55-meter-long beaver dam at the outlet to the pond is a key component of the existing hydrological regime of the pond and its associated wetlands. Review of historical aerial imagery and anecdotal evidence from Ron Stancliff, the previous landowner, suggests that this dam has only existed for the last 76 years, at the most. It is Ron's recollection that the beavers came in in the 1950s. His father engaged in what he described as, "a battle with the beavers" for a few years, pulling out the dam over and over and over again, until eventually he gave up.

Figure 11: View facing southwest of the large beaver dam located at the outlet to the pond. I was standing below the dam, so the pond water level can be seen above the dam.

Historical aerial photographs support this story of beaver influence, with images from 1942 showing no dam and a much more treed wetland area, to more recent imagery showing the dam and open canopy wetlands (**Figure 12**). The pond appears to get wider, and the wetland communities seem to change from being treed to open. Ron remembers being able to walk across the pond at its inlet and outlet as a boy, which is not possible in the current state of hydrology. He also describes the wetlands as having been forested, dominated by softwoods, when he was younger (before the beavers), and that his father warned him not to go out into the swamp, lest he fall deep into the muck and never come out again! This pattern of peatland succession is investigated further in Chapter 2.

August, 1942 June, 2023

Figure 12: Historical aerial imagery from VCGI Imagery Program shows the dramatic changes in hydrology at Joe's Pond - Morrisville over the last eighty years. The light green vegetation north of the pond on the 2023 image is open wetlands, while the dark vegetation surrounding the pond in the 1942 image is presumed to be forested wetlands

Evidence of past beaver activity was relatively abundant throughout the site. Old, chewed stumps surround the pond, especially black cherry *(Prunus serotina),* yellow birch *(Betula alleghaniensis)*, and eastern hemlock *(Tsuga canadensis)*, and chewed sticks float around the peat mat and the pond's surface. A pile of sticks on the edge of the wetlands that didn't look quite built up enough to be an active lodge during the spring and summer but was clear evidence of beaver activity (**Figure 13a**).

A beaver or muskrat was seen twice throughout the field season. Recent evidence of beaver and other wildlife activity was also found throughout the entire year of study, including chewed up stumps along the wetland edges and tunnels through the peatland vegetation that may have been created by muskrat or beaver. During a trip to the pond in early January 2026, I revisited the pile of sticks on the edge of the wetlands and found that it had been transformed into an active lodge over the fall/early winter (**Figure 13b**). Newly chewed sticks and mud and herbaceous material had been put together to form a nearly three-foot-tall lodge, which I believe was occupied at the time.

Figure 13: Evidence of beaver activity in the summer (a) and the winter (b). During the summer, the pile of stick was no higher than my mid-calf, while in the winter, the stick pile had grown into a lodge, half as tall as Matthias (seen in the photo to the left

Human History

The site has been owned by the Stancliff family since 1912. Most of the evidence of human disturbance can be attributed to the last century of activities. During the site survey, I did not specifically look for evidence of human disturbance, but interesting finds popped up along the way. A manmade ditch runs from the adjacent pasture to the north of the site into a tile drain within the Hemlock-Northern Hardwood Forest, which is mapped in **Figure 10**, seen flowing through the uplands into the wetlands on the northwest side of the pond.. Ron confirmed that this ditch was dug in the 1980s-90s, to drain the ponding from spring melting that used to occur in the pasture. A pipe that is dug into the ground carries flows from the ditch to an outfall in the southwest corner of the upland. The flow path of this drain can be seen using LiDAR imagery (**Appendix C**). Presumably, trees were cut down to bury the pipe about 35-40 years ago, but no clear sign of this activity remains. During much of the spring and summer, the inlet to the drain was pooled with water, and was sufficiently wet to support a slightly different composition of plants than the surroundings, with a predominance of sensitive ferns (*Onoclea sensibilis*).

During a field walk in April 2026, spotted salamander (*Ambystoma maculatum*) egg masses and spermatophores floated in the pool of water that sat at the inlet to the tile drain. The ditch is thus currently creating habitat for amphibian breeding.

The area around this ditch and pipe was wetter than the rest of the surrounding forest. It is possible that this area was a larger forested wetland before the installation of the ditch and pipe. Perhaps the amphibians that are using the ditch now once used to use the hummocks and hollows that can be found in the surrounding wetter forest area.

Another relic of human influence I stumbled upon was a water pump and electrical line structure along the Hemlock-Balsam Fir slope (**Figure 14**). Ron confirmed that this structure was used to provide water to 592 Stancliff Rd., but when the beavers arrived and dammed the pond, the structure became flooded and started malfunctioning and stopped being used.

Figure 14: The old water pump found just off the yellow trail.

There was a small, round depression in the ground along one of the trails/old logging trails (the red trail) that seemed to have been a cellar or just a dump site. Laura Costello and I dug up some old glass bottles and bits of ceramic, though we didn't do a full excavation of the site. Old sugaring buckets, metal cans, and other old trash are scattered throughout the site, most of which I left in place.

Natural Communities

I delineated eight natural community types within the study area (**Figure 15**). Four of these are listed in Wetland, Woodland, Wildland (WWW; Thompson et al., 2019), and the other four are variants I described because the areas did not fit well into any previously described natural community from WWW. Two of these variants are aquatic natural communities, which are outside of the scope of WWW. The two remaining natural communities are variants on existing natural communities that are not described in WWW. Bob Zaino, State Natural Community Ecologist with VTFW, during a site visit in June 2025, agreed that these additional natural communities could be distinct types that, though not previously recognized, were discerned in this close and careful study of a small parcel of land.

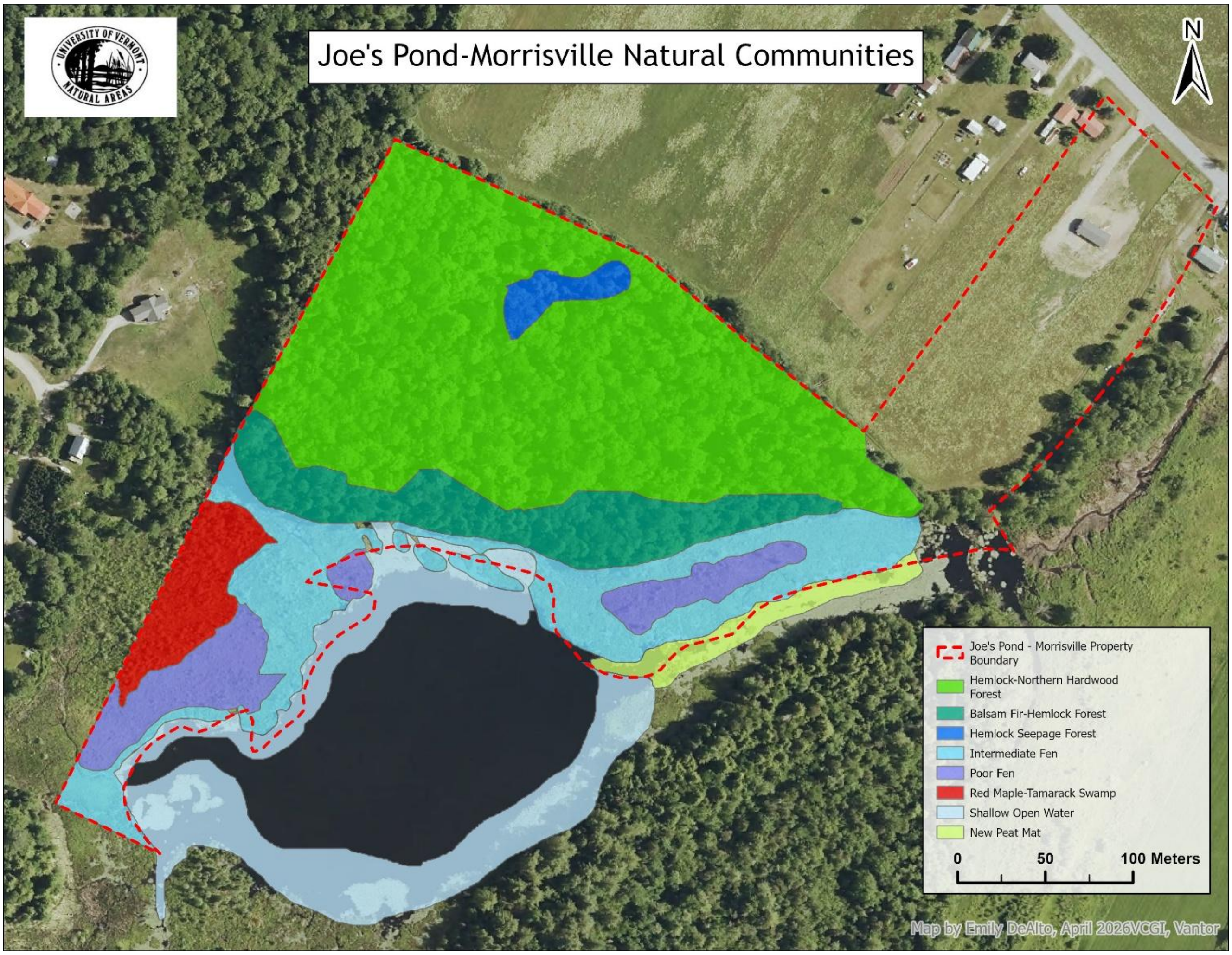


Figure 15: Natural Communities Map

Natural community boundaries in the uplands were primarily delineated by a change in tree canopy dominance and slope, and natural community lines in the wetlands were primarily delineated by a change in vegetation community composition. Overall, natural communities, especially the wetlands, are well developed examples of their types. Descriptions of each natural community follow.

Upland Natural Communities

Hemlock-Northern Hardwood Forest

Figure 16: Typical vegetation in the Hemlock-Northern Hardwood Forest includes open areas dominated by ferns, including hay scented fern, New York fern, and intermediate wood fern, among others. The dominance of hemlocks can be seen in the background of this photo.

This natural community is a classic matrix forest type in the region. Its specific makeup gives us a clue into the management history of the site. The old logging trails have turned into walking trails, and the large maples and cherry trees suggest someone has been taking particular care of specific tree species. The majority of the uplands (10.9 acres) are composed of Hemlock-Northern Hardwood Forest. This natural community was generally present on the flat plateau of the upland portion of the site, as compared to the other upland natural community, Balsam Fir-Hemlock Forest, which was present along the steep slopes along the north side of the pond. The dominant tree species in the canopy included hemlock, red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), yellow birch, black cherry, and balsam fir (*Abies balsamifera*). Beech (*Fagus grandifolia*) and striped maple (*Acer pensylvanicum*) were also scattered throughout. Ron planted a few nut bearing trees over the last twenty years in an effort to create wildlife habitat, including a swamp white oak (*Quercus bicolor*), butternut (*Juglans cinerea*), and American chestnut (*Castanea dentata*). These trees are discussed further in Chapter 4. The shrub layer is not well developed in most places within this natural community, though in some canopy openings, brambles (*Rubus spp.*) can be dominant. Deer browsing has impacted the vegetation composition of this natural community, most obviously in the herbaceous layer. Extensive fern glades are scattered throughout the uplands, especially in canopy openings, dominated by New York fern (*Amauropelta noveboracensis*), hay scented fern (*Dennstaedtia punctilobula*), lady fern (*Athyrium angustum*), and intermediate fern (*Dryopteris intermedia)*, which may be a result of deer browsing on the tree seedlings, limiting their regrowth and allowing the ferns to dominate (**Figure 17**).

Figure 17: A fern glade creeps out in a canopy opening in Hemlock-Northern Hardwood Forest.

Outside of these fern glades, a diversity of herbaceous plants can be found throughout this natural community. Other common herbs include Canada mayflower (*Maianthemum canadense*), ghost pipes (*Monotropa uniflora*), prickly tree-clubmoss (*Dendrolycopodium dendroideum*), painted trillium (*Trillium undulatum*), starflower (*Lysimachia borealis*), mountain woodsorrel (*Oxalis montana*), cucumber root (*Medeola virginiana*), whorled wood aster (*Oclemena acuminata*), wild sarsaparilla (*Aralia nudicaulis*), northern long-awned wood grass (*Brachyelytrum aristosum*), bladder sedge (*Carex intumescens),* sessile-leaved bellwort (*Uvularia sessilifolia*), and bracken fern (*Pteridium aquilinum*), among others. Herb cover in this natural community was much higher and more diverse than in the other upland natural community, Balsam Fir-Hemlock Forest, which may be due to the high slope of the other community. Generally, the structure of this natural community type was high quality, with lots of downed and dead trees, standing snags, and diverse plant assemblages, as well as mixed age classes in the canopy, suggesting either past management or natural aging of the forest.

The soils in this natural community generally matched the description of Adams loamy sand, a spodosol. Hemlocks are often dominant trees in spodosols, which are generally more acidic soils. Soil pH was quite acidic, near 4 in the O, A, E, and B horizons, though it increased slightly with depth.

Bird species most often encountered in this natural community include Red-Eyed Vireo (*Vireo olivaceus*), American Redstart (*Setophaga ruticilla*), Ovenbird (*Seiurus aurocapilla*), Black-throated Green Warbler (*Setophaga virens*), Blackburnian Warbler (*Setophaga fusca*), Black-capped Chickadee (*Poecile atricapillus*), Wood Thrush (*Hylocichla mustelina*), Hermit Thrush (*Catharus guttatus*), Chestnut-sided Warbler (*Setophaga pensylvanica*), Black-throated Blue Warbler (*Setophaga caerulescens*), Red-breasted Nuthatch (*Sitta canadensis*), Brown Creeper (*Certhia americana*), and Broad-Winged Hawk (*Buteo platypterus*), among others.

This natural community has been moderately influenced by human disturbance. Light logging has been practiced by the Stancliffs in the last century, mostly for firewood. Logging roads have been converted to hiking trails through this natural community. Black cherries, red maples, and sugar maples seem to be the largest trees (largest DBH), suggesting that they have been selected for sugaring, aesthetics, and other uses. This area may have been used as a pastured sugar bush in the 1800s to mid 1900s, which also may be why hemlock is a dominant species throughout, as cattle would have eaten the hardwood saplings and left the hemlock saplings. Spruce trees (*Picea spp.*) are lacking in the uplands, perhaps because they were harvested for building materials in the past, though there is no clear evidence of this, other than the fact that the other side of the pond has a much higher prevalence of spruces.

Balsam Fir-Hemlock Forest

The second-most abundant upland natural community found in the study area was Balsam Fir-Hemlock Forest, making up 2.4 acres. This natural community is not an official natural community listed in WWW. I found that the area where this natural community was present did not fit well into either of the two closest natural community types reviewed—Hemlock Forest and Lowland Spruce-Fir Forest. Hemlocks did not make up more than 75% of the canopy, thus Hemlock Forest didn't seem fitting. Lowland Spruce-Fir Forest was ruled out due to a lack of red spruce (*Picea rubens*) and moist soils (or a lack of white pine [*Pinus strobus*] in drier soils). Hemlock forests are generally found at lower elevations in the northeast, with an upper limit of about 1,500 feet AMSL, and balsam fir generally found at higher elevations, with most fir-dominated forests beginning at 2,500 feet AMSL (Reiners and Lang, 1979). At Joe's Pond-Morrisville, both species seem to be nearly equally dominant in this natural community. The natural community is present along the steep, north-facing slope along the pond, which may make it a bit colder than the plateau of the Hemlock-Northern Hardwood Forest area.

Figure 18: View facing south of the toe slope of the Balsam Fir-Hemlock Forest, facing Joe's Pond.

Dominant canopy species included hemlock and balsam fir, with yellow birch and black cherry also interspersed. Many of the same species as those listed in the previous section were also found in this natural community, however, to a much less significant extent, such that there was a clear transition between the two communities. Very few shrubs were present in this natural community; a few striped maples were scattered along the slope. The ground cover layer was also sparse throughout. Common herbs included Canada mayflower, starflower, graceful sedge (*Carex gracillima*), and intermediate wood fern. Other interesting plant species found within this natural community were eastern red cedar (*Juniperus virginiana*), a large, healthy American elm (*Ulmus americana*), long beech fern (*Phegopteris connectilis*), oak fern (*Gymnocarpium dryopteris*), and rough-leaved rice grass (*Oryzopsis asperifolia*).

Soils in this natural community were similar to that of the Hemlock-Northern Hardwood Forest, however, due to being on a steeper slope, soils were somewhat less horizontally organized in this natural community in some places. Layering was less clear in some soil pits dug along the slope, with more jumbled up till (stones and rocks in a more homogenized matrix of loamy sand) being found in some pits. The pH generally increased with depth from 4.5 in the O-horizon, to 5.5 in the deeper horizons, unlike the soil in the Hemlock-Northern Hardwood Forest, which was more uniformly acidic. In some pits, the till or Adams series overlay a layer of silt with a high pH of 6.5, which could also be found at the very bottom of the slope, just outside of the peatlands, suggesting some enrichment in groundwater may be seeping from the slope into the wetlands.

Figure 19: The boundary between Balsam Fir-Hemlock Forest and Hemlock-Northern Hardwood Forest is easily delineated by the Yellow Trail, which runs along the edge of the steep slope.

Bird species encountered in this natural community were the same as those in the Hemlock-Northern Hardwood Forest. This natural community was also right on the edge of the wetlands, so some wetland dwelling birds occasionally were seen along the edge of the natural community, such as Swamp Sparrow (*Melospiza georgiana*), Common Yellowthroat (*Geothlypis trichas*), and Cedar Waxwing (*Bombycilla cedrorum*). Fun sightings in this natural community included Blue-headed Vireo (*Vireo solitarius*) and Black-billed Cuckoo (*Coccyzus erythropthalmus*).

The main disturbance within this natural community is from beaver (*Castor canadensis*). Ample beaver chew of unidentified ages can be found along the pond edge of this natural community. Beavers generally do not stray more than two hundred meters from a stream or body of water (Anderson and Bonner, 2014). While it is unlikely that beavers waddled up much of the steep slope, it is possible that they did, which could have significantly impacted the tree canopy composition, as they would likely have selected out the hardwoods, leaving the now dominant hemlock and balsam fir.

Wetland Natural Communities

Hemlock Seepage Forest

Figure 20: Hemlock Seepage Forest within the Hemlock-Northern Hardwood Forest. This depression maintained surface water throughout the spring but did not have surface water in the later summer.

Within the Hemlock Northern Hardwood Forest natural community was a small, wet depression that felt significantly different from its surroundings (**Figure 20**). This community was somewhat puzzling but seemed to fit into the Hemlock Seepage Forest natural community type best. Its canopy was dominated by hemlocks, interspersed with dramatic hummocks and hollows in this small area. These hollows provided a place for water to pool and persist through the spring into the early summer. Though it did not support any amphibian egg masses, it could also be considered a vernal pool because it was very wet during the spring and the beginning of the summer and had indications of being a wetland (including hydric soils), then dried up later in the summer. It also had the capacity to serve as habitat for amphibian breeding, though none were found in this area in April 2026. *Sphagnum* coated about 5% of the overall area of the natural community, again suggesting a persistent source of water. Soils in this natural community differed significantly from those of the surrounding Hemlock-Northern Hardwood Forest, which is another reason I decided to treat it as a separate natural community. A soil pit in one of the wetter areas of this natural community revealed a layer of loamy sand with prominent redoximorphic features beneath the typical Adams loamy sand. The soil was also a much lighter grey than the soil commonly seen in the surrounding natural community. The pH of the soil in this wetter area also was dramatically different, increasing from 4 in the top horizon to 5.5 only 2 inches down, and then to 6.5 at 14 inches down, suggesting that groundwater seepage may be carrying nutrients to this small pocket within the uplands.

Intermediate Fen (S2)

Most of the wetlands in the study area were mapped as Intermediate Fen (3.8 acres). Intermediate Fen and Poor Fen form a mosaic throughout the peatlands; their lines are not always as clear-cut as those shown on the map, as is often the case in wetland complexes. Intermediate Fen at Joe’s Pond-Morrisville appeared in two different expressions.

Figure 21: View facing southeast of the Intermediate Fen, near the upland-wetland boundary. Softly waving wooly-fruited sedge dominates this expression of the Intermediate Fen, and can be seen in the foreground. CC Putnam Forest can be seen in the background.

The most prevalent was dominated by woolly-fruited sedge (*Carex lasiocarpa*)*,* which waved gently in the constant breeze that crosses the flat fen surface, and tall tussock sedge (*Carex stricta*)*,* taking its non-tussocked expression here, forming more of a sedgy mat, along with marsh cinquefoil (*Comarum palustre*)*,* marsh fern (*Thelypteris palustris*)*,* and broad-leaved cattail (*Typha latifolia*) in the herb layer*,* and leatherleaf (*Chamaedaphne calyculata*) and speckled alder (*Alnus incana*) in the shrub layer*.* While trees were not dominant anywhere in this natural community (less than 25% canopy cover overall), tamarack (*Larix laricina*) and red maple were the most common trees occurring within it, usually found perched on a slightly raised *Sphagnum* hummock, where their roots can get a bit of space from the constant wetness of this natural community. This expression of Intermediate Fen had nearly 100% ground cover by *Sphagnum* mosses.

Figure 22: Cattail dominated Intermediate Fen, facing southwest, from the dock.

The second expression of this natural community was dominated only by wooly-fruited sedge and has very little *Sphagnum* cover. Other species found throughout this natural community included round-leaved sundew (*Drosera rotundifolia*), white meadowsweet (*Spiraea alba*), lesser tussock sedge (*Carex diandra*), lake sedge (*Carex lacustre*), hoary sedge (*Carex canescens*), water arum *(Calla palustris*), cinnamon fern (*Osmundastrum cinnamomeum*), crested wood fern (*Dryopteris cristata*), common spikerush (*Eleocharis palustris*), sensitive fern (*Onoclea sensibilis*), bulb-bearing water-hemlock (*Cicuta bulbifera*), and bearded sedge (*Carex comosa*). Of note, the rare few-nerved cottongrass (*Eriophorum tenellum*) and white-fringed bog orchid (*Platanthera blephariglottis*), and the uncommon rose pogonia (*Pogonia ophioglossoides*) were all found in this natural community.

The substrate of this natural community is deep peat, up to 30 feet (See Chapter 2 for more detailed information about the peatlands). The peat is well decomposed to undecomposed. Below the peat is sandy or silty mineral substrate or gyttja.

Much of the fen is floating, bouncing up and down as you walk along it. Some areas are easy to walk in, but other areas are full of holes in the peat mat. Walking with a stick is advisable to reduce the risk of falling into the water. I fell in at least once a week, though it was usually a welcome cooling off moment in the otherwise-sunbaked fen.

Birds commonly encountered in this natural community included Swamp Sparrow, Common Yellowthroat, Cedar Waxwing, Great Blue Heron (*Ardea herodias*), American Bittern (*Botaurus lentiginosus*), Alder Flycatcher (*Empidonax alnorum*), Least Flycatcher (*Empidonax minimus*), Northern Parula (*Setophaga americana*), Great Crested Flycatcher (*Myiarchus crinitus*), Red-Winged Blackbird (*Agelaius phoeniceus*), Canada Goose (*Branta canadensis*), Eastern Kingbird

(*Tyrannus tyrannus*), White-throated Sparrow (*Zonotrichia albicollis*), Chimney Swift (*Chaetura pelagica*), Mallard (*Anas platyrhynchos*), and Belted Kingfisher (*Megaceryle alcyon*), among others. A beaver or muskrat (*Ondatra zibethicus*) was seen twice along the edge of this natural community. Many pathways cross through this natural community, perhaps created by muskrats, white-tailed deer (*Odocoileus virginianus*), and/or river otters (*Lontra canadensis*), making something of a trail system through the fen. Deer scat was often encountered on the peat mat.

Poor Fen (S2)

Figure 23: View facing west of the Poor Fen. Tamarack and other shrubs are mostly found on hummocks, as can be seen in the image. The swamp can be seen in the background on the right side of the image.

I mapped approximately 1.64 acres of Poor Fen, interspersed with Intermediate Fen throughout the peatlands on the site. This natural community is seemingly less wet, but equally as bouncy as the Intermediate Fen. A somewhat different set of plant species populate this community than those found in the Intermediate Fen, though there is some overlap. Dominant trees and shrubs included tamarack, black spruce (*Picea mariana*), and speckled alder on the hummocks. Black spruce was far less common than tamarack. Leatherleaf was dominant in both hummocks and hollows. Dominant herbs included Billing's sedge (*Carex billingsii*) and tawny cottongrass (*Eriophorum virginicum*). Other species commonly found throughout this community included round-leaved sundew, pitcher plant *(Sarracenia purpurea*)*,* high-bush blueberry (*Vaccinium corymbosum*)*,* bog rosemary (*Andromeda polifolia*)*,* American cranberry (*Vaccinium macrocarpon*)*,* mud sedge (*Carex limosa*), bog-bean (*Menyanthes trifoliata*), and sheep laurel (*Kalmia angustifolia*).

The lagg zone, a transitional area between peatland community types where nutrients and water accumulate (Howie and Meerveld, 2011), between the Poor Fen and Red Maple-Tamarack Swamp was dominated by tussock sedge and few-nerved cottongrass. Other transitional areas between Poor and Intermediate Fen were dominated by woolly-fruited sedge and/or lake sedge. The substrate was very undecomposed *Sphagnum* peat within the first meter. pH values within the Poor Fen ranged from 4.3 to 4.8. *Sphagnum* cover was generally over 95%, with no exposed rock or other ground cover observed in most expressions of the natural community. In some areas a layer of sedge and leaf litter <1cm thick covered the ground.

Red Maple-Tamarack Swamp

Figure 24: View of the typical canopy in the swamp, dominated by tamarack and red maple, with also gray birch (Betula populifolia) interspersed.

This natural community, present on the western edge of the wetlands within the study area, is not an officially described natural community in WWW and likely exists at Joe's Pond-Morrisville as an effect of natural disturbance from beavers at the site. Beaver disturbance can shift wetland natural communities away from their previous state with dramatic shifts in hydrological regime and selectively removing some of the trees present. Compared to the rest of the fen, this area had a deeper water table in some areas, which may be what is leading to a higher dominance of trees than in the open fen area. Overall, this natural community had a very high diversity of plant species. Dominant trees included red maple and tamarack, with grey birch and red spruce scattered around. The trees were generally small, with the largest measured being a tamarack of 5.4 inches DBH. Shrub diversity in this natural community was high, including highbush blueberry, lowbush blueberry (*Vaccinium angustifolium*), mountain holly (*Ilex mucronata*), velvet-leaved blueberry (*Vaccinium myrtilloides*), willows (*Salix spp.*), winterberry holly (*Ilex verticillata*), white meadowsweet, steeplebush (*Spiraea tomentosa*), and wild raisin (*Viburnum cassinoides*). The herb layer was similarly diverse; dominant species included marsh cinquefoil, broadleaved cattail, star sedge (*Carex echinata*), awl-fruited sedge (*Carex stipata*), American bur-reed (*Sparganum americanum*), and marsh fern. Other species found throughout this natural community were crested wood fern, arrow-leaved tearthumb (*Persicaria sagittata*) rice cutgrass (*Leersia oryzoides*), tussock sedge, Virginia marsh St. John's wort (*Triadenum virginicum*), downy willowherb (*Epilobium strictum*), swamp candles (*Lysimachia terrestris*), bog sedge (*Carex magellanicum*), and American cranberry.

Figure 25: Crested woodfern can be found scattered around the swamp on Sphagnum hummocks.

Soils in this natural community were completely organic peat and muck, with pH increasing with depth from 5 on *Sphagnum* hummocks to 7 at auger depth, suggesting some enrichment is coming into the system from groundwater. While the pH was high in the peat here, the natural community does not fit the Calcareous Red Maple-Tamarack Swamp natural community type because of the absence of calciphilic indicator species, such as yellow sedge (*Carex flava*), inland sedge (*Carex interior*), bristle stalked sedge (*Carex leptalea*), and showy lady's slipper (*Cypripedium reginae*).

Sphagnum cover was about 50% within this natural community; in the areas where it is present, it blankets the ground, and in other areas it is completely absent. Usually standing water covered areas that are not covered in *Sphagnum*.

Aquatic Natural Communities

Two distinct aquatic communities were present within the open-water portion of the pond. These are not described in WWW, as that work does not cover aquatic communities.

Shallow Open Water

Few vascular plant species were present in Joe's Pond, likely because the pond water is very dark with high organic content from runoff from the peatlands. Species found in the open water included Hill's pondweed (*Potamogeton hillii*), small pondweed (*Potamogeton pusillus subsp. pusillus*), common duckweed (*Lemna minor*), fragrant water-lily (*Nymphaea odorata*), yellow pond-lily (*Nuphar variegata*), coontail (*Ceratophyllum demersum*), duckmeat (*Spirodela polyrhiza*), as well as unidentified filamentous macroalgae and bryozoans.

Great Blue Heron, American Bittern, and Spotted Sandpiper (*Actitis macularius*) wandered the edges of the Shallow Open Water natural communities and the Peatland Edge/New Peat Mat natural community. Spotted Sandpiper, in particular, used the lily pads as a path to walk around the open water in the inlet and outlet to the pond.

Figure 26: Typical vegetation in the Shallow Open Water natural community includes lily pads and duckweed, while the edge often supports marsh fern, cattails, and spikerushes.

In April 2026, during a field walk I led at the site, the group found egg masses from spotted salamander and wood frog (*Lithobates sylvaticus*) scattered along the edges of the pond. Spring peepers (*Pseudacris crucifer*) also sang mightily. Having started my field season in May of 2025, I had not seen the egg masses before, highlighting the importance of year long surveys.

Peatland Edge/New Peat Mat

Figure 27: Peatland Edge/New Peat Mat. Spike-rush grows on the warm, floating peat held up by the lily pad rhizomes.

Common spikerush tended to cling to the edges of the peat mat, and common arrowhead (*Sagittaria latifolia*) grows along the edges of the peat mat and the pond. New peat mat was forming along the pond outlet, held up by the lily pad rhizomes. Stabilization of the peat mat allows sundews, rose pogonia, willowherbs, blunt spikerush (*Eleocharis obtusa*), fringed heartwort (*Ricciacarpos natans*), floating crystalwort (*Riccia fluitans*), and others to gain a foothold and start colonizing the new peat mat. The uncommon (S3) false water-pepper smartweed (*Perisicaria hydropiperoides*) also grew on this new peat mat. Over time, it is possible that this new peat mat could close the existing pond outlet, though a persistent drought might be necessary for this to happen.

Inventory: Rare and Uncommon Plants

Figure 28: Few-nerved cotton grass (Eriophorum tenellum)

The relevés proved to be a useful methodology for encountering new species for the inventory; by selecting an area that felt representative of a natural community, I encountered species I hadn't yet seen on the site nearly every time.

Results of the general inventory can be found in **Appendix D**. Of note, I found new populations of six state-listed plant species (ranking S1, S2, or S3) within the study area, including few-nerved cottongrass (S1S2), lesser bladderwort (*Utricularia minor*; S2), white-fringed bog-orchid (S2), rose pogonia (S3), tuberous grass-pink (*Calapogon tuberosus*; S3), and false water-pepper smartweed (S3).

Figure 29: Rose pogonia (Pogonia ophioglossoides)

Figure 30: Tuberous grass-pink (Calapogon tuberosus). Photo taken at Morristown Bog.

Eriophorum tenellum (S1S2)

Few-nerved cotton grass was found within a Poor Fen surrounded by an Intermediate Fen. The population was large (>100 individuals), with individuals mostly in middle range local elevations (i.e. not on top of hummocks or in the deepest hollows).

Pogonia ophioglossoides (S3)

Rose pogonia was abundant within the Intermediate Fen natural community. It was often among woolly-fruited sedge, lesser tussock sedge, round-leaved sundew, and marsh fern, among others. It could be found in a variety of microhabitats, including hummocks, hollows, standing stumps within the open water, and along the floating mat/fen edge where the fen meets the open water pond. More than 100 individuals were observed throughout the site, in both the main peat mat and the thinner strip of peat along the northern half of the pond, near the outlet.

Calopogon tuberosus (S3)

I only observed one tuberous grass-pink individual throughout the season, found in a small pocket of Poor Fen within an Intermediate Fen. It was surrounded by woolly-fruited sedge, mud sedge, leatherleaf, star sedge, marsh fern, tamarack, and speckled alder.

Platanthera blephariglottis (S2)

Ten to twenty white-fringed bog orchid individuals were found scattered around the Poor Fen natural community on the northwestern portion of the peat mat, nearest the inlet. Individuals were usually on medium-height hummocks, surrounded by mud sedge, leatherleaf, tawny cottongrass, tamarack, and round-leaved sundew, among others. Individuals were well spaced out within the population, with most individuals having at least 10 feet between one individual and the next.

Persicaria hydropiperoides (S3)

A population of at least 10 individuals grew along the newest peat mats forming in the main outlet stream of the pond, to the northwest. These mats are likely held together by yellow pond-lily rhizomes, which float near the pond surface and accumulate peat within them in this area. These new peat mats are dominated mostly by blunt spikerush.

Utricularia minor (S3)

Lesser bladderwort clinged to the edges of the Intermediate Fen peat mat, floating in the murky, mucky pond water.

Figure 31: White-fringed bog orchid (Platanthera blephariglottis)

Figure 32: Lesser bladderwort (Utricularia minor)

Chapter II: The Peatlands of Joe’s Pond-Morrisville

The marsh ferns, swamp rose, cattails, and other wetland vegetation at Joe’s Pond-Morrisville quake, floating on a slurry of water and organic material. It makes for a precarious and magical tromp across these rare natural communities. It feels as if you’ve wandered into some kind of heaven when you step out into the open peat mat, dotted with the fluffy stars of cottongrasses, the pink cheeks of rose pogonia, the shaggy white flowers of bog bean and white-fringed bog orchid. Every week there was a new plant flowering in shades of pinks, whites, purples, and yellows. What a treat to wander these wobbly wetlands!

Abstract

This study of the six acres of peatlands at Joe’s Pond-Morrisville within the UVM Natural Areas property is the first study of this portion of the larger wetland complex that also includes Morristown Bog and Valcour Bog to the south. In this study, I investigated the existing and historical conditions of the peatlands, testing several hypotheses on environmental controls of modern vegetation distribution as well as peatland development. I studied the current conditions in a six-point transect along the three natural communities, measuring environmental variables and vegetation composition. Canonical correspondence analyses showed that pH and water table fluctuations are the main variables correlated with the vegetation gradient along the peat mat from the forest edge to the open pond. I explored the historical conditions by measuring peat depth at over one hundred equally spaced sample points; I also extracted a six-meter peat core for macrofossil analysis. Results suggest that the peatlands first formed over open water, encroaching into the open water from the uplands over time by an infilling process. In more recent years, the peatlands have grown outward into the uplands by paludification due to a change in hydrology, likely from the beaver dam at the pond outlet. This study, to my knowledge, the first of its kind in the Lamoille Valley, improves our understanding of the ecology of peatlands in Vermont today and since the last Ice Age.

Introduction

The wetlands at Joe’s Pond-Morrisville are peatlands, unusual and rare wetlands in Vermont, though they make up an estimated half of all the world’s wetlands (Yu et al., 2011). Peatlands are wetlands whose substrate is waterlogged, undecomposed or partially decomposed organic soil, called peat. This new Natural Area is the fourth UVM Natural Area that supports peatlands.

The list also includes Molly Bog, Colchester Bog, and Shelburne Pond. Understanding the ecology and natural history of UVM's peatlands is crucial; they support high quality habitats, ecosystems, and ecosystem services. Like other wetland types, they provide water sequestration and water quality improvement, as well as a uniquely high carbon sequestration ability compared to other wetland and upland systems. Peatland ecology is incredibly dynamic; feedback loops between the hydrological, chemical, and the biological processes happening within them maintain the existing conditions of the peatland until some tipping point occurs, shifting the ecology from one stable state to another (Loisel and Bunsen, 2020). Shifting between stable states can have implications in the functionality of the peatlands on local and global scales (Arsenault et al., 2024; Bubier et al., 1991; Loisel and Bunsen, 2020).

This is a chapter in three parts. Part 1 is an investigation into hydrological and chemical conditions that might be driving the current natural communities present within the peatlands. It is the result of a nine-week study of vegetation and environmental variables along a transect across the wetland natural communities. This part serves to inform us of what conditions the existing natural communities might require, such that we can make some predictions about how the conditions might change if the environmental conditions were to change. Part 2 is a palaeoecological study of the peatlands through peat depth measurements and a peat core macrofossil analysis. This part aims to deepen our understanding of the succession and growth of these peatlands since the last Ice Age. Using information from the literature about local and broad scale climate and wildlife trends over the last fifteen thousand years, we can make predictions about how this peatland system has changed over time. The final section, Part 3, uses the information gathered in Parts 1 and 2 to develop an ecological interpretation of the natural history of these wetlands, and how they might change in the future.

Part 1: The Current Ecology of the Peatlands

Searching through the wetlands at Joe's Pond-Morrisville for the first time, in April 2025, I wondered whether I would find a bog. Looking at the aerials before heading out there, I noticed that the wetlands surrounding the pond looked like they might be some kind of open peatland, like a Dwarf Shrub Bog, but it looked a little different in these aerial images than the nearby bogs that had already been mapped, like Molly, Valcour, and Morristown Bogs. For one, they surrounded a much larger body of water than Molly Bog, the only other bog in the area that still has an open water body in the center, and there were also very clear inlets and an outlet to the wetland system, which feeds into Bedell Brook to the north. Bogs don't typically have inlets and outlets. Pushing through shrubby heaths, I held on tight to the inkling that I might find an open peatland on the other side of the swamp that lies on the edge of the uplands. Tumbling through a last layer of yellowed, yearling cattails, boots already twice overtopped, my eyes widened as I stepped onto a ground that buckled gently under my weight. The tall vegetation that smacked me in the face on the way in was gone, and I was met with an open landscape, a clear view of the pond on the edge of a flat expanse of maroon tinged mosses and leatherleaf and scraggly tamaracks and black spruce. Wandering out, I jumped with delight at the dramatic change.

Introduction

Peatlands hold one third of the world's carbon, an estimated 600 gigatons since the last Ice Age, while only covering three percent of the earth's surface (Renou-Wilson et al., 2019; Yu et al., 2011). The peatlands within 50-70° North, just outside of where Vermont lies (45° North), hold the highest carbon densities compared to other latitudes (Yu et al., 2011), making them a massive sink for carbon in our region, and for the world. "Peatland" is an umbrella term for any wetland whose soil is composed of more than thirty centimeters (Charman, 2009) of partially decomposed organic material, with varying levels of decomposition possible within the overarching term "peat". The main types of peatlands are fens, bogs, and swamps (treed peatlands). The two most common ways to differentiate between peatland types are water chemistry, primarily pH and nutrient gradients, and hydrological regime (Rydin and Jeglum, 2006; **Figure 33**). Peatland water chemistry varies greatly between peatland types, which is partially a function of the peatland's water source, and thus hydrological regime. For example, pH ranges from 3.0 to 9.0 and total base cation concentration ranges from near zero to 1000 mg/L between bogs and fens, respectively (Wieder and Vitt, 2006). And while a consistently high water table is a trait common to all peat types and is a main driver in many of the other key characteristics of peatlands, like low rates of decomposition, colder average temperatures than their surroundings, short growing season, and low nutrient availability, there is variability in average water table depth and seasonal fluctuation between peatland types. Fens generally have lower water table fluctuations across the growing season than bogs (Griffiths et al., 2019), and swamp peatlands must have high enough water table fluctuations through the growing season to support woody vegetation establishment and growth (Price et al., 2023). With such a wide range of environmental conditions, there is a corresponding wide range of vegetation between different peatland types. Multiple studies across peatlands in North America, South America, and Europe correlate these chemical conditions with the present vegetation, establishing a baseline understanding of the relationship between hydrology, water chemistry, and vegetation (Arsenault et al. 2019; Glaser et al., 1990; Rydin and Jeglum, 2006; Wieder and Vitt, 2006). The differences in chemistry and hydrology affect the vegetation that fit into the niche of these systems—highly specified species with physiological adaptations dominate peatlands, and each peatland type is dominated by a unique community of plants, with some overlap.

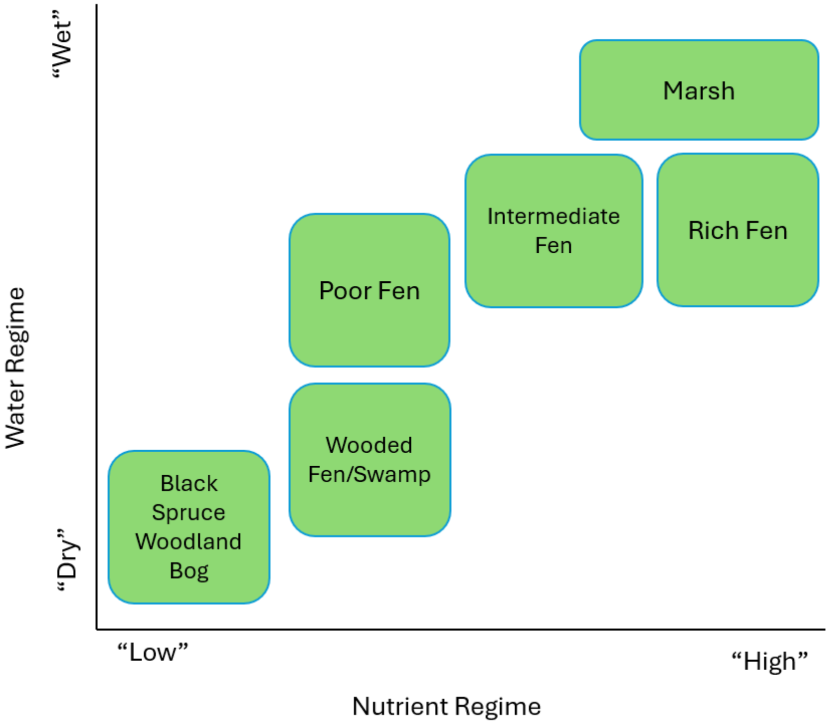


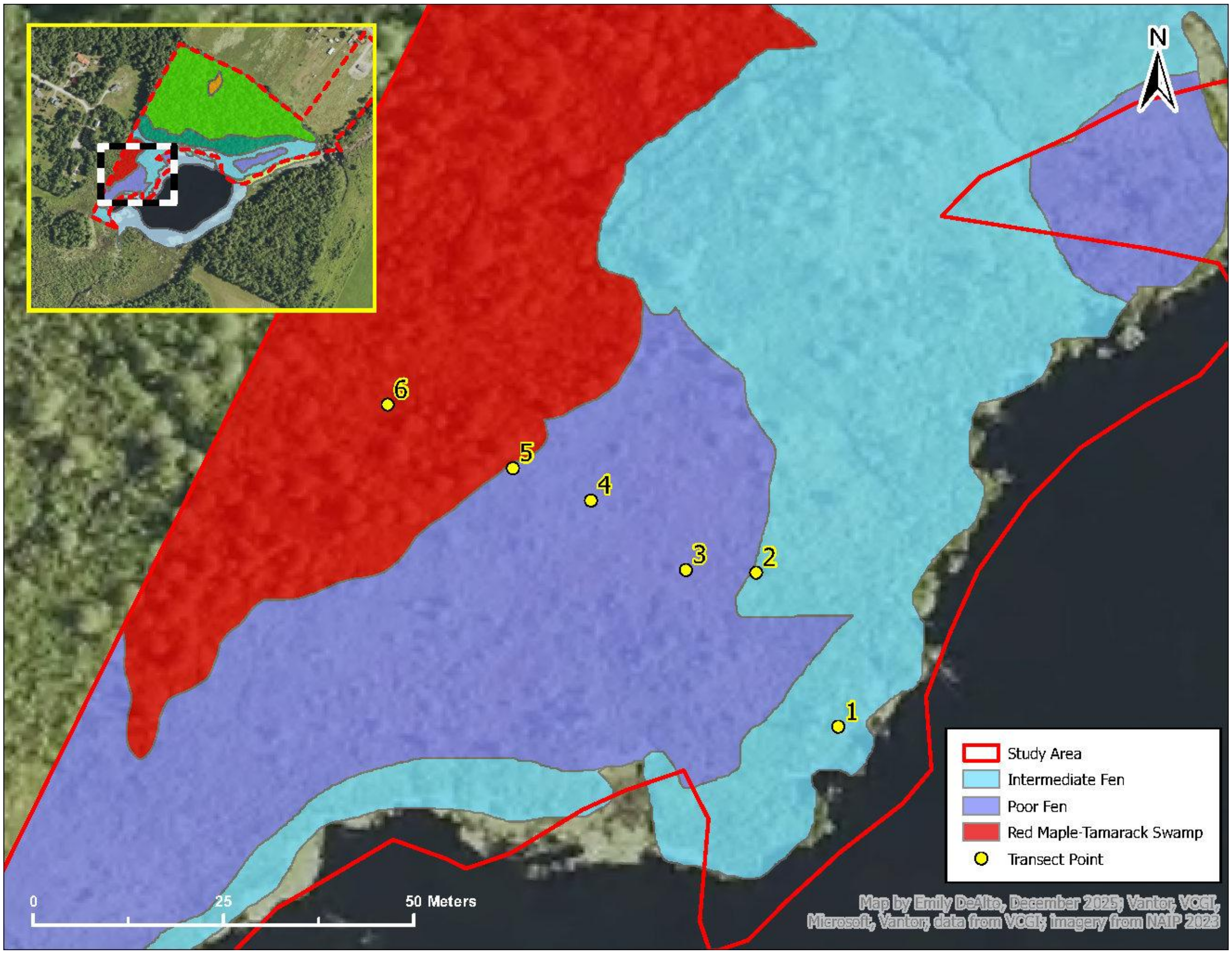
Figure 33: Wetland type scheme. A scheme showing the position of wetland types based on nutrient regime and hydrological regime, adapted from Rydin and Jeglum, 2006.

In the following study, I set out to identify which environmental factors were the most important drivers in the gradient between natural communities across the peatlands at Joe's Pond-Morrisville in Morrisville, Vermont. I hypothesized first that there would be a significant difference in the vegetation composition among natural community types along a transect from the forest edge to the open pond. Based on this first hypothesis, I then hypothesized that pH, electrical conductivity, and average depth to water table would be the most important environmental variables influencing the changes in vegetation composition, as water chemistry and hydrological regime are often cited as the most important differences among peatland types (Rydin and Jeglum, 2006).

Methods

Field Methods

I collected environmental and vegetation data along a six-point transect that crosses through the three natural communities in the wetlands. Data were collected every Monday for nine weeks, May 26th to August 11th, 2025. Sample point (SP) 1 is the point closest to the lake edge and SP6 is the point furthest from the lake edge and closest to the upland edge (**Figure 34**). Two sample points were placed within each delineated natural community type within the peatlands: Intermediate Fen (points 1 and 2), Poor Fen (points 3 and 4), and Red Maple-Tamarack Swamp (points 5 and 6). SP5 is right on the boundary between Red Maple-Tamarack Swamp and Poor Fen and SP 2 is on the boundary between Poor Fen and Intermediate Fen. The environmental variables included pH, electrical conductivity (EC), water table depth (wt), nutrients (ppm; the mass of solid content in a dissolved solution; Hanna Instruments, n.d.), and temperature (t).



Map by Emily DeAlto, December 2025; Vantor, VCGI, Microsoft, Vantor; data from VCGI; imagery from NAIP 2023

Figure 34: Transect Points Map

I collected the pH, EC, ppm, and t using a Hanna® Instruments Portable pH/EC/TDS Meter. I measured the water table depth using a homemade PVC pipe system, using the following protocol:

1. Drill holes intermittently into a 1-inch diameter by 5-foot length PVC pipe.
2. Push the pipe with holes into the peat until only about a half foot is above the ground.
3. Measure the length of the pipe sticking out of the ground, called "pipe to ground".
4. Attach two feet of 1/4 inch diameter PVC pipe onto a rubber tube of the same diameter.
5. Lower the smaller pipe into the larger PVC pipe, while blowing into the rubber tube, until you hear bubbling, indicating that you have hit the water table.
6. Record the point on the smaller pipe where the water table was hit, then measure from this point to the end of the pipe, called "pipe to water".
7. Use the following equation to find the depth to water table:

pipe to ground - pipe to water = depth to water table

I collected vegetation data by estimating the percentage cover of species found in a one-by-one meter quadrat at each sample point where environmental data were collected. Two quadrats were completed at each sample point and then combined into one data point for analysis. The data used for analysis can be found in **Appendix E**.

Data Analysis Methods

Preliminary Data Exploration

The first stage of analysis was a data exploration phase. In this phase, I looked at the variation for each environmental variable throughout the season at each sample point, the overall mean of each variable throughout the season for each sample point, and the potential correlation between environmental variables. I plotted the seasonal variation to visualize the change in each environmental variable over the season. A loess line was added to these plots to smooth the trend for interpretation. Mean values were computed by taking the mean over the nine weeks of measurements and plotting these in a line graph using the ggplot2 package in R (R Core Team, 2024). Error bars represent the standard deviation (SD) of each sample point mean to represent the relative amount of change over the season for each sample point. Correlation between the scaled covariates was calculated using the cor() function from the corrplot package in R.

Canonical Correspondence Analysis

I analyzed the peatland transect data through a canonical correspondence analysis (CCA), used to relate community composition to known variation in environmental factors (Ter Braak, 1986). I combined the vegetation data from the two plots per sample point to make one plot per sample point to perform the CCA, which requires the same number of sample points between the environmental and vegetation data. The environmental data were scaled so I could compare covariates with dissimilar scales and units. I first conducted a Principal Components Analysis (PCA) of the vegetation data to identify the groups of vegetation that are most correlated. Then, using the cca() function from the vegan package in R, I performed a CCA of the vegetation cover data and environmental variables, excluding Nutrients (ppm), to avoid multicollinearity because of its high correlation with EC. I used the mean of all the variables except for wt. The wt covariate showed a high seasonal variation in some sample points and not others, thus I hypothesized that the standard deviation (SD) is more important than the mean wt. I grouped the vegetation cover data into three groups using k-means based on their correlation with the axes.

Results

Seasonal Variation and Means Across the Transect

Water table depth (wt) and temperature (t) had the greatest variation over the season (**Figure 35**), while the other variables were relatively consistent throughout the season at each sample point. Importantly, wt had a high SD at sample points 5 and 6, the sample points furthest from the pond, while those closer to the pond (sample points 1 and 2) were much less variable (**Figure 36**). From these plots it was determined that wt SD would be used for the CCA because this variable showed the most inconsistent variation across the transects (**Figure 36**). For all other variables, mean was selected for the CCA because SD was similar across sample points.

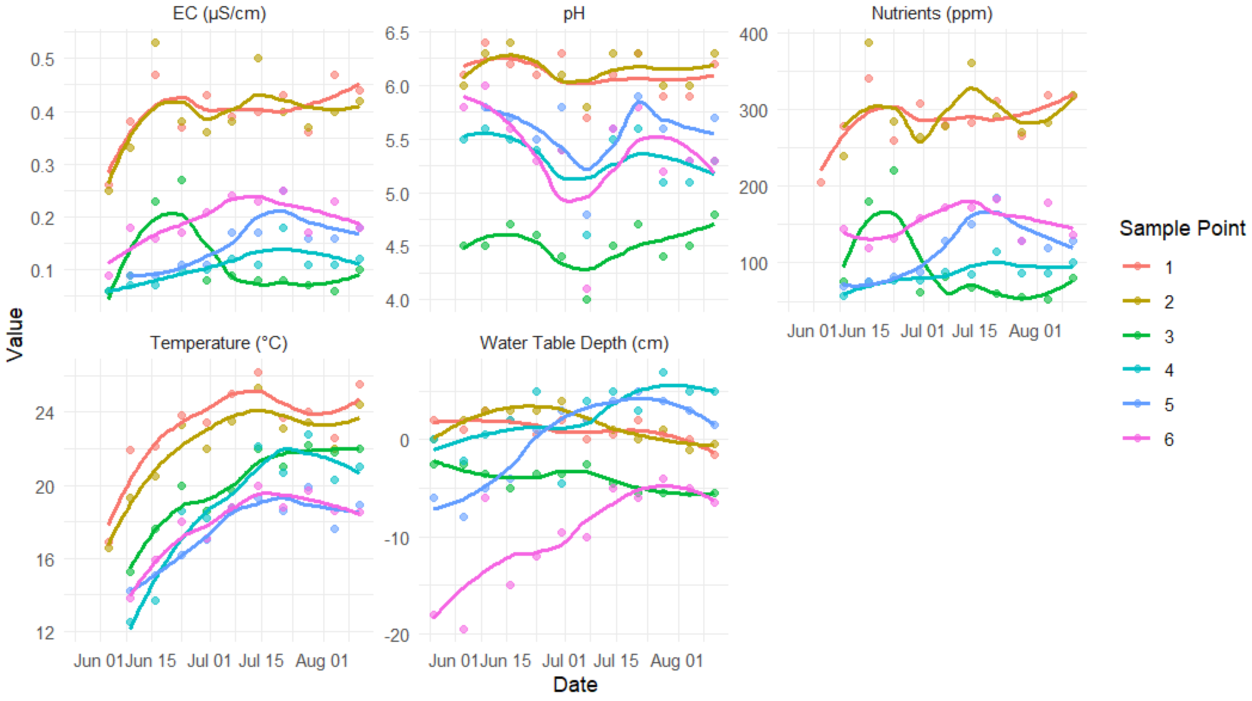
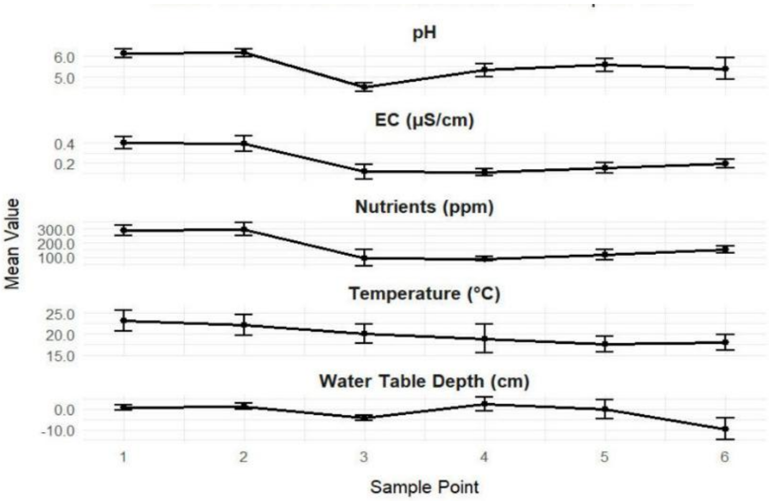
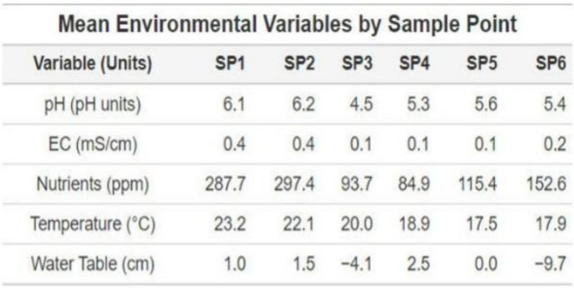


Figure 35: Seasonal Variation Plots. Sampling was completed between May 26, 2025 and August 11, 2025.





Mean Environmental Variables by Sample Point

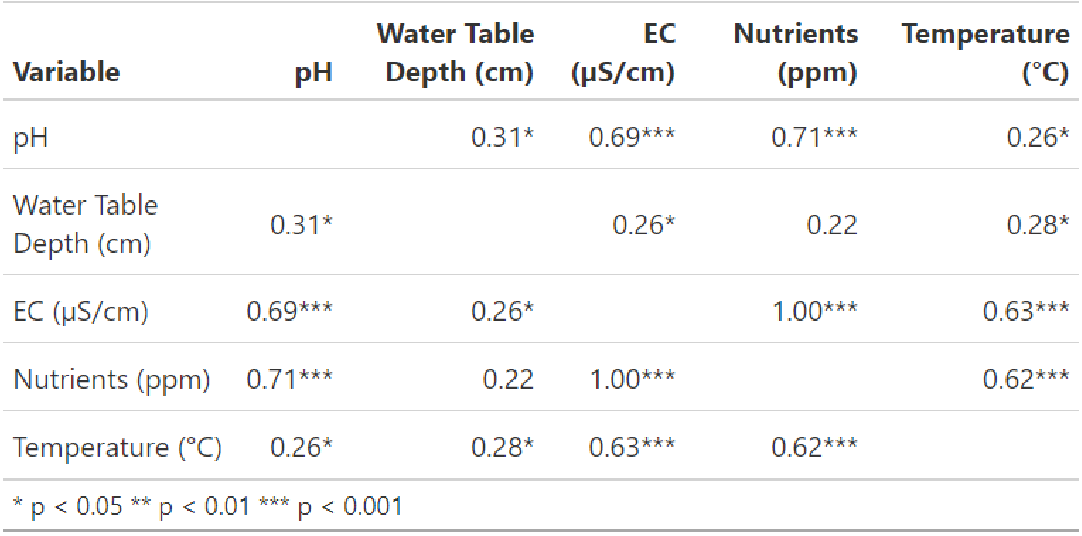
Variable (Units)	SP1	SP2	SP3	SP4	SP5	SP6
pH (pH units)	6.1	6.2	4.5	5.3	5.6	5.4
EC (mS/cm)	0.4	0.4	0.1	0.1	0.1	0.2
Nutrients (ppm)	287.7	297.4	93.7	84.9	115.4	152.6
Temperature (°C)	23.2	22.1	20.0	18.9	17.5	17.9
Water Table (cm)	1.0	1.5	−4.1	2.5	0.0	−9.7

Figure 36: Mean Environmental Variables Across Sample Points

Correlation Plot

I created a correlation plot to assess whether any environmental variables are varying together to create a more parsimonious model in my CCA. EC and nutrients are directly correlated (correlation of 1.00, p<0.001) because the probe I used to collect my data calculates nutrients by multiplying EC by a variable constant that is based on EC, because it is assumed that the solids dissolved in a solution are ionic in nature (Hanna Instruments, n.d). Consequently, I dropped the nutrients covariate from any future modeling. Of the remaining variables, the highest correlations were found between pH and EC (p>0.001), pH and Nutrients (p>0.001), temperature and EC (p>0.001), and nutrients and temperature (p>0.001; **Table 1**). Again, because EC and nutrients are assumed to be directly correlated, it is not surprising that these variables nearly equally correlate with temperature and pH. Water table depth does not significantly vary with any of the other covariates. All correlation coefficients were positive, suggesting all relationships between variables are positive. I did not choose to remove any other variables from further analysis at this point because, though they are correlated, their correlation values are not high enough to suggest they are measuring the same thing.

Table 1: Correlation matrix of environmental variables



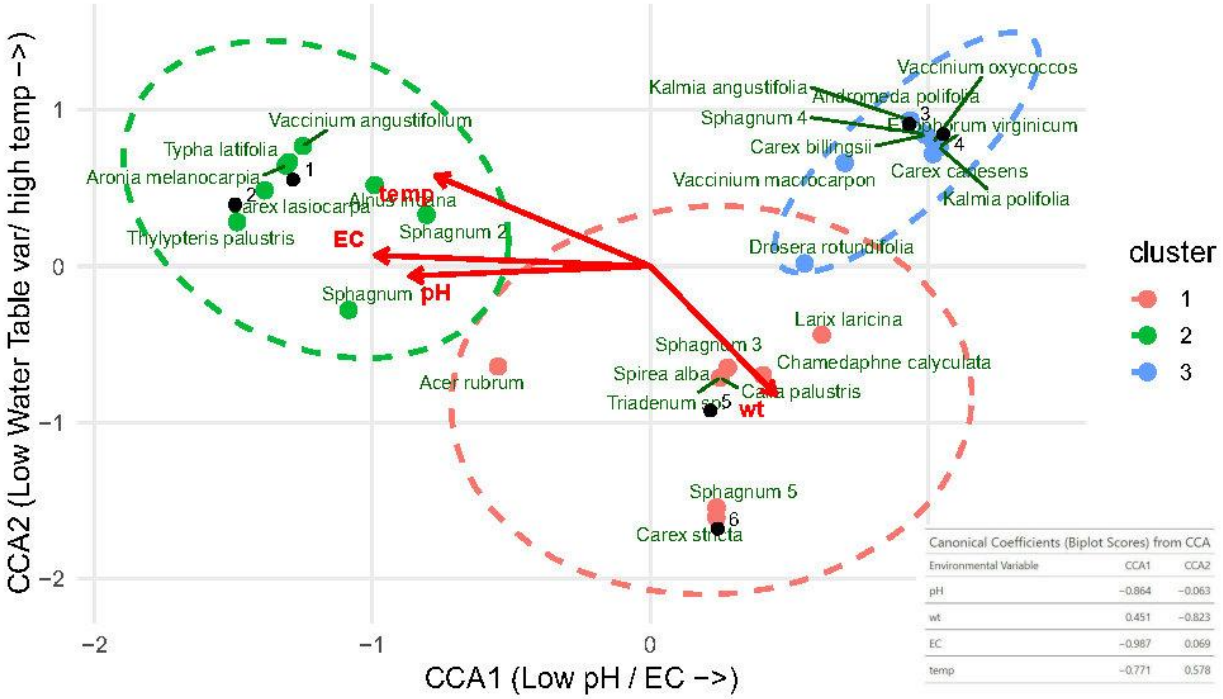
Variable	pH	Water Table Depth (cm)	EC (µS/cm)	Nutrients (ppm)	Temperature (°C)
pH		0.31*	0.69***	0.71***	0.26*
Water Table Depth (cm)	0.31*		0.26*	0.22	0.28*
EC (µS/cm)	0.69***	0.26*		1.00***	0.63***
Nutrients (ppm)	0.71***	0.22	1.00***		0.62***
Temperature (°C)	0.26*	0.28*	0.63***	0.62***	

* p < 0.05 ** p < 0.01 *** p < 0.001

Canonical Correspondence Analysis

Results of the CCA placed the sample points into groups that corresponded with the natural community delineations I created (**Figure 15**). EC and pH were the most highly correlated with CCA1 (x-axis) with biplot values of -0.987 and -0.864, respectively. Negative biplot values indicates negative correlation with the x-axis. This is interpreted as pH and EC decreasing with increased x-axis value (**Figure 37**). Temperature and wt SD were the most correlated with CCA2 (y-axis), with wt SD negatively correlated with the y-axis and temperature positively correlated with the y-axis. The accumulated constrained eigenvalues for CCA1 and CCA2 were 0.8652 and 0.6625; the proportion of variance they explained were 0.4186 and 0.3205, respectively, meaning that these two axes collectively account for about 74% of the variation in the data.

Pairwise correlations among environmental variables were moderate after removing ppm (maximum r = 0.69), but variance inflation factors (VIFs) indicated substantial multicollinearity in the initial CCA (pH = 5.49, wt = 16.77, EC = 15.34, temp = 37.30). Because values above 10 suggest problematic collinearity (Ahmad, 2021), the high VIFs for water table, EC, and especially temperature reduced confidence in coefficient interpretation.



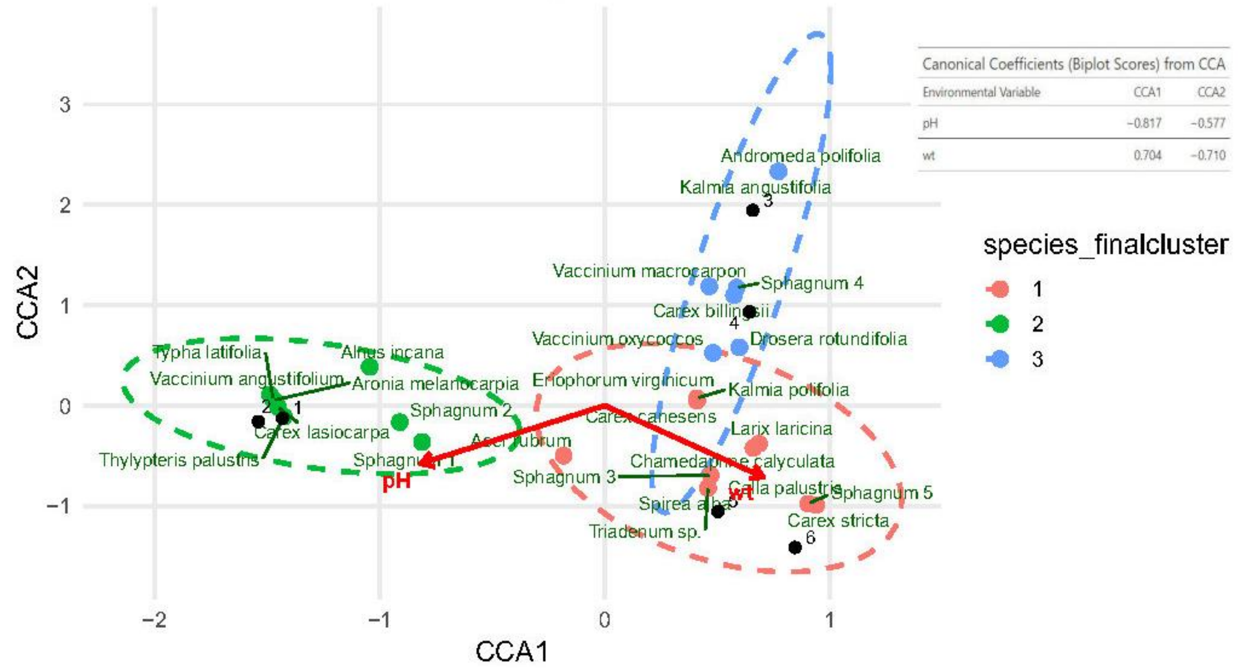
Canonical Coefficients (Biplot Scores) from CCA

Environmental Variable	CCA1	CCA2
pH	−0.864	−0.063
wt	0.451	−0.823
EC	−0.987	0.069
temp	−0.771	0.578

Figure 37: Preliminary CCA Results. The covariates included in the model were temperature (temp) in degrees Celsius, water table depth (wt, in centimeters), electrical conductivity (EC, in µS/cm), and pH (unitless). Sample points are indicated by black points on the graph, and plant species are indicated by colored points, based on cluster (see cluster legend). Canonical Coefficients (biplot scores) were extracted from the CCA to determine which covariates were most heavily tied to each axis. The accumulated constrained eigenvalues for CCA1 and CCA2 were 0.8652 and 0.6625, and their proportion explained were 0.4186 and 0.3205.

To address this, a reduced base model including only mean pH and water table SD was evaluated. Adding temperature produced high multicollinearity (VIF = 17.1) and inflated the VIF of water table SD (12.1), while adding EC similarly increased multicollinearity (EC VIF = 7.0; pH VIF = 5.4). Both variables were therefore excluded. The final CCA included only mean pH and water table SD, and VIFs for both variables were within acceptable ranges.

Mean pH was the most highly correlated with CCA1 (x-axis) with biplot value of -0.817 meaning that it is negatively correlated with the x axis, such that pH decreases with increased x-axis value (**Figure 38**). The wt SD was the most correlated with CCA2 (y-axis), with wt SD negatively correlated with the y-axis. The eigenvalues for CCA1 and CCA2 were 0.8121 and 0.5022, and their proportion explained were 0.3297 and 0.2039, respectively, meaning that these two axes account for about 53% of the variation in the vegetation data across the transect. The accumulated constrained proportion explained for CCA1 was 0.6179 and for CCA2 was 0.3821, meaning that CCA1 captures 62% and CCA2 captures 38% of the variation in vegetation explained by the environmental variables.



Canonical Coefficients (Biplot Scores) from CCA

Environmental Variable	CCA1	CCA2
pH	−0.817	−0.577
wt	0.704	−0.710

Figure 38: Final CCA Results. The covariates included in the model were water table depth SD (wt, in centimeters) and pH (unitless). Sample points are in black on the graph, and plant species are in colored points, based on cluster (see species_finalcluster legend). Canonical Coefficients (biplot scores) were extracted from the CCA to determine which covariates were most heavily tied to each axis. The eigenvalues for CCA1 and CCA2 were 0.8121 and 0.5022, and their proportion explained were 0.3297 and 0.2039, respectively.

Vegetation was grouped using K-means into three groups, based on the patterns hypothesized in the field and the results of the CCA. This involves assigning each data point, in this case, each species, a centroid based on Euclidean distance and calculating the mean position of all the points within each cluster. The two axes, CCA1 and CCA2, act as the coordinates of the species data for this analysis. This approach clusters the species into groups with similar environmental preferences. For example, bog rosemary (*Andromeda polifolia*) and bog laurel (*Kalmia polifolia*) both prefer a low pH and low change in water table over the season, while broad-leaved cattail (*Typha latifolia*) and woolly-fruited sedge (*Carex lasiocarpa*) prefer higher mean pH and relatively consistent water table depth.

Discussion

By comparing the environmental variables and vegetation present along a transect through the peatlands, I was able to determine that there is in fact a pattern between natural community composition, pH, and water table fluctuation.

Results of the final CCA suggest that three distinct groups of vegetation within the Joe's Pond wetland complex exist, with some overlap between two of the groups. The three groups correspond with the natural community types delineated during the field season: sample points 1 and 2 (cluster 2) correspond with the Intermediate Fen, sample points 3 and 4 (cluster 3) with the Poor Fen, and sample points 5 and 6 (cluster 1) with the Red Maple-Tamarack Swamp. Clusters 1 and 3 overlap, which is not surprising. I certainly saw an overlap in species between these two natural communities, especially on the boundary between them. Tawny cottongrass (*Eriophorum virginicum*), hoary sedge (*Carex canescens*), and bog laurel all overlap between clusters 1 and 3. The species found in each of the three clusters coincide with species expected in these natural communities (Thompson et al., 2019). The CCA results confirm that the three natural communities have significant differences in vegetation composition and the environmental conditions, which suggests that the environmental conditions, specifically pH and a seasonal change in water table depth play a role in the way that plant species are arrayed into natural communities in this wetland complex.

The results of this study are similar to those found in the literature regarding peatland chemistry and vegetation gradients (Glaser et al., 1990; Gorham et al., 2007; Wieder and Vitt, 2006). They thus confirm the results of previous studies and further our understanding of ecological gradients in Vermont's fens, specifically. For example, in northern Canadian peatlands poor fens have an average pH range of 4.5-5.1, intermediate fens have a pH range of 5.1-5.7, and rich fens have an average pH of 6.1-6.7 (Bubier, 1995). Similar values were reported in a study of Minnesota peatlands (Glaser et al., 1990) and in a treatment of the natural communities of Vermont (Thompson et al., 2019). At Joe's Pond-Morrisville, however, the Intermediate Fen has points that reach an average pH of 6.2 (**Figure 36**). The pond water itself has a pH of around 6, and likely plays a role in the slightly higher than normal pH for Intermediate Fen. There is evidently not enough enrichment for a Rich Fen to have become established up to this point.

Lastly, the results of this study add to our understanding of gradients and dynamics in peatlands by providing more data about natural community response to changes in hydrological regime and pH, specifically. I show a significant change in vegetation community composition across pH and water table fluctuations. These vegetation shifts are significant, especially considering they are likely quite different from what this peatland looked like before the beaver dam was built in the 1950s. Though I cannot say what pH and water table were before the construction of the dam, we can use the information about the existing conditions to make predictions about what might happen should the conditions change, locally and globally. Should the hydrology of the peatlands change—for example, if the beaver dam were to break—we might predict that the vegetation would shift more towards those plants that are found in the areas of greater water table variation throughout the season.

Part 2: Paleo/Historical Ecology of the Peatlands

Introduction

In the Northeast, peatlands form primarily through two mechanisms: paludification and infilling/terrestrialization. Paludification refers to the process by which uplands transition to wetlands and terrestrialization refers to the process of open water becoming filled with peat and other sediments (**Figure 39;** Andersen et al., 2003). Peat essentially pickles and preserves ancient organic material because its acidity, constant saturation, and cold temperatures create an anoxic environment in which decomposition is extremely slow. It can, as a result, be used as a window for observing the changes in vegetation composition and hydrological conditions over time (Bubier, 1991). Peat cores preserve several climate and palaeoecological relics, such as macrofossils, pollens, spores, testate amoebae, diatoms, and stable isotopes (Mauquoy and van Geel, 2007; Peteet et al., 2024; Ronkainen et al., 2014; Yu et al., 1996). Taking a core of peat allows us to develop a chronology of the successional changes in a peatland and hypothesize about its formation mechanisms. For example, paludification is evidenced in peat cores by finding open water sediments, like gyttja (organic-rich sediment deposited at the bottom of lakes from the partial decomposition of peat), at the bottom of the core, while terrestrialization is evidenced by finding upland, mineral substrates at the bottom of the core (Andersen et al., 2003). Plant macrofossils can be used to track the changes in the composition of the peatland vegetation, as well as the hydrological regime of the peatlands, over time. Different peat compositional types, such as *Sphagnum* peat, woody peat, and sedgy peat, can tell us something about the natural communities that might have existed over time, and the decomposition levels can shed light on the hydrological regime.

Knowledge of the ecological successional pathways of peatland communities is important to understand because it allows us to make inferences about the role they might play in nutrient cycling, including carbon cycling, and how they might change in the future.

After site visits with Jill Bubier on May 8th, 2025 and Ron Stancliff on May 13th, 2025, two working hypotheses about the mechanism of Joe's Pond-Morrisville's peatland formation emerged. The peatlands felt like a floating mat while we were walking across them, prompting the hypothesis that the peatlands have been forming through an infilling process, as typically happens in New England kettle hole bogs, such as the nearby Molly Bog. However, a georeferenced aerial image of the site from 1942 challenged this hypothesis. As seen in **Figure 12**, it looks as if the open water extent has increased over the last eighty years, rather than decreased, which would be expected if the pond were infilling. It also looks as if the pond was, in 1942, surrounded by forest, rather than more open peatlands, as it is today. This then prompted a second hypothesis, that something (e.g beavers, a road, other downstream dams) changed the water table dramatically sometime between 1942 and 1962, when it seems like the pond started getting larger and less forested, and initiated a paludification process in recent years. These two hypotheses are by no means mutually exclusive, as the second relates to the most recent 80 years of the peatland's history, while the first refers to its longer-term history and origin story.

> *Hypothesis 1: The peatlands are forming in a kettle-lake bog process, filling from the outside in; thus, the peat depth decreases as one gets closer to the open water. The peat will be underlain with a layer of gyttja, indicating that peat began growing over an open water system.*
>
> *Hypothesis 2: The peatlands are forming by way of paludification; a natural or anthropogenic event has caused a dramatic change in the hydrology of the site, allowing for peatland conditions to dominate what was once a forested wetland. Peat depth increases as one gets closer to the open water. The stratigraphy will show woody materials underneath a succession of other peat materials (marshy conditions followed by colonization of Sphagnum is predicted), and the peat will all be underlain by a layer of upland, mineral soil.*

To test these alternative hypotheses, I took a core of the peat and measured the depth of the peat throughout the wetlands to get a sense of how the peat composition and accumulation has changed over time and space.

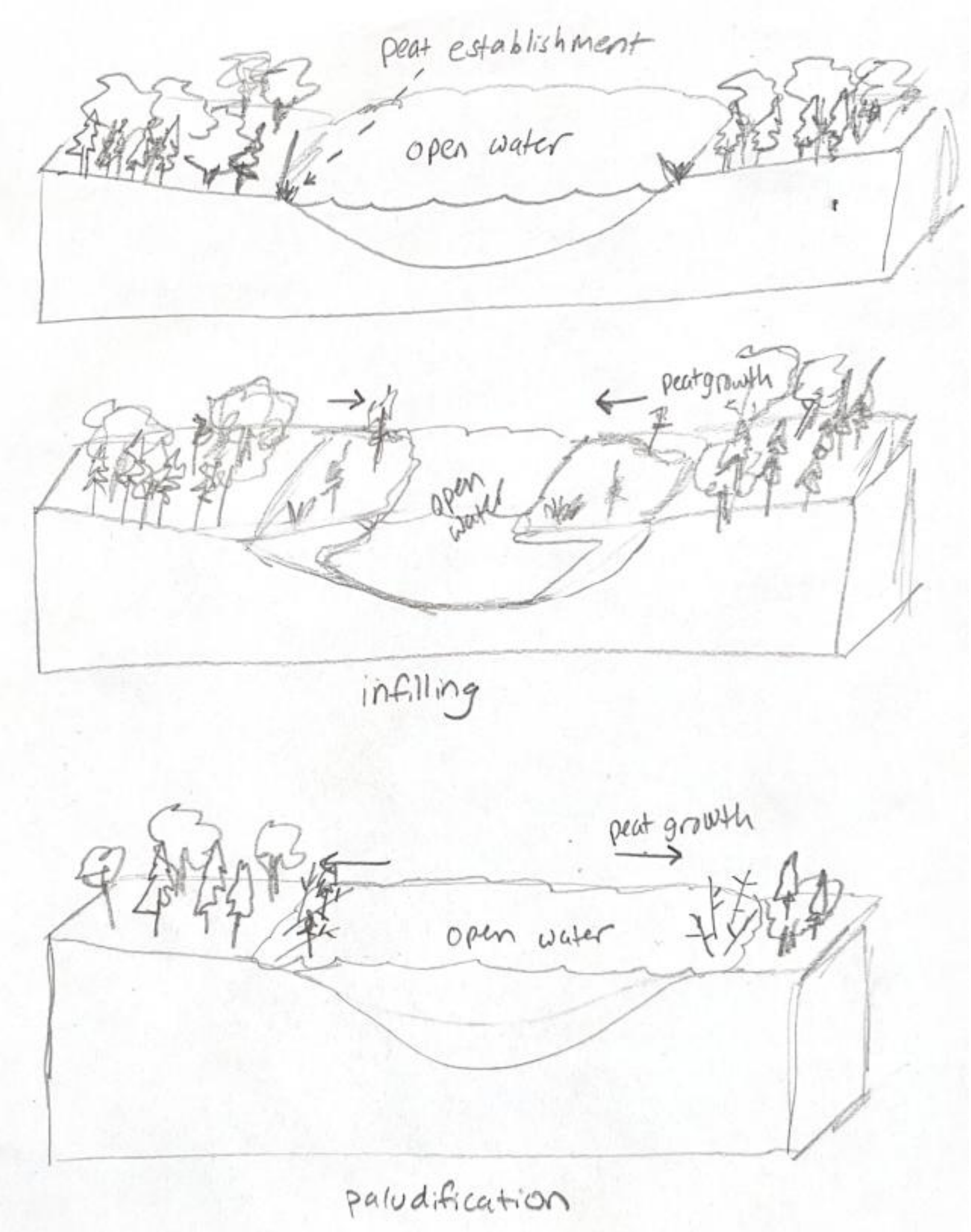


Figure 39: Infilling vs. paludification processes diagram. In infilling, the peat grows into the open water after becoming established on the lake bottom. In paludification, peat grows outward into the uplands when water reaches the uplands more frequently.

Methods

Peat Depth

Field Methods

Figure 40: Peat depth methods, featuring UVM Natural Areas Program interns Lorry Martinez and Rachel Stafford using the chimney poles to measure peat depth.

I measured peat depth using 5-foot chimney poles that can be attached, one to the other, as they are pushed into the ground (**Figure 40**). I took a total of 119 peat depth sample points using a fishnet pattern, aiming to get a relatively consistent spread of sample points along the entirety of the peatlands within the study area. Sample point location data were collected in Field Maps. "Peat depth" was taken once the poles met sufficient resistance that I could no longer push them down (indicating very highly decomposed organic material), or until I met a hard, mineral layer (clay, silt, or sand), which would feel very hard or gritty on impact. A small notch at the end of the lowermost pole would sometimes catch up a bit of bottom sediment; in such cases, I noted the composition of any visible bottom sediment.

Analysis Methods

I ran a thin-plate spline on the peat depth data I collected. I ran this analysis twice, once in R using the Tps() function from the fields package and once in ArcGIS Pro using the Spline function.

I also fit a generalized additive model (GAM) using the gam() function from the mgcv package in R to see if there was a clear linear relationship between peat depth and the distance from the pond edge. The model fit used peat depth as the response variable and distance to pond edge as the predictor (covariate), with a spatial smooth added to the distance to lake covariate. The model is as follows: gam(peat_depth ~ s(dist_to_lake)).

Peat Core

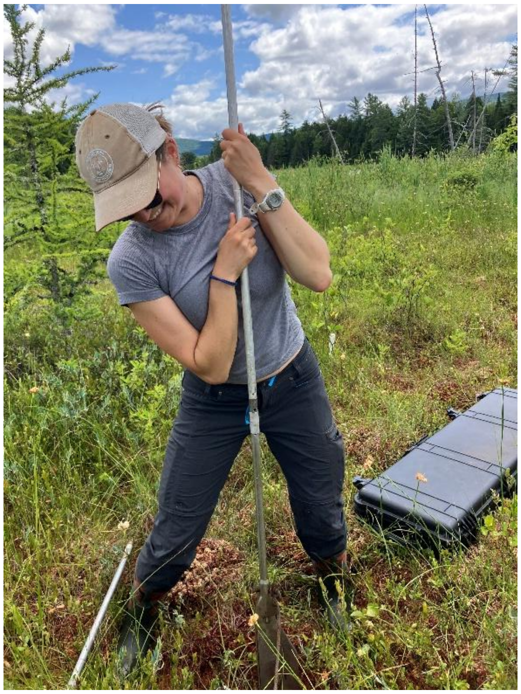


Figure 41: Peat core methods, featuring me, Emily DeAlto, taking the peat core. Photo by Catherine Wessel.

I collected a peat core on July 22nd, using a Russian corer, provided to me by Nat Merrill, Academic Lab Coordinator for the UVM Biology Department (**Figure 41**). The core was taken about one meter away from transect sample point 3, which appears to be consistently the most acidic (mean pH 4.5) sample point along the transect, and has a peat depth near the mean peat depth for the entire mat. It is in the area I have delineated as Poor Fen.

We removed the core one-half meter at a time, placing it into a PVC pipe cut in half, lengthwise, and wrapping it in tinfoil to be stored. If a full half meter was not collected on the first try, we made a second attempt to get a fuller sample. If on this second attempt the sample was still not a full half meter, we placed the pieces of the sample into the PVC pipe such that the missing and present pieces were accurately distributed along the half meter. The last half meter (5.5- to 6-meters) of the core was composed almost entirely of gyttja rather than peat, so we stopped collecting samples at that point. The tinfoil-wrapped core was stored in a plastic bin for about two weeks in a cold basement (approx. 55°F), and then in a cold-room during the analysis period.

I analyzed the peat core for macrofossils, primarily taking note of the general vegetation composition and decomposition level. I used the following methodology when sampling and analyzing the peat core, which was developed based on the methods of Peteet, et al., 2024:

Step one: Split the core in half, lengthwise, using a knife. I only used one half of the core for macrofossil analysis. The other half has been preserved for future research purposes, such as Loss on Ignition analysis, pollen analysis, etc.

Step two: Split the halved core into 5cm horizontal sections. Place the 5cm sections into plastic bags labeled with their depths. I analyzed every other 5cm section (e.g. 5-10cm, 15-20cm, 25-30cm), so every other 5cm was left in the pipe.

Step three: Note the decomposition level of the sample, then send the sample through a 500-micron sieve by gently washing it with water to remove most of the more well decomposed, unidentifiable portions of the sample. The goal is to pick out the most easily identifiable macrofossils, so minimizing the amount of less identifiable material will make this easier. Using water, push the material that has stayed in the sieve to the bottom of the sieve, and then wash it into a beaker to examine under the stereoscope.

Step four: Pour the sieved slurry into a 100mm x 20mm petri dish. Using the stereoscope, pick through the sample and look for anything symmetrical, including fruits, leaves, needles, and any other macrofossils that might look identifiable. Place these into a small glass vial and label it with the sample depth. Vials will be stored in the cold room with the rest of the core.

Step five: Note the overall vegetation composition by estimating percent composition within the sample of identifiable peat types (sedge, wood, *Sphagnum*, etc.). The *Guide to the identification of plant macrofossils in Canadian peatlands* (Lévesque, 1988) and the *Portraits of peatland deposits* (Eberswale University for Sustainable Developments, n.d.) were used to identify general peat macrofossil types, and *Seeds and fruits of plants of eastern Canada and northeastern United States* (Montgomery, 1977) and *Seed Identification Manual* (Martin and Barkley, 1961) were used to identify fruits and seeds.

Step six: Repeat steps three through five for each sample depth.

Results

Peat Depth

A few patterns can be seen in the peat depth spline results. The peat generally deepens with increasing distance from the outer peatland edge, though the trend is not spatially uniform. Estimated depths ranged from −8.26 cm (slightly above the peatland surface) to 483.97 cm. There are two main peat accumulation areas, which I will refer to as the “main mat”, on the west side, and the “outlet mat”, on the east side. Both mats contain a central band of peat approximately 100–200 cm deep, shown in turquoise (**Figure 42**); the overall average depth was 115.2 cm. In contrast, the southwestern corner of the main mat exhibited a more irregular pattern, with alternating shallow plateaus and deep pockets (**Figure 42**).

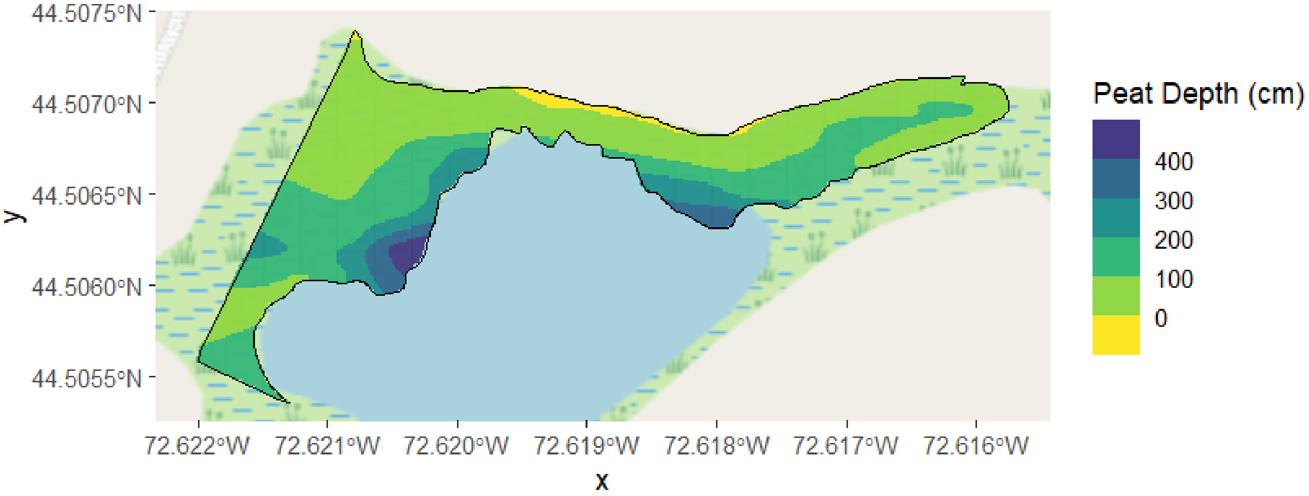


Figure 42: Peat depth interpolation results.

Results of the spline model validity check indicate that this model is highly accurate and accounts for 98.8% of the variation in the system (R^2=0.988; **Figure 43**). The root mean square error (RMSE) for the spline model is 9.87cm, meaning that the average error in peat depth is only about 10cm, and mean absolute error (MAE) was 6.54cm, meaning that the observed data are on average about 6.5cm away from the predicted data, thus the spline is performing well within the data it was given.

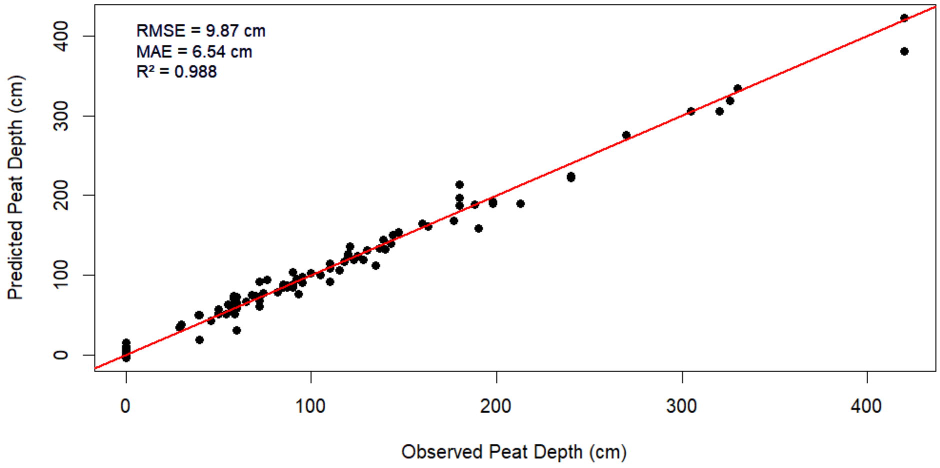


Figure 43: Observed vs. predicted peat depths based on the thin-plate spline.

The generalized additive model (GAM) showed that distance to pond edge significantly predicted peat depth (p = 2e−16), but the high effective degrees of freedom (edf = 8.54) indicated a nonlinear relationship. Including a 2D spatial smooth substantially improved model performance (edf ≈ 29, p < 0.001), showing that peat depth also depends on localized hydrology, geomorphology, and surface patterning, not just distance from open water.

Peat Core

Results of the peat core analysis are displayed in a Tilia diagram, which shows the percentage of macrofossils from different taxonomic groups found at various depths in the core (**Figure 44**). Patterns in the diagram reveal several major vegetation and decomposition shifts. *Sphagnum* dominated the upper 185 cm, while highly decomposed muck dominated 305–400 cm. Most of the profile consisted of sedge-dominated peat, with occasional woody-sedge layers. A transition from woody-sedge peat to *Sphagnum* peat occurs around 150 cm.

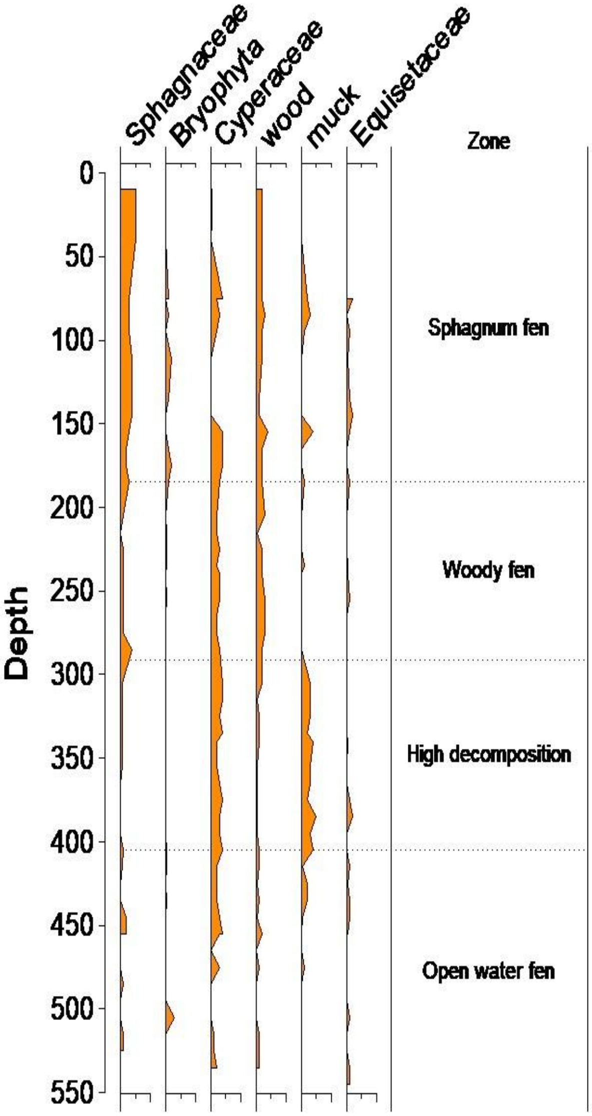


Figure 44: Peat core macrofossil results. Main groupings of macrofossils included Sphagnum (Sphagnaceaea), other mosses (Bryophyta), sedges (Cyperaceae), woody material (wood), highly decomposed sediment (muck), and horsetails (Equisetaceae). Zones were interpreted visually and described based on the most dominant peat component within the zone, or a significant change in overall composition. The figure was created using the TIlia software program.

The base of the core (550-600 cm) contained gyttja, supporting the hypothesis that peat first accumulated over open water. Abundant algal oospores and water nymph (*Najas* sp.) seeds in the lower core also indicate an aquatic origin. Through time—that is, higher up in the core—these aquatic taxa declined.

Despite recent historical evidence suggesting a tree-dominated swamp phase (e.g., 1942 aerial photography), the core did not capture a clear woody horizon. This may simply reflect sampling location or the removal of woody material by past beaver activity.

Overall, the core records shifts in hydrology and vegetation consistent with changing decomposition rates and peatland succession. The dominance of *Sphagnum* is an important shift in peatland succession: not only does this transition mark a probable shift in overall natural community composition, it also marks a shift in the ecosystem functions and values of this peatland, as *Sphagnum* dominated peatlands have a higher carbon sequestration capacity than non-*Sphagnum* dominated peatlands (Peteet et al., 2016).

Discussion

Peat Depth

The combined spline and GAM results neither fully confirm nor reject the hypotheses of peat accumulation via infilling or paludification. While peat depth often increases toward the pond edge, this trend is spatially variable. The central band of consistently deep peat (between 100-200cm depth) on both mats, shown in **Figure 42**, may represent the original locus of peat accumulation.

Because the peat mat is partially floating in the areas closest to the open water, depth measurements near the open-water edge are challenging. The core suggests that the mat is not completely freely floating but separated just enough from deeper peat to allow water movement through looser peat, thus, these areas may not represent the same rate of peat accumulation as those areas that are not lifted and floating. This, however, does not change the overall trend that the peat is shallower within the swamp area, further from the open water, than it is in the open peatland area, suggesting some paludification processes may be happening in more recent history.

Overall, the peat depth analysis suggests a combination of processes, including both infilling and paludification, shaping peat accumulation at Joe's Pond-Morrisville. More sample points, especially in those areas with sharp transitions in depth, would help smooth the model and permit better interpretation of the results. There were some limitations to further sampling across the peatlands during the field season. I was not able to get in contact with the adjacent landowners, who have posted their property, so my sampling could only go as far as the western parcel boundary, where there seems to be an anomalous deep pocket in the otherwise more clearcut pattern.

Peat Core

The peat core records a sequence of changes that could align with two different types of driving factors: autogenic factors and allogenic factors. Autogenic factors are those that are caused by changes in the system itself, such as peat accumulation and vegetation-hydrology feedback loops. Allogenic factors are those influences outside of the peatland system itself, either on a large scale, such as climatic shifts or on a more local scales, such changes in land use. The changes observed in the Joe's Pond peat core could line up with known Holocene climatic patterns in the Northeast or highly localized beaver activity. While the exact timing of the shifts seen in the core cannot be determined without radiocarbon dating of the macrofossils, we can infer some shifts based on climatic trends in Vermont and hypothesize some causes of these shifts based on our ecological understanding of this system.

Four key transitions were observed in the core, which can be used to interpret climatic or local ecological changes in this peatland system. Firstly, basal gyttja indicates that peat accumulation initiated over open water, likely when the pond was larger than it is today (**Figure 45**). The presence of aquatic species macrofossils in the bottom layers of peat, including algae and pondweeds, also supports this hypothesis. The water body that is now Joe's Pond was likely larger than it is now before the peatlands formed. If the peat had been accumulating outwards into uplands from the start, we would expect to see sandier, upland sediment at the peat bottom. Following the gyttja, sedge-dominated peat with very low *Sphagnum* content may reflect fluctuating water tables or nutrient availability in a marshy natural community around the pond edge during early peat accumulation, such that *Sphagnum* could not become established. The shift to more decomposed peat around 305–400 cm could align with the Holocene Thermal Maximum, when warmer, drier climate could have lowered water tables and increased aerobic decomposition (Grigg et al., 2023). This transition could also be initiated by more local allogenic events, such the breaking of a beaver dam lowering the water table and thus increasing decomposition rates. The increase in woody peat that follows the high decomposition zone suggests colonization by shrubs and trees under relatively drier conditions. Many peatlands have been found to have been dominated by more decomposed, woody peat during the dry, warm Holocene Thermal Maximum (Zhang et al., 2025; Kalnina et al., 2015). At Joe's Pond-Morrisville, the drying period could have resulted in a lowering of the water table, thus increasing oxygen availability in the upper layers of peat, leading to increased decomposition rates. Lastly, *Sphagnum* dominance in the most recent layer of the core could correspond to a later transition to cooler, wetter climate, or to autogenic feedback such as microhabitats created by woody peat facilitating *Sphagnum* establishment. The latter hypothesis is supported by the fact that *Sphagnum* dominance begins after the woody peat was deposited.

Figure 45: The final section of core pulled (5.5 to 6 meters), which is composed entirely of silty gyttja.

Alternatively, changes in water level could have been driven by localized beaver activity. A damming phase followed by dam abandonment and water-table recession could produce patterns similar to those engendered by large scale climatic changes through the Holocene. Beavers have been estimated to have been active in Vermont for at least the last 8000 years (Mychajliw et al. 2023), so their long-term influence at the site is quite plausible. Lastly, autogenic and allogenic factors could also be at play at the same time.

Future studies could perhaps help to choose among these alternative explanations. Future research directions could include loss-on-ignition analysis to quantify changes in organic accumulation rates, the analysis of additional cores across the transect to determine spatial consistency of stratigraphic patterns, and radiocarbon dating to align local transitions with regional Holocene climate events. I have applied for a grant to radiocarbon date samples from the core. If funded, I will date specimens from each of the transition zones, to test the hypothesis that these transitions happened during estimated climatic transition times in the Holocene (Muller et al., 2002; Yu et al., 1997).

Part 3: Ecological Interpretation Summary

Together, the peat depth patterns and peat core stratigraphy offer insight into the long-term development of the Joe's Pond-Morrisville peatlands. The system appears to have been a fen, swamp, or shrub-fen throughout its history, with no evidence of past ombrotrophic bog conditions. The most recent layers are, however, dominated by *Sphagnum*. The shifts in hydrology, and thus vegetation and decomposition rates, seen in the core could be due either to autogenic or to allogenic causes. For example, the change in hydrology could be due to larger climatic trends, including a dry period in the Mid-Holocene, lowering the water table, and then a cool, wet period in the Late-Holocene raising it again. Alternatively it could be due to other natural disturbance, such as a beaver dam break, which would also lower the water table and increase decomposition rates, followed by the subsequent reappearance of beavers, raising the water table again such that *Sphagnum* can establish. Both examples would be allogenic causes of hydrological change leading to changes in vegetation. The changes in hydrology could also be autogenic. For example, the appearance of woody vegetation in the upper portion of the peat core may have provided a sufficient substrate for *Sphagnum* to first establish and then impact the pH and availability of nutrients in the system through the physiological and structural features of *Sphagnum* that make it successful in peatland environments.

Regional research has underscored that fen-to-bog or non-*Sphagnum*-to-*Sphagnum* transitions often occur rapidly and are frequently triggered by external environmental changes. A Patagonian peatland study (Loisel and Bunsen, 2020), in which 74% of fen-to-bog transitions were shown to coincide with volcanic tephra deposition, supports the idea that such shifts are often externally forced.

At Joe's Pond-Morrisville, the peat depth data and core analysis suggest an initial infilling (terrestrialization) phase followed by paludification, consistent with other findings from northeastern North America (Andersen et al., 2003). Lateral expansion outward from peat margins into uplands has been shown to be possible even in flat and concave peatlands, rather than only in convex bogs where water can flow outwards from the peatland center (Juselius-Rajamäki et al., 2025). I believe that currently both these processes are still happening; the peatlands are continuing to accumulate inwards across the open water and outwards from the upland margins.

This analysis not only improves our understanding of this specific peatland system and other similar systems in the region, it also informs us of the function of this system within the context of climate change and climate resiliency. Although Joe's Pond–Morrisville is a minerotrophic fen, its shift from sedge-dominated to Sphagnum-dominated vegetation has important implications for carbon cycling and long-term carbon storage. Because *Sphagnum* peats accumulate greater peat mass and more than double the carbon of non-*Sphagnum* peats (Arsenault et al., 2024, Loisel and Bunsen, 2020), this transition suggests the site's function as a carbon sink may be increasing, with relevance for both watershed processes and global climate.

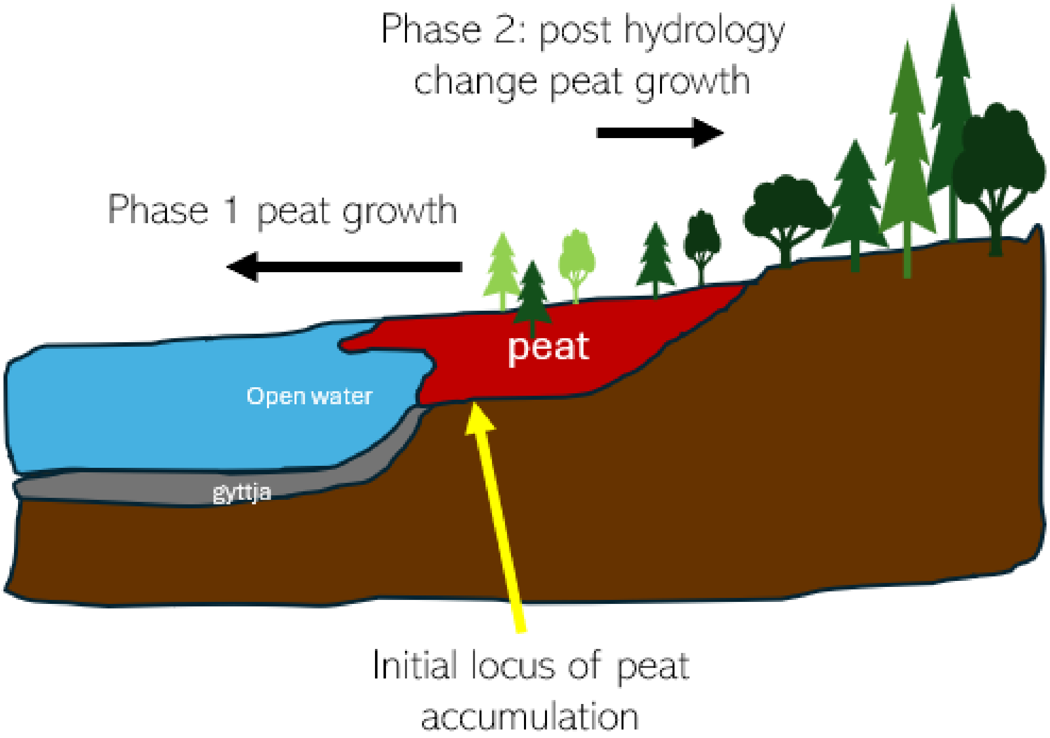


Figure 46: Joe's Pond peatland formation mechanism.

Chapter III: Assessment of the Functions and Values of the Wetlands Using the Vermont Rapid Assessment Method for Wetland (VRAM)

Introduction

Wetlands, including floodplain wetlands, swamps, marshes, peatlands, and shallow lakes, cover about 5-6% of the world's continental surface. As remote sensing abilities advance, this estimate consistently increased, even though there has been a net loss of wetlands over time as the result of human impact (Darrah et al., 2019). About 4% of Vermont is covered by wetlands (Thompson et al., 2019). These wetlands provide a number of ecosystem services, such as regulating the water cycle and promoting biodiversity, making them ecosystems of interest for protection and restoration (Janse et al., 2019). Wetlands in the northeast also support a large proportion of biodiversity. A study in Québec found that, despite covering only 1% of the study area, wetlands supported 45% of the biodiversity in the area surveyed (Flinn et al., 2008). In Vermont, wetlands play an important role in our floodplain resilience by serving as a sponge for floodwater to filter through, removing runoff nutrients from the larger watersheds and downstream neighbors. These ecosystem services can only be provided, however, by wetlands that function at a certain level. Wetland functionality is driven by several variables, including but not limited to geographic extent, hydrology (water budget and water level fluctuations), nutrient inflow and outflow, and vegetation (Janse et al., 2019). The degradation of wetland habitat leads to degradation of wetlands' ability to support floodplain resilience by preventing erosion and taking up excess nutrients from surrounding impervious surface (Janse et al., 2019). By establishing a set of metrics to determine the level of functionality of different wetland types, the Vermont Department of Environmental Conservation (DEC) Wetlands Program in the Watershed Management Division aims to better assess the state of wetlands throughout the state to prioritize the need for restoration within each watershed. To measure the relative functionality of various wetland types, a number of highest functionality wetlands, called reference wetlands, must first be established (Findlay et al., 2002). Scores for functionality metrics can then be compared to these reference wetlands, as different wetland types will have different baseline scores. The methodology used to determine the overall functionality of wetlands in Vermont is called the Vermont Rapid Assessment Methodology for Wetlands (VRAM).

Six metrics are included in the VRAM: Wetland Area, Upland Buffers and Surrounding Land Use, Hydrology, Habitat Alteration and Development, Vermont's Natural Heritage (i.e., are there any state significant natural communities or species present), and Habitat Structure and

Microtopography. Many of these metrics also have sub-metrics within them, such as Connectivity and Average Maximum Water Depth within the Hydrology metric. Some of the metrics can be completed with a desktop review, but the majority require data that can only be collected in the field. Using this methodology at UVM's Natural Areas can provide a baseline understanding of the functionality of our wetlands, and the important roles that they play in ecosystem management. We can use the VRAM as a tool for assessing the changes in wetland health following management or lack thereof in the Natural Areas, which will help us make decisions about how to manage these areas in the future. The details of the VRAM process for Joe's Pond-Morrisville are as follows; they can be used as a reference for future assessment using the VRAM at Joe's Pond-Morrisville and other UVM Natural Areas.

Methods and Results

Following the methodology described in the Vermont Rapid Assessment Method for Wetlands v.2.1 User's Manual and Scoring Form (Hohn et al., 2017), I performed three iterations of the VRAM assessment, with different study areas for each iteration (**Figure 47**). The first iteration used only the boundary of the UVM Natural Area parcel as the study area. The second iteration used the presumed extent of the fen as the study area. The last iteration used the extent of the entire wetland complex, including Valcour Bog and Morristown Bog to the south, and up to the beaver dam to the north, as the study area. Only the third iteration included the pond itself in the assessment.

The details of the steps taken for each iteration are described in this section, as well as the results of the VRAM protocol for each metric and overall score for each iteration.

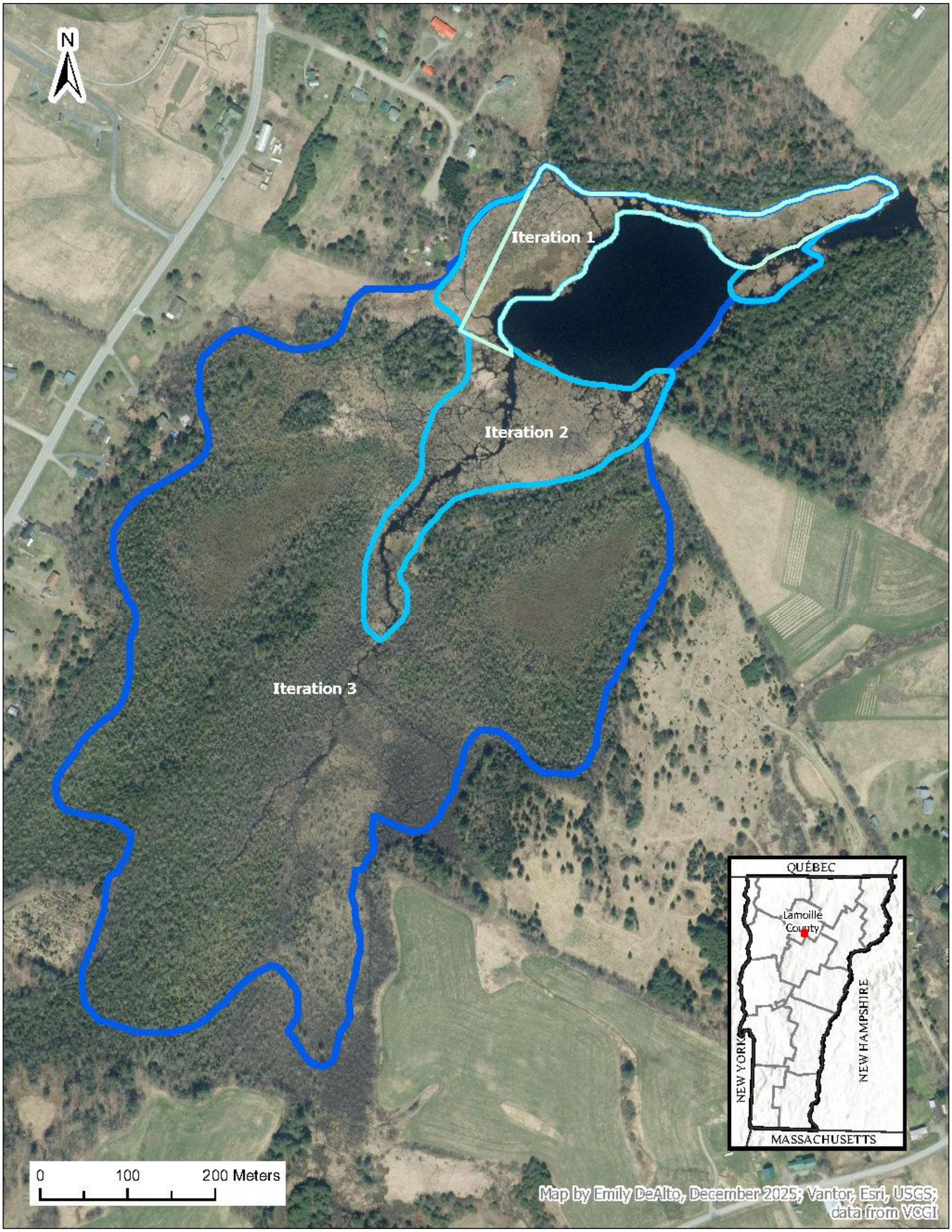


Figure 47: VRAM Assessment Areas

Metric 1: Wetland Area

I mapped the study area for each iteration in ArcGIS Pro using aerial imagery and the Vermont Significant Wetlands Inventory (VSWI) as reference for wetland extents.

Iteration 1 scored 3 points for being between 3 and 10 acres, Iteration 2 scored 4 points for being between 10 and 25 acres, and Iteration 3 scored 6 points for being larger than 50 acres.

Table 2. Metric 1: Wetland Area Scores

Iteration	Wetland Size	Points
Iteration 1	3 to 10 acres	3
Iteration 2	10 to 25 acres	4
Iteration 3	>50 acres	6

Metric 2: Upland Buffers and Surrounding Land Use

2a. Average Buffer Width

Intact buffers around the study area include natural features, such as upland and wetland forests, open water, bare cliffs, and rock outcroppings, and excludes human influenced features, such as farm fields, lawns, houses, roads, and parking lots. I created a 50-meter buffer around each study area, as recommended by the VRAM protocol, and identified areas with and without natural buffer within that range. I measured the average extent of the buffer where applicable.

Iterations 1 and 2 had wide buffers, almost completely surrounded by wetlands, as they were limited to only a few natural communities within the larger wetland complex. All the areas that had natural buffers had buffers greater than 50 meters wide. Both iterations had some small zones without buffer, but these areas made up less than 20% of the overall buffer.

Iteration 3 had a medium to narrow buffer. This study area is larger, and its extent is limited by the extent of the wetlands. The surrounding area is predominantly active farmland and Christmas tree plantation, thus not natural buffer. About half of the area had a 50-meter buffer, some areas had smaller buffers, and some areas had no buffer at all.

Table 3. Metric 2a: Average Buffer Width Scores

Iteration	Buffer Size	Points
Iteration 1	Wide	6
Iteration 2	Wide	6
Iteration 3	Medium to Narrow	3

2b. Intensity of Predominant Surrounding Land Use

I considered the land use outside of the 50-meter buffer zone to assess the wider-scale landscape influences on wetland condition, from sources like runoff, invasive species, pollution, fertilizers and pesticides, and others. The result of this question is the same for all the iterations (score of 4) because the greater context of the wetland system is considered here.

The study areas are mostly surrounded by rural residential areas, farmland, and paved and dirt roads, including Route 100, which is a main throughway of the area. The fields and pasture that surround the study areas were actively hayed and plowed through the season, thus are not old or fallow fields. They were mainly used for haying, rather than row cropping, so the intensity of the land use was rated at a moderately low level.

Table 4. Metric 2b: Intensity of Predominant Surrounding Land Use Scores

Iteration	**Intensity**	**Points**
Iteration 1	Low-Moderate	4
Iteration 2	Low-Moderate	4
Iteration 3	Low-Moderate	4

Metric 3: Hydrology

3a. Sources of Water

I assessed the presence and importance of specific listed hydrological sources, as listed in the VRAM, such as high pH groundwater, precipitation, and perennial surface water.

The three iterations have very similar results for this question, as they have generally the same hydrology. Iteration 3 had a slightly lower score because two bogs are contained in this study area; these do not get water from seasonal surface water, so this water source was ranked lower than in the other iterations.

Table 5. Metric 3a: Sources of Water Scores

Iteration	**Source of Water**	**Score**	**Overall Score**
1	High pH groundwater	0	8
	Other groundwater	0	
	Precipitation	3	
	Seasonal/Intermittent surface water	2	
	Perennial surface water	3	
2	High pH groundwater	0	8
	Other groundwater	0	
	Precipitation	3	
	Seasonal/Intermittent surface water	2	
	Perennial surface water	3	

Table 5 (cont.). Metric 3a: Sources of Water Scores

Iteration	**Source of Water**	**Score**	**Overall Score**
3	High pH groundwater	0	7
	Other groundwater	0	
	Precipitation	3	
	Seasonal/Intermittent surface water	1	
	Perennial surface water	3	

3b. Connectivity

This question assesses whether the wetland is a part of a larger wetland, riparian, or upland complex, such that it provides hydrology-related functions and values.

All three iterations scored the same for this question. The study areas are not considered to be in a floodplain, but they are between the surrounding human-influenced area and Joe's Pond and the stream that flows in and out of it. The study areas are also all part of a larger wetland/upland complex, which includes the uplands surrounding Joe's Pond and the uplands that surround the bogs.

Table 6. Metric 3b: Connectivity Scores

Iteration	**Source of Water**	**Score**	**Overall Score**
1	Floodplain	0	2
	Between stream/lake and other human use	1	
	Part of wetland/upland complex	1	
	Part of riparian or upland corridor	0	
2	Floodplain	0	2
	Between stream/lake and other human use	1	
	Part of wetland/upland complex	1	
	Part of riparian or upland corridor	0	

Table 6 (cont.). Metric 3b: Connectivity Scores

Iteration	Source of Water	Score	Overall Score
3	Floodplain	0	2
	Between stream/lake and other human use	1	
	Part of wetland/upland complex	1	
	Part of riparian or upland corridor	0	

3c. Maximum Water Depth

Wetlands with deeper water have the ability to support a higher diversity of habitats for fish, amphibians, birds, and other wildlife. Deep water also creates resiliency during floods by slowing down water flow to the surrounding areas and provides resiliency during drought periods by retaining water longer term than uplands.

The maximum water depth at all study areas was in the 0.4 to 0.7m range, scoring 2 points for each iteration. None of the study areas contain vernal pools, however, due to being along Joe's Pond, some ponding inherently occurs along the edge of the fen that surrounds the pond.

3d. Duration of Inundation/Saturation

Similar to wetlands with deeper water, wetlands that are wet for longer periods can support more habitats for wildlife; those that are infrequently flooded and located in floodplains provide stormwater retention.

The fen complex (Iterations 1 and 2) is nearly permanently inundated, with water from the pond and from the main inlets that flow from the surrounding areas. The peat substrate of the fen holds a great quantity of water, keeping it saturated throughout the year. Iteration 3 is somewhat less permanently saturated because the bogs and surrounding swamps are not as wet as the fen is.

Table 7. Metric 3d: Duration of Inundation/Saturation Scores

Iteration	Duration	Points
Iteration 1	Semi- to permanently inundated/saturated	4
Iteration 2	Semi- to permanently inundated/saturated	4
Iteration 3	Regularly inundated/saturated	3

3e. Anthropogenic modifications to natural hydrologic regime

All three iterations received the same score (11) for this question as the only direct modification to hydrology from human influence is the tile drain that comes in from the northern boundary of the parcel in the uplands.

Metric 4: Habitat Alteration and Development

4a. Substrate/Soil Disturbance

This question assesses the level of disturbance of soil and substrate of the wetland. All three iterations received a score of 4 for this metric, meaning no apparent substrate disturbance is present.

4b. Habitat Development

This question rates the overall development of habitat for the wetlands relative to wetlands of similar types.

All three iterations received a score of 6 (very good) for this metric. All of the wetland types within the study areas are very high-quality examples of the natural communities within them. Some natural disturbance from beavers has changed hydrology over the last eighty years, thus some of the communities present are not clearcut examples with the full suite of species described in WWW. For example, the Red Maple-Sphagnum Swamp that surrounds Morristown Bog does not fit perfectly the description of this natural community type. This, however, does not mean that this natural community is not of high functional value, nor is its ranking related to any human activity.

4c. Habitat Alteration

This question rates the extent of human influence on the wetland habitat in the study area. All three iterations received a score of 8 for this question, meaning that very few apparent alterations of the habitat are present. The only direct alteration to the wetland habitat was the removal of some saplings from the edge of the Joe's Pond-Morrisville UVM property in 2018 by the adjacent landowner.

The fen is dominated by cattails in some areas, which can be an indicator of disturbance, however, to my knowledge, their presence in the study areas is not directly linked to any anthropogenic influence. They may have established when the beavers flooded the pond, raising the water table. Farming, mowing, and probably nutrient enrichment from these activities surrounds the study areas, however, they have not occurred directly in the wetland habitat itself.

Metric 5. Special Wetlands

All three iterations have both state significant natural communities and species ranked as rare in the state of Vermont. All three iterations thus score 10 points for this metric. The significant natural communities observed included Poor Fen, Intermediate Fen, Black Spruce Woodland Bog, and Dwarf Shrub Bog. Iteration 3 also included an endangered species.

Metric 6: Habitat Structure and Microtopography

6a. Vegetation Cover Types

This question scores the presence of vegetation layers and microtopographic features, and their condition.

The first two iterations scored 8 for this question, as they have similar overall vegetation structure. Herbs and shrubs are the most important, abundant, and diverse wetland vegetation type throughout these study areas. The third iteration received a score of 12. While the aquatic bed, herb, and shrub layers were all the same in this iteration, there are many more trees within the swamp areas surrounding the two bogs, and within the Black Spruce Woodland Bogs themselves. This iteration also included the open water of Joe's Pond.

Table 8. Metric 6a: Vegetation Cover Types Scores

Iteration	**Wetland Vegetation Community**	**Score**	**Overall Score**
1	Aquatic bed	1	8
	Emergent/herb	3	
	Shrub	3	
	Tree	1	
	Open water	0	
	Other	0	
2	Aquatic bed	1	8
	Emergent/herb	3	
	Shrub	3	
	Tree	1	
	Open water	0	
	Other	0	
3	Aquatic bed	1	12
	Emergent/herb	3	
	Shrub	3	
	Tree	3	
	Open water	2	
	Other	0	

6b. Diversity of Habitat Types

This question describes the variation of habitat types within a wetland from a bird-eye-view, including the variety of natural communities and how many different layers of vegetation are there (e.g. herbaceous layer, shrub layer, tree canopy layer). The level of interspersion of natural communities types is also considered.

Relative to one another, the iterations increased in habitat diversity from one to the next. Increasing the study area size also increased number of natural communities present within each. The Poor Fen areas along the pond, south of the UVM property, added to the second iteration have much more horizontal diversity than those present in the UVM property. The first iteration thus received a moderate score and the second a moderately high score. The third iteration contains even more natural community types; these types form a mosaic with high interspersion and horizontal variation.

Table 9. Metric 6b: Diversity of Habitat Types Scores

Iteration	**Diversity Level**	**Points**
Iteration 1	Moderate	3
Iteration 2	Moderately high	4
Iteration 3	High	5

6c. Coverage of Invasive Plants

This question rates invasive plant abundance throughout the study area. These species can displace or exclude native species, thus they have a negative impact on the functionality and value of the wetlands.

All three iterations had less than 5% cover by invasive species (broadleaf cattail is not considered an invasive species here), thus all three iterations received a score of zero for this question.

6d. Microtopography

This question assessed the microtopographical features of wetlands that increase the overall diversity of available habitat. Hummocks, for example, provide very different hydrological regime than do hollows, especially on the micro scale for small organisms like *Sphagnum*s, which are often specialized to a specific water table level.

All three iterations received a score of 7 for this question, as all three have lots of cover of high-quality hummocks, and moderate-to-low cover of high quality coarse woody debris and standing dead wood.

Table 10. Metric 6d: Microtopography Scores

Iteration	Microtopography type	Score	Overall Score
1	Vegetated hummocks or tussocks	3	7
	Coarse woody debris >6” diameter	2	
	Standing dead wood >10 inches dbh	2	
	Amphibian breeding pools	0	
2	Vegetated hummocks or tussocks	3	7
	Coarse woody debris >6” diameter	2	
	Standing dead wood >10 inches dbh	2	
	Amphibian breeding pools	0	
3	Vegetated hummocks or tussocks	3	7
	Coarse woody debris >6” diameter	2	
	Standing dead wood >10 inches dbh	2	
	Amphibian breeding pools	0	

Overall Score

The Grand Total score includes all metrics of the VRAM. The score ranges from 1 to 100, combining its condition, function, and value. Importantly, these scores are meant to be compared between wetlands of similar types. For example, these scores could be useful to compare Joe’s Pond-Morrisville to Shelburne Pond, because it is similarly a pond with peatlands surrounding it. While these two systems are not the same, similar ecological processes that drive the vegetation, wildlife habitat, and wetland formation at both sites, begetting similar natural communities in both sites. All three of the iterations scored in the 85-100 range, which puts these wetlands in the Reference Wetland Status.

The Condition % metric ranks the extent to which humans have caused degradation of the wetland, with higher values indicating less disturbance. A low score does not indicate that the wetland does not provide functions and values, only that it has been significantly disturbed. The Condition % score for all three iterations is relatively high, with the third iteration being slightly lower than the other two because of the lack of buffer.

The Function Score metric represents the extent to which the wetland provides Functions and Values as listed in the VRAM, including water storage, water quality protection, fish habitat, wildlife habitat, sensitive species, exemplary communities, opportunities for education and research, recreation, open space, and erosion control. The third iteration had a slightly higher Function Score than the first two iterations because of its higher diversity in habitat type.

The Restoration Index score includes those metrics that are relevant to estimating the success of restoration projects (VTDEC, 2019). Lower values indicate lower success of restoration, and higher success of restoration. It also, however, can be used to determine which wetlands should be prioritized for restoration, as it points out which are most degraded. All three iterations scored in the 50s, which is considered high for this index, indicating that they are not very disturbed (VTDEC, 2019).

Table 11. Combined VRAM scores using the results from metrics 1-6.

Iteration	Grand Total	Condition %	Function Score	Restoration Index
1	86	83.0	61.8	53
2	88	83.0	64.5	54
3	86	76.6	72.4	57

Conclusions

The VRAM conducted at Joe’s Pond-Morrisville in 2025 provides us with a baseline understanding of the condition, functionality, and value of the wetlands there. Should any management actions be taken at this UVM Natural Area in the future, or any changes be made to the greater wetland complex and watershed, the impacts of these changes can be assessed by comparing a new VRAM assessment to the results of this study. Additionally, the VRAM can be used at the other Natural Areas containing wetlands, including, but not limited to, Carse Wetlands, Shelburne Pond, East Woods, and Centennial Woods, for the same reason, and to compare any like wetlands to one another. According to the Vermont Agency of Natural Resources (ANR) Wetlands Inventory Map, Molly Bog, another UVM Natural Area, and the adjacent Andromeda Bog to its southwest, already had the VRAM completed in 2018, receiving an overall score of 83. The Restoration Index score, for example, could be used to decide which Natural Areas should be prioritized for restoration efforts. For example, the wetlands at Centennial Woods would likely score moderately for this index, due to the combination of high number of invasive species throughout the wetlands, which would give it a low success ranking, and the fact that they are in the middle of the city of Burlington, giving them high values for the city’s water quality.

Chapter IV: Management Recommendations

> *Joe's Pond-Morrisville is in fantastic ecological shape. Wandering its woods and wetlands offers an opportunity to see reference conditions of high-quality natural communities, and the power of conservation easements. Its hidden nature gives it the chance to remain relatively untouched, while being surrounded by farmland and state highways.*

Natural Community and Habitat Management

The natural communities and wildlife habitat of Joe's Pond-Morrisville are of high quality. Very few invasive species are present, though continued monitoring for invasives is recommended. Should any be found, rapid treatment is recommended to prevent further spread. In wetlands, control of non-native invasive plants is considered an "allowed use" under the Vermont Wetlands Rules, if conducted under a plan approved by the Secretary of Natural Resources.

A population of reed canary grass (*Phalaris arundinacea*), considered a watch list species in Vermont, is present at the inlet to the pond near the Red Maple-Tamarack Swamp. I do not recommend treating the species, as it is a large enough patch that physical removal (aka digging it up or hand pulling) will not be effective, and herbicide treatment has the potential to negatively impact the diverse community of native plant species that surround it. The species does not seem to be taking over the wetlands, only the edge closest to the uplands; the remainder of the wetlands are high quality and highly diverse. Thus, management is not recommended.

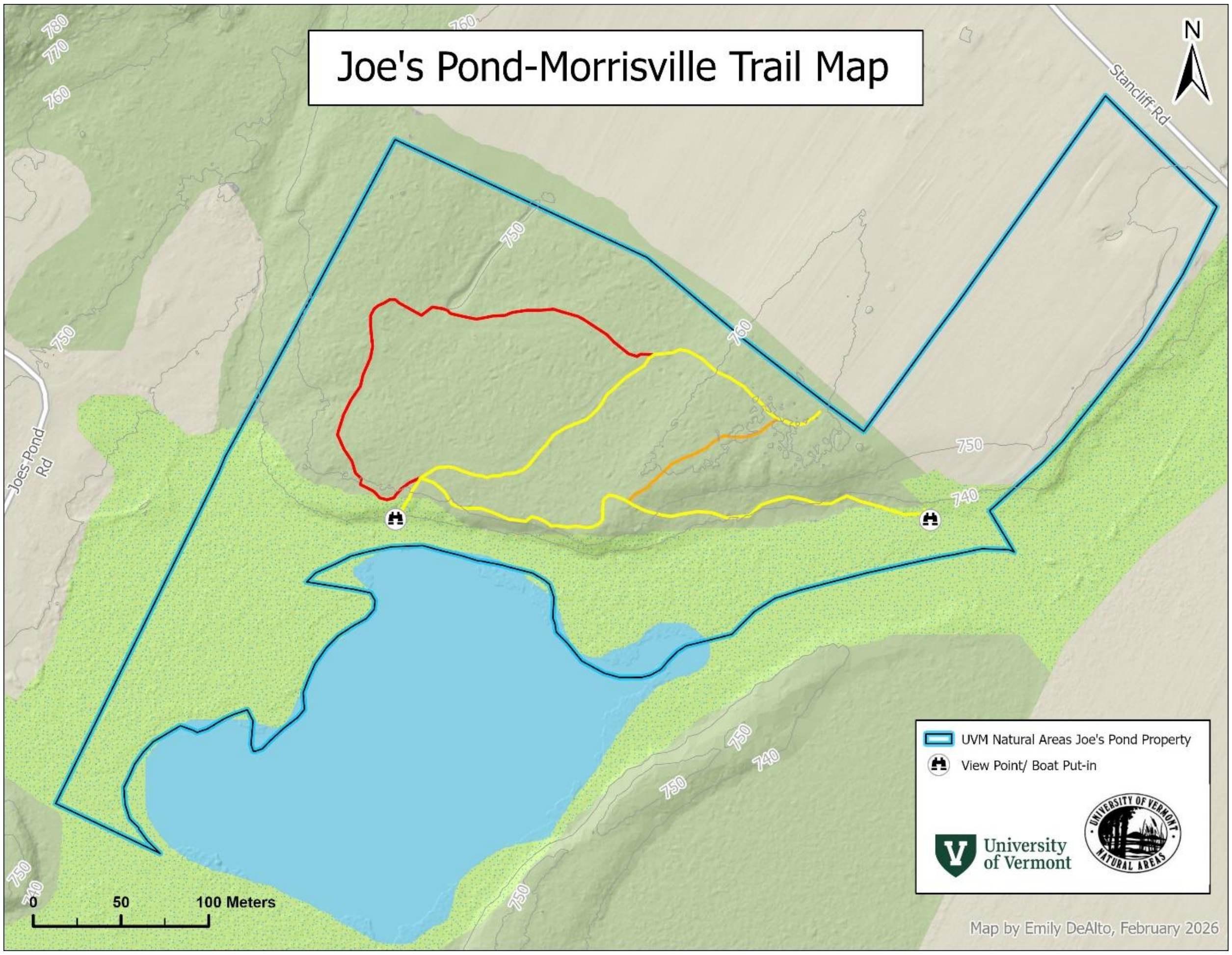
Six uncommon and rare species are present on the site. These species should be continually monitored, using the EO reports (**Appendix B**) as a reference for their status, as of summer 2025.

Trails and Access Management

Three main trails currently run through Joe's Pond-Morrisville Natural Area (**Figure 48**). Some of these trails were previously used as logging trails, and are double-wide. Others are single-wide. Throughout the summer, I noticed vehicle tracks through some of the trails near the openings to the pasture, so it's probable that someone is still driving into these trails occasionally. This has caused muddy conditions and deep ruts on these portions of the trails, especially the wet area that the red trail crosses through.

This wetter area in particular may require further investigation to determine whether the existing ruts and trail have altered the hydrology of the wetter portions of the forest, near the manmade ditch. As noted in Chapter 1, this area may have once supported a forested wetland prior to the ditch and piping, and could potentially be restored to this status through management.

Only once did I encounter a group of kids biking through the trails. SLT and the Natural Areas Program both have signs on the trail entrance stating that bikes are not allowed on the property, so maintaining this signage is a best practice.



Map by Emily DeAlto, February 2026

Figure 48: Joe's Pond-Morrisville Trail Map

The only trail that is not a previous logging trail is the yellow trail, which traverses the edge of the steep slope on the north side of the pond.

All of the trails are relatively flat, with the maximum slope of the trails being 15 degrees at the pitch to the second lookout (**Figure 48**). I would rate them as easy trails that are family friendly, easy to follow, and easy to traverse. They are not, however, wheelchair accessible, by my assessment, due to uneven paths, especially the yellow trail. The main lookout points are marked on the trail map. The first is the trailhead, where the small dock is. This viewpoint offers a prospect of the pond outlet and the surrounding mountains, including Mount Elmore to the east.

A few offshoot trails should be left to grow over (**Figure 49**). The yellow trail leads down to the area I used to cross the inlet to get to the main peat mat. The main loop should be utilized more than this offshoot, as the fen itself should not be used for recreation, rather only for research and educational purposes. Its accessibility is thus not a priority, and this trail can be left alone to grow over. An abandoned trail that is growing in with ferns that cuts across the red trail can likewise be left to grow over. There are enough trails that cross through this area such that this trail offshoot isn't necessary for a nice loop around the site.

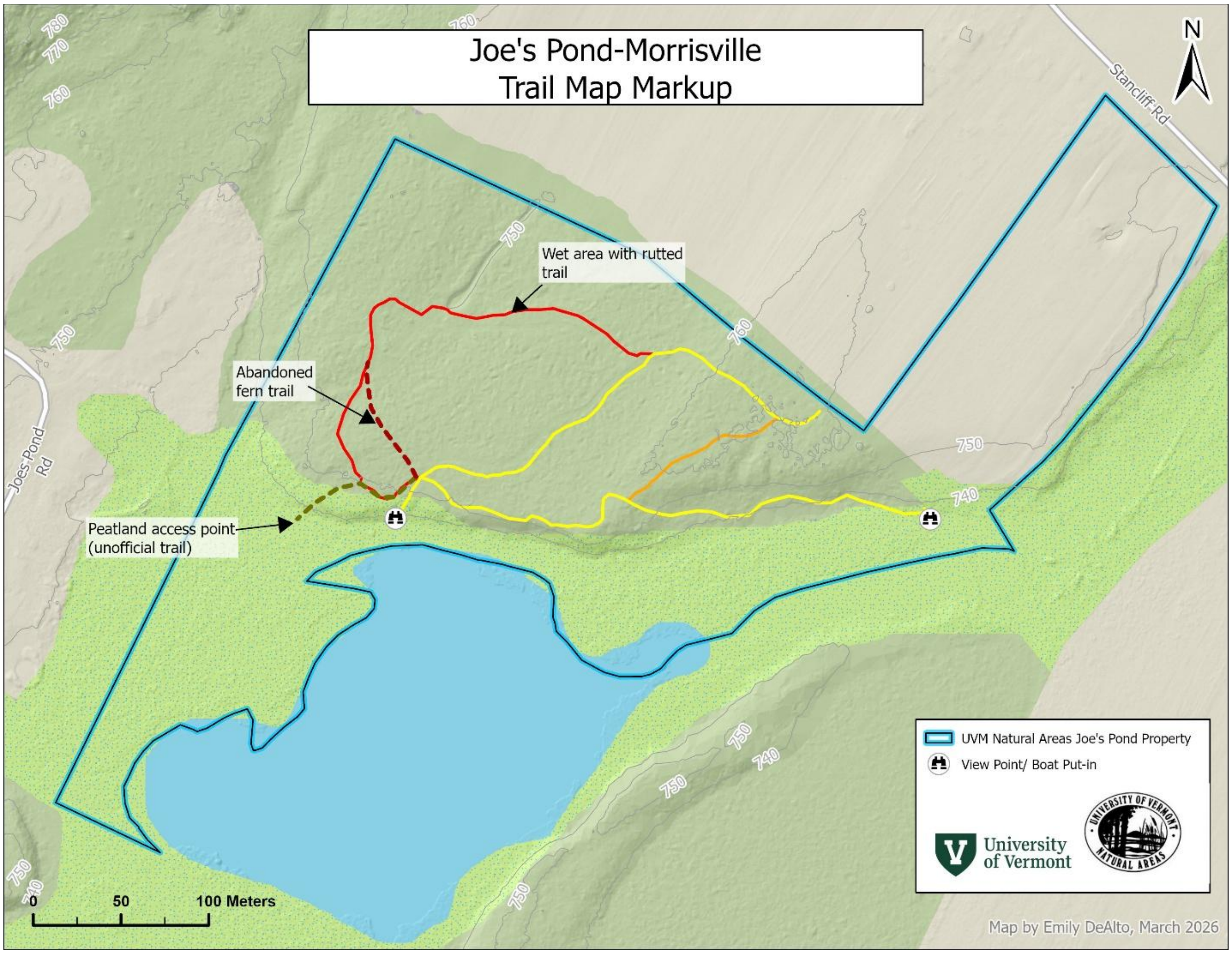


Figure 49: Joe's Pond-Morrisville Trail Markup. Trails that are abandoned or to be abandoned are in dashed lines, while active trails are in solid lines.

Paddling out from the put-in dock is a worthwhile adventure. While the dense colony of lily pads makes the start of the paddle a bit of an effort, once you make it out beyond them, paddling is easy. A gorgeous view of Mount Mansfield to the southwest from the pond allows boaters to get a different perspective of the peatlands than the view they can get from the trails. No management is recommended for paddling purposes. The water lilies and other aquatic plants that make the paddle a bit difficult at first are simply a part of the ever-evolving ecology. Changes in hydrology might change their dominance in some areas, but overall, there will always be a significant number of aquatic plants in the shallower areas of the lake, likely due to the high nutrient load of the lake water (evidenced by the murky, dark brown, highly organic/peaty water throughout).

Naming opportunities: Trails could be named after the natural history features present along them, such as the plants, birds, and natural community types. Alternatively, trails could be named in honor of those who stewarded Joe's Pond-Morrisville before it became a UVM Natural Area.

Wetland Management/Policy Actions

VRAM

The 2025 VRAM serves as a baseline for comparison should any changes to the wetlands occur in the future. I recommend completing the VRAM at this Natural Area every five years, to identify any changes that may have occurred, and to continue to assess the functions and values of these wetlands.

Class I Wetland Status Petition

Class I wetlands are considered exceptional or irreplaceable in their contribution to Vermont's natural heritage. To be designated as a Class I wetland, they must meet one or more of the following criteria: representative example of a wetland type, rare natural community, community assemblages/wetland complexes, and landscape association. The following sub-criteria can also be used to support the case for a Class I designation: Presence of rare, threatened, or endangered species; undisturbed condition; unfragmented and intact landscape; useful resource for education and scientific research; habitat connectivity/wildlife corridor (VTDEC, n.d.). Class I wetlands are also generally larger than 10 acres and already mapped in the VSWI.

The wetlands within the Joe's Pond-Morrisville property are within a larger wetland mosaic of very high quality, as evidenced by the VRAM, and likely would qualify for Class I wetland status. Obtaining Class I status would provide extra protection for the wetlands, including a wider required buffer (100 feet for a Class I wetland vs. 50 feet for a Class II wetland) should any development or other impacts to adjacent parcels be permitted. The process for a Class I petition involves significant community outreach as well as the completion of a scientific study.

This masters project could qualify as a scientific study for reclassification purposes if the petition were focused on the parcel rather than the entire wetland complex. Further study would be needed if the petition were to be for the entire complex. This is something the Natural Areas Program could certainly consider doing here at Joe's Pond-Morrisville, and likely would have support from the State, considering the rare and uncommon plants and natural communities present, and overall high-quality nature of the wetland complex. Should this action be taken, I would recommend including the entire wetland complex in the petition, not just the wetlands on the UVM property, however the UVM-owned wetlands could likely qualify for Class I status on their own. This idea is discussed further in the Educational Opportunities section.

Hydrology

Should the beaver dam break, the hydrology of these wetlands would completely change The water table would likely drop significantly, which could change the conditions away from the open fen that currently exists back to the more woody-plant-dominated peatlands that are presumed to have existed prior to the 1950s, before the beavers dammed the pond most recently. This would be considered a natural disturbance and would not necessarily be a cause for alarm or necessitate an intervention. While the use of extensive beaver-dam-analogs (BDAs) could be used to repair the dam, this may not be necessary. Should the dam break, the VRAM could be performed again to assess whether the functions and values of the wetlands have changed, and if so, whether restoration efforts may be indicated. Wetland restoration is currently considered an allowed use under the Vermont Wetlands Rules when completed in accordance with a plan approved by the Secretary of Natural Resources. The *Vermont Wetland Restoration Manual* (Arrowwood Environmental, 2024) can be used should restoration be found to be necessary.

Changes in the surrounding land use could also lead to changes in the hydrology of the site. Changes in land use, such as the creation of a manmade dam somewhere up or downstream of the site, changes in permeability of surrounding land, construction of roads, etc., should be considered by UVM, even if they are not occurring on the site itself, as these changes could change the existing natural communities of the wetlands and transition them to a different wetland type. Should land use changes in the area be made, this study serves as a useful baseline for comparison and to assess for potential management needs.

Implications for Climate Change

As discussed in Chapter 3, different peatland types have different carbon sequestration abilities; the information gained in this study can be used as a reference for the important potential of these peatlands to positively impact our local and global climate.

Fens, being minerotrophic, generally see higher rates of decomposition than bogs (Arsenault et al., 2024). A study in Patagonia found that all 12 of the peatlands they studied have been effective carbon sinks over the Holocene (~12,000 years ago to present), though peat, and thus carbon, accumulation over time was not linear (Loisel and Bunsen, 2020). Those peatlands that are composed primarily of *Sphagnum* had a statistically higher peat mass on average than those composed of non-*Sphagnum* (sedges, woody material, etc.), throughout every time period measured (>14,000 to 0 years calculated before present), meaning *Sphagnum* peat is a greater carbon sink than non-*Sphagnum* peat. Joe's Pond is currently a *Sphagnum*-dominated fen, but it has transitioned from being sedge dominated to *Sphagnum* dominated, suggesting that the peatlands at Joe's Pond are currently increasing their carbon storage capacity as an effect of the beaver activity that has happened over at least the last 80 years. Overall, understanding these complex dynamics is critical for arguing for the protection of peatland natural communities and making decisions about their future management, restoration, and rehabilitation. Maintaining these peatlands, as a consequence, has not only local, but global importance.

Chapter V: Educational and Research Opportunities

> *Joe's Pond-Morrisville is rich in educational and research opportunities. I had the chance to design my own study here and learned about peatlands, natural community mapping, wetland functionality, beaver ecology, and more, only scratching the surface of what might be learned from this Natural Area. Opportunities abound for other students to do the same.*

Class I Wetland Petition Process

The Class I wetland petition process has been used as an educational opportunity for the NR4060 class with the Natural Areas Program serving as the Community Partner in the past. In 2024, a group of students went through this process for Colchester Bog. While the bog has not yet been designated a Class I wetland, the process of petitioning for this status is an incredible opportunity for students to learn about the functions and values of wetlands in Vermont and about the process of petitioning for Class I status, which relies on both social and hard sciences. The Story Map created by the NR4060 students can be found on the DEC Wetlands Program's website.

Chestnuts and Other Nut Bearing Trees

Over the last two decades, Ron Stancliff has acquired and planted an unknown number of chestnut trees throughout the site. I did not map these trees during my field season, but there seems to be a healthy little population growing. Ron informed me that some of the chestnuts are from the American Chestnut Foundation and are from individuals bred to be resistant to blight. Others, he told me, are from other chestnut enthusiasts in the area, who trade nuts to be planted. A student could establish a monitoring plan for these trees, first by finding them all, and then measuring them to evaluate their survival rate.

Ron planted these chestnuts, as well as the swamp white oak, butternut, and apple (*Malus domestica*) trees, in an attempt to support wildlife on the site. There is an opportunity to assess how effective this effort has been or will be when the trees begin producing fruit by assessing whether wildlife species who might eat these nuts are actually moving through the site.

Wildlife

There are certainly opportunities for further wildlife research at the site. The site provides a lovely environment for wildlife surveys because of its diversity of upland and wetland natural communities in such a small area. I did not conduct any specific surveys for mammals or amphibians, so there is a gap in our knowledge of what species are using the site, and which natural communities they are using most.

It is my understanding that the VT Fish and Wildlife Department has in the past put up equipment to monitor bat activity at the site. While I did not continue this study, coordination with the State could be initiated by students interested in the Natural Area as a habitat for bats and other mammals.

I found evidence of otters in both the summer and winter months. In the summer, I believe I found a latrine on the peat mat, though I could not confirm this. During the winter, I observed tracks in the form of sliding marks that may have been made by otters. Habitat for otters could also be assessed, and their presence needs confirmation.

Hydrology

The overall hydrology of this wetland complex is not well studied. There has been one study of Molly Bog's hydrology (Mouser et al., 2005), however, it is not clear whether the three nearby bogs are hydrologically connected to Joe's Pond-Morrisville, and if the stream that feeds the pond is fed by Molly Bog, upstream of the site.

The site is also very near the headwaters of the Lamoille River, making it incredibly important ecologically for water quality in the greater watershed. A deeper dive into the physical and chemical properties of the pond's hydrology could help inform water quality goals in the watershed.

Connection with Molly Bog and Other Bogs

Joe's Pond-Morrisville is just across Route 100 from Molly Bog, another UVM Natural Area. The two sites together make for a very interesting study of peatland ecology, as one is a fen and the other, a bog. One is seen as a "classic kettle hole bog", the other has a much less clear, highly beaver influenced, natural history. The two together would provide an ideal opportunity to contrast bogs and fens, a concept I only figured out myself a year ago. The two sites also present an interesting comparison between what peatlands with public access and patterns of beaver disturbance look like, versus what a more isolated, non-beaver influenced peatland looks like. These two Natural Areas, being so close together, make for a good field trip for ecology courses.

Additionally, the two other bogs adjacent to Joe's Pond-Morrisville, Morristown Bog and Valcour Bog, are also protected, by the State and by SLT, respectively. Access to Morristown Bog is considered public, as it is state owned land. Access to Valcour Bog is public with landowner permission. Both bogs are sensitive to foot traffic by their nature and are only meant to be visited infrequently for research and educational purposes. I had the opportunity to use both of these bogs in my own investigation of the natural history of Joe's Pond-Morrisville, and I am certain others can learn from these sites as well.

Human History

Opportunities exist for further investigation into the human history of this site, which features a pit with old trash and other relics around the site that I did not investigate. Also, taking time to look into the stewardship/ownership of the land beyond the Stancliff family could be interesting. I am aware that Eugene Morse owned the land before the Stancliff family but, in a brief search of the deed records at the Town Clerk's office, was unable to find the paperwork deeding the land from Morse to Arthur Stancliff (Ron's grandfather), or who owned it before Morse.

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Appendix A: Relevé Forms at Joe’s Pond-Morrisville

UVM Natural Areas Releve Form

Surveyor: Emily DeAtto
Date: 10/9/25
Sample Point: 1
Site Name: Joes Pond

Location Information

Latitude: 44.506978
Longitude: -72.620964
County: Washington, VT

Stand Information

Vegetation Group Wooded upland Open upland [✓ Wooded wetland] Open wetland

Natural Community: N/A
Natural Community Ranking:
Stand typical of NC? Y [✓ N]

If no, why? [✓ Natural disturbance] Human disturbance Young stand (<40 years) Other: beavers
Releve typical of stand? [✓ Y] N
If no, why? Higher quality Lower quality Other:
Plot Location in NC: Far from community boundary Moderately far from boundary Close to boundary Ecotonal

Plot Information

Size: 20x20 m
Elevation:
Shape: Circle [✓ Square] Other:
Topographic context: Crest Upper Middle Lower Toe [✓ Flat] Depression Uncertain
Aspect: LV (e.g. N, NE, etc; LV for level)

Soil Information

Soil Type (map unit):
Litter thickness: <1cm
Litter type: [✓ Leaves] Needles Grass Other:

Depth to redox: N/A peat

Drainage Class: Excessively Well Moderately well drained Somewhat poorly Poorly [✓ Very poorly]

Height of Moss Hummocks: 40cm
Sphagnum cover: 50 %
Depth of standing water: <1cm
pH of surface water:
Exposed rock: 0 %
Rock Type: N/A

UVM Natural Areas Releve Form

Page 2: Soil Layers and DBH

Soil Layers:

Depth (in)	Color	Texture	pH	Coarse Fragments
auger depth		peat	7	sedge, wood
upper hummock			5.5	
peat				
0 - 10	10YR 2/1			
10 - 20	10YR 2/2			
20 - 40	10YR 3/2			

(Gr=gravel, Co=cobbles, St=stones, Bo=boulders)

DBH:

List: Complete [✓ Partial]

Species	DBH
Acer rubrum	1.1, 1.1, 1.1, 1.1, 1.2, 1.2, 2.3, 1.2
Larix laricina	2.5, 5.4, 1.1, 3.75, 3.1, 3.4,
	38, 3.3, 2.0, 1.6, 2.35
Picea rubens	4.5

Remarks:

UVM Natural Areas Releve Form

Page 3: Vegetation

ID	C.S.	Species Name	Cover Class	Remarks
		Osmundastrum cinnamomeum		
	★	Acer rubrum		
		Calla palustris		
	★	Typha latifolia		
		Onoclea sensibilis		
later →	★	Marsh cinquefoil		
		Carex canescens		
	☆	Carex echinata		
	★	Carex stipata		
		Myosotis scorpioides		
	?	Leersia oryzoides		
		Rubus hispidus		
		Triadenum sp.		
		Impatiens sp.		
	☆	Thelypteris palustris		1
		Chamaedaphne calyculata		
		Picea rubens		
		Ilex verticillata		
		Betula alleghaniensis		
		Betula populifolia		
	★	Larix laricina		
		Carex stricta		
	?	Sparganium americanum		2
		Epilobium strictum		
		Ilex mucronata		3
		Spiraea tomentosa		
		Vaccinium myrtilloides		3
		Vaccinium corymbosum		
		Spiraea alba		
		Salix sp. (discolor?)		
		Vaccinium macrocarpon		
		Viburnum cassinoides		
		Dryopteris cristata		
		Carex magellanica		2

1 = hummock dominant

2 = swales dominant

3 = locally dominant

UVM Natural Areas Releve Form

Surveyor: Emily DeAlto **Sample Point:** 2
Date: 6/9/25 **Site Name:** Joe's Pond

Location Information

Latitude: 44.506277 **Longitude:** -72.620913
County: Lamoille, VT

Stand Information

Vegetation Group Wooded upland Open upland Wooded wetland [✓ Open wetland]

Natural Community: Poor fen **Natural Community Ranking:** S2
Stand typical of NC? [✓ Y] N
If no, why? Natural disturbance Human disturbance Young stand (<40 years) Other:
Releve typical of stand? [✓ Y] N
If no, why? Higher quality Lower quality Other:
Plot Location in NC: Far from community boundary Moderately far from boundary Close to boundary Ecotonal

Plot Information

Size: 10 x 10m **Elevation:**
Shape: Circle [✓ Square] Other:
Topographic context: Crest Upper Middle Lower Toe [✓ Flat] Depression Uncertain
Aspect: LV (e.g. N, NE, etc; LV for level)

Soil Information

Soil Type (map unit):
Litter thickness: <1cm
Litter type: [✓ Leaves] Needles Grass [✓ Other:] sedge
Depth to redox: N/A, peat
Drainage Class: Excessively Well Moderately well drained Somewhat poorly Poorly [✓ Very poorly]

Height of Moss Hummocks: 30cm **Sphagnum cover:** 99 %
Depth of standing water: 1cm **pH of surface water:** 5
Exposed rock: N/A % **Rock Type:** N/A

UVM Natural Areas Releve Form

Page 2: Soil Layers and DBH

Soil Layers:

Depth	Color	Texture	pH	Coarse Fragments

(Gr=gravel, Co=cobbles, St=stones, Bo=boulders)

DBH:

List: [✓ Complete] Partial ≥1in

Species	DBH
Larix laricina	1.5, 1.5, 2.1
Picea mariana	1.0
outside plot	
Larix	3.5, 2.3, 2.1
Picea	2.3, 1.5, 1.4

Remarks:

Soil – very undecomposed sphagnum peat to auger depth

Tree heights ranging 3ft to ~15ft for both spp.
some Picea ~2ft.

Plot captures transition from poor fen to swamp lagg
@ 44.506267, -72.620909 there is a N-S line where the lagg is,
visible on aerial as lighter brown NW of dark red

UVM Natural Areas Releve Form

Page 3: Vegetation

ID	C.S.	Species Name	Cover Class	Remarks
	H	Alnus incana		
	H	Larix laricina		
	*	Chamaedaphne calyculata		
		Kalmia polifolia		
		Vaccinium sp.		
	h	Carex billingsii		
		Drosera rotundifolia		
		Carex stricta		
		Rhododendron groenlandicum		
	H	Picea mariana		
		Saraccenea purpurea		
		Menyanthes trifoliata		
		Calla palustris		
		Andromeda polifolia		
		Carex canescens		

check

H = hummock

h = hollow

UVM Natural Areas Releve Form

Surveyor: Emily DeAtto
Sample Point: 3
Date: 6/11/25
Site Name: JOES Pond

Location Information

Latitude: 44.5067767
Longitude: -72.616 954
County: Lamoille, VT

Stand Information

Vegetation Group Wooded upland Open upland Wooded wetland [✓ Open wetland]

Natural Community: Intermediate Fen
Natural Community Ranking:
Stand typical of NC? Y [✓ N]
If no, why? [✓ Natural disturbance] Human disturbance Young stand (<40 years) Other:
beavers
Releve typical of stand? [✓ Y] N
If no, why? Higher quality Lower quality Other:
Plot Location in NC: Far from community boundary Moderately far from boundary [✓ Close to boundary] [✓ Ecotonal]

Plot Information

Size: 10x10
Elevation:
Shape: Circle [✓ Square] **Other:**
Topographic context: Crest Upper Middle Lower Toe [✓ Flat] Depression Uncertain
Aspect: LV (e.g. N, NE, etc; LV for level)

Soil Information

Soil Type (map unit):
Litter thickness: <1cm
Litter type: Leaves Needles [✓ Grass] Other: sedges

Depth to redox:

Drainage Class: Excessively Well Moderately well drained Somewhat poorly Poorly [✓ Very poorly]

Height of Moss Hummocks: 20cm
Sphagnum cover: ~~0-100~~ 0 or 100 % =50
Depth of standing water: 0-2cm
pH of surface water:
Exposed rock: 0 %
Rock Type: N/A

UVM Natural Areas Releve Form

Page 2: Soil Layers and DBH

Soil Layers:

Depth	Color	Texture	pH	Coarse Fragments

(Gr=gravel, Co=cobbles, St=stones, Bo=boulders)

DBH:

List: Complete Partial

Species	DBH
N/A, no trees >1in DBH	
Very few present in general	

Remarks:

Soil is very undecomposed sphagnum peat to auger depth
Floating mat
Lots of holes (muskrat paths?) + small streams break up the veg.

UVM Natural Areas Releve Form

Page 3: Vegetation

ID	C.S.	Species Name	Cover Class	Remarks
		Typha latifolia	★	
		Marsh fern	★	
		Marsh cinquefoil	3	
		Chamaedaphne calyculata	★ -	
		Carex lasiocarpa		
		Carex lacustris		
		Carex diandra	1	
		Acer rubrum		
		Osmundastrum cinnamomeum		
		Spirea alba		
		Dryopteris cristata	☐	
		Triadenum sp.		
		Eleocharis palustris	1	
		Carex canescens		
		Drosera rotundifolia		
		Veronica scutellata		
		Calla palustris		
		Onoclea sensibilis	2	
		Spirea tomentosa	2	
		Cicuta bulbifera	2	
		Carex comosa	1, 2	
		Nymphaea odorata	4	
		V. ulammusula		

★ = dominant in plot

☐ = rare in plot

1 = along wettest edges

2 = near lake edge only

3 = in deep water

4 = deep water only

UVM Natural Areas Releve Form

Surveyor: Emily DeAlto
Date: 6/15/25
Sample Point: SP4
Site Name: JOEs Pond - Morrisville

Location Information

Latitude: 44.508226
Longitude: -72.618455
County: Lamoille

Stand Information

Vegetation Group Wooded upland Open upland [✓ Wooded wetland] Open wetland

Natural Community: Wet Hemlock Forest
Natural Community Ranking: N/A
Stand typical of NC? [✓ Y] N
If no, why? Natural disturbance [✓ Human disturbance] Young stand (<40 years) Other: Ditch/dam
Releve typical of stand? [✓ Y] N
If no, why? Higher quality Lower quality Other:
Plot Location in NC: Far from community boundary Moderately far from boundary [✓ Close to boundary] Ecotonal

Plot Information

Size: 10x10
Elevation: 767
Shape: Circle [✓ Square] Other:
Topographic context: Crest Upper Middle Lower Toe Flat [✓ Depression] Uncertain
Aspect: LV (e.g. N, NE, etc; LV for level)

Soil Information

Soil Type (map unit): Adams loamy sand
Litter thickness: 2cm
Litter type: [✓ Leaves] Needles Grass Other:

Depth to redox: 10in
at

Drainage Class: Excessively Well Moderately well drained Somewhat poorly Poorly Very poorly

Height of Moss Hummocks: ~~8cm~~ 2cm (ast hummock)
Sphagnum cover: 5 %
Depth of standing water: 0
pH of surface water: N/A
Exposed rock: ~~15~~ 0 %
Rock Type: Till

UVM Natural Areas Releve Form

Page 2: Soil Layers and DBH

Soil Layers:

Depth in	Color	Texture	pH	Coarse Fragments
O 0 - 2"	10YR 2/1	organic	4	
2 - 10	2.5Y 5/1	LS	5.5	pebbly till St
10 - 14"	2.5Y 3/1	LS	5.5	pebbly till
redox	7.5YR 4/6 20%	LS		
14 - 18"	2.5Y 4/2	LS	6.5	
18+ "	5Y 4/1	LS	6.5	

(Gr=gravel, Co=cobbles, St=stones, Bo=boulders)

DBH:

List: [✓ Complete] Partial

Species	DBH
Tsuga canadensis	11.7, 9.0, 14.9, 3.8, 2.3, 3.1, 2.2
Acer rubrum	5.7
betula alleghenensis	5.5

Remarks:

Areas with the wettest soils are in sparsely covered depressions
Nearby uplands have clear Adams soil (mostly gelisol)
Less wet spots have less well sorted soil, more till (sandier)

Yellow birch a dominant in the understory

UVM Natural Areas Releve Form

Page 3: Vegetation

ID	C.S.	Species Name	Cover Class	Remarks
	★	Tsuga Canadensis		
	★	Dryopteris intermedia		
	★	Betula alleghaniensis		mostly saplings
		Acer rubrum		mostly saplings
		Sphagnum sp.		
		Oxalis montana		
		NY fern		
		Lysimachia borealis		
		Carex intumescens		
		Brachyelytrum aristosum		
		Rubus sp.		
	–	Osmundastrum cinnamomeum		
		Carex trisperma		

★ = dom

– = few

UVM Natural Areas Releve Form

Surveyor: Emily DeAtto **Sample Point:** 5
Date: 6/17/25 **Site Name:** Joe's Pond

Location Information

Latitude: 44.506837 **Longitude:** -72.417316
County: Lamoille, VT

Stand Information

Vegetation Group Wooded upland Open upland Wooded wetland [✓ Open wetland]

Natural Community: Poor fen **Natural Community Ranking:**
Stand typical of NC? Y [✓ N]

If no, why? [✓ Natural disturbance] beavers Human disturbance Young stand (<40 years) Other:
Releve typical of stand? [✓ Y] N
If no, why? Higher quality Lower quality Other:
Plot Location in NC: Far from community boundary Moderately far from boundary [✓ Close to boundary/Ecotonal]

Plot Information

Size: 10×10 **Elevation:**
Shape: Circle [✓ Square] Other:
Topographic context: Crest Upper Middle Lower Toe [✓ Flat] Depression Uncertain
Aspect: LV (e.g. N, NE, etc; LV for level)

Soil Information

Soil Type (map unit):
Litter thickness: <1cm
Litter type: Leaves Needles [✓ Grass] Other: Sedges

Depth to redox:

Drainage Class: Excessively Well Moderately well drained Somewhat poorly Poorly [✓ Very poorly]

Height of Moss Hummocks: 35-50cm **Sphagnum cover:** 100% %
Depth of standing water: 0-2cm **pH of surface water:** 4.0
Exposed rock: 0 % **Rock Type:** N/A

~~sp~~ conifer cone came up in auger @ 4ft down!

UVM Natural Areas Releve Form

Page 3: Vegetation

ID	C.S.	Species Name	Cover Class	Remarks
		Chamaedaphne calyculata	☆	
		Ilex verticillata		
		Larix laricina	2	
		Acer rubrum		
		Carex lacustre	1	
		Spirea alba		
		Drosera rotundifolia		
		Prunus virginiana	☐	
		Betula populifolia		
		Osmundastrum cinnamomeum		
*		Unknown shrub		
		Vaccinium macrocarpon	2	
		Vaccinium corymbosum		

☆ = dominant

1 = on ecotone

☐ = rare in plot

2 = hummock

UVM Natural Areas Releve Form

Surveyor: Emily DeAtto
Date: 10/19/25
Sample Point: SP6?
Site Name: Joe's Pond Morrisville

Location Information

Latitude: 44.507087
Longitude: -72.619334
County: Lamoille

Stand Information

Vegetation Group [✓ Wooded upland] Open upland Wooded wetland Open wetland

Natural Community: Hemlock forest
Natural Community Ranking:
Stand typical of NC? Y [✓ N]
If no, why? [✓ Natural disturbance] beaver Human disturbance Young stand (<40 years) Other: Climate ?
Releve typical of stand? [✓ Y] N
If no, why? Higher quality Lower quality Other:
Plot Location in NC: Far from community boundary Moderately far from boundary [✓ Close to boundary] Ecotonal

Plot Information

Size: 10x10
Elevation: 762
Shape: Circle [✓ Square] Other:
Topographic context: Crest Upper [✓ Middle] Lower Toe Flat Depression Uncertain
Aspect: S (e.g. N, NE, etc; LV for level)

Soil Information

Soil Type (map unit): Adams (top of slope)
Litter thickness: 2cm
Litter type: [✓ Leaves] Needles Grass Other:

Depth to redox: N/A

Drainage Class: Excessively Well Moderately well drained Somewhat poorly Poorly Very poorly

Height of Moss Hummocks: N/A
Sphagnum cover: %
Depth of standing water: N/A
pH of surface water:
Exposed rock: N/A %
Rock Type:

UVM Natural Areas Releve Form

Page 2: Soil Layers and DBH

Soil Layers:

Depth	Color	Texture	pH	Coarse Fragments
0 - 6	2.5Y 4/2	SL	4.5	Gr, till pebbles
6 +	2.5Y 5/2	SCL	5.5	none
couldnt get deeper				

(Gr=gravel, Co=cobbles, St=stones, Bo=boulders)

DBH:

List: Complete Partial

Species	DBH
Tsuga canadensis	6.6, 5.9, 8.5, 23, 1.1, 8.7, 4.0,
	10.3, 23
Abies balsamifera	5.9
Ulmus americana	11.2
Prunus serotina	21.4
Picea sp. (glauca or rubens)	10.1

Remarks:

Soils are Adams series on top of slope

UVM Natural Areas Releve Form

Page 3: Vegetation

ID	C.S.	Species Name	Cover Class	Remarks
	*	Tsuga canadensis		
		Abies balsamea		
		Cornus alternifolia		
		Dennstaedtia punctilobula		
		Phegopteris connectilis		
		Acer pensylvanicum		
		Acer saccharum		
		Acer rubrum		
	*	Maianthemum canadense		
		Gymnocarpium dryopteris		
		Lysimachia borealis		
		Betula alleghaniensis		
		Fagus grandifolia		One larger outside plot
		Dryopteris intermedia		
		Amauropelta noveboracensis		
		Oryzopsis asperifolia		
		Juniperus virginiana		
		Coptis trifolia		
		Picea glauca?		
		Ulmus americana		
		Pinus serotina		
		Carex gracillima		

weird! →

UVM Natural Areas Releve Form

Surveyor: Emily DeAlto **Sample Point:** 7
Date: 6/11/25 **Site Name:** Joes Pond

Location Information

Latitude: 44.597622 **Longitude:** -72.619749
County: Lamoille, VT

Stand Information

Vegetation Group [✓ Wooded upland] Open upland Wooded wetland Open wetland

Natural Community: Hemlock Northern Hardwood **Natural Community Ranking:**
Stand typical of NC? Y [✓ N]

If no, why? Natural disturbance [✓ Human disturbance] Young stand (<40 years) Other:
logging road (minimal) — on trail on plot
Releve typical of stand? [✓ Y] N
If no, why? Higher quality Lower quality Other:
Plot Location in NC: [✓ Far from community boundary] Moderately far from boundary Close to boundary Ecotonal

Plot Information

Size: 20 x 20 m **Elevation:**
Shape: Circle [✓ Square] Other:
Topographic context: [✓ Crest] Upper Middle Lower Toe Flat Depression Uncertain
Aspect: LV (e.g. N, NE, etc; LV for level)

Soil Information

Soil Type (map unit): Adams loamy sand
Litter thickness: 2cm
Litter type: [✓ Leaves] Needles Grass Other:

Depth to redox:

Drainage Class: Excessively Well Moderately well drained Somewhat poorly Poorly Very poorly

Height of Moss Hummocks: N/A **Sphagnum cover:** N/A %
Depth of standing water: N/A **pH of surface water:** N/A
Exposed rock: 0 % **Rock Type:** N/A

UVM Natural Areas Releve Form

Page 2: Soil Layers and DBH

Soil Layers:

Depth	Color	Texture	pH	Coarse Fragments
1-2 in	10YR 2/1	O	4	
2-5 in	10 YR 4/1	SCL	4	pebbles / S
5-	10YR 3/4	SCL	4	S

(Gr=gravel, Co=cobbles, St=stones, Bo=boulders)

DBH:

List: Complete [✓ Partial]

Species	DBH
Abies balsamifera	12.5^{D}, 8.4^{D} 10.1^{D}, 8.05
Acer rubrum	10.7, 10.7, 4.6, 3.15
Betula alleghaniensis	5.15, 2.2, 2.3, 10.6, 10.0, 6.4
	3.9
Prunus serotina	9.9, 6.0, 7.0
Acer saccharum	2.3, 5.9, 2.1, 2.3, 1.8, 5.8
Tsuga canadensis	2.4, 4.7, 14.0, 3.2
Sorbus americana	4.55
Acer pensylvanicum	2.8
Fagus grandifolia	3.9

D = dead

Remarks:

Soil - lots of pebbles going down, quartz, + flaky angular stuff

till derived?

hard to get past 12 in deep w/auger

Other - lots of down + dead stems + standing dead stems

UVM Natural Areas Releve Form

Page 3: Vegetation

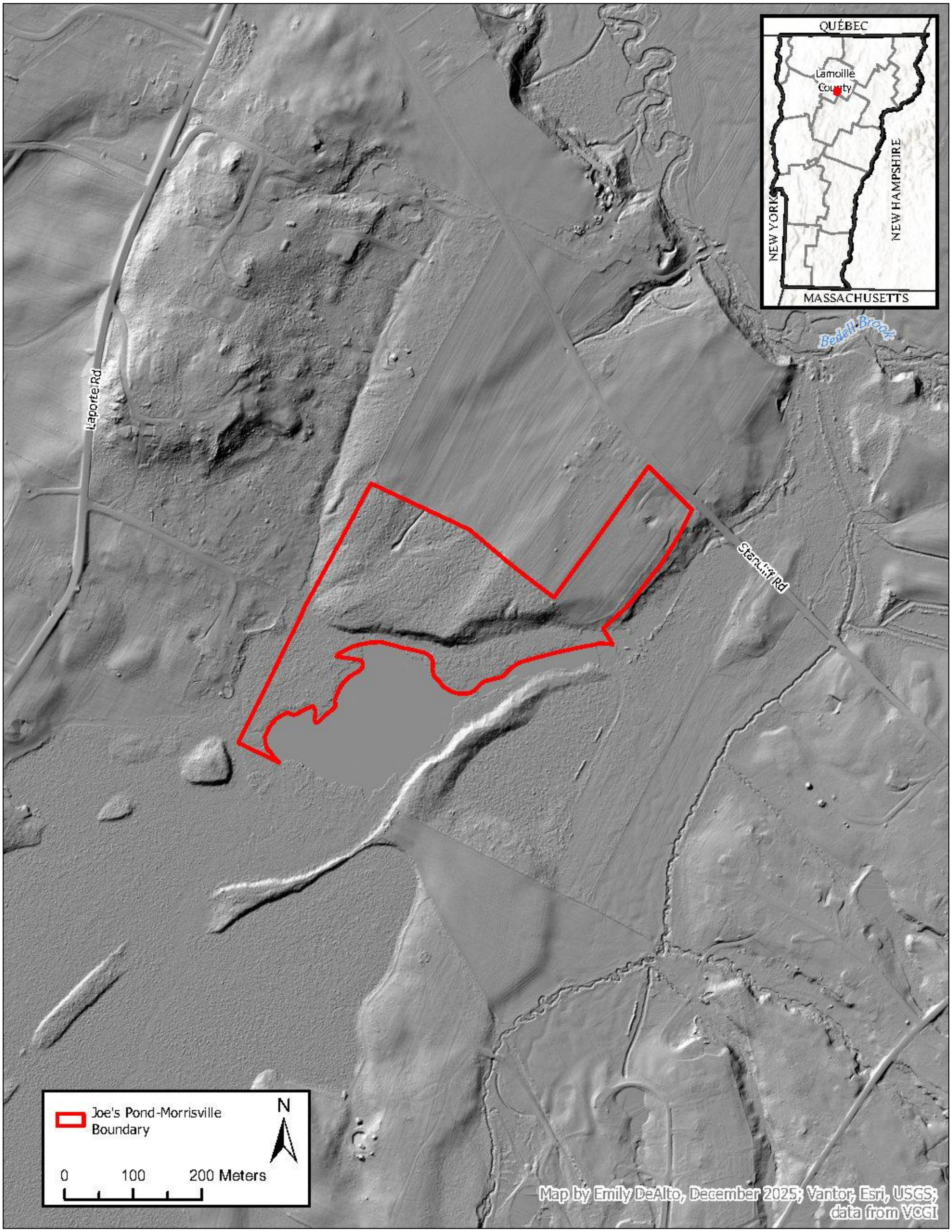
ID	C.S.	Species Name	Cover Class	Remarks
		Dryopteris intermedia	☆	
		Abies balsamifera		
		Prunus serotina		
		Acer saccharum		
		Betula papyrifera		
		Dennstaedtia punctilobula	☆	
		Maianthemum canadense		
		Acer rubrum		
		Trillium erectum		
		Lysimachia borealis		
		Carex intumescens		
		Tsuga canadensis		
		Polygonatum pubescens		
		Carex scabrata		
		Callopia Cilinodis	1	
		Oclemena acuminata	1	
		Acer pensylvanicum		
		Athyrium angustum		
		Viola sp.		
		Carex disperma ?		
		Brachyelytrum aristosum		
		Carex gracillima		
		Foamflower		
		Ribes glandulosum		
		Cornus alternifolia		
		Prunus pensylvanica		
		Mountain woodsorrel		
		Sorbus americana		
		Cucumber root		

☆dominant

1 = trail edge

Appendix B: Element Occurrence Reports

Appendix C: Hillshade Map



Map by Emily DeAlto, December 2025; Vantor, Esri, USGS; data from VCGI

VERMONT RARE PLANT FORM

rev. 2023

Vermont Natural Heritage Inventory

Scientific Name: Calapogon tuberosus

EO# (if known):

New: X

Update:

Surveyor(s): Emily DeAlto

Mailing address (phone, email): 9732558335, esdealto@gmail.com

Survey Date(s): 7/15/26-8/1/26

Report Date: 03/23/26

Survey Site: Joe's Pond-Morrisville

Town(s): Morrisville

Directions to location(s) of plants:

From the trails: From the Joe's Pond trailhead, take the yellow trail all the way across the north side of the pond. Follow an unofficial trail that extends from the yellow trail to the small inlet that comes from the adjacent properties uplands. Cross the inlet and follow another unofficial trail along the down logs that form a line. Cut southeast into the swamp towards the open fen. Once in the open fen, the plants can be found along the edges of the peat mat.

From the pond: Individuals can be found along the edge of the pond/peat mat edge on the southwest side of the pond

Are plants in same location(s) as previously observed?

LANDOWNER(S) / CONTACT(S) (**Name**, **Telephone**, **Address**, **Email—**if not in a Site Summary Form)

Permission?

UVM Natural Areas Program, 617 Main Street, Burlington, VT, (802) 656-7853, Lori.Anderson@uvm.edu ☒

☐

BIOLOGY

Approximate #

1 ramets

(Stems originating separately from ground)

genets

(Presumed genetic individuals, e.g. clumps, patches, stems)

Population Area(s)

(e.g. 30x10ft; 1m^2; 0.5 acre, 1ha)

Phenology (% or #)

	in leaf
	in bud
100%	in flower
	immature fruit
	mature fruit
	dormant

Verbal synopsis of above biological data and evidence of reproduction (if not found, discuss search effort):

One flowering individual found.

SURVEY SITE & HABITAT INFORMATION (if not provided in a Site Summary Form or previous form)

Survey site description:

One individual throughout the season, found in a small pocket of Poor Fen within an Intermediate Fen. It was surrounded by woolly-fruited sedge, mud sedge, leatherleaf, star sedge, marsh fern, tamarack, and speckled alder.

Substrate: Peat

Topographic position: Open water peat mat

Aspect: N/A

Slope: 0

Elevation (in feet): minimum 739 maximum 740

Light: Open canopy

Moisture: On floating peat mat

Associated plant species observed (immediate vicinity):

Carex echinata, Carex limosa

IDENTIFICATION Characteristics used for plant ID. Photos taken: ☒

Specimen collected? ☐ Collection #: ________ Collector (s): ____________________________ Repository: ____________

(A permit is required to collect Threatened & Endangered species)

CONSERVATION SUMMARY

Is the habitat likely to persist? Yes, conserved by Stowe Land Trust and UVM Natural Areas Program

Explain any threats: If the beaver dam on the pond were to break, site hydrology could change dramatically.

Conservation, management, and inventory needs:

N/A

Full extent of population known? Amount or percent of habitat searched:

Searched UVM property and along the inlet and outlet to Joe's Pond by boat.

Comments that do not fit in another field:

MAPPING (required if not provided in a Site Summary)

Attach a copy of Map or Aerial Image showing the rare plant location(s): ☒

(Keep in mind that if an area occupied is longer or wider than 12.5 meters, we prefer to map a polygon or line)

Shapefile with all species identified during survey was sent.

AND/OR: Attach shapefile (must be *NAD83 State Plane*) ☐; GPS point printout ☐; or write out GPS coordinates below:

GPS Points: ____________________ Datum (required; NAD83 preferred): ____________

Accuracy (if known): +/- meters☐/feet☐

Optional: Sketches with rare plant location(s), direction & scale: 1) Cross-section of local topography; 2) Diagram of site with survey route

In Word 2007/2010, to unlock the form to draw a diagram or insert pictures or maps, click on the padlock in the "Review" or "Developer" tab/ribbon, select "Restrict Formatting and Editing," then click the "Stop Protection" button. When finished, click, "Yes, Start Enforcing Protection," and then click "OK."

Please send completed forms to Grace Glynn: Grace.Glynn [at] vermont.gov / Vermont Natural Heritage Inventory, Vermont Fish & Wildlife Department, 5 Perry St., Suite 40, Barre, VT 05641 / (802) 505-3439

VERMONT RARE PLANT FORM

Vermont Natural Heritage Inventory

rev. 2023

Scientific Name: Eriophorum tenellum EO# (if known): New: X Update:

Surveyor(s): Emily DeAlto
Mailing address (phone, email): 9732558335, esdealto@gmail.com

Survey Date(s): 6/24/26-8/1/26 Report Date: 03/23/26

Survey Site: Joe's Pond-Morrisville **Town**(s): Morrisville

Directions to location(s) of plants:

From the trails: From the Joe's Pond trailhead, take the yellow trail all the way across the north side of the pond. Follow the unofficial trail to the small inlet that comes from the adjacent properties uplands. Cross the inlet and follow the unofficial trail along the logs on the ground. Cut southeast into the swamp towards the open fen. Once in the open fen, the plants can be found near the boundary between the swamp and open fen.

From the pond: Paddle out to the main fen mat. You can pull your boat onto the mat at one of the small inlets where the water is shallower. Walk across the fen to near the edge of the swamp. The plants are along the lagg zone between the swampier area and open fen area.

Are plants in same location(s) as previously observed?

LANDOWNER(S) / CONTACT(S) (**Name, Telephone, Address, Email—**if not in a Site Summary Form) Permission?

UVM Natural Areas Program, 617 Main Street, Burlington, VT, (802) 656-7853, Lori.Anderson@uvm.edu ☐

☐

BIOLOGY

Approximate #

>100 ramets
(Stems originating separately from ground)

genets
(Presumed genetic individuals, e.g. clumps, patches, stems)

Population Area(s)
(e.g. 30x10ft; 1m²; 0.5 acre, 1ha)

Phenology (% or #)
in leaf
in bud
99 in flower
%
immature fruit
mature fruit
dormant

Verbal synopsis of above biological data and evidence of reproduction (if not found, discuss search effort)**:**

All individuals were in fruit throughout the season and during the time of survey. Individuals were not counted but are presumed to be ramets.

SURVEY SITE & HABITAT INFORMATION (if not provided in a Site Summary Form or previous form)

Survey site description:

Few-nerved cotton grass was found within a Poor Fen surrounded by Intermediate Fen. The population was large (>100 individuals) population, with individuals mostly in middle range local elevations (i.e. not on top of hummocks or in the deepest hollows

Substrate: peat/Sphagnum peat Topographic position: Between hummocks and hollows

Aspect: Slope: 0 Elevation (in feet): minimum 741 maximum 741

Light: Moisture:

Associated plant species observed (immediate vicinity):

Carex stricta

IDENTIFICATION Characteristics used for plant ID. Photos taken: ☒

Specimen collected? ☐ Collection #: ________ Collector (s): ______________________________ Repository: ______________

(A permit is required to collect Threatened & Endangered species)

CONSERVATION SUMMARY

Is the habitat likely to persist? Yes, conserved by Stowe Land Trust and UVM Natural Areas Program

Explain any threats: If the beaver dam on the pond were to break, site hydrology could change dramatically.

Conservation, management, and inventory needs:

Did not count individuals.

Full extent of population known? Amount or percent of habitat searched:

Searched UVM property and along the inlet to Joe's Pond by boat.

Comments that do not fit in another field:

MAPPING (required if not provided in a Site Summary)

Attach a copy of Map or Aerial Image showing the rare plant location(s): ☒

(Keep in mind that if an area occupied is longer or wider than 12.5 meters, we prefer to map a polygon or line)

AND/OR: Attach shapefile (must be *NAD83 State Plane*) ☐; GPS point printout ☐; or write out GPS coordinates below:

GPS Points: ______________________________ Datum (required; NAD83 preferred): ______________

Accuracy (if known): +/- meters☐/feet☐

Optional: Sketches with rare plant location(s), direction & scale: 1) Cross-section of local topography; 2) Diagram of site with survey route

In Word 2007/2010, to unlock the form to draw a diagram or insert pictures or maps, click on the padlock in the "Review" or "Developer" tab/ribbon, select "Restrict Formatting and Editing," then click the "Stop Protection" button. When finished, click, "Yes, Start Enforcing Protection," and then click "OK."

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VERMONT RARE PLANT FORM

rev. 2023

Vermont Natural Heritage Inventory

Scientific Name: Platanthera blephariglottis EO# (if known): New: X Update:

Surveyor(s): Emily DeAlto
Mailing address (phone, email): 9732558335, esdealto@gmail.com

Survey Date(s): 6/24/26-8/1/26 Report Date: 03/23/26

Survey Site: Joe's Pond-Morrisville **Town**(s): Morrisville

Directions to location(s) of plants:

From the trails: From the Joe's Pond trailhead, take the yellow trail all the way across the north side of the pond. Follow the unofficial trail to the small inlet that comes from the adjacent properties uplands. Cross the inlet and follow the unofficial trail along the logs on the ground. Cut southeast into the swamp towards the open fen. Once in the open fen, the plants can be found near the boundary between the swamp and open fen.

From the pond: Paddle out to the main fen mat. You can pull your boat onto the mat at one of the small inlets where the water is shallower. Walk across the fen to near the edge of the swamp. The plants are along the lagg zone between the swampier area and open fen area.

Are plants in same location(s) as previously observed?

LANDOWNER(S) / CONTACT(S) (**Name, Telephone, Address, Email—**if not in a Site Summary Form) Permission?

UVM Natural Areas Program, 617 Main Street, Burlington, VT, (802) 656-7853, Lori.Anderson@uvm.edu ☐

☐

BIOLOGY

Approximate #		**Population Area**(s)	Phenology (% or #)	
17	ramets	(e.g. 30x10ft; 1m^2; 0.5 acre, 1ha)		in leaf
(Stems originating separately from ground)				in bud
			100%	in flower
	genets			immature fruit
(Presumed genetic individuals, e.g. clumps, patches, stems)				mature fruit
				dormant

Verbal synopsis of above biological data and evidence of reproduction (if not found, discuss search effort):

All individuals were in flower throughout the season and during the time of survey. Presumed to be ramets. None within 10 feet of one another.

SURVEY SITE & HABITAT INFORMATION (if not provided in a Site Summary Form or previous form)

Survey site description:

Ten to twenty individuals were found scattered around the Poor Fen natural community on the northwestern portion of the peat mat, nearest the inlet. Individuals were usually on medium-height hummocks, surrounded by mud sedge, leatherleaf, tawny cottongrass, tamarack, and round-leaved sundew, among others. Individuals were well spaced out within the population, with most individuals having at least 10 feet between one individual and the next

Substrate: peat/Sphagnum peat Topographic position: usually on medium-height hummocks

Aspect: N/A Slope: 0 Elevation (in feet): minimum 741 maximum 741

Light: Open canopy Moisture:

Associated plant species observed (immediate vicinity):

Eriophorum virginicum, Sphagnum spp., Chamedaphne calyculata, Alnus incana

IDENTIFICATION Characteristics used for plant ID. Photos taken: ☒

Specimen collected? ☐ Collection #: ________ Collector (s): ____________________ Repository: __________

(A permit is required to collect Threatened & Endangered species)

CONSERVATION SUMMARY

Is the habitat likely to persist? Yes, conserved by Stowe Land Trust and UVM Natural Areas Program

Explain any threats: If the beaver dam on the pond were to break, site hydrology could change dramatically.

Conservation, management, and inventory needs:

N/A

Full extent of population known? Amount or percent of habitat searched:

Searched UVM property and along the inlet and outlet to Joe's Pond by boat.

Comments that do not fit in another field:

In both Intermediate and Poor fen.

MAPPING (required if not provided in a Site Summary)

Attach a copy of Map or Aerial Image showing the rare plant location(s): ☒

(Keep in mind that if an area occupied is longer or wider than 12.5 meters, we prefer to map a polygon or line)

Shapefile with all species identified during survey was sent.

AND/OR: Attach shapefile (must be *NAD83 State Plane*) ☐; GPS point printout ☐; or write out GPS coordinates below:

GPS Points: ____________________ Datum (required; NAD83 preferred): __________

Accuracy (if known): +/- meters☐/feet☐

Optional: Sketches with rare plant location(s), direction & scale: 1) Cross-section of local topography; 2) Diagram of site with survey route

In Word 2007/2010, to unlock the form to draw a diagram or insert pictures or maps, click on the padlock in the "Review" or "Developer" tab/ribbon, select "Restrict Formatting and Editing," then click the "Stop Protection" button. When finished, click, "Yes, Start Enforcing Protection," and then click "OK."

Please send completed forms to Grace Glynn: Grace.Glynn [at] vermont.gov / Vermont Natural Heritage Inventory, Vermont Fish & Wildlife Department, 5 Perry St., Suite 40, Barre, VT 05641 / (802) 505-3439

VERMONT RARE PLANT FORM

rev. 2023

Vermont Natural Heritage Inventory

Scientific Name: Persicaria hydropiperoides EO# (if known): ______ New: X Update: ______

Surveyor(s): Emily DeAlto
Mailing address (phone, email): 9732558335, esdealto@gmail.com

Survey Date(s): 7/1526-8/1/26 Report Date: 03/23/26

Survey Site: Joe's Pond-Morrisville **Town**(s): Morrisville

Directions to location(s) of plants:

From the trails: From the Joe's Pond trailhead, take the yellow trail all the way across the north side of the pond. Follow the unofficial trail to the small inlet that comes from the adjacent properties uplands. Cross the inlet and follow the unofficial trail along the logs on the ground. Cut southeast into the swamp towards the open fen. Once in the open fen, the plants can be found along the edges of the peat mat.
From the pond: Individuals can be found along the edge of the pond/peat mat edge on the southwest side of the pond

Are plants in same location(s) as previously observed? ______

LANDOWNER(S) / CONTACT(S) (**Name**, **Telephone, Address, Email—**if not in a Site Summary Form) Permission?

UVM Natural Areas Program, 617 Main Street, Burlington, VT, (802) 656-7853, Lori.Anderson@uvm.edu ☒
______ ☐

BIOLOGY

Approximate #		**Population Area**(s)	Phenology (% or #)	
~10	ramets	(e.g. 30x10ft; 1m²; 0.5 acre, 1ha)		in leaf
(Stems originating separately from ground)				in bud
				in flower
	genets			immature fruit
(Presumed genetic individuals, e.g. clumps, patches, stems)				mature fruit
				dormant

Verbal synopsis of above biological data and evidence of reproduction (if not found, discuss search effort):

Flowering and fruiting individuals found throughout the pond outlet on newly forming peat mat. Presumed to be ramets.

SURVEY SITE & HABITAT INFORMATION (if not provided in a Site Summary Form or previous form)

Survey site description:

A population of at least 10 individuals grows along the newest peat mats forming in the main outlet stream of the pond, to the northwest. These mats are likely held together by yellow pond-lily rhizomes, which float near the pond surface and accumulate peat within them in this area. These new peat mats are dominated mostly by blunt spikerush.

Substrate: Peat Topographic position: Open water peat mat

Aspect: N/A Slope: 0 Elevation (in feet): minimum 739 maximum 740

Light: Open canopy Moisture: On floating peat mat

Associated plant species observed (immediate vicinity):

N/A

IDENTIFICATION Characteristics used for plant ID. Photos taken: ☒

Stems unarmed, flowers ascending to spreading, inflorescence terminal and axillary, tepals not spotted with glandular dogs, ocreae gradually enlarged at base and perianth pink

Specimen collected? ☐ Collection #: ________ Collector (s): ______________________ Repository: __________

(A permit is required to collect Threatened & Endangered species)

CONSERVATION SUMMARY

Is the habitat likely to persist? Yes, conserved by Stowe Land Trust and UVM Natural Areas Program

Explain any threats: If the beaver dam on the pond were to break, site hydrology could change dramatically.

Conservation, management, and inventory needs:

N/A

Full extent of population known? Amount or percent of habitat searched:

Searched UVM property and along the inlet and outlet to Joe's Pond by boat.

Comments that do not fit in another field:

MAPPING

(required if not provided in a Site Summary)

Attach a copy of Map or Aerial Image showing the rare plant location(s): ☒

(Keep in mind that if an area occupied is longer or wider than 12.5 meters, we prefer to map a polygon or line)

Shapefile with all species identified during survey was sent.

AND/OR: Attach shapefile (must be *NAD83 State Plane*) ☐; GPS point printout ☐; or write out GPS coordinates below:

GPS Points: ______________________ Datum (required; NAD83 preferred): __________

Accuracy (if known): +/- meters☐/feet☐

Optional: Sketches with rare plant location(s), direction & scale: 1) Cross-section of local topography; 2) Diagram of site with survey route

In Word 2007/2010, to unlock the form to draw a diagram or insert pictures or maps, click on the padlock in the "Review" or "Developer" tab/ribbon, select "Restrict Formatting and Editing," then click the "Stop Protection" button. When finished, click, "Yes, Start Enforcing Protection," and then click "OK."

Please send completed forms to Grace Glynn: Grace.Glynn [at] vermont.gov / Vermont Natural Heritage Inventory, Vermont Fish & Wildlife Department, 5 Perry St., Suite 40, Barre, VT 05641 / (802) 505-3439

VERMONT RARE PLANT FORM

rev. 2023

Vermont Natural Heritage Inventory

Scientific Name: Pogonia ophioglossoides EO# (if known): ______ New: X Update: ______

Surveyor(s): Emily DeAlto

Mailing address (phone, email): 9732558335, esdealto@gmail.com

Survey Date(s): 6/24/26-8/1/26 Report Date: 03/23/26

Survey Site: Joe's Pond-Morrisville **Town**(s): Morrisville

Directions to location(s) of plants:

From the trails: From the Joe's Pond trailhead, take the yellow trail all the way across the north side of the pond. Follow the unofficial trail to the small inlet that comes from the adjacent properties uplands. Cross the inlet and follow the unofficial trail along the logs on the ground. Cut southeast into the swamp towards the open fen. Once in the open fen, the plants can be found throughout the open fen and along the edges of the peat mat.

From the pond: Individuals can be found all along the edge of the pond/peat mat edge.

Are plants in same location(s) as previously observed? ______

LANDOWNER(S) / CONTACT(S) (**Name**, **Telephone**, **Address**, **Email—**if not in a Site Summary Form) Permission?

UVM Natural Areas Program ☒

☐

BIOLOGY

Approximate #		**Population Area**(s)	Phenology (% or #)	
>100	ramets	(e.g. 30x10ft; 1m²; 0.5 acre, 1ha)		in leaf
(Stems originating separately from ground)				in bud
			100%	in flower
	genets			immature fruit
(Presumed genetic individuals, e.g. clumps, patches, stems)				mature fruit
				dormant

Verbal synopsis of above biological data and evidence of reproduction (if not found, discuss search effort)**:**

All individuals were in flower throughout the season and during the time of survey. Presumed to be ramets.

SURVEY SITE & HABITAT INFORMATION (if not provided in a Site Summary Form or previous form)

Survey site description:

Rose pogonia is abundant within the Intermediate Fen natural community. It is often among woolly-fruited sedge, lesser tussock sedge, round-leaved sundew, and marsh fern, among others. It can be found in a variety of microhabitats, including hummocks, hollows, standing stumps within the open water, and along the floating mat/fen edge where the fen meets the open water pond.

Substrate: peat/Sphagnum peat Topographic position: Hummocks, hollows, peat mat edge

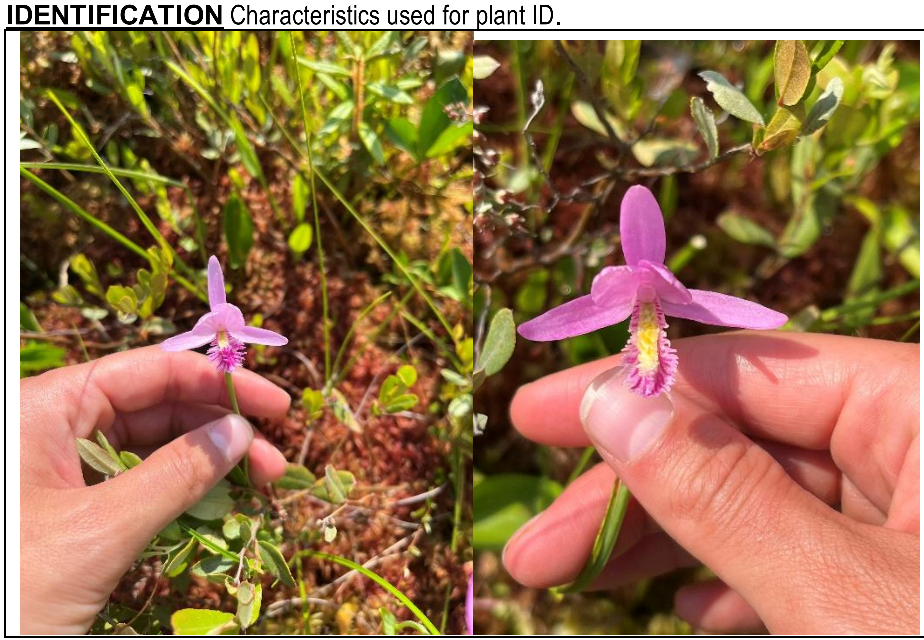
Aspect: N/A Slope: 0 Elevation (in feet): minimum 739 maximum 741

Light: Open canopy Moisture: ______

Associated plant species observed (immediate vicinity):

Eriophorum virginicum, Sphagnum spp., Chamedaphne calyculata, Alnus incana

IDENTIFICATION Characteristics used for plant ID. Photos taken: ☒



Specimen collected? ☐ Collection #: ________ Collector (s): ____________________ Repository: __________
(A permit is required to collect Threatened & Endangered species)

CONSERVATION SUMMARY

Is the habitat likely to persist? Yes, conserved by Stowe Land Trust and UVM Natural Areas Program

Explain any threats: If the beaver dam on the pond were to break, site hydrology could change dramatically.

Conservation, management, and inventory needs:
N/A

Full extent of population known? Amount or percent of habitat searched:
Searched UVM property and along the inlet and outlet to Joe's Pond by boat.

Comments that do not fit in another field:

MAPPING (required if not provided in a Site Summary)

Attach a copy of Map or Aerial Image showing the rare plant location(s): ☒
(Keep in mind that if an area occupied is longer or wider than 12.5 meters, we prefer to map a polygon or line)
Shapefile with all species identified during survey was sent.
AND/OR: Attach shapefile (must be *NAD83 State Plane*) ☐; GPS point printout ☐; or write out GPS coordinates below:

GPS Points: ____________________ Datum (required; NAD83 preferred): __________
Accuracy (if known): +/- meters☐/feet☐
Optional: Sketches with rare plant location(s), direction & scale: 1) Cross-section of local topography; 2) Diagram of site with survey route

In Word 2007/2010, to unlock the form to draw a diagram or insert pictures or maps, click on the padlock in the "Review" or "Developer" tab/ribbon, select "Restrict Formatting and Editing," then click the "Stop Protection" button. When finished, click, "Yes, Start Enforcing Protection," and then click "OK."

Please send completed forms to Grace Glynn: Grace.Glynn [at] vermont.gov / Vermont Natural Heritage Inventory, Vermont Fish & Wildlife Department, 5 Perry St., Suite 40, Barre, VT 05641 / (802) 505-3439

VERMONT RARE PLANT FORM

rev. 2023

Vermont Natural Heritage Inventory

Scientific Name: Utricularia minor

EO# (if known):

New: X

Update:

Surveyor(s): Emily DeAlto

Mailing address (phone, email): 9732558335, esdealto@gmail.com

Survey Date(s): 7/1526-8/1/26

Report Date: 03/23/26

Survey Site: Joe's Pond-Morrisville

Town(s): Morrisville

Directions to location(s) of plants:

From the trails: From the Joe's Pond trailhead, take the yellow trail all the way across the north side of the pond. Follow the unofficial trail to the small inlet that comes from the adjacent properties uplands. Cross the inlet and follow the unofficial trail along the logs on the ground. Cut southeast into the swamp towards the open fen. Once in the open fen, the plants can be found along the edges of the peat mat.

From the pond: Individuals can be found along the edge of the pond/peat mat edge on the southwest side of the pond

Are plants in same location(s) as previously observed?

LANDOWNER(S) / CONTACT(S) (**Name**, **Telephone**, **Address**, **Email—**if not in a Site Summary Form)

Permission?

UVM Natural Areas Program, 617 Main Street, Burlington, VT, (802) 656-7853, Lori.Anderson@uvm.edu ☒

☐

BIOLOGY

Approximate #

ramets

(Stems originating separately from ground)

3 genets

(Presumed genetic individuals, e.g. clumps, patches, stems)

Population Area(s)

(e.g. 30x10ft; 1m²; 0.5 acre, 1ha)

Phenology (% or #)

in leaf

in bud

in flower

immature fruit

mature fruit

dormant

Verbal synopsis of above biological data and evidence of reproduction (if not found, discuss search effort):

Clumps of plants seen floating along the edge of the peat mat. Unsure whether ramets or genets, but were all in clumps of plants.

SURVEY SITE & HABITAT INFORMATION (if not provided in a Site Summary Form or previous form)

Survey site description:

Lesser bladderwort clings to the edges of the Intermediate Fen peat mat, floating in the murky, mucky pond water

Substrate: Open water

Topographic position: Open water

Aspect: N/A

Slope: 0

Elevation (in feet): minimum 739 maximum 739

Light: Open canopy

Moisture: Submerged aquatic

Associated plant species observed (immediate vicinity):

N/A

IDENTIFICATION Characteristics used for plant ID. Photos taken: ☒

Free floating, creeping on sediment, leaves fine, branched forked 3-7x, bladders scattered

Specimen collected? ☐ Collection #: ________ Collector (s): ____________________ Repository: __________

(A permit is required to collect Threatened & Endangered species)

CONSERVATION SUMMARY

Is the habitat likely to persist? Yes, conserved by Stowe Land Trust and UVM Natural Areas Program

Explain any threats: If the beaver dam on the pond were to break, site hydrology could change dramatically.

Conservation, management, and inventory needs:

Individuals not counted.

Full extent of population known? Amount or percent of habitat searched:

Searched UVM property and along the inlet and outlet to Joe's Pond by boat.

Comments that do not fit in another field:

MAPPING (required if not provided in a Site Summary)

Attach a copy of Map or Aerial Image showing the rare plant location(s): ☒

(Keep in mind that if an area occupied is longer or wider than 12.5 meters, we prefer to map a polygon or line)

Shapefile with all species identified during survey was sent.

AND/OR: Attach shapefile (must be *NAD83 State Plane*) ☐; GPS point printout ☐; or write out GPS coordinates below:

GPS Points: ______________________ Datum (required; NAD83 preferred): __________

Accuracy (if known): +/- meters☐/feet☐

Optional: Sketches with rare plant location(s), direction & scale: 1) Cross-section of local topography; 2) Diagram of site with survey route

In Word 2007/2010, to unlock the form to draw a diagram or insert pictures or maps, click on the padlock in the "Review" or "Developer" tab/ribbon, select "Restrict Formatting and Editing," then click the "Stop Protection" button. When finished, click, "Yes, Start Enforcing Protection," and then click "OK."

Please send completed forms to Grace Glynn: Grace.Glynn [at] vermont.gov / Vermont Natural Heritage Inventory, Vermont Fish & Wildlife Department, 5 Perry St., Suite 40, Barre, VT 05641 / (802) 505-3439

NATURAL COMMUNITY SURVEY FORM
Vermont Natural Heritage Inventory (VNHI)
Vermont Fish & Wildlife Department

Revised: December 11, 2023

Contact Bob Zaino with questions about natural communities or this form: 802-476-0128 or Robert.Zaino@vermont.gov

Natural Community Type: Intermediate Fen
Natural Community Variant Name (if applicable): Click here to enter text.
Association Name (NHI office only): Click here to enter text.

Is this an update of an existing NHI record? (NHI office only) Yes ☐ No ☒
Site Name: Joe's Pond-Morrisville

Site Location Road Address: 688 Stancliff Rd, Morristown, VT 05661
Town: Morristown

Surveyor(s): Emily DeAlto
Mailing Address: 120 N Willard St., Burlington, VT
Phone: 9732558335
E-mail: esdealto@gmail.com

Survey Date(s): June 2025

Owner(s) of Natural Community: Name(s): UVM Natural Aras Program
Address: Click here to enter text.
Phone: Click here to enter text.
E-mail: Click here to enter text.

GENERAL DESCRIPTION OF THE SITE

Briefly describe the natural and man-made features of the site and setting in which the natural community occurs, including topography, size of the contiguous forested area, other natural community types present, surface waters and drainage patterns, and land use history and land management.

The Joe's Pond-Morrisville property is a 26 acre parcel, consisting of mixed wetlands surrounded by Hemlock-Northern Hardwood Forest forests. The wetlands are a part of a larger wetland mosaic that extends to the south and includes Valcour Bog to the southeast and Morristown Bog to the southwest. These wetlands include Red Maple-Sphagnum Basin Swamp, Black Spruce Swamp, Black Spruce Woodland Bog, and Dwarf Shrub Bog. The wetlands surrounding Joe's Pond, to the north of these bogs, is composed of intermixed Intermediate and Poor Fen. It is heavily influenced by beaver activity, with abundant evidence of beavers including chew and multiple dams and lodges throughout the reach of the pond. The wetlands surround Joe's Pond, a 10-acre mucky bottomed pond owned by the town of Morrisville.

NATURAL COMMUNITY INFORMATION

Concisely describe the natural community, including canopy cover, dominant species, the physical setting, evidence of human and natural disturbance, forest community age, woody debris abundance, and presence of invasive species.

Most of the wetlands in the study area were mapped as Intermediate Fen (3.4 acres). Intermediate Fen and Poor Fen form a mosaic throughout the peatlands; their lines are not always as clear-cut as those shown on the map, as is often the case in wetland complexes. Intermediate Fen at Joe's Pond-Morrisville appeared in two different expressions. The most prevalent was dominated by woolly-fruited sedge (*Carex lasiocarpa*) and tall tussock sedge (*Carex stricta*), along with marsh cinquefoil (*Comarum palustre*), marsh fern (*Thelypteris palustris*), and broad-leaved cattail (*Typha latifolia*) in the herb layer, and leatherleaf (*Chamaedaphne calyculata*) and speckled alder (*Alnus incana*) in the shrub layer. While trees were not dominant anywhere in this natural community (less than 25% canopy cover overall), tamarack (*Larix laricina*) and red maple (Acer rubrum) are the most common trees occurring within it, usually found perched on a slightly raised *Sphagnum* hummock. This expression of Intermediate Fen has nearly 100% ground cover by *Sphagnum* mosses..

The second expression of this natural community is dominated only by wooly-fruited sedge and has very little *Sphagnum* cover. Other species found throughout this natural community include round-leaved sundew (*Drosera rotundifolia*), white meadowsweet (*Spiraea alba*), lesser tussock sedge (*Carex diandra*), lake sedge (*Carex lacustre*), hoary sedge (*Carex canescens*), water arum *(Calla palustris*), cinnamon fern (*Osmun-dastrum cinnamomeum*), crested wood fern (*Dryopteris cristata*), common spikerush (*Eleocharis palustris*), sensitive fern (*Onoclea sensibilis), bulb-bearing water-hemlock (Cicuta bulbifera), and bearded sedge (Carex comosa). Of note, the rare few-nerved cottongrass (Eriophorum tenellum) and white-fringed bog orchid (Platanthera blephariglottis), and the* uncommon rose pogonia (*Pogonia ophioglossoides*) were all found in this natural community.
The substrate of this natural community is deep peat, up to 30 feet. The peat is well decomposed to undecomposed. Below the peat is sandy or silty mineral substrate.

Elevation (feet): minimum: 740 **maximum**: 742

Slope (degrees): 0

Aspect (degrees or cardinal direction): N/A

Bedrock geologic type (2012 VT bedrock geology map): Ottauquechee Formation

Soil type (Natural Resources Conservation Service) or description: Borohemists, deep; Water

Vegetation Description: To be applied to a representative area of the community large enough to capture most species.

Total Canopy Cover: 0%

Total Shrub Cover: 55%

	Trees			Shrubs				
	T1Emergent	T2 Canopy	T3 Subcanopy	S1 Tall (> 4 ft.)	S2 Short (<4 ft.)	H Herbaceous	N Nonvascular	V Vine
Height (ft.)					2	1.5	0	
% Cover					55	85	10 or 100	0

Dominant Species and their cover for each stratum (T1- emergent, T2-main canopy, T3-subcanopy, S1-tall shrub, S2-short shrub, H-herb, N-nonvascular, V-vine). Give average DBH (inches) for trees. For each species estimate actual percent cover or use one of the cover class categories below. Use the species list table below or attach a separate sheet.

Stratum	Species	DBH	Cover	Stratum	Species	Cover
H	Typha latifolia		C/D			
S2	Chamedaphne calyculata		D			
H	Carex lasiocarpa		C/D			
H	Carex lacustre		C			
H	Cared diandra		C			
T1	Acer rubrum		O			
H	Osmundastrum cinneamomeum		C			
S2	Spiraea alba		C			
H	Dryopteris cristata		R			
H	Triadenum sp.		O			
H	Eleocharis palustris		C			
H	Carex canescens		C			
H	Drosera rotundifolia		C			
H	Veronica scutellata		O			
H	Calla palustris		C			
H	Onoclea sensibilis		O			
S2	Spiraea tomentosa		O			
H	Cicuta bulbifera		O			
H	Carex comosa		C			
H	Nymphaea oderata		R			
H	Viola miniscula		C			
H	Thelypteris palustris		D			
H	Comarum palustre		C			

Cover Classes	
r	**< 1% rare**
+	**< 1% occs**
1	**1-5 %**
2	**6-25 %**
3	**26-50 %**
4	**51-75 %**
5	**76-100 %**

OR

Cover Classes	
D	**Dominant; cover > 50%**
C	**Common; 6 to 50 % or numerous individuals**
O	**Occasional; 1 to 5% or scattered individuals**
R	**Rare; < 1% or one to a few individuals**

Provide ages for representative trees in the community (optional).

Tree Species	**DBH**	**Age**

Comments about the natural community that do not fit in another field:
No trees had a DBH >1".

NATURAL COMMUNITY MAPPING

Attach GIS shapefiles (preferred) or digital or paper map of the natural community boundaries with labeled polygons.

Estimate percent of mapped polygon occupied by the natural community: >95%☐; 80-95%☐; 20-80%☐; 0-20%☐
Explain if <95%, explain what other communities are present: Click here to enter text.

Indicate type and scale of Base Map used to map the natural community: Click here to enter text.

Confidence in the Extent of the Natural Community as Mapped (check one)

☒ Confident that the full extent is known and mapped:
☐ Full extent is not known:
☐ Uncertain if full extent is known:

Comments: (If the natural community extends off the subject property, explain, and estimate total area of community.)
Full extent withing UVM site is mapped. Natural community likely is more extensive off the UVM site, specifically south of the open water portion of Joe's Pond.

COMMUNITY OCCURRENCE RANKING: a range of ranks may be used (such as AB)
Using **VT NHI ranking specifications** (if available)*: OR Using **Generic ranking specifications** (provided below):

	Rank (A-D)	**Comments**
Current Condition	A	High quality and mature, though only has existed since 1950 when the beavers dammed the pond.
Landscape Context	B	Part of a larger wetland mosaic that includes Morristown Bog and Valcour Bog, but the complex is surrounded by rural residential and agriculture.
Size (acres)	3.80 acres	Community size and how determined: Mapped in the field using FieldMaps and desktop review in ArcGIS Pro
Overall Rank	A	Click here to enter text.

* Available for some natural communities from Bob Zaino (robert.zaino@vermont.gov) or 802-476-0128.

Generic ranking specifications
Use the following guidelines to fill in the grid above if VT NHI ranking specifications are not yet available for the community type.

Current Condition
A: mature example of the community type (forests with trees generally >150 years old); natural processes intact; no exotics
B: some minor alteration of vegetation structure and composition, such as by selective logging; minor alterations in ecological processes; exotics species present in low abundance
C: significant alteration of vegetation structure and composition, such as by heavy logging; alteration of ecological processes are significant, but community recovery/restoration is likely; exotic species are abundant and control will take significant effort
D: ecological processes significantly altered to the point where vegetation composition and structure are very different from A-ranked condition and restoration/recovery is unlikely; exotic species are abundant or control will be difficult

Landscape Context
A: highly connected; area around EO (>1,000acres) is largely intact natural vegetation, with species interactions and natural processes occurring across communities; surrounding matrix forest meets at least B specifications for Condition.
B: moderately connected; area around EO (>1,000acres) is moderately intact natural vegetation, with species interactions and some natural processes occurring across many communities, although temporary disturbances such as logging have reduced condition of the landscape; surrounding matrix forest meets at least C specifications for Condition
C: moderately fragmented; area around EO is largely a combination of cultural and natural vegetation with barriers to species interactions and natural processes across communities; surrounding land is a mix of fragmented forest, agriculture, and rural development
D: highly fragmented; area around EO is entirely, or almost entirely, surrounded by agriculture or urban development

Size
No Generic ranking applicable. Please provide size of community in grid above.

Overall Rank (based on best judgment)
A: excellent estimated viability
B: good estimated viability
C: fair estimated viability
D: poor estimated viability

NATURAL COMMUNITY MANAGEMENT

Discuss management needs and plans for this natural community, including need for invasive species monitoring and control. If the natural community requires a buffer with specific management, describe and map the buffer width and specifically explain the ecological need for the buffer:

Community is preserved with a conservation easement with Stowe Land Trust and UVM Natural Areas program.

ADDITIONAL INFORMATION; (none required) (check those that are attached):
☐ Additional plant species list attached
☐ Plot form(s) attached
☐ Animal list attached

Please send completed form and GIS shapefiles to Bob Zaino:
robert.zaino@vermont.gov
or
Bob Zaino
Natural Heritage Inventory
Vermont Fish and Wildlife Department
5 Perry Street, Suite 40
Barre, Vermont 05641

NATURAL COMMUNITY SURVEY FORM
Vermont Natural Heritage Inventory (VNHI)
Vermont Fish & Wildlife Department

Revised: December 11, 2023

Contact Bob Zaino with questions about natural communities or this form: 802-476-0128 or Robert.Zaino@vermont.gov

Natural Community Type: Poor Fen
Natural Community Variant Name (if applicable): Click here to enter text.
Association Name (NHI office only): Click here to enter text.

Is this an update of an existing NHI record? (NHI office only) Yes ☐ No ☒
Site Name: Joe's Pond-Morrisville

Site Location Road Address: 688 Stancliff Rd, Morristown, VT 05661
Town: Morristown

Surveyor(s): Emily DeAlto
Mailing Address: 120 N Willard St., Burlington, VT
Phone: 9732558335
E-mail: esdealto@gmail.com

Survey Date(s): June 2025

Owner(s) of Natural Community: Name(s): UVM Natural Areas Program
Address: 85 S. Prospect St Burlington, VT 05408
Phone: Click here to enter text.
E-mail: natural.areas@uvm.edu

GENERAL DESCRIPTION OF THE SITE

Briefly describe the natural and man-made features of the site and setting in which the natural community occurs, including topography, size of the contiguous forested area, other natural community types present, surface waters and drainage patterns, and land use history and land management.

The Joe's Pond-Morrisville property is a 26 acre parcel, consisting of mixed wetlands surrounded by Hemlock-Northern Hardwood Forest forests. The wetlands are a part of a larger wetland mosaic that extends to the south and includes Valcour Bog to the southeast and Morristown Bog to the southwest. These wetlands include Red Maple-Sphagnum Basin Swamp, Black Spruce Swamp, Black Spruce Woodland Bog, and Dwarf Shrub Bog. The wetlands surrounding Joe's Pond, to the north of these bogs, is composed of intermixed Intermediate and Poor Fen. It is heavily influenced by beaver activity, with abundant evidence of beavers including chew and multiple dams and lodges throughout the reach of the pond. The wetlands surround Joe's Pond, a 10-acre mucky bottomed pond owned by the town of Morrisville.

NATURAL COMMUNITY INFORMATION

Concisely describe the natural community, including canopy cover, dominant species, the physical setting, evidence of human and natural disturbance, forest community age, woody debris abundance, and presence of invasive species.

Approx 1.64 acres of Poor Fen was mapped to be integrated with Intermediate Fen throughout the peatlands on the site. The sub strate is very undecomposed sphagnum peat within the first meter of substrate. The pH within the Poor Fen ranged from 4.5 to 5.0. Sphagnum cover was generally over 95% of the ground cover, with no exposed rock or other ground cover observed in most expressions of the natural community. In some areas there was a layer of sedge and leaf litter <1cm thick as ground cover. Dominant trees and shrubs included *Larix laricina, Picea mariana* and *Alnus incana* on the hummocks. Black spruce was far less common than tamarack. *Chamedaphne calyculata* was dominant in both hummocks and hollows. Dominant herbs included *Carex billingsii* and *Eriophorum virginicum*. Other species commonly found throughout this community included *Drosera rotundifolia, Saracenea purpurrea, Vaccinium corymbosum, Andromeda polifolia, Vaccinium macrocarpon,* and *Kalmia angustifolia*. The lagg area on the edge of this natural community and a Tamarack-Red Maple Swamp is dominated by tussock sedge (*Carex stricta*) and the S1S2 (*Eriophorum tenellum*). Other transitional areas were dominated by wooly-fruited sedge (*Carex lasiocarpa*) or lake sedge (*Carex lacustre*). No invasive species present. Little woody debris present on surface. Some standing dead wood along the edge of the fen.

Elevation (feet): minimum: 740 **maximum**: 740

Slope (degrees): 0

Aspect (degrees or cardinal direction): N/A

Bedrock geologic type (2012 VT bedrock geology map): Ottauquechee Formation

Soil type (Natural Resources Conservation Service) or description: Borohemists, deep

Vegetation Description: To be applied to a representative area of the community large enough to capture most species.

Total Canopy Cover: 15%

Total Shrub Cover: 65%

	Trees			Shrubs				
	T1Emergent	T2 Canopy	T3 Subcanopy	S1 Tall (> 4 ft.)	S2 Short (<4 ft.)	H Herbaceous	N Nonvascular	V Vine
Height (ft.)	2	15	5		2			
% Cover		5	10		65	75	100	

Dominant Species and their cover for each stratum (T1- emergent, T2-main canopy, T3-subcanopy, S1-tall shrub, S2-short shrub, H-herb, N-nonvascular, V-vine). Give average DBH (inches) for trees. For each species estimate actual percent cover or use one of the cover class categories below. Use the species list table below or attach a separate sheet.

Stratum	**Species**	**DBH**	**Cover**	**Stratum**	**Species**	**Cover**
S1	Alnus incana		C			
T2	Larix laricina	2.2	C			
S2	Chamedaphne calyculata		D			
S2	Kalmia polifolia		O			
S1	Vaccinium corymbosum		O			
H	Carex billingsii		O			
H	Carex stricta		C			
H	Drosera rotundifolia		C			
T2	Picea mariana	1.4	O			
S2	Rhododentron groenlandicum		C			
H	Saraccenea purpurea		C			
H	Menyanthes trifoliata		C			
H	Calla palustris		O			
S2	Andromeda polifolia		C			
H	Carex canescens		C			
N	Sphagnum spp.		D			

Cover Classes	
r	**< 1% rare**
+	**< 1% occs**
1	**1-5 %**
2	**6-25 %**
3	**26-50 %**
4	**51-75 %**
5	**76-100 %**

OR

Cover Classes	
D	**Dominant; cover > 50%**
C	**Common; 6 to 50 % or numerous individuals**
O	**Occasional; 1 to 5% or scattered individuals**
R	**Rare; < 1% or one to a few individuals**

Provide ages for representative trees in the community (optional).

Tree Species	DBH	Age
Larix laricina	**1.5, 1.5, 2.1, 2.3**	
Picea mariana	**1.0, 2.3, 1.4**	

Comments about the natural community that do not fit in another field:
Click here to enter text.

NATURAL COMMUNITY MAPPING

Attach GIS shapefiles (preferred) or digital or paper map of the natural community boundaries with labeled polygons.

Estimate percent of mapped polygon occupied by the natural community: >95%☒; 80-95%☐; 20-80%☐; 0-20%☐
Explain if <95%, explain what other communities are present: Click here to enter text.

Indicate type and scale of Base Map used to map the natural community: NAIP aerial imagery

Confidence in the Extent of the Natural Community as Mapped (check one)
☒ Confident that the full extent is known and mapped:
☐ Full extent is not known:
☐ Uncertain if full extent is known:

Comments: (If the natural community extends off the subject property, explain, and estimate total area of community.) Natural community may be present off of the UVM site. Specifically, is likely present on the peat mat south of Joe's Pond open water area.

COMMUNITY OCCURRENCE RANKING: a range of ranks may be used (such as AB)
Using **VT NHI ranking specifications** (if available)*: OR Using **Generic ranking specifications** (provided below):

	Rank (A-D)	Comments
Current Condition	A	High quality and mature, though only has existed since 1950 when the beavers dammed the pond.
Landscape Context	B	Part of a larger wetland mosaic that includes Morristown Bog and Valcour Bog, but the complex is surrounded by rural residential and agriculture.
Size (acres)	1.64	Community size and how determined: Mapped in the field using FieldMaps and desktop review in ArcGIS Pro
Overall Rank	A	Click here to enter text.

* Available for some natural communities from Bob Zaino (robert.zaino@vermont.gov) or 802-476-0128.

Generic ranking specifications
Use the following guidelines to fill in the grid above if VT NHI ranking specifications are not yet available for the community type.

Current Condition
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D: ecological processes significantly altered to the point where vegetation composition and structure are very different from A-ranked condition and restoration/recovery is unlikely; exotic species are abundant or control will be difficult

Landscape Context

A: highly connected; area around EO (>1,000acres) is largely intact natural vegetation, with species interactions and natural processes occurring across communities; surrounding matrix forest meets at least B specifications for Condition.

B: moderately connected; area around EO (>1,000acres) is moderately intact natural vegetation, with species interactions and some natural processes occurring across many communities, although temporary disturbances such as logging have reduced condition of the landscape; surrounding matrix forest meets at least C specifications for Condition

C: moderately fragmented; area around EO is largely a combination of cultural and natural vegetation with barriers to species interactions and natural processes across communities; surrounding land is a mix of fragmented forest, agriculture, and rural development

D: highly fragmented; area around EO is entirely, or almost entirely, surrounded by agriculture or urban development

Size

No Generic ranking applicable. Please provide size of community in grid above.

Overall Rank (based on best judgment)

A: excellent estimated viability

B: good estimated viability

C: fair estimated viability

D: poor estimated viability

NATURAL COMMUNITY MANAGEMENT

Discuss management needs and plans for this natural community, including need for invasive species monitoring and control. If the natural community requires a buffer with specific management, describe and map the buffer width and specifically explain the ecological need for the buffer:

N/A, Community is preserved with a conservation easement with Stowe Land Trust and UVM Natural Areas program.

ADDITIONAL INFORMATION; (none required) (check those that are attached):

☐ Additional plant species list attached
☐ Plot form(s) attached
☐ Animal list attached

Please send completed form and GIS shapefiles to Bob Zaino:

robert.zaino@vermont.gov
or
Bob Zaino
Natural Heritage Inventory
Vermont Fish and Wildlife Department
5 Perry Street, Suite 40
Barre, Vermont 05641

Appendix D: Flora, Fauna, and Fungi of Joe's Pond-Morrisville

Plants

Non-Vascular Plants

Liverworts

Marchantiaceae
Marchantia polymorpha – Common liverwort
Ricciaceae
Riccia fluitans – Floating crystalwort
Ricciocarpos natans – Fringed heartwort

Mosses

Sphagnaceae
Sphagnum spp. – *Sphagnum* mosses not keyed to species
Hylocomiaceae
Pleurozium schreberi – Red-stemmed feather moss
Ptilium crista-castrensis – Knight's plume moss

Vascular Plants

Lycophytes

Lycopodiaceae
Dendrolycopodium dendroideum – Tree clubmoss
Spinulum annotinum – Stiff clubmoss

Horsetails and Ferns

Equisetaceae
Equisetum fluviatile – Water horsetail
Equisetum sylvaticum – Woodland horsetail
Athyriaceae
Athyrium angustum – Northern lady fern
Dennstaedtiaceae
Dennstaedtia punctilobula – Hayscented fern
Pteridium aquilinum – Bracken fern
Dryopteridaceae
Dryopteris campyloptera – Mountain wood fern
Dryopteris cristata – Crested wood fern
Dryopteris marginalis – Marginal wood fern
Gymnocarpium dryopteris – Oak fern

Onocleaceae
Matteuccia struthiopteris – Ostrich fern
Onoclea sensibilis – Sensitive fern
Osmundaceae
Osmundastrum cinnamomeum – Cinnamon fern
Osmunda claytoniana – Interrupted fern
Osmunda regalis – Royal fern
Thelypteridaceae
Phegopteris connectilis – Long beech fern
Amauropelta noveboracensis – New York fern
Thelypteris palustris – Marsh fern

Gymnosperms

Cupressaceae
Juniperus virginiana – Eastern red cedar
Pinaceae
Abies balsamea – Balsam fir
Larix laricina – Tamarack
Picea glauca – White spruce
Picea mariana – Black spruce
Picea rubens – Red spruce
Pinus strobus – White pine
Tsuga canadensis – Eastern hemlock

Angiosperms

Adoxaceae
Sambucus canadensis – American elderberry
Sambucus racemosa – Red elderberry
Viburnum cassinoides – Northern wild raisin
Viburnum opulus – Guelder rose
Alismataceae
Sagittaria latifolia – Broadleaf arrowhead
Sagittaria spp. – Arrowhead
Apiaceae
Cicuta bulbifera – Bulblet-bearing water hemlock
Daucus carota – Queen Anne's lace
Aquifoliaceae
Ilex mucronata – Mountain holly
Ilex verticillata – Winterberry
Araceae
Arisaema triphyllum – Jack-in-the-pulpit
Calla palustris – Marsh calla
Lemna minor – Duckweed
Spirodella polyrhiza – Giant duckweed

Araliaceae
Aralia nudicaulis – Wild sarsaparilla
Asclepiadaceae
Asclepias syriaca – Common milkweed
Asparagaceae
Maianthemum canadense – Canada mayflower
Polygonatum pubescens – Hairy Solomon's-seal
Asteraceae
Bidens cernua – Nodding beggarticks
Erigeron strigosus – Daisy fleabane
Eupatorium perfoliatum – Common boneset
Euthamia graminifolia – Grass-leaved goldenrod
Eutrochium maculatum – Joe-Pye weed
Lactuca biennis – Tall blue lettuce
Oclemena acuminata – Whorled aster
Solidago canadensis – Canada goldenrod
Solidago rugosa – Wrinkle-leaved goldenrod
Betulaceae
Alnus incana – Speckled alder
Betula alleghaniensis – Yellow birch
Betula cordifolia – Heart-leaved birch
Betula populifolia – Gray birch
Ostrya virginiana – Hop-hornbeam
Boraginaceae
Myosotis scorpioides – Common forget-me-not
Cabombaceae
Brasenia schreberi – Watershield
Caprifoliaceae
Diervilla lonicera – Bush honeysuckle
Lonicera canadensis – American fly honeysuckle
Celastraceae
Celastrus orbiculatus – Oriental bittersweet
Colchicaceae
Uvularia sessilifolia – Sessile-leaved bellwort
Cornaceae
Cornus alternifolia – Alternate-leaved dogwood
Cyperaceae
Carex aquatilis – Water sedge
Carex arctata – Wood sedge
Carex billingsii – Billings' sedge
Carex canescens – Hoary sedge
Carex comosa – Bearded sedge
Carex debilis – Weak straw sedge
Carex diandra – Lesser tussock sedge

Carex disperma – Few-seeded sedge
Carex echinata – Star sedge
Carex gracillima – Graceful sedge
Carex intumescens – Bladder sedge
Carex lacustris – Lake sedge
Carex lasiocarpa – Woolly-fruited sedge
Carex limosa – Mud sedge
Carex lurida – Sallow sedge
Carex magellanica – Boreal bog sedge
Carex scoparia – Broom sedge
Carex stipata – Awl-fruited sedge
Carex stricta – Tussock sedge
Carex trisperma – Three-seeded sedge
Carex utriculata – Beaked sedge
Dulichium arundinaceum – Three-way sedge
Eleocharis palustris – Common spikerush
Eleocharis obtusa – Blunt spikerush
Eriophorum tenellum – Few-nerved cottongrass
Eriophorum virginicum – Tawny cottongrass
Rhynchospora alba – White beaksedge
Scirpus atrocinctus – Black-girdled woolgrass
Scirpus cyperinus – Woolgrass
Schoenoplectus tabernaemontani – Soft-stem bulrush
Droseraceae
Drosera rotundifolia – Round-leaved wundew
Ericaceae
Andromeda polifolia – Bog rosemary
Chamaedaphne calyculata – Leatherleaf
Gaultheria hispidula – Creeping wnowberry
Gaultheria procumbens – Wintergreen
Kalmia angustifolia – Sheep laurel
Kalmia polifolia – Bog laurel
Rhododendron groenlandicum – Labrador tea
Vaccinium angustifolium – Lowbush blueberry
Vaccinium corymbosum – Highbush blueberry
Vaccinium macrocarpon – American cranberry
Vaccinium myrtilloides – Velvetleaf blueberry
Vaccinium oxycoccos – Small cranberry
Fagaceae
Castanea dentata – American chestnut
Fagus grandifolia – American beech
Quercus bicolor – Swamp white oak
Quercus rubra – Northern red oak

Hypericaceae
Hypericum ellipticum – Pale St. John's-wort
Hypericum majus – Large St. John's-wort
Hypericum perforatum – Common St. John's-wort
Hypericum spp. – St. John's-wort
Triadenum virginicum – Marsh St. John's-wort
Iridaceae
Iris versicolor – Blue flag iris
Juncaceae
Juncus canadensis – Canada rush
Juncus effusus – Soft rush
Juncus tenuis – Path rush
Lamiaceae
Scutellaria galericulata – Marsh skullcap
Scutellaria lateriflora – Mad-dog skullcap
Liliaceae
Clintonia borealis – Bluebead lily
Erythronium americanum – Yellow trout lily
Medeola virginiana – Indian cucumber-root
Menyanthaceae
Menyanthes trifoliata – Bogbean
Monotropaceae
Monotropa uniflora – Ghost pipe
Nymphaeaceae
Nuphar variegata – Yellow pond-lily
Nymphaea odorata – White waterlily
Orchidaceae
Calopogon tuberosus – Grass-pink
Cypripedium acaule – Pink lady's-slipper
Epipactis helleborine – Broad-leaved helleborine
Goodyera pubescens – Rattlesnake plantain
Platanthera blephariglottis – White-fringed orchid
Platanthera clavellata – Small Green Woodland orchid
Pogonia ophioglossoides – Rose pogonia
Poaceae
Agrostis scabra – Rough bentgrass
Anthoxanthum odoratum – Sweet vernal grass
Brachyelytrum aristosum – Northern woodgrass
Calamagrostis canadensis – Bluejoint reedgrass
Glyceria canadensis – Rattlesnake mannagrass
Glyceria grandis – American mannagrass
Glyceria striata – Fowl mannagrass
Leersia oryzoides – Rice cut grass
Leersia virginica. – Rice cutgrass

Phalaris arundinacea – Reed canary-grass
Phleum pratense – Timothy
Poa annua – Annual bluegrass
Rosaceae
Amelanchier spp. – Serviceberry
Aronia melanocarpa – Black chokeberry
Comarum palustre – Marsh cinquefoil
Crataegus flabellata – Hawthorn
Fragaria virginiana – Wild strawberry
Potentilla norvegica – Norwegian cinquefoil
Potentilla recta – Sulphur cinquefoil
Prunus pensylvanica – Pin cherry
Prunus serotina – Black cherry
Prunus virginiana – Chokecherry
Rosa palustris – Marsh rose
Rosa rugosa – Rugosa rose
Rubus hispidus – Swamp dewberry
Rubus pubescens – Dwarf raspberry
Rubus spp. – Blackberry
Sorbus americana – American mountain-ash
Spiraea alba – White meadowsweet
Spiraea tomentosa – Steeplebush
Salicaceae
Populus tremuloides – Quaking aspen
Salix bebbiana – Bebb’s willow
Salix eriocephala – Heart-leaved willow
Salix spp. – Other willows
Sapindaceae
Acer pensylvanicum – Striped maple
Acer rubrum – Red maple
Acer saccharum – Sugar maple
Sarraceniaceae
Sarracenia purpurea – Northern pitcher plant
Saxifragaceae
Tiarella cordifolia – Foamflower
Typhaceae
Sparganium americanum – American bur-reed
Typha latifolia – Broad-leaved cattail
Ulmaceae
Ulmus americana – American elm
Violaceae
Viola minuscula – Northern white violet
Viola sororia – Common blue violet
Viola striata – Striped cream violet

Animals

Birds

Accipitridae
Buteo platypterus – Broad-winged Hawk
Haliaeetus leucocephalus– Bald Eagle
Alcedinidae
Megaceryle alcyon – Belted Kingfisher
Apodidae
Chaetura pelagica – Chimney Swift
Anatidae
Anas platyrhynchos – Mallard
Branta canadensis – Canada Goose
Aramidae
Botaurus lentiginosus – American Bittern
Ardeidae
Ardea herodias – Great Blue Heron
Bombycillidae
Bombycilla cedrorum – Cedar Waxwing
Cardinalidae
Cardinalis cardinalis – Northern Cardinal
Cathartidae
Cathartes aura – Turkey Vulture
Certhiidae
Certhia americana – Brown Creeper
Charadriidae
Actitis macularius – Spotted Sandpiper
Columbidae
Zenaida macroura – Mourning Dove
Corvidae
Corvus brachyrhynchos – American Crow
Corvus corax – Common Raven
Cyanocitta cristata – Blue Jay
Cuculidae
Coccyzus erythropthalmus – Black-billed Cuckoo
Emberizidae
Junco hyemalis – Dark-eyed Junco
Melospiza georgiana – Swamp Sparrow
Melospiza melodia – Song Sparrow
Spizella passerina – Chipping Sparrow
Zonotrichia albicollis – White-throated Sparrow
Hirundinidae
Tachycineta bicolor – Tree Swallow

Icteridae
Agelaius phoeniceus – Red-winged Blackbird
Dolichonyx oryzivorus – Bobolink
Quiscalus quiscula – Common Grackle
Megascopidae
Strix varia – Barred Owl
Paridae
Baeolophus bicolor – Tufted Titmouse
Poecile atricapillus – Black-Capped Chickadee
Parulidae
Geothlypis trichas – Common Yellowthroat
Seiurus aurocapilla – Ovenbird
Setophaga americana – Northern Parula
Setophaga caerulescens – Black-throated Blue Warbler
Setophaga coronata – Yellow-rumped Warbler
Setophaga fusca – Blackburnian Warbler
Setophaga pensylvanica – Chestnut-sided Warbler
Setophaga ruticilla – American Redstart
Setophaga striata – Blackpoll Warbler
Setophaga virens – Black-throated Green Warbler
Picidae
Colaptes auratus – Northern Flicker
Dryocopus pileatus– Pileated Woodpecker
Dryobates pubescens – Downy Woodpecker
Dryobates villosus – Hairy Woodpecker
Regulidae
Regulus satrapa – Golden-crowned Kinglet
Sittidae
Sitta canadensis – Red-breasted Nuthatch
Sitta carolinensis– White-breasted Nuthatch
Strigidae
Strix varia – Barred Owl
Turdidae
Catharus fuscescens – Veery
Catharus guttatus – Hermit Thrush
Hylocichla mustelina – Wood Thrush
Turdus migratorius – American Robin
Tyrannidae
Contopus cooperi – Olive-sided Flycatcher (observed by local birders)
Empidonax alnorum– Alder Flycatcher
Empidonax minimus– Least Flycatcher
Myiarchus crinitus – Great Crested Flycatcher
Tyrannus tyrannus – Eastern Kingbird

Vireonidae
Vireo olivaceus – Red-eyed Vireo
Vireo solitarius – Blue-headed Vireo

Mammals

Castoridae
Castor canadensis – Beaver
Cervidae
Odocoileus virginianus – White-tailed Deer
Cricetidae
Ondatra zibethicus – Muskrat
Sciuridae
Sciurus carolinensis – Gray Squirrel
Tamiasciurus hudsonicus – Red Squirrel
Ursidae
Ursus americanus – Black Bear (sign only)
Mustelidae
Lontra canadensis – River Otter (sign only)

Reptiles and Amphibians

Ambystomatidae
Ambystoma maculatum – Spotted Salamander
Bufonidae
Anaxyrus americanus – American Toad
Crocodylidae
Chrysemys picta – Painted Turtle
Natricidae
Thamnophis sirtalis – Common Garter Snake
Hylidae
Pseudacris crucifer – Spring Peeper
Ranidae
Lithobates clamitans – Green Frog
Lithobates sylvaticus – Wood Frog

Insects and Other Invertebrates

Tipulidae
Tipula – Crane flies
Limoniidae
Limnophila – Limoniid crane flies
Papilionidae
Swallowtail butterfly – Swallowtails

Tenebrionidae

Bolitotherus cornutus – Forked fungus beetle

Scarabaeidae

Macrodactylus subspinosus – Rose chafer

Popillia japonica – Japanese beetle

Curculionidae

Polydrusus formosus – Green immigrant leaf weevil

Buprestidae

Dicerca divaricata – Flatheaded hardwood borer

Cerambycidae

Brachysomida bivittata – Double-lined longhorn beetle

Coenagrionidae

Enallagma ssp. – Bluets

Enallagma hageni – Hagen’s bluet

Libellulidae

Leucorrhinia – Whitefaces

Apidae

Apis mellifera – Western honeybee

Vespidae

Dolichovespula maculata – Bald-faced hornet

Geometridae

Caripeta divisata – Gray spruce looper

Erebidae

Renia sp. – Renia litter moth

Reduviidae

Phymata sp. – Jagged ambush bug

Fungi

Hymenogastraceae

Galerina paludosa – Bog bell

Geoglossaceae

Mitrula paludosa – Bog beacon

Lyophyllaceae

Sphagnurus paluster – Sphagnum greyling

Pyronemataceae

Scutellinia scutellata – Common eyelash

Peziza varia – Common cup fungus

Ganodermataceae

Ganoderma sp. – Reishi

Hymenochaetaceae

Inonotus obliquus – Chaga

Stereum complicatum – Crimped stereum

Helicogloeaceae

Helicogloea compressa – Jelly rot fungus

Pucciniastraceae

Calyptospora columnaris – Blueberry rust

Amanitaceae

Amanita flavoconia – Yellow patches amanita

Agaricaceae

Lycoperdon perlatum – Common puffball

Russulaceae

Russula sp. – Brittlegill

Physalacriaceae

Oudemansiella furfuracea – Beech rooter

Omphalotaceae

Gymnopus dryophilus – Oak-loving gymnopus

Hygrophoraceae

Hygrocybe cantharellus – Goblet waxcap

Lichens

Parmeliaceae (lichens)

Usnea sp. – Beard lichen

Evernia mesomorpha – Boreal oakmoss

Flacoparmelia caperata – Common greenshield lichen

Parmelia sulcata – Hammered shield lichen

Tuckermanopsis sp. – Tuckerman’s lichen

Slime Molds

Ceratiomyxaceae

Ceratiomyxa fruticulosa – Coral slime mold

Physaraceae

Fuligo septica – Dog vomit slime mold

Reticulariaceae

Lycogala epidendrum – Wolf’s milk

Stemonitidaceae

Stemonitis splendens – Chocolate tube slime mold

Appendix E: Peatland Study Dataset

Mean Percent Cover of Vegetation by Species

Columns are transect points, rows are species

Species	1	2	3	4	5	6
Sphagnum 1	0	30	0	0	0	10
Sphagnum 2	47.5	0	0	0	20	0
Sphagnum 3	0	0	2.5	0	60	0
Sphagnum 4	0	0	95	100	0	0
Sphagnum 5	0	0	0	0	15	70
Chamedaphne calyculata	7.5	0	17.5	40	40	95
Carex stricta	0	0	0	0	7.5	60
Thylypteris palustris	12.5	75	0	0	0	0
Vibernum cassinoides	0	0	0	0	0	0
Spirea alba	0	0	0	0	2.5	0
Typha latifolia	4.5	1	0	0	0	0
Triadenum sp	0	0	0	0	1.5	0
Drosera rotundifolia	0	0	4	0	5	0
Calla palustris	0	0	0	0	4	0
Vaccinium macrocarpon	0	2	13.5	7	2.5	0
Larix laricina	0	0	0.5	5	1	5
Acer rubrum	5	10	0.5	0	1	15
Carex canesens	0	0	0	50	1.5	0
Vaccinium oxycoccos	0	0	2.5	10	0	0
Alnus incana	10	15	5.5	0	0	0
Carex billingsii	0	0	12.5	15	0	0
Andromeda polifolia	0	0	6	0	0	0
Kalmia angustifolia	0	0	3.5	0	0	0
Carex diandra	0	0	0	0	0	0
Saracenea purpurea	0	0	0	0	0	0
Aronia melanocarpia	10.5	3	0	0	0	0
Pogonia ophioglossoides	0	0	0	0	0	0
Eriophorum tenellum	0	0	0	0	0	0
Eriophorum virginicum	0	0	0	55	0	0
Carex lasiocarpa	80	80	0	0	0	0
Vaccinium angustifolium	2.5	0	0	0	0	0
Carex limosa	0	0	0	0	0	0
Kalmia polifolia	0	0	0	7	0	0
Lysemachia terrestris	0	0	0	0	0	0

Values represent mean percent cover across paired vegetation quadrats. Absence indicates zero observed cover.

EC Measurements by Sample Point

Rows = Week/Date; Columns = Sample Points 1–6

date	*1*	*2*	*3*	*4*	*5*	*6*
5/26/2025	NA	NA	NA	NA	NA	NA
6/3/2025	0.26	0.25	0.06	0.06	NA	0.09
6/9/2025	0.38	0.33	0.09	0.07	0.09	0.18
6/16/2025	0.47	0.53	0.23	0.07	0.09	0.16
6/23/2025	0.37	0.38	0.27	0.1	0.11	0.17
6/30/2025	0.43	0.36	0.08	0.1	0.11	0.21
7/7/2025	0.39	0.38	0.09	0.12	0.17	0.24
7/14/2025	0.4	0.5	0.08	0.11	0.17	0.23
7/21/2025	0.43	0.4	0.08	0.18	0.25	0.25
7/28/2025	0.36	0.37	0.07	0.11	0.16	0.17
8/4/2025	0.47	0.4	0.06	0.11	0.16	0.23

Raw measurements of EC for sample points 1–6 each week. All decimals preserved.

pH Measurements by Sample Point

Rows = Week/Date; Columns = Sample Points 1–6

date	*1*	*2*	*3*	*4*	*5*	*6*
5/26/2025	NA	NA	NA	NA	NA	NA
6/3/2025	6.1	6	4.5	5.5	NA	5.8
6/9/2025	6.4	6.3	4.5	5.6	5.8	6
6/16/2025	6.2	6.4	4.7	5.5	5.7	5.6
6/23/2025	6.1	6.2	4.6	5.4	5.5	5.3
6/30/2025	6.3	6.1	4.4	5.4	5.8	5.4
7/7/2025	5.7	5.8	4	4.6	4.8	4.1
7/14/2025	6.1	6.3	4.5	5.5	5.6	5.6
7/21/2025	6.3	6.3	4.7	5.6	5.9	5.8
7/28/2025	5.9	6	4.4	5.1	5.6	5.2
8/4/2025	5.9	6	4.5	5.1	5.3	5.3

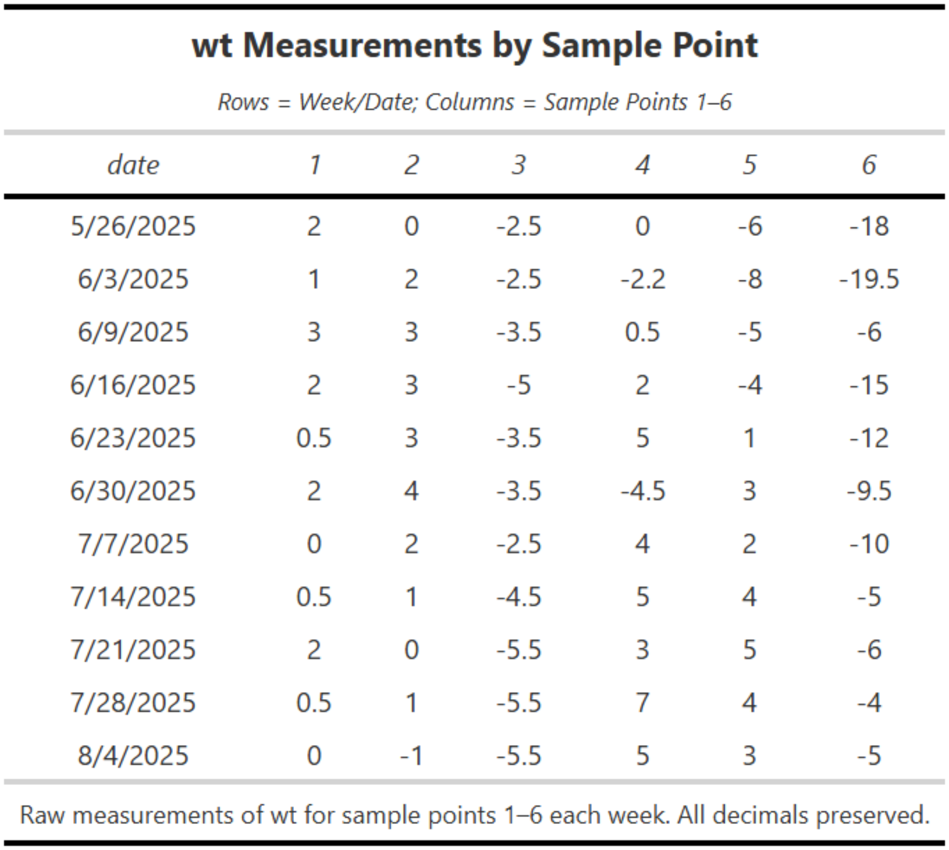
Raw measurements of pH for sample points 1–6 each week. All decimals preserved.

temp Measurements by Sample Point

Rows = Week/Date; Columns = Sample Points 1–6

date	*1*	*2*	*3*	*4*	*5*	*6*
5/26/2025	NA	NA	NA	NA	NA	NA
6/3/2025	16.9	16.6	NA	NA	NA	NA
6/9/2025	21.9	19.3	15.3	12.5	14.2	13.8
6/16/2025	22.1	20.5	17.6	13.7	15.1	15.9
6/23/2025	23.8	23.3	20	18.6	16.2	18
6/30/2025	23.4	22	18.6	18.2	17	17.1
7/7/2025	25	23.5	19.7	18.8	18.6	18.8
7/14/2025	26.2	25.3	22	22.1	19.3	20
7/21/2025	23.7	23.1	21	20.7	18.6	18.8
7/28/2025	24	23.4	22.2	22.8	19.9	19.7
8/4/2025	22.6	22	21.8	20.3	17.6	18.6

Raw measurements of temp for sample points 1–6 each week. All decimals preserved.

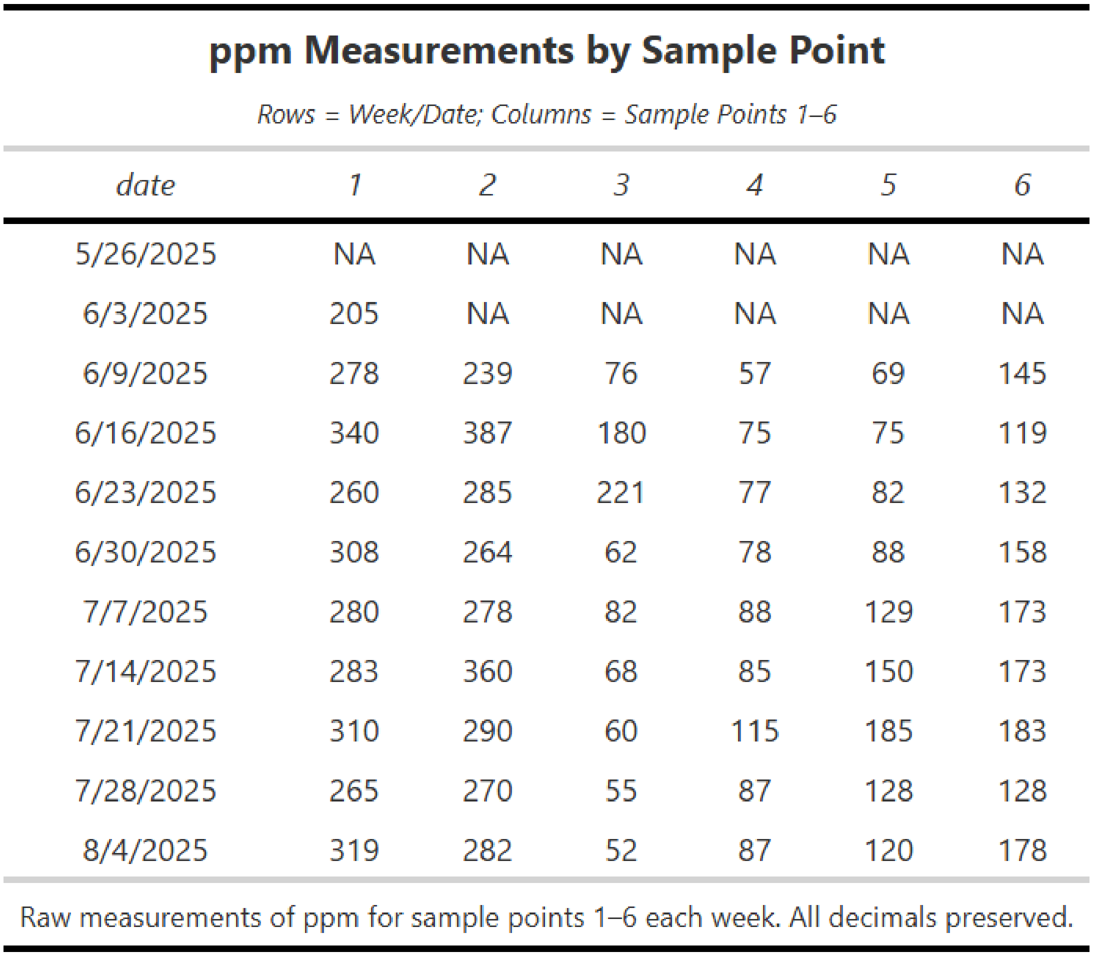


wt Measurements by Sample Point

Rows = Week/Date; Columns = Sample Points 1–6

date	*1*	*2*	*3*	*4*	*5*	*6*
5/26/2025	2	0	-2.5	0	-6	-18
6/3/2025	1	2	-2.5	-2.2	-8	-19.5
6/9/2025	3	3	-3.5	0.5	-5	-6
6/16/2025	2	3	-5	2	-4	-15
6/23/2025	0.5	3	-3.5	5	1	-12
6/30/2025	2	4	-3.5	-4.5	3	-9.5
7/7/2025	0	2	-2.5	4	2	-10
7/14/2025	0.5	1	-4.5	5	4	-5
7/21/2025	2	0	-5.5	3	5	-6
7/28/2025	0.5	1	-5.5	7	4	-4
8/4/2025	0	-1	-5.5	5	3	-5

Raw measurements of wt for sample points 1–6 each week. All decimals preserved.



ppm Measurements by Sample Point

Rows = Week/Date; Columns = Sample Points 1–6

date	*1*	*2*	*3*	*4*	*5*	*6*
5/26/2025	NA	NA	NA	NA	NA	NA
6/3/2025	205	NA	NA	NA	NA	NA
6/9/2025	278	239	76	57	69	145
6/16/2025	340	387	180	75	75	119
6/23/2025	260	285	221	77	82	132
6/30/2025	308	264	62	78	88	158
7/7/2025	280	278	82	88	129	173
7/14/2025	283	360	68	85	150	173
7/21/2025	310	290	60	115	185	183
7/28/2025	265	270	55	87	128	128
8/4/2025	319	282	52	87	120	178

Raw measurements of ppm for sample points 1–6 each week. All decimals preserved.

Peat Core Composition by Depth

Rows = Depth (cm); Columns = Vegetation/Material Type

	Sphagnum	*Other mosses*	*Sedges*	*Wood*	*Muck*	*Horsetail*
10	5	0	0.5	2	0	0
30	5	0	0.5	2	0	0
40	5	0	0	2	0	0
80	3	1	4	2	0	0
80	3	0	2	2	0	2
90	3	1	3	3	0	0
100	3	0	2	2	0	1
119	4	2	0	2	0	0.5
140	4	1	0	1	0	1
150	4	0	0	1	0	2
160	3	0	4	4	0	1
170	2	1	4	2	0	0
180	2	2	4	2	0	0
190	3	1	3	2	0	1
210	1	0.5	2	3	0	0
220	0	0.5	2	0.5	0	0
230	1	0.5	3	2	0.5	0.5
240	1	0.5	2	2	0	0.5
248	1	0	3	2	0	0.5
260	1	0.5	3	3	0	1
270	1	0	2	3	0	0
280	1	0	2	3	0	0
291	4	0	3	2	0	0
310	0.5	0	4	2	3	0
320	0.5	0	4	0.5	3	0
330	0.5	0	3	1	3	0
340	0.5	0	4	1	2	2
347	0.5	0	2	1	4	3
360	0.5	0	2	0.5	3	0
370	0	0	3	0.5	3	1
380	0	0	4	0.5	2	2
390	0	0	3	0	5	0
400	0	0	3	0.5	3	0
410	1	0.5	4	1	4	1
420	0.5	0.5	2	1	0.5	0.5
430	0	0	2	0.5	2	1
440	0	0	2	1	2	1
450	2	0.5	3	0.5	0.5	0.5
460	2	0	4	2	0	0
460	0	0	3	2	0	0
480	1	0	3	1	0	0
490	0.5	0	3	1	0	0
500	2	0	1	2	0	0
510	0	1	0	0	0	0
520	0	3	0	0	0	1
540	1	0	1	0	0	0
550	1	0	2	1	0	1

Values represent cover classes (1–5) using the Daubenmire method