

# **Aquatic Plant Inventory of Silvio O. Conte National Fish & Wildlife Refuge: Pondicherry Division (Cherry, Little Cherry, and Mud Ponds) and Nulhegan Division (Lewis Pond) (*Redacted Version*)**

**Prepared for  
Silvio O. Conte National Fish & Wildlife Refuge, U.S. Fish and Wildlife Service**



**Cherry Mountain across Cherry Pond**

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## Introduction

The ponds of the Silvio O. Conte National Fish and Wildlife Refuge are ecological centerpieces of both the Pondicherry and Nulhegan Divisions; however, they have received little attention in prior ecological inventories. This study fills that gap with baseline information on the aquatic flora of the Refuge ponds, including species composition, abundance, community mapping, and rare and invasive species inventories. Studied water bodies include Lewis Pond in the Nulhegan Division and Cherry Pond, Little Cherry Pond, Mud Pond, the Johns River & Deadwater (above and below Little Cherry Pond), and the small open water areas of Cedar and Moorhen Marshes in the Pondicherry Division. Fieldwork occurred over six days in late August and early September of 2022. This report version has been redacted to remove sensitive rare species data.

## Methodology

To accomplish the study goals of developing baseline aquatic habitat and floristic information we used a three-stage approach consisting of desktop review and background research, field studies, and subsequent data compilation and analysis. We first gathered botanical, water quality, and physical information on all the ponds. Principal sources of botanical information were Pease' (1964) *Flora of Northern New Hampshire*, online herbarium specimen data portals including the Consortium of Northeastern Herbaria data portal (CNH 2022) and the Southeast Regional Network of Expertise and Collections (SERNEC 2022), and the Natural Heritage program databases of Vermont and New Hampshire. For Lewis Pond, the Vermont Department of Environmental Conservation's Lake Score Card and associated data provided a useful summary of extant information including limited water quality, physical, and botanical data (VTDEC 2022). For Pondicherry Division ponds and the Johns River between Cherry and Little Cherry Ponds the New Hampshire Department of Environmental Services Surface Water Quality Assessment Viewer provides access to scorecard style information and underlying water quality data (NHDES 2022). Other useful information included bathymetry maps for Lewis and Cherry Ponds made available by VT Department of Environmental Conservation and NH Fish and Game Department.

Pond surveys took place via canoe from mid-August to early September with visitation dates by water body listed in Table 1. Two visits were made to the larger Cherry Pond with one visit to each of the other sites. The Johns River & Deadwater, Cedar Marsh, and Moorhen Marsh were not included in the original study plan. However, the relative homogeneity of the other Pondicherry ponds freed up additional time with which to include these areas, though Cedar and Moorhen Marshes each received only cursory visits. Surveys encompassed all parts of the waterbodies, with an emphasis on nearshore shallows (typically less than ~1.2m deep) where the diversity of aquatics was greatest and visibility was better. Strongly tannic (tea-colored) waters greatly limited visibility and light transmission into the deeper parts of the Pondicherry Division waterbodies though none are more than about 2m deep. The shorelines were surveyed, but the adjacent wetlands, which we studied previously at Pondicherry (Engstrom et al. 2020), were excluded, with the exception of the large bog mat island in Cherry Pond that was not previously accessed. Our sampling used the 'intuitive meander' approach (translated to a canoe) rather than a gridded approach in order to maximize effectiveness at detecting rare species and unique microhabitats and increase our time in more diverse areas. Given the shallow depth of the studied waterbodies, long-handled garden rakes were sufficient sampling devices to retrieve samples from deeper areas (to about 2m deep). Track and waypoint spatial data were collected via field

grade GPS receivers. Element occurrence data were gathered for all rare and uncommon plants for the USFWS, NH Natural Heritage Bureau, and VT Natural Heritage Inventory. Comprehensive floristic inventories were made, recording all species encountered with notations of abundance and plant community composition. Plants not identifiable in the field were collected for later identification. Whenever populations permitted, voucher specimens were collected to document previously undocumented rare species as well as selected common species. Specimens are currently housed in the personal collections of the authors. Water quality, chemistry, depth, or other physical sampling was not a part of this study, though we opportunistically conducted a few sediment depth probes in the four ponds using segmented chimney sweeping rods pushed down into the sediment.

## Overview of Sites

All of the sites lie within the upper Connecticut River watershed sharing the same broad-scale ecological context of the northern forest region, being embedded in a fairly undeveloped matrix of northern hardwood and lowland spruce-fir forests with extensive histories of industrial scale forest management. However, Lewis Pond, in the Nulhegan Division in Vermont, stands apart geographically and in other regards from the other studied waterbodies, which lie about 36 miles south-southeast in the Pondicherry Division on the opposite side of the Connecticut River in New Hampshire. This dichotomy persists with a look at the local ecological context. While all the waterbodies lie within regions of generally acidic bedrock types, Lewis Pond is underlain by Gile Mountain Formation schistose rocks (phyllites and quartzites) while granitic rocks underlie the Pondicherry water bodies. More significantly, the Pondicherry waterbodies are interconnected (see Figure 1) and nearly completely surrounded by extensive peatlands (i.e. wetland) in a single, low-relief basin, whereas Lewis Pond is an isolated waterbody with about 60% of its shoreline flanked by upland forest on gently hilly terrain. These broad differences in setting, not surprisingly, translate into different floristics and ecological dynamics between Lewis Pond and the Pondicherry sites, so they will be considered separately in most subsequent analysis presented here.

Table 1 below provides a summary of some basic physical attributes of the studied waterbodies highlighting the range of sizes from a quarter to 120 acres, the narrow range of maximum depths from about 1 to 2.5m, varying provisional trophic status, and the sometimes-surprising depth of bottom sediments. Trophic status is typically divided into three states ranging from oligotrophic, which have clear water, low nutrient availability and productivity, to eutrophic, which also can have clear water but have high nutrient levels and productivity. Mesotrophic has intermediate nutrient levels and productivity compared to oligotrophic and eutrophic. Additionally, dystrophic is a lake condition with high dissolved organic carbon, and while typically oligotrophic and acidic, these “brown” water bodies can range in their trophic levels and pH (Wikipedia 2023). More water quality data is needed to confidently classify the trophic levels of the Conte Refuge ponds.

The following subsections provide more detailed descriptions of the physical and botanical attributes of the studied water bodies. Photos illustrating various features and community types are provided in the Photo Gallery section at the end of the report, as are maps depicting the principal community types.

**Table 1.** Physical and Trophic Characteristics and Visitation Dates of Conte Refuge Water Bodies.

Waterbody	Open Water Acres	Max Water Depth	Max Organic Sediment Depth	Trophic Status	Date Visited
Lewis Pond	69.5	2.5m (~8ft)	4m (>13ft)	oligotrophic	9/6/2022
Cherry Pond	120	1.5m (~5ft)	4.5m (14.75ft) Thompson et al 2017 [3.3m (~10.5ft) 2022]	dystrophic?	8/16/2022, 8/22/2022
Little Cherry Pond	20.5	1.5m (~5ft)	8m (>26ft)	dystrophic?	8/29/2022
Mud Pond	1.75	1m (~3.3ft)	8m (>26ft)	dystrophic?	8/23/2022
Johns River & Deadwater	13.6	2m (~6.5ft)	unknown	dystrophic?	8/30/2022
Cedar Marsh	0.23	1.5m (<5ft)	unknown	mesotrophic?	8/23/2022
Moorhen Marsh	0.39	1.5m (<5ft)	unknown	mesotrophic?	8/23/2022
<b>Total</b>	<b>226</b>				

#### Lewis Pond

Lewis Pond spans 69.5 acres at 558 m (1,830ft) elevation and has a watershed to lake area ratio of 18. Its maximum depth is about 2.5m (8ft) and it has over 4m (13ft) of unconsolidated organic-rich sediments in the center. It is fed primarily by Logger Brook, a small stream that enters from the north center of the pond and exits not far away near the northeast corner. There is some beaver damming activity at the outlet that may slightly influence water levels over time. Significantly and uniquely among the studied ponds, Lewis Pond has extensive areas of predominantly sandy bottom sediments, especially in the eastern and southern shallows that likely receive higher-energy wave disturbance due to prevailing wind directions. These sandy shallows extend out about 15-30m from shore and to depths over 1m. Despite this sandy bottom there was virtually no exposed sandy shoreline at the time of survey late in the season, though this may fluctuate somewhat with beaver activity. Field surveys and bathymetry maps reveal a fairly simple underwater topography of gently sloping bottom with the deepest zones near the center. The southern end of the pond has a cross-cutting feature of sandy shallows extending from near the viewing platform west to a small sand spit peninsula.

VT DEC's (2022) Lake Score Card for Lewis Pond indicates 'good' for shoreline condition and invasive species, 'insufficient data' for water quality/nutrient trends, 'fair' for mercury pollution, and 'pH stressed' for water quality standards status. The latter score relates to low alkalinity readings that leave the pond somewhat sensitive to acidification, though it is unclear if this represents an impairment per se or simply a sensitive natural condition. Note that in the Score Card language 'stressed' is intermediate between 'good' and 'impaired' and that the mercury score is likely based on modeling rather than lake specific testing. Water quality and chemistry data for the pond appear limited to the three years of spring phosphorus monitoring program data

presented in Table 2. These phosphorus readings (mean 9.5 ug/l) place the pond near the 10 µg/l threshold between oligotrophic and mesotrophic conditions.

**Table 2.** Spring Phosphorus Monitoring Water Quality Data for Lewis Pond. (VTDEC 2022)

Year	Phosphorus (µg/l)	Nitrogen (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)
2008	9	0.18	6	3
2011	8	0.215	7	3
2015	11	0.215	7	6

As is characteristic of oligotrophic ponds, Lewis Pond’s vegetation is relatively sparse and can be coarsely divided into two or three zones. The near-shore littoral zone up to about 1.5m depth has predominantly sandy substrate grading to silty organic ooze with depth and is dominated by pipewort (*Eriocaulon aquaticum*) with abundant leafless water-milfoil (*Myriophyllum tenellum*), and sporadic water lobelia (*Lobelia dortmanna*), spiny quillwort (*Isoetes echinospora*), and a submersed form of mud-rush (*Juncus pelocarpus*). Slightly deeper zones over roughly 1m have abundant common bladderwort (*Utricularia macrorrhiza*), and occasional ribbon-leaved pondweed (*Potamogeton epihydrus*). Despite fairly clear waters, the deepest zones, about 2-2.5m, seem to have very little vegetation, consisting of occasional strands of common bladderwort (*Utricularia macrorrhiza*) and algae. Floating-leaved aquatic plants have minimal presence at Lewis Pond.

#### Pondicherry Division Waterbodies

The Pondicherry ponds collectively span about 142 acres, mainly in Cherry and Little Cherry Ponds, with an additional roughly 14 acres of open water in the Johns River & Deadwater, upper river channel, and small impounded areas of Cedar and Moorhen Marshes. The ponds range from about 336 to 348m (1102-1142ft) in elevation with Mud Pond the highest and Cherry about 2m above Little Cherry. Figure 1 below shows the hydrologic connectivity of the waterbodies. Open water impoundments in Cedar and Moorhen Marshes drain diffusely through anastomosing channels and extensive peatland into Cherry Pond, which in turn drains to Little Cherry Pond via the uppermost Johns River channel. Mud Pond also drains to Little Cherry Pond but the connection is obscure with Mud Pond’s small outlet channel vanishing into the extensive mixed conifer swamps and mixed hardwood-conifer seepage swamps between the two ponds. Our prior natural community mapping (Engstrom et al. 2020) indicates nearly continuous wetland between the two ponds with the small (20m) upland gap presumably spanned by either channelized or subsurface flow. From Little Cherry Pond, the Deadwater sluggishly flows roughly 2.7km (1.7 miles) west before becoming a somewhat steeper free-flowing stream (albeit with various wetland sections). There is beaver activity at the outlets of all six studied Pondicherry waterbodies, though the impact on water levels is modest at present. Cherry Pond and the Deadwater have geologic thresholds (boulders and mineral sediments) on their outlet elevations that are only slightly affected by beaver augmentation. At time of survey, Little Cherry Pond’s outlet had a maintained beaver dam which elevated the pond eight inches above the Deadwater. Mud Pond presently has a couple levels of leaky, inactive beaver dams at its stagnant ‘outlet’ channel (west end) which only marginally raise pond water levels. Cedar and Moorhen Marshes are both artificial impoundments created by the railbed and have beaver baffles regulating their outflows through the railbed.

As noted previously, the Pondicherry waterbodies sit in a vast peatland basin making their bottoms predominantly or wholly of organic material. Notable exceptions to this are in Cherry Pond which has small sections of sandy and stony or mucky sand bottoms associated with the ‘ice-push ramparts’ along the western, eastern, and southeastern shorelines. The Johns River above and below Little Cherry also has intermittent sections of sand, cobble, and boulder bottom in shallows where the waterflow is slightly quickened, though its channel is predominantly organic bottom. Maximum water depths vary from about 1m in Mud Pond to 2m in deeper western sections of the Deadwater. Most of the acreage is estimated to be between 1-2m water depth. The maximum depth of bottom sediments was probed in the three ponds and had previously been documented for Cherry Pond during sediment coring by Thompson et al. (2017). Surprisingly, both Mud and Little Cherry Ponds have organic bottom sediments greater than 8m (26ft) deep (the maximum depth we could probe), much greater than the 4.5m (14.75ft) documented by Thompson et al. for Cherry Pond.

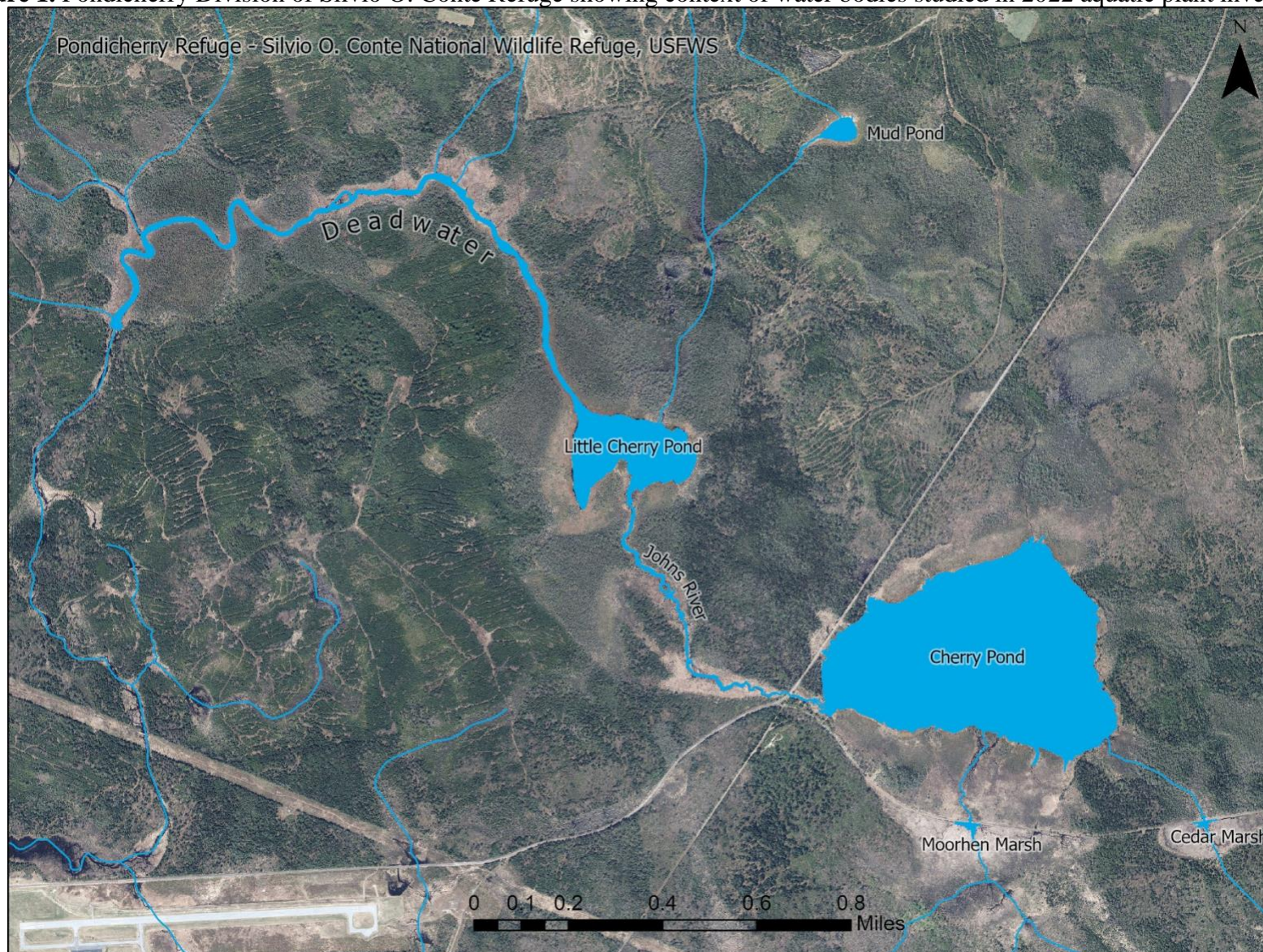
Water quality and chemistry data for Pondicherry waterbodies are limited, but Table 3 presents the most recent 2020 data available from NHDES sampling (2022) of Cherry and Little Cherry Ponds. Additional data for prior sampling years is available from NHDES (2022) through their Surface Water Quality Assessment Viewer website. No data were found for Mud Pond or the other water bodies. Interestingly, NHDES datasets classify the trophic status of Cherry and Little Cherry Ponds as eutrophic, perhaps due to moderate phosphorus levels, though their strongly tannic waters and low alkalinity suggest a dystrophic condition, which aligns better with natural community typing.

**Table 3.** 2020 Surface Water Quality Assessment Data for Cherry and Little Cherry Ponds. (NHDES 2022). Note that value ranges represent 2 measurements each.

Parameter Name	Cherry Pond	Little Cherry Pond
ALKALINITY (carbonate as CaCO <sub>3</sub> )	5-8.5 MG/L	6.6-8.7 MG/L
APPARENT COLOR	80-100 PCU	100-130 PCU
CALCIUM	2.8 MG/L	no data
CHLORIDE	4-6 MG/L	8 MG/L
CHLOROPHYLL A (uncorrected for pheophytin)	8.23 MG/M <sup>3</sup>	11.54 MG/M <sup>3</sup>
DISSOLVED OXYGEN	3.5-7.1 MG/L	9.5 MG/L
DISSOLVED OXYGEN SATURATION	76-79%	no data
NITROGEN, KJELDAHL	0.8 MG/L	no data
NITROGEN (nitrite (NO <sub>2</sub> ) + nitrate (NO <sub>3</sub> ) as N)	<.05-0.12 MG/L	0.14 MG/L
pH	5.6-6.3	6-6.4
PHOSPHORUS AS P	21-32 µg/l	22 µg/l
SECCHI DISK TRANSPARENCY	>1.3 m	no data
SPECIFIC CONDUCTANCE	37.6-62.6 UMHO/CM	38.5-65 UMHO/CM



**Figure 1.** Pondicherry Division of Silvio O. Conte Refuge showing context of water bodies studied in 2022 aquatic plant inventory.





### **Cherry Pond**

Cherry Pond appears to have three distinct aquatic plant zones: near-shore aquatic beds on organic sediment substrate dominated by floating leaved species, near-shore aquatic beds on sandy mineral substrate, and a deeper central zone with mainly submersed species, especially Berchtold's pondweed (*Potamogeton berchtoldii*). The extensive floating-leaved aquatic beds ringing the pond are variably dominated by water shield (*Brasenia schreberi*), waterlily (*Nymphaea odorata*), or water-bur-reed (*Sparganium fluctuans*), with lesser amounts of common yellow pond-lily (*Nuphar variegata*). Ribbon-leaved pondweed (*Potamogeton epihydrus*) is also common, but had few floating leaves during our survey. Common bladderwort (*Utricularia macrorrhiza*) and pipewort (*Eriocaulon aquaticum*) are also abundant. Less frequent species include floating pondweed (*Potamogeton natans*), Oakes' pondweed (*Potamogeton oakesianus*), common snailseed pondweed (*Potamogeton spirillus*), Canada naiad (*Najas canadensis*), and water bulrush (*Schoenoplectus subterminalis*). The emergent species marsh spike-rush (*Eleocharis palustris*), common bur-reed (*Sparganium americanum*), common arrowhead (*Sagittaria latifolia*), and pickerelweed (*Pontederia cordata*) are all abundant along the margins, though the latter species also has substantial presence as an almost wholly submersed form into deeper water.

Uniquely among the Pondicherry ponds, there are small sections of sandy or mucky sandy substrate aquatic beds along the east and west sides of Cherry Pond associated with where the ice rampart features come in contact with the pond. These areas are dominated by pipewort (*Eriocaulon aquaticum*) accompanied by sparsely scattered spiny quillwort (*Isoetes echinospora*), a few patches of emergent common bulrush (*Schoenoplectus tabernaemontani*), and a smattering of the previously noted species. Associated exposed, narrow, sand and mucky sand shorelines also have swamp-candles (*Lysimachia terrestris*), needle spike-rush (*Eleocharis acicularis*), pale manna grass (*Torreyochloa pallida*), rice cut-grass (*Leersia oryzoides*), and ticklegrass (*Agrostis scabra*). Eastern Elliptio (*Elliptio complanata*) and Eastern Floater (*Pyganodon cataracta*) mussels are notably abundant in sandy bottom areas, and shell middens are occasionally present along the shore.

The central zone of Cherry Pond, consisting of the bulk of the pond, has less diverse flora. Some parts are very sparsely vegetated while others have large, dense beds of Berchtold's pondweed (*Potamogeton berchtoldii*). Charophyte macroalgae, which can be mistaken for vascular plants, are widespread. Other occasional species include common bladderwort (*Utricularia macrorrhiza*), Canada naiad (*Najas canadensis*), ribbon-leaved pondweed (*Potamogeton epihydrus*), and water starwort (*Callitriche palustris*).

The large 'island' bog mat toward the western side of the pond is similar in composition to some of the shoreline wetlands with dominance by leatherleaf (*Chamaedaphne calyculata*) and sweet gale (*Myrica gale*) with hairy-fruited sedge (*Carex lasiocarpa*), broad-leaved cat-tail (*Typha latifolia*), and common arrowhead (*Sagittaria latifolia*), as well as cranberry (*Vaccinium macrocarpon*) and other wetland species. It is a true island rather than a purely floating mat, grounded on large boulders below and in surrounding shallows. There is an old beaver lodge in the center. Interestingly, this island feature is much smaller in older aerial imagery (~1994) perhaps indicating water level changes.

### **Little Cherry Pond**

The flora of Little Cherry Pond has much in common with Cherry Pond, though there are several unique features and species. Roughly the western third to half of the pond becomes a mosaic of floating muck mats later in the season. These mats consist of bottom sediments densely interwoven with aquatic plant rhizomes, mainly *Brasenia* and *Nymphaea*, that become buoyant due to trapped gases. While the mats are floating and do not support one's weight, they are also difficult to submerge, at times presenting an unnavigable barrier to watercraft. This interesting situation also makes them excellent habitat for waterfowl and wading birds and allows varying degrees of colonization by emergent plants typically found on shorelines, including pale spike-rush (*Eleocharis flavescens*). The degree of exposure of these muck mats (and associated emergent flora) may vary somewhat with beaver damming at the outlet. These muck mats together with most of the rest of the pond comprise an aquatic bed dominated by floating-leaved plants, mainly water shield (*Brasenia schreberi*) and waterlily (*Nymphaea odorata*), with occasional common yellow pond-lily (*Nuphar variegata*), especially along the western edge. Other common species include common bladderwort (*Utricularia macrorrhiza*), Berchtold's pondweed (*Potamogeton berchtoldii*), and Canada naiad (*Najas canadensis*); less frequent species include slender naiad (*Najas gracillima*), water-bur-reed (*Sparganium fluctuans*), ribbon-leaved pondweed (*Potamogeton epihydrus*), floating pondweed (*Potamogeton natans*), Oakes' pondweed (*Potamogeton oakesianus*), cf. water bulrush (*Schoenoplectus subterminalis*), and, rarely, alga-like pondweed (*Potamogeton confervoides*) and hornwort (*Ceratophyllum echinatum*). The emergent species pickerelweed (*Pontederia cordata*) and common bur-reed (*Sparganium americanum*) are sparsely present across the pond, but the former is very abundant in large shoreline beds, particularly at the mouth and outlet of the Johns River. The northeast side and northern rim of the pond provide slightly deeper aquatic bed habitats that share the same species, but have a predominance of submersed rather than floating-leaved species.

### **Mud Pond**

Mud Pond is a fairly homogenous and less diverse aquatic bed community dominated by the floating-leaved species common yellow pond-lily (*Nuphar variegata*), water-bur-reed (*Sparganium fluctuans*), and ribbon-leaved pondweed (*Potamogeton epihydrus*), though the latter largely lacked floating leaves at the time of survey. Other species include common bladderwort (*Utricularia macrorrhiza*), waterlily (*Nymphaea odorata*), Berchtold's pondweed (*Potamogeton berchtoldii*), and floating pondweed (*Potamogeton natans*). The emergent species common arrowhead (*Sagittaria latifolia*), common bur-reed (*Sparganium americanum*), marsh spike-rush (*Eleocharis palustris*), are present around the margins, though, curiously, pickerelweed (*Pontederia cordata*) is absent. Other shoreline species include swamp-candles (*Lysimachia terrestris*) and needle spike-rush (*Eleocharis acicularis*) around the pond and pale spike-rush (*Eleocharis flavescens*), beggar-ticks (*Bidens spp.*), and pale manna grass (*Torreyochloa pallida*) on exposed mucky flats along the outlet channel.

### **Johns River & Deadwater**

The physical setting of the upper Johns River and its Deadwater section varies from a 2m wide, few centimeters deep, sand and boulder bed channel just below Cherry Pond, to a nearly 40m wide, virtually stagnant, 2m deep, beaver impounded 'channel' very similar to a dystrophic pond. The predominant condition in much of the Deadwater below Little Cherry Pond is a 10-20m wide, 1-2m deep, very sluggish channel with organic substrate. This condition is

interspersed with shorter reaches of shallower, sand, cobble, and boulder substrate that is intermittently exposed later in the season partly as a result of beaver impoundments, which are numerous between Cherry Pond and the Deadwater outlet. These “bony” stretches also relate to channel constrictions imposed by underlying mineral soil and stone topography that is presumably glacial in origin. Correspondingly, the floristic assemblage varies somewhat with substrate, depth, and flow. The prevailing conditions, similar to a dystrophic pond, not surprisingly share much in common with the aquatic beds of Cherry and Little Cherry Pond. In general, there are flanking aquatic beds of floating-leaved species along the channel margins and a central open water surface with submersed species below; the deepest sections appear sparsely vegetated in the center of the channel, but can only be observed via rake sampling due to the tannic waters. Water shield (*Brasenia schreberi*), waterlily (*Nymphaea odorata*), and water-bur-reed (*Sparganium fluctuans*) are the dominant floating-leaved species, with lesser amounts of common yellow pond-lily (*Nuphar variegata*), and narrow-leaved bur-reed (*Sparganium angustifolium*). The emergent species pickerelweed (*Pontederia cordata*), common bur-reed (*Sparganium americanum*), green bur-reed (*Sparganium emersum*), marsh spike-rush (*Eleocharis palustris*), and common arrowhead (*Sagittaria latifolia*) are all common to occasional, especially along the channel margins and shallow sections. Common submersed (or mainly so) species include common bladderwort (*Utricularia macrorrhiza*), Berchtold’s pondweed (*Potamogeton berchtoldii*), cf. water bulrush (*Schoenoplectus subterminalis*), and Charophyte macroalgae; less frequent to rare species include ribbon-leaved pondweed (*Potamogeton epihydrus*), floating pondweed (*Potamogeton natans*), Oakes’ pondweed (*Potamogeton oakesianus*), and hornwort (*Ceratophyllum echinatum*). Exposed shallows of muck or mucky sand and mineral bottom segments differ mainly in supporting more emergent growth, including additional species, and relatively few floating-leaved species. Additional emergent/exposed species included blunt spike-rush (*Eleocharis obtusa*), pale spike-rush (*Eleocharis flavescens*), needle spike-rush (*Eleocharis acicularis*), and a few other shoreline species, as well as graminoids from adjacent wetlands.

### ***Cedar and Moorhen Marshes***

These small, shallow aquatic beds intergrade into mucky hollows in their surrounding marshes. True aquatic species are few, including ribbon-leaved pondweed (*Potamogeton epihydrus*) and common bladderwort (*Utricularia macrorrhiza*) in both, and Berchtold’s pondweed (*Potamogeton berchtoldii*), hornwort (*Ceratophyllum echinatum*), duckweed (*Lemna minor*), greater duckweed (*Spirodela polyrrhiza*) in Cedar Marsh. Shoreline and emergent species are abundant at the margins and in marsh hollows, including blunt spike-rush (*Eleocharis obtusa*), common water-purslane (*Ludwigia palustris*), purple-stemmed beggar-ticks (*Bidens connata*), rice cut-grass (*Leersia oryzoides*) in both, and pale manna grass (*Torreyochloa pallida*), green bur-reed (*Sparganium emersum*), marsh spike-rush (*Eleocharis palustris*), in at least one site. Many other graminoids from the surrounding marsh are also present at the margins.

## Natural Community Types

The Conte Refuge waterbodies inventoried in 2022 can be assigned aquatic natural community or aquatic plant community names according to various northern New England and New York state classifications, as well as the United States National Vegetation Classification (Table 4). However, none of these classification systems provide comprehensive matches to the range of conditions and species assemblages found in the Refuge waterbodies. Thus, we have provided our own map unit names suited to the site and scale of this analysis, and have provided cross-walking of the different systems to the extent possible. Our names and mapping emphasize a combination of water depth, bottom substrate type, and aquatic vegetation type, and they are found in Maps 1-4 and the “ContePonds\_Communities.shp” shapefile, which correlate with the site descriptions provided in the Overview of Sites section above.

The prevailing aquatic community found in the Pondicherry water bodies, exclusive of both Cedar and Moorhen Marshes, fits reasonably well into the recent New Hampshire draft classification of Bog pond aquatic bed (Nichols 2015). However, this community type description does not distinguish zones dominated by floating-leaved versus submersed species, whereas our classification splits these zones, which here appear to largely correlate with water depth (i.e., Submersed aquatic beds are deeper). Cherry Pond also has small sections of shoreline and shallows that are similar to NH’s rare (S2) Water lobelia aquatic sandy pond shore community type; however, this type is typically associated with oligotrophic rather than dystrophic conditions. We refer to this as Pipewort aquatic sandy pond shore since the distinctive water lobelia (rare in NH) is absent. Additionally, while portions of the Deadwater and Johns River are also similar to the Bog pond aquatic bed type, in these areas we favored map units that emphasize differences in substrate (mineral vs. organic). Most regional “bog lake or pond” type classifications, including the recent New Hampshire draft, are derived from New York’s (Reschke 1990) original Bog lake ecological community description. There are other New Hampshire natural community types (Sperduto & Nichols 2012) that have some relevance to the Conte Refuge, such as Floating marshy peat mat, Short graminoid-forb meadow marsh/mudflat, and Spikesedge-floating leaved aquatic mudflat marsh. However, these were not best fits for the study areas and are peripheral to the main aquatic plant communities, and, therefore, not utilized in this project’s mapping.

Lewis Pond fits quite well into NH’s Water lobelia aquatic sandy pond shore community within the Oligotrophic Pond System (a higher level in the classification) as described by Nichols (2015). This nutrient poor, clear water, and sandy bottomed aquatic community also fits well in the NY aquatic natural community classification (Reschke 1990 and second edition Edinger et al 2014) as an Oligotrophic pond. A recent (2014-2016) draft proposal for Vermont aquatic natural communities by Michael Lew-Smith of Arrowwood Environmental also includes a similar Pipewort - water lobelia aquatic community with a preliminary rank of S2? (rare). While informative, it seems premature for application in this early draft stage. This sandy bottom community, which we have called Pipewort-water lobelia sandy pond shore, encompasses only the shallower zone of the pond periphery, while we have termed the deeper center a Submersed aquatic bed.

Although reasonably effective at the higher Alliance level, the national classification (USNVC 2022) did not work well for the Conte Refuge water bodies at the Association level, which would most equivalent to a natural community. It is apparent that more work is needed to integrate these classifications so that they would cover all the Conte Refuge waterbodies studied in 2022.

**Table 4.** Natural community and aquatic vegetation classifications of the Conte Refuge water bodies. Yellow highlighted communities have descriptions that best fit those inventoried in the Conte Refuge in 2022.

Classification Systems	Cherry Pond, Little Cherry Pond, Mud Pond, Johns River & Deadwater	Cedar & Moorhen Marshes	Lewis Pond
This Study	Floating-leaved aquatic bed, Submersed aquatic bed, Pipewort aquatic sandy pond shore, Organic bottom aquatic bed, Mineral bottom aquatic bed	Submersed aquatic bed	Pipewort-water lobelia sandy pond shore, Submersed aquatic bed
NH (Nichols 2015)	Bog Pond System: <b>Bog pond aquatic bed</b> (G-, S3 draft); Floating marshy peat mat, Water lobelia aquatic sandy pond shore at Cherry Pond (GNR, S2)	?	Oligotrophic Pond System: <b>Water lobelia aquatic sandy pond shore</b> (GNR, S2)
VT (Langdon et al 1998, Lew-Smith 2014-2016)	Dystrophic lake >1500', tannic water macrophyte assemblage (Langdon)	?	Oligotrophic lake (Langdon); Pipewort - water lobelia aquatic community (S2?) (Lew-Smith)
NY (Reschke 1990; Edinger et al 2014)	Bog lake	?	Oligotrophic pond
ME (Maine Natural Areas Program 1991)	Bog Pond Community	?	Monomictic Oligotrophic Lake Community
USNVC (United States National Vegetation Classification 2022)	<i>Nymphaea odorata</i> - <i>Nuphar</i> spp.- <i>Brasenia schreberi</i> Aquatic Vegetation Alliance (A4064); NVC crosswalk association = unknown	?	<i>Eleocharis</i> spp.- <i>Eriocaulon aquaticum</i> Coastal Plain Pondshore Marsh Alliance



## Botanical Inventory

Before summarizing the botanical results of the current study, it is worth briefly exploring the botanical history of these sites. Cherry Pond was explored quite early in the region's botanical history as Dr. James W. Robbins visited it in 1829 during his six month long botanical journey through New England. Notably, his visit provides the only botanical records prior to the development of railroad grades through the Pondicherry basin in the 1870's. Among his Cherry Pond discoveries were two aquatic plants that were then new to science, making Cherry Pond their 'type locality': Robbins' Pondweed (*Potamogeton robbinsii*) and Robbins' Spikerush (*Eleocharis robbinsii*). Additionally, he found Reddish Pondweed (*Potamogeton alpinus*), which is currently ranked S1- Endangered in NH. Unfortunately, the whereabouts of most of his original specimens, including those cited above, are currently unknown and may be lost, but they are cited by Pease (1964). Then, from 1907 to 1950 noted North Country botanist Arthur S. Pease made many trips to the Cherry Pond area, including Little Cherry and Mud Ponds, and collected several dozen specimens of at least 16 species of aquatic and shallow water emergent plants. Most of these records are published in his 1964 *A Flora of Northern New England*, and the corresponding specimen data, sometimes including images, are available through herbarium portal websites (CNH 2022, SERNEC 2022). The physical specimens are housed in various herbaria, mainly at the University of New Hampshire (NHA) and Harvard University (NEBC, GH), as well as a smattering of other herbaria (CONN, MICH, BSN, RSA, SJNM, HAM). Pease collected several species of conservation significance, including an Endangered (S1) species and Watch List (S3) Torrey's bulrush (*Schoenoplectus torreyi*) at Cherry Pond, an Endangered (S1) species and Watch List (S3) alga-like pondweed (*Potamogeton confervoides*) at Little Cherry Pond, and Watch List (S3) pod-grass (*Scheuchzeria palustris*) at all three ponds. Most of these were collected over a century ago. Notably, Pease did not relocate (or at least did not collect) three of Robbins' earlier discoveries: Reddish Pondweed, Robbins' Spike-rush, or Robbin's Pondweed. In more recent decades a few dozen specimens have been collected from the area by various botanists, but these have not included any additional rare species or the Robbins' missing species.

By contrast, there is no historical botanical information about Lewis Pond, though the Vermont Natural Heritage Inventory database revealed several rare plant records from 2001 and 1989; these records noted a few associated species. Subsequent to our field studies we found a species list of 26 vascular plant species associated with the Lake Score Card (VTDEC 2022) compiled from various monitoring visits from 1989-2020 by undetermined VT DEC staff; virtually all reported species were confirmed by our study.

Our present study focused on documentation of the strictly aquatic flora and that of adjacent shores and seasonally exposed bottom habitats. These species have habitat preferences as well as physiological adaptations, that make for fairly distinct categories and that more or less sharply distinguish them from species of adjacent wetlands. Unless noted otherwise, the following analyses focus only on the strictly aquatic flora summarized in Table 5 with relative abundance at each site. Table 6 similarly summarizes species of shores and seasonally exposed bottom habitats. Classification of species as 'Aquatic' represents the authors' opinion, but attempts to capture species that are primarily submersed, floating-leaved, and/or emergent for most of the year. As species of ecotones many of these have the ability to exist amphibiously, or in distinct

submersed and emersed forms. Two species, mud-rush (*Juncus pelocarpus*) and needle spike-rush (*Eleocharis acicularis*), whose habits particularly defied categorization as solely aquatic or shore-based are listed under both categories, as their occurrence warranted. Complete species lists with abundance codes and annotations of distribution are provided for each waterbody in Appendices A-G. These lists include some additional species of adjacent wetlands that were essentially overhanging the aquatic and exposed shore habitats along the water's edge, but that component of the flora was not comprehensively or consistently recorded.

This study documented an aquatic vascular plant flora of about 47 species in 17 families across all study sites, plus a few aquatic bryophytes (mosses) and charophyte macroalgae. By Refuge Division, this includes 35 species in 14 families for Pondicherry and 25 species in 13 families for Nulhegan. Additionally, shores and exposed bottom habitats include 16 more species (9 Nulhegan Division, 14 Pondicherry Division) in 7 additional families. Table 7 provides a summary of the family breakdown of the strictly aquatic flora (i.e., excluding shore/ exposed bottom species). The most speciose families of aquatic plants at the Refuge level include the Pondweeds (Potamogetonaceae) – 8-9 species (6 this study), Bladderworts (Lentibulariaceae) – 6 species, Sedges (Cyperaceae) – 6 species (4 this study), and Cattail family (Typhaceae) – 4 species. At the division level, only Bladderwort diversity is high in the Nulhegan, with 6 species. Pondweeds, Sedges, and Cattail family are most speciose in the Pondicherry division.

In comparing the flora across refuge divisions, it is noteworthy that Lewis Pond supports 9 species, representing 36% of its aquatic flora, that are absent from the Pondicherry Division waterbodies; these include several abundant state-tracked rare species. A fairly obvious explanation for this divergence is found in the gross habitat differences presented by Lewis Pond's sandy bottom and oligotrophic, non-tannic waters, as contrasted with Pondicherry's predominantly organic substrate and dystrophic, highly tannic waters.

**Table 5.** Aquatic plants of Conte refuge waterbodies and their relative abundance.

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (&gt;25-year-old record)

Scientific Name	Common Name	Family	Lewis Pond	Cherry Pond	Little Cherry Pond	Mud Pond	Deadwater & Johns R.	Cedar Marsh	Moorhen Marsh
<i>Brasenia schreberi</i>	water shield	Nymphaeaceae		D	D		C		
<i>Redacted species</i>	Redacted species	Redacted species	R						
<i>Callitriche palustris</i>	water starwort	Plantaginaceae	R	R			R		
<i>Ceratophyllum echinatum</i>	hornwort	Ceratophyllaceae			R		R	C	
<i>Charophytes</i>	macroalgae	Characeae	?	Oc			Oc		
<i>Eleocharis acicularis</i>	needle spike-rush	Cyperaceae	Oc	Oc			C		
<i>Eleocharis palustris</i>	marsh spike-rush	Cyperaceae	Oc	C		R	C	Oc	Oc
<i>Eleocharis robbinsii</i>	Robbins' spike-rush	Cyperaceae		H					
<i>Eriocaulon aquaticum</i>	pipewort	Eriocaulaceae	D	C			R		
<i>Fontinalis antipyretica</i>	an aquatic moss	Fontinalaceae					R		
<i>Fontinalis sp.</i>	an aquatic moss	Fontinalaceae		R					
<i>Glyceria borealis</i>	northern manna grass	Poaceae	R				R		
<i>Isoetes echinospora</i>	spiny quillwort	Isoetaceae	Oc	R					
<i>Redacted species</i>	Redacted species	Redacted species	Oc						
<i>Juncus pelocarpus</i> <i>forma submersus</i>	mud-rush	Juncaceae	Oc						
<i>Lemna minor</i>	duckweed	Araceae			H		R	Oc	
<i>Lobelia dortmanna</i>	water lobelia	Campanulaceae	Oc						
<i>Myriophyllum farwellii</i>	Farwell's water-milfoil	Haloragaceae	Oc						
<i>Myriophyllum tenellum</i>	leafless water-milfoil	Haloragaceae	C						
<i>Najas flexilis s.l.</i>	wavy naiad	Hydrocharitaceae	H						
<i>Najas gracillima</i>	slender naiad	Hydrocharitaceae			Oc				
<i>Najas canadensis</i>	Canada naiad	Hydrocharitaceae		C	C		R		
<i>Nuphar variegata</i>	common yellow pond-lily	Nymphaeaceae	R	Oc	Oc	D	Oc		
<i>Nymphaea odorata</i>	waterlily	Nymphaeaceae		D	D	Oc	C		
<i>Pontederia cordata</i>	pickerelweed	Pontederiaceae		C	C		C		
<i>Potamogeton alpinus</i>	alpine pondweed	Potamogetonaceae		H					
<i>Potamogeton berchtoldii</i>	Berchtold's pondweed	Potamogetonaceae		D	C	Oc	C	Oc	
<i>Potamogeton confervoides</i>	alga-like pondweed	Potamogetonaceae			R				
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	Potamogetonaceae	Oc	C	Oc	D	Oc	D	Oc
<i>Potamogeton natans</i>	floating pondweed	Potamogetonaceae		Oc	Oc	Oc	Oc		
<i>Potamogeton oakesianus</i>	Oakes' pondweed	Potamogetonaceae		R	R		R		

Scientific Name	Common Name	Family	Lewis Pond	Cherry Pond	Little Cherry Pond	Mud Pond	Deadwater & Johns R.	Cedar Marsh	Moorhen Marsh
<i>Potamogeton pusillus</i>	small pondweed	Potamogetonaceae	?						
<i>Potamogeton robbinsii</i>	Robbins' pondweed	Potamogetonaceae		H					
<i>Potamogeton spirillus</i>	common snailseed pondweed	Potamogetonaceae		Oc					
<i>Redacted species</i>	Redacted species	Redacted species		R					
<i>Sagittaria latifolia</i>	common arrowhead	Alismataceae		Oc	H	C	Oc		
<i>Schoenoplectus subterminalis</i>	water bulrush	Cyperaceae		Oc	Oc		C		
<i>Schoenoplectus tabernaemontani</i>	common bulrush	Cyperaceae		Oc			R		
<i>Schoenoplectus torreyi</i>	Torrey's bulrush	Cyperaceae		H					
<i>Sparganium americanum</i>	common bur-reed	Typhaceae		C	Oc	Oc	C	Oc	Oc
<i>Sparganium angustifolium</i>	narrow-leaved bur-reed	Typhaceae	H	H?			C		
<i>Sparganium emersum</i>	green bur-reed	Typhaceae	Oc	R?			Oc		Oc
<i>Sparganium fluctuans</i>	water-bur-reed	Typhaceae		C	Oc	D	C		
<i>Sparganium sp.</i>	bur-reed	Typhaceae	R						
<i>Spirodela polyrrhiza</i>	greater duckweed	Araceae		R			R	Oc	
<i>Utricularia cornuta</i>	naked-stemmed bladderwort	Lentibulariaceae	R						
<i>Utricularia gibba</i>	humped bladderwort	Lentibulariaceae	R						
<i>Utricularia macrorrhiza (vulgaris)</i>	common bladderwort	Lentibulariaceae	C	C	C	C	C	D	C
<i>Utricularia minor</i>	lesser bladderwort	Lentibulariaceae	?			R	R	R	
<i>Utricularia purpurea</i>	purple bladderwort	Lentibulariaceae	R						
<i>Redacted species</i>	Redacted species	Redacted species	C						
<b>Aquatic Vascular Plant Species Richness</b>			<b>25</b>	<b>29</b>	<b>18</b>	<b>11</b>	<b>26</b>	<b>9</b>	<b>5</b>

**Table 6.** Shore and exposed bottom plants of Conte refuge waterbodies and their relative abundance.

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (>25-year-old record)

Scientific Name	Common Name	Family	Lewis Pond	Cherry Pond	Little Cherry Pond	Mud Pond	Deadwater & Johns R.	Cedar Marsh	Moorhen Marsh
<i>Agrostis scabra</i>	ticklegrass	Poaceae	R	Oc					
<i>Bidens cernua</i>	nodding bur-marigold	Asteraceae				R			
<i>Bidens connata</i>	purple-stemmed beggar-ticks	Asteraceae				R		C	Oc
<i>Carex cryptolepis</i>	small yellow sedge	Cyperaceae		R					
<i>Eleocharis acicularis</i>	needle spike-rush	Cyperaceae	Oc	Oc		Oc	C		
<i>Eleocharis flavescens</i>	pale spike-rush	Cyperaceae		R	Oc	R	Oc		
<i>Eleocharis obtusa</i>	blunt spike-rush	Cyperaceae	R				Oc	C	C
<i>Redacted species</i>	Redacted species	Redacted species	R	R	Oc		R	Oc	Oc
<i>Equisetum fluviatile</i>	water horsetail	Equisetaceae	R						
<i>Hypericum mutilum</i>	dwarf St. John's-wort	Hypericaceae		R			Oc		
<i>Juncus pelocarpus</i>	mud-rush	Juncaceae	R	Oc	R	Oc			
<i>Leersia oryzoides</i>	rice cut-grass	Poaceae		Oc			Oc	C	C
<i>Lindernia dubia</i>	false pimpernel	Linderniaceae					R		
<i>Ludwigia palustris</i>	common water-purslane	Onagraceae					R	C	C
<i>Lysimachia terrestris</i>	swamp-candles	Primulaceae	Oc	Oc	Oc	C	Oc		
<i>Ranunculus flammula</i>	creeping buttercup	Ranunculaceae	H						
<i>Redacted species</i>	Redacted species	Redacted species					R		
<i>Torreyochloa pallida</i>	pale manna grass	Poaceae	R	R		R			C
<b>Shore &amp; Exposed Bottom Species Richness</b>			<b>9</b>	<b>10</b>	<b>4</b>	<b>7</b>	<b>10</b>	<b>5</b>	<b>6</b>



**Table 7.** Family composition of the aquatic vascular plants of the Conte Refuge.

Family	Number of Species per Family		
	All sites	Nulhegan Division (Lewis Pond)	Pondicherry Division
Potamogetonaceae	8-9	2	8
Cyperaceae	6	2	6
Lentibulariaceae	6	6	2
Typhaceae	4	2-3	4
Hydrocharitaceae	3	1	2
Nymphaeaceae	3	1	3
Alismataceae	2	0	2
Araceae	2	0	2
Haloragaceae	2	2	0
Isoetaceae	2	2	1
Plantaginaceae	2	2	1
Campanulaceae	1	1	0
Ceratophyllaceae	1	0	1
Eriocaulaceae	1	1	1
Juncaceae	1	1	0
Poaceae	1	1	1
Pontederiaceae	1	0	1

## Rare Species

No federally listed plant species were found or particularly anticipated. However, state and regionally rare or uncommon plants were found in all surveyed water bodies. In total, 31 occurrences (a species at a site) encompassing 19 species have been documented or are suspected. All but two of the 31 occurrences are extant, most being newly discovered during this study. However, it is also noteworthy that several of the rare species found during this study were rediscoveries of species first recorded (and last documented) in the early 1900's. Identities and details of the rare species have been redacted from this public version of the report, but were provided to managers and the respective Natural Heritage Programs. Note that Species of Greatest Conservation Need (SGCN) status applies only to Lewis Pond (Vermont) occurrences as New Hampshire's State Wildlife Action Plan does not currently include plants.

Six of the rare species have state ranks of S1 or S2 corresponding, respectively, to Endangered or Threatened status in New Hampshire and Very Rare or Rare designations in Vermont; one of the S1 species also has the legal status of Threatened in Vermont. Three species are designated Species of Greatest Conservation Need (SGCN) in Vermont. One species is currently designated regionally rare in *Flora Conservanda* (Brumback and Gerke 2013); however, we suspect it has been significantly overlooked and may be removed from a pending update to this list. A number of the rare species have disparate ranks between Vermont and New Hampshire, in some cases being considered rare or uncommon in one state and not so in the other.

Most of the rare species had only a single occurrence, while four species occurred across multiple sites. These included a sedge that is present at all but Mud Pond and is the only rare species confirmed in both refuge Divisions in this study. Three other species are each present at three sites in the Pondicherry Division. Five occurrences of three species are tentative and need further confirmation with additional surveys.

Two historically documented rare plants, alpine pondweed (*Potamogeton alpinus*) and Torrey's bulrush (*Schoenoplectus torreyi*), both from Cherry Pond, were not rediscovered. The former was collected in 1829 by Robbins and the latter in 1907, 1908, and 1913 by Pease. Combined with our failure to rediscover Robbin's 1829 stations for Robbins' pondweed (*Potamogeton robbinsii*) and Robbins' spike-rush (*Eleocharis robbinsii*) these absences raise questions about potential changes to Cherry Pond's aquatic habitats, perhaps linked to the railroad.

## Invasive Species

Fortunately, no aquatic invasive species were found in any of the surveyed water bodies, further attesting to the high ecological condition and value of these refuge lands and waters. The terrestrial invasives purple loosestrife (*Lythrum salicaria*) and glossy buckthorn (*Frangula alnus*) were noted in a few locations within the Pondicherry Division, as had been previously documented (Engstrom et al. 2020). Purple loosestrife was primarily noted in Cedar Marsh, where it had been recently treated, and as scattered plants along the Johns River between Cherry and Little Cherry Ponds. A single fruiting plant of glossy buckthorn was noted just below the outlet of Cherry Pond.

## Photo Galleries

### Lewis Pond Photos



Overview of the pond from SE side of pond.



Pipewort-water lobelia sand pond shore at outlet



Pipewort – water lobelia sandy pond shore with pipewort rosettes and leafless water-milfoil running in lines on sandy bottom (right).



Cherry Pond Photos

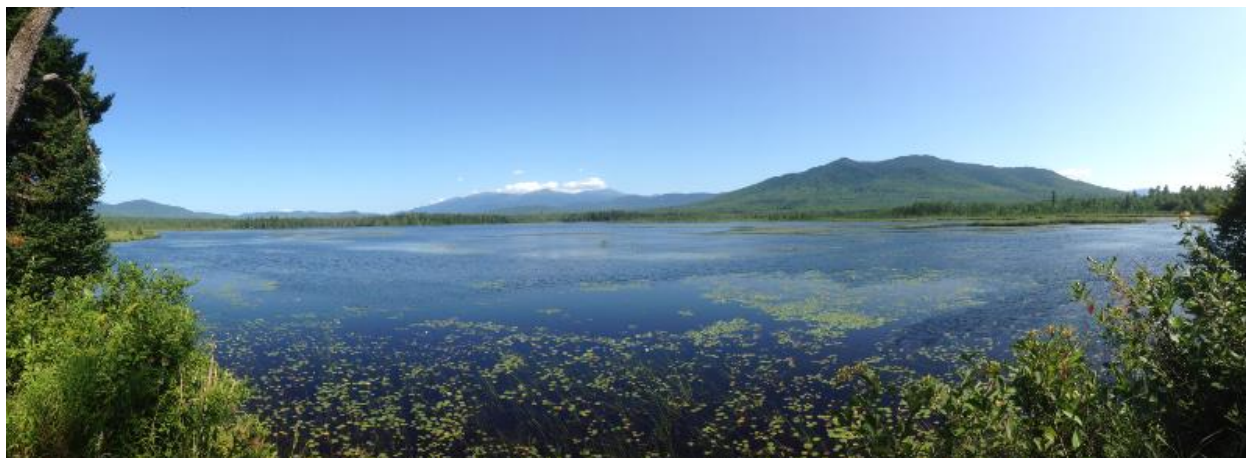
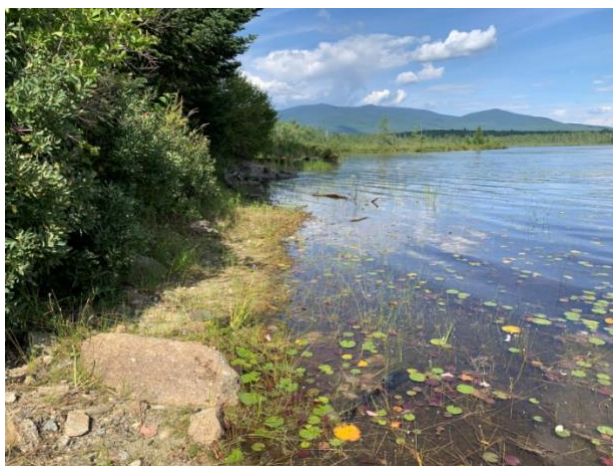


Photo pan from northwest shore showing Floating-leaved aquatic bed community nearshore.



Left: Floating-leaved aquatic bed flush with sweet-scented pond lily.



Right: Pipewort sandy pond shore community on west side of Cherry Pond



Submersed aquatic bed of pondweed.



*Little Cherry Pond Photos*



Photo pan from on top of beaver hut on south shore.



Left: dense Floating-leaved aquatic bed, predominately yellow and white waterlilies.



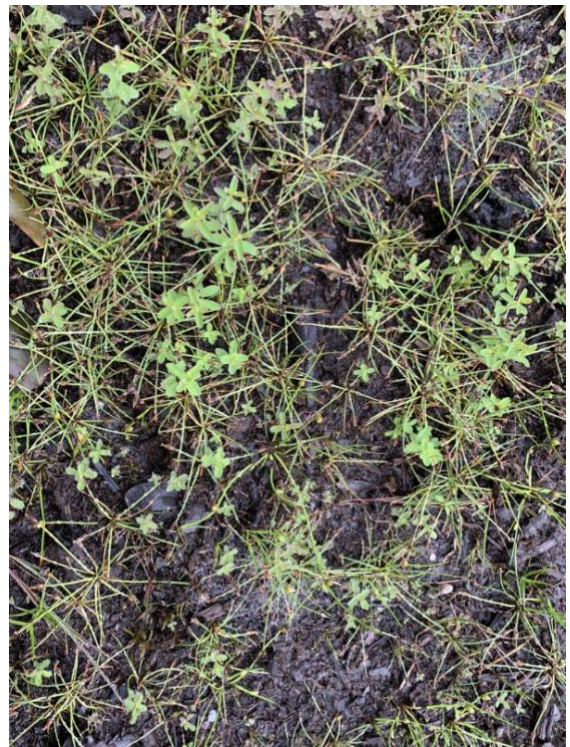
Right: Floating-leaved aquatic bed of watershield with extensive floating muck mats beyond.



Deadwater Photos



Downstream (left) and upstream (right) views of showing Organic bottom aquatic bed with floating-leaved aquatics and patches of emergent pickerelweed.



Extremely rocky Mineral bottom aquatic bed with exposed mucky sand matrix (left) densely vegetated by small tussock spikerushes, especially *Eleocharis flavescens*(right).

*Johns River between Cherry and Little Cherry Ponds Photos*



Organic bottom aquatic bed reach with big patches of pickerelweed along channel margins.



“Boney” Mineral bottom aquatic bed.



### Mud Pond Photos



Photo pan of pond from viewing platform showing extensive Floating-leaved aquatic bed



Typical Floating-leaved aquatic bed of pondlilies and water bur-reed; Matt probing organic bottom sediments which ran over 8m (26ft).

*Cedar Marsh and Moorhen Marsh Photos*



Combination of submersed and floating-leaved aquatic bed at Cedar Marsh impoundment.

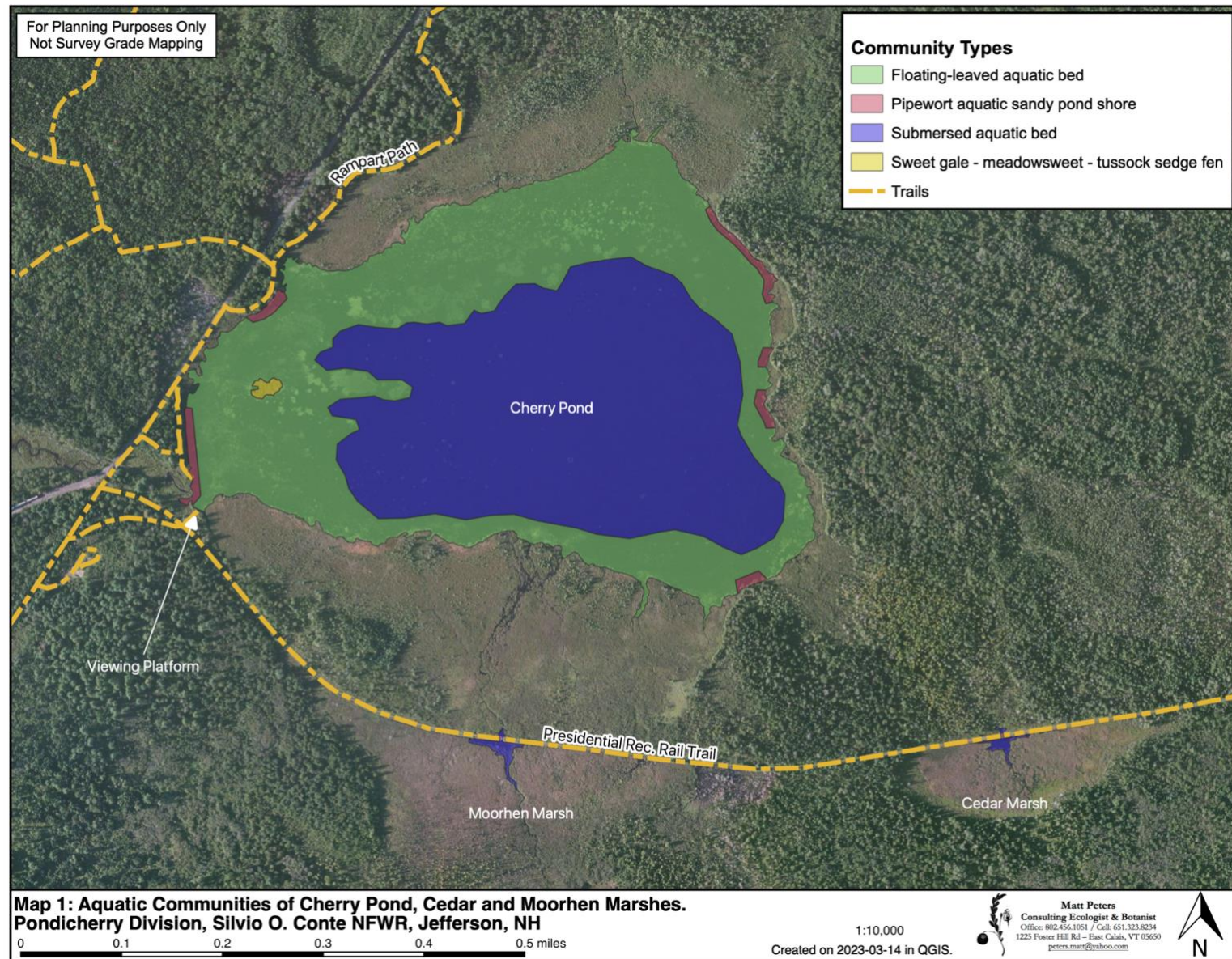


Similar combination of submersed and floating-leaved aquatic bed at Moorhen Marsh.



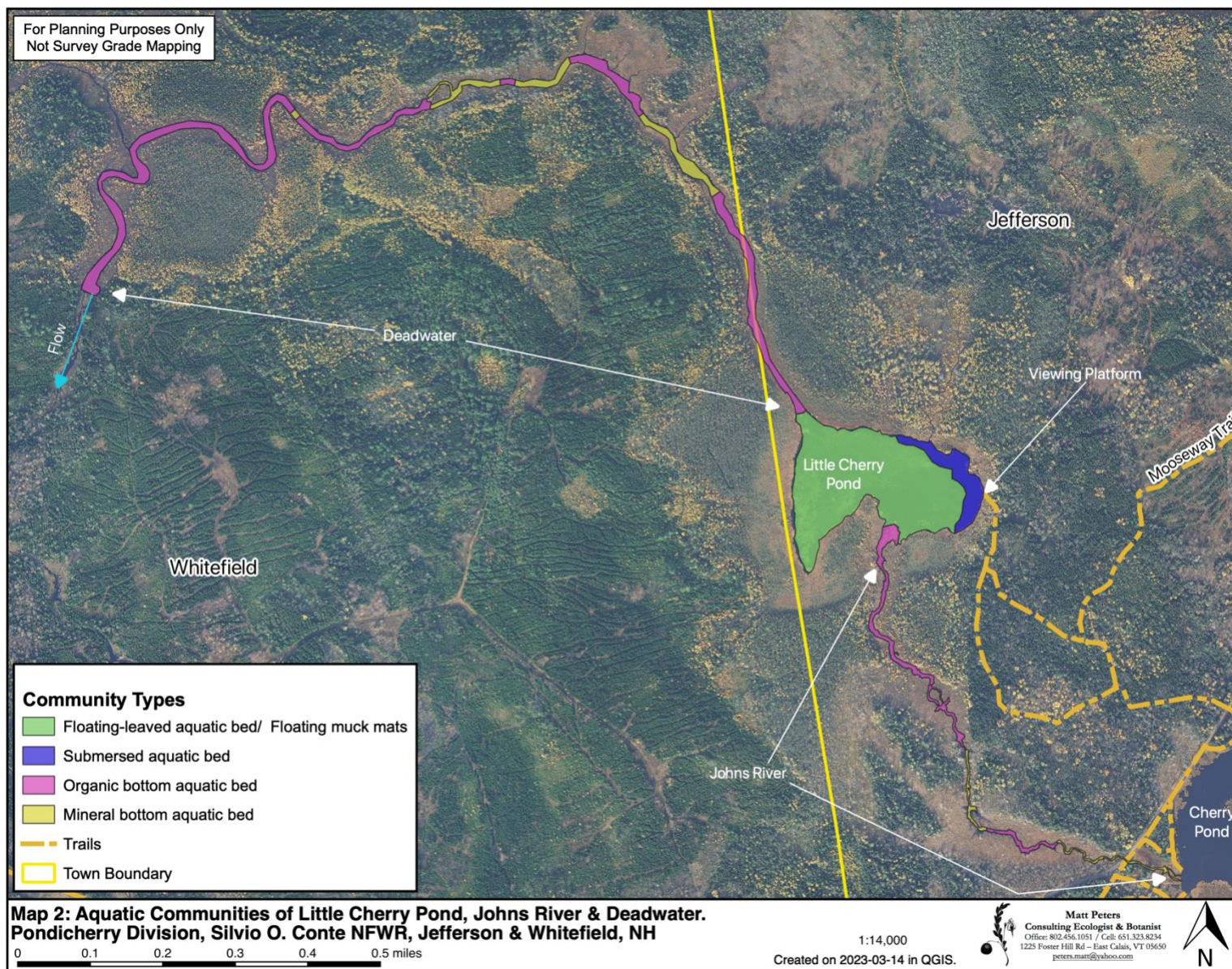
## Maps:

*Map 1: Aquatic Communities of Cherry Pond, Cedar and Moorhen Marshes.*



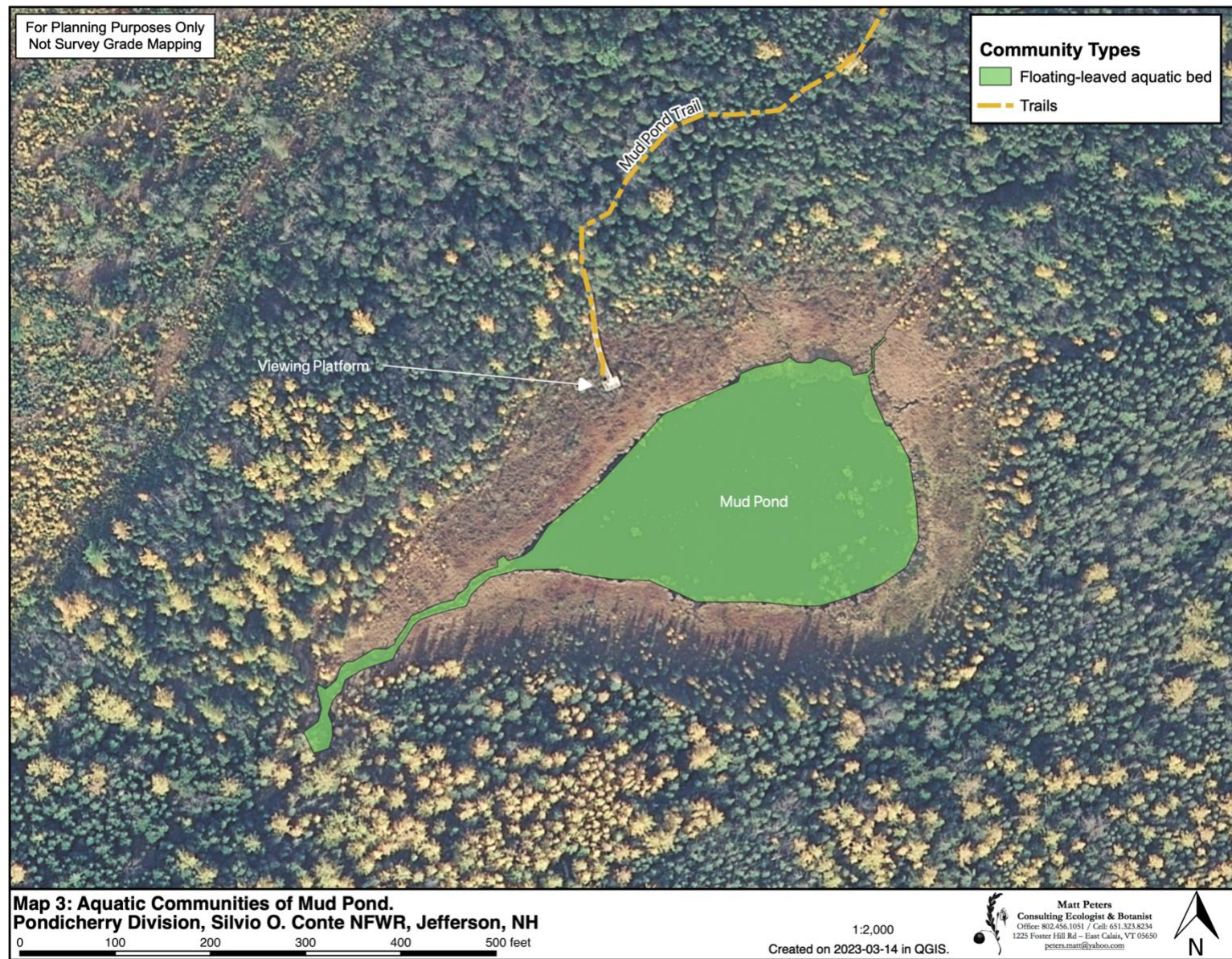


*Map 2: Aquatic Communities of Little Cherry Pond, Johns River & Deadwater.*



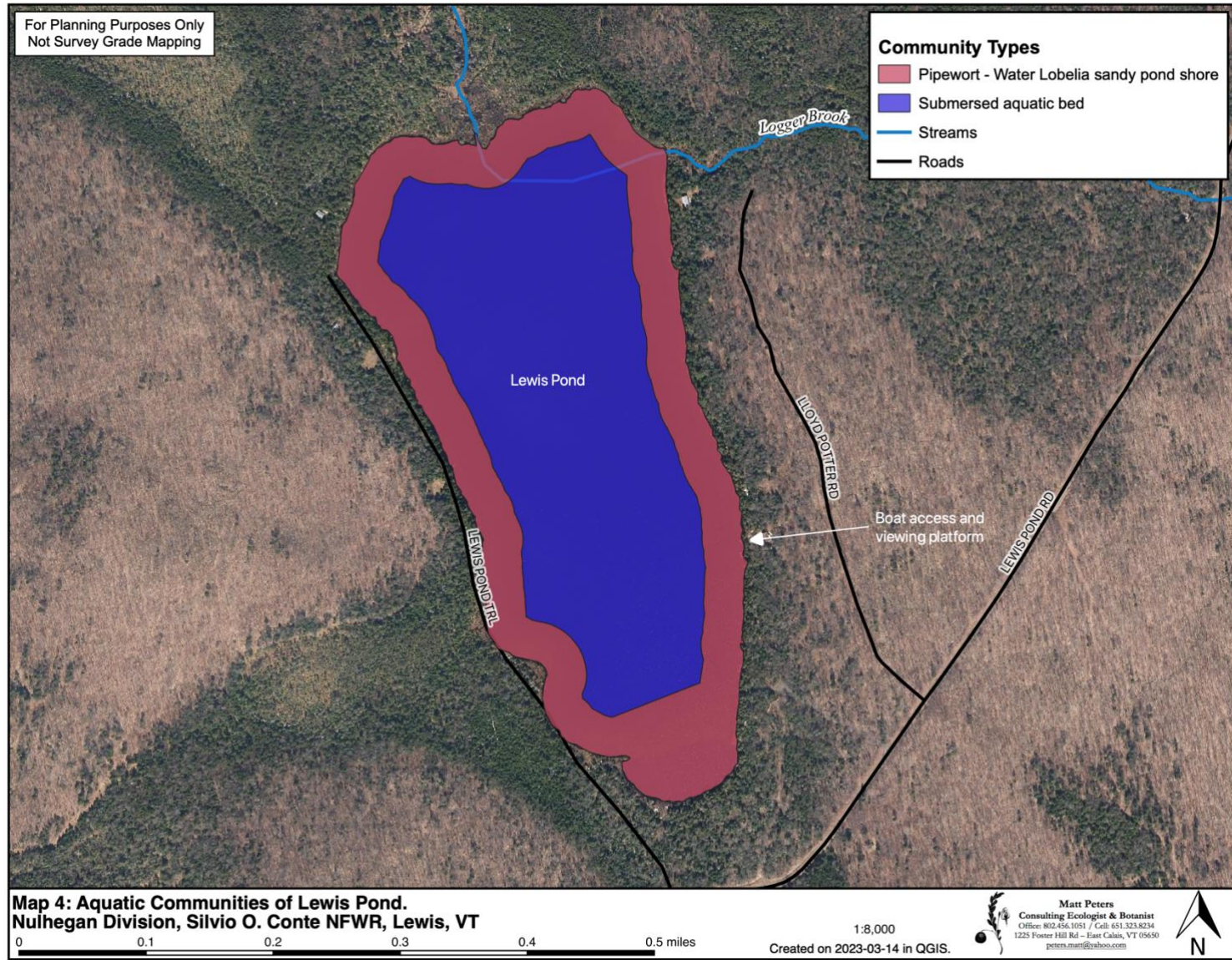


*Map 3: Aquatic Communities of Mud Pond.*





*Map 4: Aquatic Communities of Lewis Pond.*



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## Appendices: Annotated Species Lists

### Appendix A: Lewis Pond Annotated Species List, Lewis, Vermont (Nulhegan Division)

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (>20-year-old record)

Scientific Name	Common Name	Abundance*	Annotation
<i>Redacted species</i>	Redacted species	R	Redacted
<i>Callitriche palustris</i>	water starwort	R	A few clumps in shallow waters toward south end.
Charophytes	macroalgae	?	Reported by VT DEC (as Tolypella sp.) from 2020 surveys, but not noted in present study.
<i>Eleocharis acicularis</i>	needle spike-rush	Oc	Scattered patches along shore and in shallows.
<i>Eleocharis palustris</i>	marsh spike-rush	Oc	Isolated patches toward south end of pond.
<i>Eriocaulon aquaticum</i>	pipewort	D	Very abundant and ubiquitous in shallows and at greater depths, sandy and finer substrates.
<i>Glyceria borealis</i>	northern manna grass	R	One patch out from viewing platform.
<i>Isoetes echinospora</i>	spiny quillwort	Oc	Present around the pond and intermixing with <i>I. lacustris</i> , occasionally emerged on small sandy shores, but also to depths of 1.5m or more with longer, more flaccid leaves.
<i>Redacted species</i>	Redacted species	Oc	Redacted
<i>Juncus pelocarpus forma submersus</i>	mud-rush	Oc	Submersed patches in shallow waters with sandy bottom, often amid mats of <i>Eriocaulon</i> and <i>Lobelia dortmannii</i> . Few typical emergent/ above water plants noted.
<i>Lobelia dortmanna</i>	water lobelia	Oc	Scattered patchily in areas of shallow sandy bottom.
<i>Myriophyllum farwellii</i>	Farwell's water-milfoil	Oc	Widespread though sparse throughout much of the pond with a few dense patches where it is dominant toward the south end.
<i>Myriophyllum tenellum</i>	leafless water-milfoil	C	Widespread and abundant throughout pond up to perhaps 1.5m depth (vegetative only at depth).
<i>Najas flexilis s.l.</i>	wavy naiad	H	Reported by VT DEC from 1989 & 2001 surveys, but not found in present study. Could be either <i>N. flexilis sensu stricto</i> or <i>N. canadensis</i> , a recent, cryptic segregate taxon.
<i>Nuphar variegata</i>	common yellow pond-lily	R	A single mature plant noted out from viewing platform.
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	Oc	Sparsely scattered around pond, more abundant toward south end with beds of <i>Myriophyllum farwellii</i> .



Scientific Name	Common Name	Abundance*	Annotation
<i>Potamogeton pusillus</i>	small pondweed	?	Reported by VT DEC from 2001 & 2020 surveys, but not found in present study. Could be either <i>P. pusillus</i> sensu stricto or <i>P. berchtoldii</i> .
<i>Sparganium angustifolium</i>	narrow-leaved bur-reed	H	Reported by VT DEC from 1989 surveys, but not found fruiting in present study.
<i>Sparganium emersum</i>	green bur-reed	Oc	Around mouth of Logger Brook inflow.
<i>Sparganium sp.</i>	bur-reed	R	A few vegetative floating-leaved bur-reed plants scattered, either <i>S. angustifolium</i> or small <i>S. fluctuans</i> - ID indeterminate, the former species reported by VTDEC in 1989.
<i>Utricularia cornuta</i>	naked-stemmed bladderwort	R	One small exposed patch of vegetative leaves in organic turf at the mouth of Logger Brook entering the pond. Possibly just an exposed form of <i>U. resupinata</i> , but leaf tips slightly flattened and apparently non-septate.
<i>Utricularia gibba</i>	humped bladderwort	R	ID tentative from fragmentary material, <i>U. minor</i> also possible; In shallow muck at mouth of Logger Brook inflow. Also reported by VT DEC from 2020 surveys.
<i>Utricularia macrorrhiza (vulgaris)</i>	common bladderwort	C	Widespread and variable depth, often near bottom in deeper waters.
<i>Utricularia minor</i>	lesser bladderwort	?	Reported by VT DEC from 2020 surveys, but not found in present study. Needs confirmation with a specimen, but none known.
<i>Utricularia purpurea</i>	purple bladderwort	R	Noted sparsely in one area out from viewing platform amid <i>Myriophyllum farwellii</i> . Also reported by VT DEC from 2001 & 2020 surveys.
<i>Redacted species</i>	Redacted species	C	Redacted
<b>Aquatic Species Richness</b>		<b>26</b>	
<i>Agrostis scabra</i>	ticklegrass	R	On exposed mucky sand at mouth of Logger Brook inflow.
<i>Eleocharis acicularis</i>	needle spike-rush	Oc	Scattered patches along shore and in shallows.
<i>Eleocharis obtusa</i>	blunt spike-rush	R	On exposed mucky sand at mouth of Logger Brook inflow.
<i>Eleocharis ovata</i>	ovate spike-rush	VR	Few plants on exposed mucky sand at mouth of Logger Brook inflow.
<i>Equisetum fluviatile</i>	water horsetail	R	Sandy shoreline.
<i>Juncus pelocarpus</i>	mud-rush	R	Few typical emergent/ above water plants noted at shore. Mainly present as a submersed aquatic (forma submersus).
<i>Lysimachia terrestris</i>	swamp-candles	Oc	Shorelines.
<i>Ranunculus flammula</i>	creeping buttercup	H	Noted as an associate (as <i>R. reptans</i> ) in 1989 Heritage record for <i>Myriophyllum farwellii</i>

Scientific Name	Common Name	Abundance*	Annotation
<i>Torreyochloa pallida</i>	pale manna grass	R	On small patches of exposed sand/cobble shore created by cedar windthrow.
<b>Shore &amp; Exposed Bottom Species Richness</b>		<b>9</b>	
<i>Alnus incana</i>	gray alder	Oc	Shorelines.
<i>Carex lasiocarpa</i>	hairy-fruited sedge	Oc	Fenny shoreline area toward southwest side of pond along point with rusty old boat.
<i>Carex utriculata</i>	beaked sedge	R	Around mouth of Logger Brook inflow.
<i>Drosera intermedia</i>	narrow-leaved sundew	R	Few plants on mucky sand shore with <i>Carex lasiocarpa</i> toward southwest side of pond.
<i>Muhlenbergia uniflora</i>	fall dropseed	R	Few plants on mucky sand shore with <i>Carex lasiocarpa</i> toward southwest side of pond.
<i>Chamaedaphne calyculata</i>	leatherleaf	C	Shorelines.
<i>Myrica gale</i>	sweet gale	C	Shorelines.
<b>Wetland Edge Species Richness (incomplete)</b>		<b>7</b>	

*Appendix B: Cherry Pond Annotated Species List, Jefferson, NH (Pondicherry Division)*

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (>25-year-old record)

Scientific Name	Common Name	Abundance*	Annotation
<i>Brasenia schreberi</i>	water shield	D	Widespread, dominant or co-dominant with Nymphaea across much of the shallower, peripheral aquatic beds.
<i>Callitriche palustris</i>	water starwort	R	Only a few plants noted, both in deeper waters as submersed plants and on exposed muck shores.
<i>Charophytes</i>	macroalgae	Oc	Aquatic macroalgae, at least two species noted but not identified, can form mats on bottom in deeper areas.
<i>Eleocharis acicularis</i>	needle spike-rush	Oc	Patchy on exposed shores and into shallows.
<i>Eleocharis palustris</i>	marsh spike-rush	C	Patch forming in shallows at pond margins, both along sandy shores and bog mat margins with peaty substrate.
<i>Eleocharis robbinsii</i>	Robbins' spike-rush	H	1829 Collection by Robbins, type locality for the species, but not found.
<i>Eriocaulon aquaticum</i>	pipewort	C	Perhaps the most widely distributed and abundant species from exposed shores to deeper setting over 1m, most noticeable along sandy shorelines.
<i>Fontinalis sp.</i>	an aquatic moss	R	A large aquatic moss noted in a few small patches near shore, perhaps associated with inflowing waters.
<i>Isoetes echinospora</i>	spiny quillwort	R	Sparsely present along sandy shores and sandy bottom area associated with ice ramparts, though potentially overlooked in deeper waters.
<i>Najas canadensis</i>	Canada naiad	C	Most common in the deeper central parts of the pond in sparsely vegetated areas and among denser Potamogeton berchtoldii beds, but fragments easily and drifts about.
<i>Nuphar variegata</i>	common yellow pond-lily	Oc	Widespread across much of the shallower, peripheral aquatic beds with Nymphaea and Brasenia but less frequent.
<i>Nymphaea odorata</i>	waterlily	D	Widespread, dominant or co-dominant with Brasenia across much of the shallower, peripheral aquatic beds.
<i>Pontederia cordata</i>	pickerelweed	C	Abundant and locally dominant in patches around pond margins, but also scattered into deeper water with forms that barely emerge above water.
<i>Potamogeton alpinus</i>	alpine pondweed	H	1829 Collection by Robbins, but not found.
<i>Potamogeton berchtoldii</i>	Berchtold's pondweed	D	Particularly abundant in deeper center of pond (1.5-2m depth) where it can form near monocultures, scattered elsewhere, probably the most abundant pondweed.

Scientific Name	Common Name	Abundance*	Annotation
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	C	Widespread throughout the peripheral aquatic beds, though often lacking floating leaves, the most abundant pondweed of the outer aquatic beds.
<i>Potamogeton natans</i>	floating pondweed	Oc	Scattered sparsely in peripheral aquatic beds and occasionally stranded/emergent on soft exposed muck flats along the shore.
<i>Potamogeton oakesianus</i>	Oakes' pondweed	R	Very sparsely scattered in peripheral aquatic beds.
<i>Potamogeton robbinsii</i>	Robbins' pondweed	H	1829 Collection by Robbins, type locality.
<i>Potamogeton spirillus</i>	common snailseed pondweed	Oc	Sparsely but widely scattered and easily overlooked.
<i>Redacted species</i>	Redacted species	R	Redacted
<i>Sagittaria latifolia</i>	common arrowhead	Oc	Widespread along shorelines and bog mat margins, often narrow leaved forms.
<i>Schoenoplectus subterminalis</i>	water bulrush	Oc	Scattered patchy beds, typically in areas about 1m deep or less. Fruiting stems observed in only one area. Where only sterile stems observed, this is a presumed ID. Could possibly be <i>Eleocharis robbinsii</i> .
<i>Schoenoplectus tabernaemontani</i>	common bulrush	Oc	Scattered patches mainly in sandy/rocky substrate off ice rampart shorelines.
<i>Schoenoplectus torreyi</i>	Torrey's bulrush	H	1907, 1908 & 1913 Pease specimens.
<i>Sparganium americanum</i>	common bur-reed	C	Apparently the dominant emergent burreed forming large patches along shores and in shallows.
<i>Sparganium angustifolium</i>	narrow-leaved bur-reed	H?	1908 Pease specimen. No fruiting material found in this study, but some vegetative plants could be this species or narrow forms of <i>S. fluctuans</i> .
<i>Sparganium emersum</i>	green bur-reed	R?	Less common, perhaps restricted to backchannels in bog mats.
<i>Sparganium fluctuans</i>	water-bur-reed	C	Widespread and locally dominant throughout the peripheral aquatic beds.
<i>Spirodela polyrrhiza</i>	greater duckweed	R	Noted once in an inlet into bog mats.
<i>Utricularia macrorrhiza (vulgaris)</i>	common bladderwort	C	Widespread and abundant.
<b>Aquatic Species Richness</b>		<b>31</b>	
<i>Agrostis scabra</i>	ticklegrass	Oc	Scattered along exposed shorelines.
<i>Carex cryptolepis</i>	small yellow sedge	R	A small cluster of 10 plants on exposed sandy shoreline at the pond outlet.

Scientific Name	Common Name	Abundance*	Annotation
<i>Eleocharis acicularis</i>	needle spike-rush	Oc	Patchy on exposed shores and into shallows.
<i>Eleocharis flavescens</i>	pale spike-rush	R	On exposed organic muck along the shore in a few patches.
<i>Redacted species</i>	Redacted species	R	Redacted
<i>Hypericum mutilum</i>	dwarf St. John's-wort	R	Sparsely scattered in exposed mucky and sandy shores.
<i>Juncus pelocarpus</i>	mud-rush	Oc	Along edges of bog mats and on sandy shores.
<i>Leersia oryzoides</i>	rice cut-grass	Oc	On shorelines.
<i>Lysimachia terrestris</i>	swamp-candles	Oc	Shorelines to shallowly emergent, especially along sandy ice rampart shores.
<i>Torreyochloa pallida</i>	pale manna grass	R	Noted once on exposed mucky sands of ice rampart shoreline.
<b>Shore &amp; Exposed Bottom Species Richness</b>		<b>10</b>	
<i>Alnus incana</i>	gray alder	Oc	Sparsely in bog mats and along inlet channels.
<i>Calla palustris</i>	calla	H	1907 Pease specimen. Likely still present.
<i>Carex lasiocarpa</i>	hairy-fruited sedge	C	Extensive along shorelines and bog mats.
<i>Carex stricta</i>	tussock sedge	Oc	In bog mats, especially along inlet channels.
<i>Carex utriculata</i>	beaked sedge	Oc	In bog mats, especially along inlet channels.
<i>Chamaedaphne calyculata</i>	leatherleaf	C	Widespread in shoreline bog mats.
<i>Cicuta bulbifera</i>	bulbiferous water-hemlock	H	1953 Steele specimen from muddy shore. Likely still present.
<i>Comarum palustre</i>	marsh cinquefoil	R	Noted once along inlet.
<i>Dulichium arundinaceum</i>	three-way sedge	Oc	Scattered along shorelines.
<i>Epilobium ciliatum</i>	ciliate willow-herb	R	Noted on beaver lodge in 'island'.
<i>Galium palustre</i>	marsh bedstraw	R	On shorelines.
<i>Galium tinctorium</i>	southern three-lobed bedstraw	H	1948 & 49 Krochmal, Hodgdon and Pease specimens from pond edge, presumably in bog mats.
<i>Galium trifidum</i>	northern three-lobed bedstraw	H	1949 Pease specimen from pond edge, presumably in bog mats. Likely still present.
<i>Glyceria canadensis</i>	rattlesnake grass	H	1964 Steele specimen from pond edge and 1993 from outlet stream. Likely still present.
<i>Juncus brevicaudatus</i>	narrow-panicked rush	H	1948 and 93 specimens from pond shore or adjacent bog mats. Likely still present.

Scientific Name	Common Name	Abundance*	Annotation
<i>Juncus canadensis</i>	Canada rush	R	Scattered along bog mat margins.
<i>Lonicera villosa</i>	mountain fly-honeysuckle	Oc?	1947 Krochmal and Pease specimen from bog mats. Still present.
<i>Lycopus uniflorus</i>	common water-horehound	Oc	Scattered along shorelines and in bog mats.
<i>Myrica gale</i>	sweet gale	C	Widespread in shoreline bog mats.
<i>Salix lucida</i>	shining willow	R	Noted once at edge of bog mat.
<i>Scheuchzeria palustris</i>	pod-grass	R	A few large colonies in bog mats near the shore.
<i>Triadenum fraseri</i>	Fraser's marsh St. John's-wort	Oc	Occasional in shoreline bog mats.
<i>Triadenum virginicum</i>	marsh St. John's-wort	H	1949 Pease specimen.
<i>Typha latifolia</i>	broad-leaved cat-tail	Oc	Scattered in bog mats, including out at largest bog mat island.
<i>Vaccinium macrocarpon</i>	cranberry	R	Noted in 'island' bog mats.
<b>Wetland Edge Species Richness (incomplete)</b>		<b>25</b>	



*Appendix C: Little Cherry Pond Annotated Species List, Jefferson, NH (Pondicherry Division)*

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (>25-year-old record)

Scientific Name	Common Name	Abundance*	Annotation
<i>Brasenia schreberi</i>	water shield	D	The dominant floating leaved plant throughout much of the pond.
<i>Ceratophyllum echinatum</i>	hornwort	R	Noted once, dredged up from bottom ~1m deep, possibly more extensive.
<i>Lemna minor</i>	duckweed	H	1953 Steele specimen. Not found.
<i>Najas canadensis</i>	Canada naiad	C	Scattered throughout eastern half of pond.
<i>Najas gracillima</i>	slender naiad	Oc	Scattered throughout eastern half of pond, though less abundant than <i>N. canadensis</i> overall.
<i>Nuphar variegata</i>	common yellow pond-lily	Oc	Scattered, mainly along west side.
<i>Nymphaea odorata</i>	waterlily	D	Throughout pond.
<i>Pontederia cordata</i>	pickerelweed	C	In a near continuous patchy band, 5-15m wide, around the pond, though widest at mouth of John's River and narrower/patchier on northeast side. Scattered nearly submersed forms in deeper areas.
<i>Potamogeton berchtoldii</i>	Berchtold's pondweed	C	Throughout pond.
<i>Potamogeton confervoides</i>	alga-like pondweed	R	Two large patches in the SW bay, rediscovery of Pease's 1910 station.
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	Oc	Widely scattered.
<i>Potamogeton natans</i>	floating pondweed	Oc	Widely scattered.
<i>Potamogeton oakesianus</i>	Oakes' pondweed	R	Noted in wrack at outlet.
<i>Sagittaria latifolia</i>	common arrowhead	H	1910 Pease specimen.
<i>Schoenoplectus subterminalis</i>	water bulrush	Oc	Small patches, mainly toward margins in shallows. Because only sterile stems observed, this is a presumed ID. Could possibly be <i>Eleocharis robbinsii</i> .
<i>Sparganium americanum</i>	common bur-reed	Oc	Sparsely scattered across pond, few if any large beds.
<i>Sparganium fluctuans</i>	water-bur-reed	Oc	Widely scattered.
<i>Utricularia macrorrhiza (vulgaris)</i>	common bladderwort	C	Widespread.
<b>Aquatic Species Richness</b>		<b>18</b>	
<i>Eleocharis flavescens</i>	pale spike-rush	Oc	Scattered on extensive floating muck mats seasonally buoyed up with trapped gases.
<i>Redacted species</i>	Redacted species	Oc	Redacted

Scientific Name	Common Name	Abundance*	Annotation
<i>Juncus pelocarpus</i>	mud-rush	R	Bog mat margins.
<i>Lysimachia terrestris</i>	swamp-candles	Oc	on floating Sphagnum mat in small inlet
<b>Shore &amp; Exposed Bottom Species Richness</b>		<b>4</b>	
<i>Asclepias incarnata</i>	swamp milkweed	Oc	Fruiting plants at inlet from Mud Pond
<i>Carex canescens</i>	silvery sedge	Oc	on floating Sphagnum mat in small inlet
<i>Carex lasiocarpa</i>	hairy-fruited sedge	Oc	Along shorelines and in bog mats.
<i>Carex stricta</i>	tussock sedge	C	In bog mats.
<i>Chamaedaphne calyculata</i>	leatherleaf	C	In bog mats.
<i>Dulichium arundinaceum</i>	three-way sedge	Oc	Bog mat margins.
<i>Eriophorum virginicum</i>	tawny cotton-grass	Oc	on floating Sphagnum mat in small inlet
<i>Myrica gale</i>	sweet gale	C	In bog mats.
<i>Scheuchzeria palustris</i>	pod-grass	R	In bog mats on west side of pond.
<i>Spiraea tomentosa</i>	steeplebush	Oc	Bog mats.
<i>Typha latifolia</i>	broad-leaved cat-tail	R	Bog mats.
<b>Wetland Edge Species Richness (incomplete)</b>		<b>11</b>	

*Appendix D: Mud Pond Annotated Species List, Jefferson, NH (Pondicherry Division)*

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (>25-year-old record)

Scientific Name	Common Name	Abundance*	Annotation
<i>Eleocharis palustris</i>	marsh spike-rush	R	Small patches at east end along margins.
<i>Nuphar variegata</i>	common yellow pond-lily	D	One of three most abundant species.
<i>Nymphaea odorata</i>	waterlily	Oc	A few colonies near center of pond.
<i>Potamogeton berchtoldii</i>	Berchtold's pondweed	Oc	Sparsely scattered.
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	D	One of three most abundant species.
<i>Potamogeton natans</i>	floating pondweed	Oc	Scattered patches, especially toward west side outlet.
<i>Sagittaria latifolia</i>	common arrowhead	C	Scattered along shores.
<i>Sparganium americanum</i>	common bur-reed	Oc	Small but locally dense beds in a few spots along the bog mat shore.
<i>Sparganium fluctuans</i>	water-bur-reed	D	One of three most abundant species. More abundant in in shallows towards pond margins
<i>Utricularia macrorrhiza (vulgaris)</i>	common bladderwort	C	Widespread.
<i>Utricularia minor</i>	lesser bladderwort	R	Needs Confirmation - ID from fragmentary material lacking achlorophyllous shoots, thus potentially U. gibba. Present in inlet channel thru fen-mat at east end of pond.
<b>Aquatic Species Richness</b>		<b>11</b>	
<i>Bidens cernua</i>	nodding bur-marigold	R	On exposed muck in west side outlet channel.
<i>Bidens connata</i>	purple-stemmed beggar-ticks	R	Edges of bog mat shoreline.
<i>Eleocharis acicularis</i>	needle spike-rush	Oc	Edges of bog mat shoreline.
<i>Eleocharis flavescens</i>	pale spike-rush	R	Locally abundant in small areas of exposed muck mats in outlet channel at west side of pond.
<i>Juncus pelocarpus</i>	mud-rush	Oc	Edges of bog mat shoreline.
<i>Lysimachia terrestris</i>	swamp-candles	C	Edges of bog mat shoreline.
<i>Torreyochloa pallida</i>	pale manna grass	R	In shallow water/ exposed muck in west side outlet channel.
<b>Shore &amp; Exposed Bottom Species Richness</b>		<b>7</b>	
<i>Alnus incana</i>	gray alder	Oc	In poor fen mats.
<i>Calla palustris</i>	calla	Oc	In poor fen mats.

Scientific Name	Common Name	Abundance*	Annotation
<i>Carex billingsii</i>	Billings' sedge	Oc	In poor fen mats.
<i>Carex canescens</i>	silvery sedge	Oc	Edges of bog mat shoreline.
<i>Carex lasiocarpa</i>	hairy-fruited sedge	C	Along bog mat shores.
<i>Carex magellanica</i>	boreal bog sedge	Oc	Growing with Scheuchzeria in open gold and red Sphagnum mat in poor fen
<i>Carex pauciflora</i>	few-flowered sedge	Oc	In poor fen mats.
<i>Chamaedaphne calyculata</i>	leatherleaf	C	In poor fen mats.
<i>Dulichium arundinaceum</i>	three-way sedge	Oc	Scattered along shores.
<i>Eriophorum virginicum</i>	tawny cotton-grass	Oc	In poor fen mats.
<i>Galium trifidum</i>	northern three-lobed bedstraw	Oc	Edges of bog mat shoreline.
<i>Glyceria canadensis</i>	rattlesnake grass	R	In shallow water/ exposed muck in west side outlet channel.
<i>Lycopus uniflorus</i>	common water-horehound	Oc	Edges of bog mat shoreline.
<i>Maianthemum trifolium</i>	three-leaved false Solomon's-seal	Oc	In poor fen mats.
<i>Myrica gale</i>	sweet gale	C	In poor fen mats.
<i>Rhynchospora alba</i>	white beak rush	Oc	Edges of bog mat shoreline.
<i>Sarracenia purpurea</i>	pitcher-plant	Oc	In poor fen mats.
<i>Scheuchzeria palustris</i>	pod-grass	Oc	Several large colonies in poor fen mats on north and south sides of pond, mainly west of viewing platform.
<i>Spiraea tomentosa</i>	steeplebush	Oc	In poor fen mats.
<i>Triadenum fraseri</i>	Fraser's marsh St. John's-wort	Oc	Edges of bog mat shoreline.
<i>Vaccinium macrocarpon</i>	cranberry	C	Edges of bog mat shoreline.
<i>Vaccinium oxycoccos</i>	dwarf cranberry	C	In poor fen mats.
<b>Wetland Edge Species Richness (incomplete)</b>		<b>22</b>	

Appendix E: Johns River & Deadwater Annotated Species List, Jefferson & Whitefield, NH (Pondicherry Division)

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (>25-year-old record)

Scientific Name	Common Name	Abundance*	Annotation
<i>Brasenia schreberi</i>	water shield	C	Widespread, especially in extensive bands along the margins of deeper sections.
<i>Callitriche palustris</i>	water starwort	R	One small patch noted at inlet from enriched swamps to north towards downstream end of Deadwater.
<i>Ceratophyllum echinatum</i>	hornwort	R	Dredged up from bottom twice in 1.5-2m of water toward downstream end, perhaps more widespread but overlooked due to depth.
<i>Charophytes</i>	macroalgae	Oc	On bottom in deeper sections.
<i>Eleocharis acicularis</i>	needle spike-rush	C	Scattered in patches of exposed muck and mucky sands along shorelines and shallow channel segments and shallowly submersed in some areas.
<i>Eleocharis palustris</i>	marsh spike-rush	C	Patchy colonies along channel margins and shallow channel segments.
<i>Eriocaulon aquaticum</i>	pipewort	R	Sparse small patches at channel margins, muck flats, and dewatered shallows, often with sandy substrate or beaver haulouts.
<i>Fontinalis antipyretica</i>	an aquatic moss	R	John's River channel from shortly below Cherry Pond to just below rail bridge crossing.
<i>Glyceria borealis</i>	northern manna grass	R	John's River channel below rail bridge between Cherry and Little Cherry Ponds.
<i>Lemna minor</i>	duckweed	R	One small patch noted toward downstream end at inlet from enriched swamps to north, with Spirodela.
<i>Najas canadensis</i>	Canada naiad	R	Small amounts toward east end.
<i>Nuphar variegata</i>	common yellow pond-lily	Oc	Scattered in aquatic beds and channels margins.
<i>Nymphaea odorata</i>	waterlily	C	Mainly in beds along margins of deeper sections.
<i>Pontederia cordata</i>	pickerelweed	C	Patchy dense colonies along shores and in shallower sections, sporadic, barely emersed forms in deeper sections.
<i>Potamogeton berchtoldii</i>	Berchtold's pondweed	C	Widespread, especially in deeper sections toward the west end.
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	Oc	Widespread, especially in deeper sections.
<i>Potamogeton natans</i>	floating pondweed	Oc	Sparsely scattered along margins of deeper sections.
<i>Potamogeton oakesianus</i>	Oakes' pondweed	R	Sparsely scattered along margins of deeper sections.
<i>Sagittaria latifolia</i>	common arrowhead	Oc	Shallows, muck flats, and bog mat margins.

Scientific Name	Common Name	Abundance*	Annotation
<i>Schoenoplectus subterminalis</i>	water bulrush	C	Mainly in beds along margins of deeper sections and in shallow sections with mucky bottoms, almost all vegetative, at times difficult to distinguish from submersed <i>E. acicularis</i> . Also could possibly be <i>Eleocharis robbinsii</i> .
<i>Schoenoplectus tabernaemontani</i>	common bulrush	R	In John's River between Cherry Pond and rail bridge crossing.
<i>Sparganium americanum</i>	common bur-reed	C	Sporadic patches along channel margins and shallows.
<i>Sparganium angustifolium</i>	narrow-leaved bur-reed	C	Large beds along channel margins and in shallow sections.
<i>Sparganium emersum</i>	green bur-reed	Oc	Sporadic patches, mainly in shallow channel sections.
<i>Sparganium fluctuans</i>	water-bur-reed	C	Widespread, especially in extensive bands along the margins of deeper sections toward the west end.
<i>Spirodela polyrrhiza</i>	greater duckweed	R	One small patch noted toward downstream end at inlet from enriched swamps to north, with <i>Lemna</i> .
<i>Utricularia macrorrhiza (vulgaris)</i>	common bladderwort	C	Widespread, especially in deeper sections.
<i>Utricularia minor</i>	lesser bladderwort	R	In shallow water and exposed muck in dewatered section of channel and margins of deeper sections.
<b>Aquatic Species Richness</b>		<b>28</b>	
<i>Eleocharis acicularis</i>	needle spike-rush	C	Scattered in patches of exposed muck and mucky sands along shorelines and shallow channel segments and shallowly submersed in some areas.
<i>Eleocharis flavescens</i>	pale spike-rush	Oc	Scattered in patches of exposed muck and mucky sands along shorelines and shallow channel segments.
<i>Eleocharis obtusa</i>	blunt spike-rush	Oc	Scattered in patches of exposed muck and mucky sands along shorelines and shallow channel segments, especially in dewatered channels between Cherry and Little Cherry Ponds.
<i>Redacted species</i>	Redacted species	R	Redacted
<i>Hypericum mutilum</i>	dwarf St. John's-wort	Oc	Scattered in patches of exposed muck and mucky sands along shorelines and shallow channel segments.
<i>Leersia oryzoides</i>	rice cut-grass	Oc	Shorelines and dewatered channels, rarely emergent from shallow waters.
<i>Lindernia dubia</i>	false pimpernel	R	In dewatered section of John's River channel below rail bridge between Cherry and Little Cherry Ponds.



Scientific Name	Common Name	Abundance*	Annotation
<i>Ludwigia palustris</i>	common water-purslane	R	Small patch noted toward west end at inlet from enriched swamps to north and in dewatered section of John's River channel below rail bridge between Cherry and Little Cherry Ponds.
<i>Lysimachia terrestris</i>	swamp-candles	Oc	Dewatered channels and bog mat margins.
<i>Redacted species</i>	Redacted species	R	Redacted
<b>Shore &amp; Exposed Bottom Species Richness</b>		<b>10</b>	
<i>Asclepias incarnata</i>	swamp milkweed	Oc	Surprisingly abundant and fruitful along bog mat margins, monarch larvae noted.
<i>Calamagrostis canadensis</i>	Canada bluejoint	Oc	Present in sweetgale-meadowsweet-sedge meadow marsh along Johns R. below Cherry P.
<i>Carex lasiocarpa</i>	hairy-fruited sedge	C	Bog mats margins.
<i>Carex stricta</i>	tussock sedge	Oc	Present in sweetgale-meadowsweet-sedge meadow marsh along Johns R. below Cherry P.
<i>Chamaedaphne calyculata</i>	leatherleaf	C	Marginal bog mats
<i>Cicuta bulbifera</i>	bulbiferous water-hemlock	R	John's River channel below rail bridge between Cherry and Little Cherry Ponds.
<i>Drosera intermedia</i>	narrow-leaved sundew	R	Present on marginal bog mat at LCP outlet into Deadwater.
<i>Dulichium arundinaceum</i>	three-way sedge	C	Shorelines.
<i>Glyceria canadensis</i>	rattlesnake grass	R	John's River channel below rail bridge between Cherry and Little Cherry Ponds.
<i>Juncus canadensis</i>	Canada rush	R	Present on marginal bog mat at LCP outlet into Deadwater.
<i>Muhlenbergia uniflora</i>	fall dropseed	R	Tiny patch on marginal bog mat at LCP outlet into Deadwater.
<i>Myrica gale</i>	sweet gale	C	Marginal bog mats
<i>Rhynchospora alba</i>	white beak rush	R	Present on marginal bog mat at LCP outlet into Deadwater.
<i>Scirpus cyperinus</i>	woolgrass	Oc	Present in sweetgale-meadowsweet-sedge meadow marsh along Johns R. below Cherry P.
<i>Veronica scutellata</i>	marsh speedwell	R	John's River channel below rail bridge between Cherry and Little Cherry Ponds.
<b>Wetland Edge Species Richness (incomplete)</b>		<b>15</b>	

*Appendix F: Cedar Marsh Annotated Species List, Jefferson, NH (Pondicherry Division)*

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (>25-year-old record)

Scientific Name	Common Name	Abundance*	Annotation
<i>Ceratophyllum echinatum</i>	hornwort	C	Stranded and submersed in shallow open water.
<i>Eleocharis palustris</i>	marsh spike-rush	Oc	Fruiting
<i>Lemna minor</i>	duckweed	Oc	Present in open water area.
<i>Potamogeton berchtoldii</i>	Berchtold's pondweed	Oc	Present in open water area.
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	D	Abundant, in fruiting condition.
<i>Sparganium americanum</i>	common bur-reed	Oc	Around margins.
<i>Spirodela polyrrhiza</i>	greater duckweed	Oc	On open water and pools throughout the marsh.
<i>Utricularia macrorrhiza (vulgaris)</i>	common bladderwort	D	Abundant.
<i>Utricularia minor</i>	lesser bladderwort	R	On exposed muck hollows and in shallow water. ID needs confirmation with better specimens, ideally flowering, a chance this is actually U. gibba.
<b>Aquatic Species Richness</b>		<b>9</b>	
<i>Bidens connata</i>	purple-stemmed beggar-ticks	C	On exposed muck hollows adjacent the open water.
<i>Eleocharis obtusa</i>	blunt spike-rush	C	On exposed muck hollows adjacent the open water.
<i>Redacted species</i>	Redacted species	Oc	Redacted
<i>Leersia oryzoides</i>	rice cut-grass	C	On exposed muck hollows adjacent the open water.
<i>Ludwigia palustris</i>	common water-purslane	C	On exposed muck hollows adjacent the open water.
<b>Shore &amp; Exposed Bottom Species Richness</b>		<b>5</b>	
<i>Calamagrostis canadensis</i>	Canada bluejoint	Oc	Around margins of open water and throughout the marsh.
<i>Carex canescens</i>	silvery sedge	C	On exposed muck hollows adjacent the open water.
<i>Carex pseudocyperus</i>	cyperus-like sedge	Oc	Scattered about margins of open water and throughout the marsh.
<i>Cicuta bulbifera</i>	bulbiferous water-hemlock	Oc	Around margins of open water and throughout the marsh.
<i>Dulichium arundinaceum</i>	three-way sedge	Oc	Around margins of open water and throughout the marsh.
<i>Galium trifidum</i>	northern three-lobed bedstraw	C	Flowering and fruiting on edge of exposed muck bottom

Scientific Name	Common Name	Abundance*	Annotation
<i>Glyceria canadensis</i>	rattlesnake grass	Oc	Around margins of open water and throughout the marsh.
<i>Juncus canadensis</i>	Canada rush	Oc	Around margins of open water and throughout the marsh.
<i>Lythrum salicaria</i>	purple loosestrife	Oc	Around margins of open water and throughout the marsh.
<i>Typha latifolia</i>	broad-leaved cat-tail	C	Around margins of open water and throughout the marsh.
<b>Wetland Edge Species Richness (incomplete)</b>		<b>10</b>	

*Appendix G: Moorhen Marsh Annotated Species List, Jefferson, NH (Pondicherry Division)*

\*Abundance codes: D= dominant, C= common, Oc= occasional, R= rare, H= historical (>25-year-old record)

Scientific Name	Common Name	Abundance*	Annotation
<i>Eleocharis palustris</i>	marsh spike-rush	Oc	Around margins of open water and throughout the marsh.
<i>Potamogeton epihydrus</i>	ribbon-leaved pondweed	Oc	Present in open water area.
<i>Sparganium americanum</i>	common bur-reed	Oc	Present
<i>Sparganium emersum</i>	green bur-reed	Oc	Emergent from shallows and in muck hollows of marsh.
<i>Utricularia macrorrhiza (vulgaris)</i>	common bladderwort	C	In open water area.
<b>Aquatic Species Richness</b>		<b>5</b>	
<i>Bidens connata</i>	purple-stemmed beggar-ticks	Oc	On exposed muck hollows adjacent the open water.
<i>Eleocharis obtusa</i>	blunt spike-rush	C	On exposed muck hollows adjacent the open water.
<i>Redacted species</i>	Redacted species	Oc	Redacted
<i>Leersia oryzoides</i>	rice cut-grass	C	Present in marshy edges.
<i>Ludwigia palustris</i>	common water-purslane	C	On exposed muck hollows adjacent the open water.
<i>Torreyochloa pallida</i>	pale manna grass	C	On exposed muck hollows adjacent the open water and in the water.
<b>Shore &amp; Exposed Bottom Species Richness</b>		<b>6</b>	
<i>Juncus canadensis</i>	Canada rush	Oc	Around margins of open water and throughout the marsh.
<b>Wetland Edge Species Richness (incomplete)</b>		<b>1</b>	