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NH Department of
Environmental Services
February 2023

Long-Term Variable Milfoil Management Plan

Pawtuckaway Lake
Nottingham, New Hampshire

Contents

Purpose

The purposes of this exotic aquatic plant management and control plan are:

1. To identify and describe the historic and current exotic aquatic infestation(s) in the waterbody;
2. To identify short-term and long-term exotic aquatic plant control goals;
3. To minimize any adverse effects of exotic aquatic plant management strategies on non-target species;
4. To recommend exotic plant control actions that meet the goals outlined in this plan; and
5. To evaluate control practices used in this waterbody over time to determine if they are meeting the goals outlined in this plan.

This plan also summarizes the current physical, biological, ecological, and chemical components of the subject waterbody as they may relate to both the exotic plant infestation and recommended control actions, and the potential social, recreational and ecological impacts of the exotic plant infestation.

The intent of this plan is to establish an adaptive management strategy for the long-term control of the target species (in this case variable milfoil) in the subject waterbody, using an integrated plant management approach.

Appendix A and Appendix B detail the general best management practices and strategies available for waterbodies with exotic species, and provide more information on each of the activities that are recommended within this plan.

Invasive Aquatic Plant Overview

Exotic aquatic plants pose a threat to the ecological, aesthetic, recreational, and economic values of lakes and ponds (Luken & Thieret, 1997, Halstead, 2000), primarily by forming dense growths or monocultures in critical areas of waterbodies that are important for aquatic habitat and/or recreational use. Under some circumstances, dense growths and near monotypic stands of invasive aquatic plants can result, having the potential to reduce overall species diversity in both plant and animal species, and can alter water chemistry and aquatic habitat structure that is native to the system.

Since January 1, 1998, the sale, distribution, importation, propagation, transportation, and introduction of key exotic aquatic plants have been prohibited (RSA 487:16-a) in New Hampshire. This law was designed as a tool for lake managers to help prevent the spread of nuisance aquatic plants.

New Hampshire lists 27 exotic aquatic plant species as prohibited in the state (per Env-Wq 1303.02) due to their documented and potential threat to surface waters of the state.

According to the federal Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM), "exotic macrophytes are non-native, fast growing aquatic plants, which can quickly dominate and choke out native aquatic plant growth in the surface water. Such infestations are in violation of New Hampshire regulation Env-Wq 1703.19, which states that surface waters shall support and maintain a balanced, integrated and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region" (DES, 2006). In fact, waterbodies that contain even a single exotic aquatic plant do not attain water quality standards and are listed as impaired.

Variable Milfoil Infestation in Pawtuckaway Lake

Variable milfoil (*Myriophyllum heterophyllum*) was first documented in Pawtuckaway Lake in Nottingham, New Hampshire in 2015. Lake residents observed a large patch of growth off from Horse Island. From there, variable milfoil plants have been found in a number of locations around the lake, and have been managed exclusively by diving through 2022.

Over time as plant fragments drifted or boats moved plants around, new populations have established around the lake, some of them forming larger and dense patches of growth.

Figure 1 illustrates the milfoil population over time in Pawtuckaway Lake, and the following table provides a summary of milfoil growth in the pond over time. Figure 2 illustrates historic and future management practices (over several maps by year).

Location/Area Description	Year	Description of Growth
A/B	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
C	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
D	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
E (first documented growth in 2015)	2015	Variable milfoil first documented in this area, small patches and scattered single stems
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
F	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
G	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches

	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
H	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
I	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
J	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
K	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
L	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
M	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches

	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
N	2015	Scattered stems and patches
	2016	Scattered stems and patches
	2017	Scattered stems and patches
	2018	Scattered stems and patches
	2019	Scattered stems and patches
	2020	Scattered stems and patches
	2021	Scattered stems and patches
	2022	Scattered stems and patches
O	2015	Patchy growth
	2016	Patchy growth
	2017	Patchy growth
	2018	Patchy growth
	2019	Patchy growth
	2020	Patchy growth
	2021	Patchy growth, some areas of larger growth
	2022	Patchy growth, some areas of larger growth
P	2015	Patchy growth
	2016	Patchy growth
	2017	Patchy growth
	2018	Patchy growth
	2019	Patchy growth
	2020	Patchy growth
	2021	Patchy growth, some areas of larger growth
	2022	Patchy growth, some areas of larger growth

In terms of the impacts of the variable milfoil in the system, there are several houses around the shoreline of Pawtuckaway Lake, and there is a major state park campground on the lake. It is a popular lake for transient boaters and particularly fishermen to visit, so there is a fair amount of traffic on the lake during the boating season.

Lake residents have expressed concern over expansion of the milfoil. A large percentage of the lake is fairly shallow, providing suitable habitat for further expansion.

Milfoil Management Goals and Objectives

The goal for Pawtuckaway Lake is the containment and management of variable milfoil in the system, using an Integrated Plant Management Approach.

Local Support

Pawtuckaway Lake Improvement Association

Pawtuckaway Lake has an active lake association that has long been involved in water quality monitoring, lake and watershed protection, Lake Hosting and Weed Watching and a variety of other activities.

The lake association has individuals that are committed to performing follow-up monitoring for milfoil re-growth and doing what is needed to control the milfoil in the system. They have posted information on their website about the plant, and many shoreline residents have be actively looking for and reporting milfoil growth along shoreline areas of the lake, which is helpful for updating maps between NHDES surveys. Local divers have also been assisting with harvesting efforts as plants are found.

Waterbody Characteristics

The following table summarizes basic physical and biological characteristics of Pawtuckaway Lake, including the milfoil infestation and a current review of the Natural Heritage Bureau (NHB) database.

Parameter/Measure	Value/Description
Lake area (acres)	899.6
Watershed area (acres)	13,247.8
Shoreline Uses (residential, forested, agriculture)	Residential development along shoreline, including a campground, otherwise forested with both dirt and tar roads along shoreline edge in areas, and wetland systems/edge.
Max Depth (ft)	50.49
Mean Depth (ft)	9.9
Trophic Status	Mesotrophic
Color (CPU) in Epilimnion	48
Clarity (ft)	11.9
Flushing Rate (yr-1)	2.2
Natural waterbody/Raised by Damming/Other	Natural w/ 2 dams
Invasive Plants (Latin name)	Variable milfoil *(Myriophyllum heterophyllum)*
Infested Area (acres)	See Figures for historic and current distributions
Distribution (ringing lake, patchy growth, etc)	See Figures for historic and current distributions
Sediment type in infested area (sand/silt/organic/rock)	Areas of organic substrate, sandy, glacial erratics, boulder, fractured ledge
Rare, Threatened, or Endangered Species in Waterbody	2023 Results River birch (*Betula nigra*) Toothcup (*Rotala ramosior*) American eel (*Anguilla rostrata*) Blanding's Turtle (*Emydoidea blandingii*) Common loon (*Gavia immer*)

A native aquatic vegetation map and key from a summer survey by the NHDES Biology Section is shown in Figure 3. A bathymetric map is shown in Figure 4.

Beneficial (Designated) Uses of Waterbody

In New Hampshire, beneficial (designated) uses of our waterbodies are categorized into five general categories: Aquatic Life, Fish Consumption, Recreation, Drinking Water Supply, and Wildlife (CALM).

Of these, Aquatic Life, Wildlife and Recreation are the ones most often affected by the presence of invasive plants, though drinking water supplies can also be affected as well in a number of ways.
Following is a general discussion of the most potentially impacted designated uses, including water supplies and near shore wells, as they relate to this system and the actions proposed in this long-term plan.

The goal for aquatic life support is to provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of the region.

Aquatic Life

Fisheries Information

According to the NH Fish and Game Department, Pawtuckaway Lake is a warmwater fishery supporting smallmouth bass, largemouth bass, Eastern chain pickerel, brown bullhead, white perch, black crappie, American eel, and yellow perch. The American eel is state listed as a species of concern in New Hampshire,

Pawtuckaway Lake is popular among local transient fishing enthusiasts, and receives many transient boaters and fishermen each week.

Wildlife Information

Based on the NHB review for this waterbody, Blanding's turtle (*Emydoidea blandingii*) and Common loon (*Gavia immer*) have been documented in/on/around the lake. The Blanding's turtle is listed as state endangered, and the common loon is listed as state threatened. Every effort will be made to minimize and avoid impact to habitat and to species directly as a result of milfoil management efforts in the lake.

Recreational Uses and Access Points

Pawtuckaway Lake is used for boating, water sports, and fishing by both lake residents and transient boaters in the summer, and in winter it is used for ice fishing and ice skating.

A public access site is located along the northern end of the lake in Fundy Cove, with a dirt lot. A Lake Host is on duty during higher use times, to provide courtesy boat inspections and educational materials on aquatic

invasive species, and the lake association maintains signage at the access site about invasive species. Public access can also be achieved via a dirt launch on Horse Island (part of Pawtuckaway State Park), as well as by the town beach at the state park.

In terms of boating activity, lake residents indicate that there are several boaters throughout the week, including several transient fishermen.

The campground on the lake has an access site for campground visitors, as well as a small beach area for their use. They also have canoe rentals, trails, and other recreational opportunities.

Figure 5 shows the location of public access sites and other information about the lake and shoreline uses.

Macrophyte Community Evaluation

The littoral zone is defined as the nearshore areas of a waterbody where sunlight penetrates to the bottom sediments. The littoral zone is typically the zone of rooted macrophyte growth in a waterbody.

The littoral zone of Pawtuckaway Lake is characterized by native plant growth and locally dense areas of non-native variable milfoil (Figure 3). Native species include a mix of floating plants (watershield, white water lily, yellow water lily, floating heart, pondweeds), emergent plants (arrowhead, cattail, three-way sedge, grasses, bulrush, buttonbush, pipewort, softstem bulrush, bur-reed, sweet fern, sweet gale, high bush blueberry, spike rush, pickerelweed, skullcap, nightshade, sweet pepperbush, sedges), and submergent plants (various pondweeds, bladderwort, grassy spike rush, coontail, St. John's wort, waterweed, filamentous green algae, quillwort, tapegrass, hedge hyssop, Robbins pondweed). Native plant communities are mixed around the entire lake, and are characterized as 'common/abundant' by the NHDES.

Variable milfoil is the only invasive aquatic in the lake at this time, and it is present in locally abundant growths along near shoreline areas, to depths of approximately 6-7 feet. The lake shoreline areas also have a history of common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*).

River birch (state threatened) and toothcup (state endangered) were documented in areas around the lake, mostly on/along shoreline areas. Based on the NHB review for the lake, Natural Heritage commented that "*There is a historic record of toothcup in Pawtuckaway Lake. NHB recommends pretreatment surveys for this plant as it appears that this lake has not been treated in the past. Please provide NHB with information related to the impact of ProcellaCOR on river birch or similar tree species so that we may make recommendations related to this rare tree*."

Wells and Water Supplies

Figure 6 shows the location of wells, water supplies, well-head protection areas, and drinking water protection areas around the subject waterbody, based on information in the DES geographic information system records. Note that it is likely that Figure 6 does not show the location of all private wells.

Note that the map in Figure 6 cannot be provided on a finer scale than 1:48,000. Due to public water system security concerns, a large-scale map may be made available upon agreement with DES' data security policy. Visit DES' OneStop Web GIS, http://www2.des.state.nh.us/gis/onestop/ and register to Access Public Water Supply Data Layers. Registration includes agreement with general security provisions associated with public water supply data. Paper maps that include public water supply data may be provided at a larger-scale by DES' Exotic Species Program after completing the registration process.

In the event that an herbicide treatment is needed for this waterbody, the applicator/contractor will provide more detailed information on the wells and water supplies within proximity to the treatment areas as required in the permit application process with the Division of Pesticide Control at the Department of Agriculture. It is beyond the scope of this plan to maintain updated well and water supply information other than that provided in Figure 6.

Historical Control Activities

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
8/26/2015	DIVING/HAND HARVESTING	1 HOUR, 25 GALLONS	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
9/11/2015	DIVING/HAND HARVESTING	1 HOUR, 1 GALLON	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
6/24/2016	DIVING/HAND HARVESTING	1.5 HOURS, 30 GALLONS	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
6/29/2016	DIVING/HAND HARVESTING	2 HOURS, 20 GALLONS	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
7/14/2016	DIVING/HAND HARVESTING	1.5 HOURS, 10 GALLONS	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
8/5/2016	DIVING/HAND HARVESTING	2 HOURS, 1 GALLON	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
8/17/2016	DIVING/HAND HARVESTING	2.5 HOURS, 10 GALLONS	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
6/28/2017	DIVING/HAND HARVESTING	1 HOUR, 1 GALLON	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
7/28/2017	DIVING/HAND HARVESTING	1.5 HOURS, <1 GALLON	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
8/31/2017	DIVING/HAND HARVESTING	1 HOUR, 1 GALLON	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
9/29/2017	DIVING/HAND HARVESTING	3 HOURS, 30 GALLONS	NH DES DIVERS	OFF HORSE ISLAND/NARROWS
6/25/2018	DIVING/HAND HARVESTING	1.5 HOURS, <1 GALLON	NH DES DIVERS	SOUTH CHANNEL AREA 1
7/2/2018	DIVING/HAND HARVESTING	2.5 HOURS, 1 GALLON	NH DES DIVERS	SOUTH CHANNEL AREA 2
7/2/2018	DIVING/HAND HARVESTING	1 HOUR, 0 GALLONS	NH DES DIVERS	GOVES COVE
7/5/2018	DIVING/HAND HARVESTING	1.5 HOURS, 1 GALLON	NH DES DIVERS	GOVES COVE
7/6/2018	DIVING/HAND HARVESTING	1.5 HOURS, 3 GALLONS	NH DES DIVERS	GOVES COVE
7/8/2018	DIVING/HAND HARVESTING	1.5 HOURS	NH DES DIVERS	GOVES COVE

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
7/13/2018	DIVING/HAND HARVESTING	1 HOUR, 0.25 GALLON	NH DES DIVERS	GOVES COVE
7/13/2018	DIVING/HAND HARVESTING	1 HOUR, 1 GALLON	NH DES DIVERS	SOUTH CHANNEL AREA 3
7/14/2018	DIVING/HAND HARVESTING	1.5 HOURS, 0 GALLONS	NH DES DIVERS	
7/21/2018	DIVING/HAND HARVESTING	1.5 HOURS, 0 GALLONS	NH DES DIVERS	SOUTH CHANNEL AREA 3
7/28/2018	DIVING/HAND HARVESTING	2 HOURS, 0 GALLONS	NH DES DIVERS	SOUTH CHANNEL AREA 4
8/2/2018	DIVING/HAND HARVESTING	3 HOURS, 1.5 GALLONS	NH DES DIVERS	SOUTH CHANNEL AREA 1 AND 4
8/5/2018	SEARCH	2 HOURS	NH DES DIVERS	SOUTH CHANNEL AREA 1
8/9/2018	DIVING/HAND HARVESTING	1 HOUR, 0.5 GALLONS	NH DES DIVERS	SOUTH CHANNEL AREA 1
8/12/2018	SEARCH	0 HOURS	NH DES DIVERS	SOUTH CHANNEL AREA 4
8/26/2018	SEARCH	1.5 HOURS	NH DES DIVERS	SOUTH CHANNEL AREA 6
9/2/2018	SEARCH	1.5 HOURS	NH DES DIVERS	SOUTH CHANNEL AREAS 1, 2
9/2/2018	DIVING/HAND HARVESTING	0.5 HOURS, 1.5 GALLONS	NH DES DIVERS	SOUTH CHANNEL AREAS 1, 2
9/16/2018	SEARCH	0.5 HOURS	NH DES DIVERS	SOUTH CHANNEL AREA 3
6/9/2019	SEARCH	1.5 HOURS	NEIL SANTOS, TIM ROOS, STEVE ARNAULT	AREA 6, SOUTH CHANNEL
6/12/2019	DIVING/HAND HARVESTING	1.5 HOURS, 10 GALLONS	TIM ROOS	AREA 6, SOUTH CHANNEL
6/14/2019	DIVING/HAND HARVESTING	2 HOURS, 18-20 GALLONS	NH DES DIVERS	AREA 6, SOUTH CHANNEL
6/23/2019	DIVING/HAND HARVESTING	4 HOURS, 4 GALLONS	STEVE ARNAULT, JIM KELLY, GARRETT STUMB, NEIL SANTOS, TIM ROOS	AREA 6, SOUTH CHANNEL

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
6/26/2019	SEARCH	3 HOURS	JIM KELLY, NEIL SANTOS	AREA 1, SOUTH CHANNEL
6/26/2019	SEARCH	1 HOUR	TIM ROOS	SOUTH CHANNEL, GOVES COVE
6/27/2019	DIVING/HAND HARVESTING	6 HOURS, 14 GALLONS	TIM ROOS	AREA 1, SOUTH CHANNEL AND GOVES COVE
6/28/2019	DIVING/HAND HARVESTING	2 HOURS, 10 GALLONS	NH DES DIVERS	AREA 1 AND 6, SOUTH CHANNEL
6/29/2019	DIVING/HAND HARVESTING	3 HOURS, 3 GALLONS	TIM ROOS, STEVE TATARZUK	AREA 1, SOUTH CHANNEL AND GOVES COVE
6/30/2019	SEARCH	3.5 HOURS	GARRETT STUMB, NEIL SANTOS	AREA 2, SOUTH CHANNEL
7/1/2019	DIVING/HAND HARVESTING	4.5 HOURS, 10 GALLONS	TIM ROOS	AREA 2, SOUTH CHANNEL
7/2/2019	DIVING/HAND HARVESTING	3.5 HOURS, 6 GALLONS	TIM ROOS	AREA 2, SOUTH CHANNEL
7/5/2019	SEARCH	1.5 HOURS	NEIL SANTOS	SMALL COVE JUST NORTH OF AREA 6, SOUTH CHANNEL
7/6/2019	DIVING/HAND HARVESTING	1.5 HOURS	SARAH PATEY, JAMIE BURLEIGH, GARRETT STUMB, TED ALDRICH	SOUTH CHANNEL AT 28 LAMPREY DR
7/6/2019	DIVING/HAND HARVESTING	7 HOURS, 5 GALLONS	JAMIE BURLEIGH, SARAH PATEY, GARRETT STUMB	AREA 3 SOUTH CHANNEL
7/7/2019	SEARCH	2 HOURS	NEIL SANTOS, ANDY MARTIN, JIM KELLY	AREA 4, SOUTH CHANNEL
7/10/2019	DIVING/HAND HARVESTING	3 HOURS, 3 GALLONS	JAMIE BURLEIGH, SARAH PATEY	AREA 4, SOUTH CHANNEL
7/13/2019	DIVING/HAND HARVESTING	1.5 HOURS, 1 GALLON	JAMIE BURLEIGH, SARAH PATEY	AREA 3, SOUTH CHANNEL
7/14/2019	SEARCH	2 HOURS	STEVE ARNAULT, GARRETT STUMB, NEIL SANTOS	AREA 3, SOUTH CHANNEL

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
7/17/2019	DIVING/HAND HARVESTING	2.5 HOURS, 3 GALLONS	JAMIE BURLEIGH, SARAH PATEY	AREA 3, SOUTH CHANNEL
7/17/2019	SEARCH	1.5 HOURS	NEIL SANTOS	COVE
7/19/2918	DIVING/HAND HARVESTING	5 HOURS, 8 GALLONS	TIM ROOS	SMALL COVE JUST NORTH OF AREA 6, SOUTH CHANNEL
7/21/2019	SEARCH	3 HOURS	NEIL SANTOS, JIM KELLY	AREA 5, SOUTH CHANNEL
7/21/2019	DIVING/HAND HARVESTING	3.5 HOURS, 4 GALLONS	GARRETT STUMB	AREA 3, SOUTH CHANNEL
7/28/2019	SEARCH	3.5 HOURS	NEIL SANTOS, JIM KELLY	AREA 2, SOUTH CHANNEL
7/31/2019	SEARCH	2.5 HOURS	NEIL SANTOS, JIM KELLY	AREA 1, SOUTH CHANNEL
8/1/2019	DIVING/HAND HARVESTING	1.5 HOURS, 2 GALLONS	TIM ROOS, NEIL SANTOS, CAROL WAWRZONEK, DIANE CLARE	AREA 1, SOUTH CHANNEL
8/1/2019	DIVING/HAND HARVESTING	2 HOURS, 2 GALLONS	TIM ROOS, NEIL SANTOS, CAROL WAWRZONEK, DIANE CLARE	AREA 2, SOUTH CHANNEL
8/4/2019	SEARCH	3 HOURS, 1 GALLON	NEIL SANTOS, STEVE ARNAULT, JAMIE BURLEIGH, BARB THOMPSON	AREA 6, SOUTH CHANNEL
8/4/2019	DIVING/HAND HARVESTING	4 HOURS, 1 GALLON	TIM ROOS, MEDEIROS	AREA 6, SOUTH CHANNEL
8/4/2019	MISC	2 HOURS	NEIL SANTOS	
8/11/2019	SEARCH	2 HOURS	JIM KELLY, NEIL SANTOS, BARB THOMPSON, CAROL & PETE WAWRZONEK	AREA 4, SOUTH CHANNEL
8/11/2019	DIVING/HAND HARVESTING	2 HOURS, 3.5 GALLONS	TIM ROOS, GARRETT STUMB, CHRIS FORTIN	AREA 4, SOUTH CHANNEL
8/11/2019	MISC	2 HOURS		

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
8/18/2019	SEARCH	3 HOURS	NEIL SANTOS	GOVE COVE
8/18/2019	DIVING/HAND HARVESTING	5 HOURS, 4 GALLONS	TIM ROOS, SUSAN MEDEIROS	GOVE COVE
8/25/2019	DIVING/HAND HARVESTING	1 HOUR, 0.1 GALLONS	GARRETT STUMB, NEIL SANTOS	GOVE COVE
8/25/2019	SEARCH	2.5 HOURS	NAIL SANTOS	SMALL COVE NORTH OF SOUTH CHANNEL
8/25/2019	DIVING/HAND HARVESTING	2.5 HOURS, 10.5 GALLONS	TIM ROOS, JAMIE BURLEIGH, BARB THOMPSON, SUSAN MEDEIROS	SMALL COVE NORTH OF SOUTH CHANNEL
8/25/2019	DIVING/HAND HARVESTING	1 HOUR, 0.5 GALLONS	JAMIE BURLEIGH, NEIL SANTOS	AREA 4, SOUTH CHANNEL
8/28/2019	SEARCH	1.5 HOURS	NEIL SANTOS	SMALL COVE NORTH OF SOUTH CHANNEL
8/29/2019	DIVING/HAND HARVESTING	2 HOURS, 0.25 GALLONS	TIM ROOS, NEIL SANTOS	SMALL COVE NORTH OF SOUTH CHANNEL
9/1/2019	SEARCH	3.5 HOURS	GARRETT STUMB, TIM ROOS, NEIL SANTOS, CAROL WAWRZONEK, BARB THOMPSON, CHRIS FORTIN	AREA 2, SOUTH CHANNEL
9/1/2019	DIVING/HAND HARVESTING	2.5 HOURS, 4 GALLONS	GARRETT STUMB, TIM ROOS, CAROL WAWRZONEK, BARB THOMPSON, CHRIS FORTIN	AREA 2, SOUTH CHANNEL
9/8/2019	SEARCH	3.5 HOURS	STEVE ARNAULT, JIM KELLY, NEIL SANTOS, BARB THOMPSON, PETE WAWRZONEK, CAROL WAWRZONEK	SOUTH CHANNEL, AREA 4
9/8/2019	MISC	2 HOURS		
9/15/2019	DIVING/HAND HARVESTING	1.5 HOURS, 4 GALLONS	GARRETT STUMB, BARB THOMPSON, NEIL SANTOS	SOUTH CHANNEL, AREA 4

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
9/17/2019	SEARCH	1.5 HOURS	JIM KELLY, NEIL SANTOS, BARB THOMPSON	SOUTH CHANNEL, AREA 8
9/22/2019	DIVING/HAND HARVESTING	3 HOURS, 1.5 GALLONS	TIM ROOS, PETE WAWRZONEK, CAROL WAWRZONWK	SOUTH CHANNEL, AREA 8
9/29/2019	SEARCH	2 HOURS	RYAN O'CONNELL, NIEL SANROS	FUNDY
Multiple	MISC	11 HOURS	NIEL SANTOS	
6/4/2020	DIVING/HAND HARVESTING	3 HOURS 5 GALLONS	Jamie Burleigh Pete Wawrzonek	AREA 3 SOUTH CHANNEL
6/14/2020	DIVING/HAND HARVESTING	1.5 HOURS 2.5 GALLONS	Garrett Stumb Carol Wawrzonek	AREA 6, SOUTH CHANNEL
6/18/2020	DIVING/HAND HARVESTING	2.5 HOURS 3.5 GALLONS	Jamie Burleigh Neil Santos	AREA 6, SOUTH CHANNEL
6/18/2020	DIVING/HAND HARVESTING	2.5 HOURS 0 GALLONS	Sarah Patey Neil Santos	
6/25/2020	DIVING/HAND HARVESTING	3.5 HOURS 2.0 GALLONS	Tim Roos Barb Thompson	
6/27/2020	DIVING/HAND HARVESTING	3.0 HOURS 3.5 GALLONS	Jamie Burleigh Barb Thompson	AREA 2, SOUTH CHANNEL
6/27/2020	DIVING/HAND HARVESTING	3.0 HOURS 0 GALLONS	Sarah Patey Mary Bates	
7/9/2020	DIVING/HAND HARVESTING	1.0 HOURS 0.5 GALLONS	Jamie Burleigh, John Bartsch	Tuckaway Shores
7/9/2020	DIVING/HAND HARVESTING	2.0 HOURS, 8.5 GALLONS	Jamie Burleigh, Shane Pelletier	Goves Cove
7/9/2020	DIVING/HAND HARVESTING	1.0 HOURS 0 GALLONS	Sarah Patey, Mary Colvard	Tuckaway Shores
7/9/2020	DIVING/HAND HARVESTING	2.0 HOURS, 0 GALLONS	Sarah Patey, Shane Pelletier	Goves Cove
7/12/2020	DIVING/HAND HARVESTING	5.0 HOURS, 4 GALLONS	Tim Roos, Barb Thompson	Small Cove North of South Channel
7/19/2020	DIVING/HAND HARVESTING	4.0 HOURS, 1 GALLONS	Tim Roos, Pete Wawrzonek	Small Cove North of South Channel
7/30/2020	DIVING/HAND HARVESTING	2.0 HOURS, 0.5 GALLONS	Jamie Burleigh, Shane Pelletier	Goves Cove

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
7/30/2020	DIVING/HAND HARVESTING	2.0 HOURS, 0 GALLONS	Sarah Patey	Goves Cove
8/2/2020	DIVING/HAND HARVESTING	3 GALLONS	Garrett Stumb, Mary Bates	Area 6
8/2/2020	DIVING/HAND HARVESTING	1.5 GALLONS	Tim Roos, Barb Thompson	Area 6
8/6/2020	DIVING/HAND HARVESTING	0.5 GALLONS	Tim Roos, Neil Santos	Gove's Cove
8/9/2020	DIVING/HAND HARVESTING	1.5 GALLONS	Garrett Stumb	South Channel, Area 4
8/16/2020	DIVING/HAND HARVESTING	0.5 GALLONS	Garrett Stub, Anne Noeth	Upper Gove's Cove
8/23/2020	DIVING/HAND HARVESTING	1.5 GALLONS	Sarah Patey, Steve Soreff	South Channel, Area 2
8/23/2020	DIVING/HAND HARVESTING	0.5 GALLONS	Tim Roos, Shelly Heit	South Channel, Area 2
8/30/2020	DIVING/HAND HARVESTING	0.5 GALLONS	Jamie Burleigh, Carol Wawzronek	South Channel, Area 5
8/30/2020	DIVING/HAND HARVESTING	1.5 GALLONS	Sarah Patey, Pete Wawzronek	South Channel, Area 5
9/6/2020	DIVING/HAND HARVESTING	2.5 GALLONS	Garrett Stub, Steve Soreff	South Channel, Area 1
9/10/2020	DIVING/HAND HARVESTING	3.0 GALLONS	Jamie Burleigh, Neil Santos	South Channel, Area 8
9/10/2020	DIVING/HAND HARVESTING	0 GALLONS	Sarah Patey, Neil Santos	South Channel, Area 8
9/13/2020	DIVING/HAND HARVESTING	0.5 GALLONS	Garrett Stub, Pete Wawzronek	Northeast end of South Channel
9/13/2020	DIVING/HAND HARVESTING	1.5 GALLONS	Sarah Patey, Pete Wawzronek	South Channel, Area 8
9/16/2020	DIVING/HAND HARVESTING	0 GALLONS	Tim Roos, Neil Santos	South Channel, Area 4
9/28/2020	DIVING/HAND HARVESTING	2.0 GALLONS	Jamie Burleigh, Pete Wawzronek	South Channel, Area 4
9/28/2020	DIVING/HAND HARVESTING	0 GALLONS	Sarah Patey, Carol Wawzronek	South Channel, Area 4

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
4/6/2021	DIVING/HAND HARVESTING	1 GALLON	Jamie Burleigh, Neil Santos	South Channel, Area 2
4/6/2021	DIVING/HAND HARVESTING	1 GALLON	Sarah Patey, Neil Santos	South Channel, Area 2
4/28/2021	DIVING/HAND HARVESTING	1.5 GALLONS	Jamie Burleigh, Neil Santos	South Channel, Area 6
4/28/2021	DIVING/HAND HARVESTING	1 GALLON	Sarah Patey, Neil Santos	South Channel, Area 6
5/19/2021	DIVING/HAND HARVESTING	1 GALLON	Sarah Patey, Neil Santos	Gove's Cove, Dike End
5/19/2021	DIVING/HAND HARVESTING	5 GALLONS	Jamie Burleigh, Neil Santos	Gove's Cove, Dike End
5/27/2021	DIVING/HAND HARVESTING	4 GALLONS	Garrett Stub, Shelly Heit	Gove's Cove, Dike End
7/2/2021	DIVING/HAND HARVESTING	5 GALLONS	Sarah Patey, Don Roberge, Kim Gable	Tuckaway Shores Cove, South Channel Area 3, Gove's Cove Dike end
7/2/2021	DIVING/HAND HARVESTING	0.25 GALLONS	Jamie Burleigh, Don Roberge, Kim Gable	Tuckaway Shores Cove, South Channel Area 3, Gove's Cove Dike end
7/14/2021	DIVING/HAND HARVESTING	10 GALLONS	Jamie Burleigh, Shelly Heit	Goves Cove, Area 2
7/14/2021	DIVING/HAND HARVESTING	5 GALLONS	Garrett Stumb, Pete Wawrzonek	Goves Cove, Area 2
7/15/2021	DIVING/HAND HARVESTING	6 GALLONS	Sarah Patey, Neil Santos	Little Cahill Cove
7/15/2021	DIVING/HAND HARVESTING	5 GALLONS	Tim Roos, Barb Thompson	Goves Cove, Area 3
7/17/2021	DIVING/HAND HARVESTING	8 GALLONS	Jamie Burleigh, Anne Noeth	Goves Cove, Area 3
7/17/2021	DIVING/HAND HARVESTING	7 GALLONS	Sarah Patey, Barb Thompson	Goves Cove, Area 3
7/18/2021	DIVING/HAND HARVESTING	9 GALLONS	Tim Roos, Pete Wawrzonek	South Channel, Area 6

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
7/26/2021	DIVING/HAND HARVESTING	2.5 GALLONS	Sarah Patey, Anne Noeth	South Channel, Area 4
7/30/2021	DIVING/HAND HARVESTING	2 GALLONS	Tim Roos, Anne Noeth	Goves Cove, Area 2
7/30/2021	DIVING/HAND HARVESTING	4.5 GALLONS	Sarah Patey, Peggy Tucker	Mooers Road Cove
7/30/2021	DIVING/HAND HARVESTING	1 GALLON	Tim Roos, Neil Santos	Little Cahill Cove
9/2/2021	DIVING/HAND HARVESTING	4 GALLONS	Sarah Patey, Carol Wawrzonek	Gove's Cove, Area 2
9/6/2021	DIVING/HAND HARVESTING	4 GALLONS	Garrett Stumb	South Channel, Area 3
9/7/2021	DIVING/HAND HARVESTING	4 GALLONS	Sarah Patey, Steve Soreff	South Channel, Area 6
9/10/2021	DIVING/HAND HARVESTING	2 GALLONS	Tim Roos, Neil Santos	Tuckaway Shores, Little Cahill, Gove's Cove
9/12/2021	DIVING/HAND HARVESTING	8 GALLONS	Kamil Supronik, Shelly Heit	South Channel, Area 6
9/14/2021	DIVING/HAND HARVESTING	55 GALLONS	Jamie Burleigh, Sarah Patey, Carol Wawrzonek, Neil Santos	State Park Canoe Rental
9/19/2021	DIVING/HAND HARVESTING	10 GALLONS	Kamil Supronik, Carol Wawrzonek	State Park Canoe Rental
9/19/2021	DIVING/HAND HARVESTING	0 GALLONS	Tim Roos, Susan Hayes	State Park Canoe Rental
9/21/2021	DIVING/HAND HARVESTING	5 GALLONS	Jamie Burleigh, Sarah Patey, Neil Santos	Drowns Dike, Drowns Dam, Neals Cove, South Channel Area 4
9/26/2021	DIVING/HAND HARVESTING	7 GALLONS	Tim Roos, Barb Thompson	South Channel, Area 4
7/1/2022	DIVING/HAND HARVESTING	10 GALLONS	Neil Santos,Jamie Burleigh, Carol Wawrzonek	South Channel, Area 7
7/7/2022	DIVING/HAND HARVESTING	SEVERAL LARGE CLUSTERS	Joe Medeiros, Bob Given, Jim Kelly	Gove's Cove, Areas 1 and 2

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
7/8/2022	DIVING/HAND HARVESTING	34 GALLONS	Jamie Burleigh, Sarah Patey	Gove's Cove, Areas 2 and 3
7/9/2022	DIVING/HAND HARVESTING	24 GALLONS	Garrett Stumb, Tim Roos	Little Cahill Cove, Gove's Cove Area 1
7/11/2022	DIVING/HAND HARVESTING	74 GALLONS	Jaime Burleigh, Sarah Patey	Little Cahill Cove, Gove's Cove Area 3
7/14/2022	DIVING/HAND HARVESTING	SEVERAL LARGE CLUSTERS	Neil Santos, Joe Medeiros, Bob Given, and Jim Kelly	Gove's Cove Area 2, and State Park Canoe Rental
7/16/2022	DIVING/HAND HARVESTING	14 GALLONS	Bob Given, Steve Arnault, Ty Quinn, Joe Medeiros, Aaron Wojtkowski	Mooers Road Cove (North and South), Tuckaway Shores, South Channel Area 2, Little Cahill Cove
7/21/2022	DIVING/HAND HARVESTING	MOSTLY SMALL/MEDIUM PLANTS	Bob Given, Neil Santos, Joe Medeiros	South Channel Area 6, Little Cahill Cove
7/22/2022	DIVING/HAND HARVESTING	6 GALLONS	Sarah Patey	South Channel Area 8
7/23/2022	DIVING/HAND HARVESTING	20 GALLONS	Garrett Stumb	Gove's Cove, Area 2
7/29/2022	DIVING/HAND HARVESTING	14 GALLONS	Sarah Patey, Bob Given, Neil Santos, Aaron Wojtkowski	Gove's Cove Area 2, South Channel Area 4
8/1/2022	DIVING/HAND HARVESTING	25 GALLONS	Jamie Burleigh, Anne Noeth	South Channel Area 6
8/2/2022	DIVING/HAND HARVESTING	8 GALLONS	SARAH PATEY, JAMIE BURLEIGH	Tuckaway Shores
8/4/2022	DIVING/HAND HARVESTING	Two big clusters, the rest medium to small	Bob Given, Neil Santos, Jim Kelly	Area 4
8/5/2022	DIVING/HAND HARVESTING	8 GALLONS	Sarah Patey, Aaron Wojtkowski, Bob Given,	SOUTH CHANNEL AREAS 1, 2
8/12/2022	DIVING/HAND HARVESTING	8 GALLONS	Bob Given, Neil Santos, Jaime Burliegh	SOUTH CHANNEL AREAS 1, 2

DATE	CONTROL ACTION	TIME/YIELD	CONTRACTOR/ENTITY	LOCATION
8/14/2022	DIVING/HAND HARVESTING	ONE CLUSTER OF SMALL PLANTS	Bob Given, Neil Santos, Joe Medeiros, Aaron Wojtkowski	South Channel Area 3
8/16/2022	DIVING/HAND HARVESTING	9 GALLONS	Sarah Patey, Jaime Burleigh	South Channel Area 3, North Cove, Gove's Cove Area 3
8/20/2022	DIVING/HAND HARVESTING	DID NOT SPECIFY	Joe Medeiros, Ty Quinn, Tim Kelly, Steve Arnault	South Channel Area 5
8/22/2022	DIVING/HAND HARVESTING	7 GALLONS	Sarah Patey, Jaime Burleigh	South Channel Area 5, Gove's Cove Area 1
8/24/2022	DIVING/HAND HARVESTING	4-5 LARGE CLUSTERS, THE REST SMALL/MEDIUM	Bob Given, Neil Santos	Gove's Cove Area 3
8/25/2022	DIVING/HAND HARVESTING	6 GALLONS	Sarah Patey	Gove's Cove Area 3
8/28/2022	DIVING/HAND HARVESTING	12 LARGE CLUSTERS THE REST SMALL/MEDIUM	Joe Medeiros, Ty Quinn, Jim Kelly, Neil Santos, Steve Arnault	Gove's Cove Areas 1,2
8/31/2022	DIVING/HAND HARVESTING	7 PLANTS	Bob Given, Neil Santos	Gove's Cove Area 1

Aquatic Invasive Plant Management Options

The control practices used should be as specific to the target species as feasible. No control of native aquatic plants is intended.

Exotic aquatic plant management relies on a combination of proven methods that control exotic plant infestations, including physical control, chemical control, biological controls (where they exist), and habitat manipulation.

Integrated Pest Management Strategies (IPM) are typically implemented using Best Management Practices (BMPs) based on site-specific conditions so as to maximize the long-term effectiveness of control strategies. Descriptions for the control activities are closely modeled after those prescribed by the Aquatic Ecosystem Restoration Foundation (AERF) (2004). This publication can be found online at http://www.aquatics.org/bmp.htm.

Additional information can be obtained from a document prepared for the State of Massachusetts called the Generic Environmental Impact Report for Lakes and Ponds, available at http://www.mass.gov/dcr/watersupply/lakepond/geir.htm.

Criteria for the selection of control techniques are presented in Appendix A. Appendix B includes a summary of the exotic aquatic plant control practices currently used by the State of New Hampshire.

Feasibility Evaluation of Control Options in this Waterbody

NHDES has evaluated the feasibility of potential control practices on the subject waterbody. The following table summarizes DES' control strategy recommendations for the subject waterbody:

Control Method	Use on Pawtuckaway Lake
Restricted Use Areas (RUAs) and/or Fragment Barriers	The purpose of RUAs and fragment barriers is to contain small areas of exotic aquatic plant growth to prevent them from spreading further in a system.
Hand-pulling and Diver-Assisted Suction Harvesting (DASH)	Recommended as a primary means of control for milfoil regrowth as it occurs, and for areas where density is low.
Mechanical Harvesting/Removal	Not recommended due to the risk of fragmentation and drift, and subsequent further spread of the invasive plant; also densities are too low to warrant such a practice.
Benthic Barriers	Recommended for small patches that are 20' x 20' in size or less, and where practical and useful.
Herbicides	Herbicide treatment is recommended for larger areas of growth that are not suitably managed by other non-chemical means of control.
Extended Drawdown	Not feasible or practical for this waterbody. Plant growth is deeper than would be exposed as a result of drawdown.
Dredge	Cost prohibitive and not often effective for controlling invasive aquatic plants like variable milfoil.
Biological Control	No biological controls are yet approved for use on variable milfoil.

Control Method	Use on Pawtuckaway Lake
No Control	A no control option would result in Pawtuckaway Lake being dominated by variable milfoil growth, and this is not a recommended strategy.

Recommended Actions, Timeframes and Responsible Parties

An evaluation of the size, location, and type of variable milfoil infestation, as well as the waterbody uses was conducted at the end of the last growing season (see attached figures for findings). Based on this survey the following recommendations are made for variable milfoil control in the system:

Year	Action	Responsible Party	Schedule
2023	Survey and planning for variable milfoil control activities	NHDES	May
	Weed Watching	Local Weed Watchers	Once a month from May through September
	Herbicide treatment (TBD based on May survey)	Solitude Lake Management	May/June or August
	Lake Hosting at public access site	Local Lake Hosts	Popular Boating Use Times
	Diving/DASH if needed	Local divers	As needed during growing season
	Survey waterbody and planning for next season's control actions	NHDES	September
2024	Survey and planning for variable milfoil control activities	NHDES	May

Year	Action	Responsible Party	Schedule
	Weed Watching	Local Weed Watchers	Once a month from May through September
	Herbicide treatment (TBD based on May survey)	Solitude Lake Management	May/June
	Lake Hosting at public access site	Local Lake Hosts	Popular Boating Use Times
	Diving/DASH if needed	Local divers	As needed during growing season
	Survey waterbody and planning for next season's control actions	NHDES	September
2025	Survey and planning for variable milfoil control activities	NHDES	May
	Weed Watching	Local Weed Watchers	Once a month from May through September
	Lake Hosting at public access site	Local Lake Hosts	Popular Boating Use Times
	Diving/DASH if needed	Local divers	As needed during growing season
	Survey waterbody and planning for next season's control actions	NHDES	September
2026	Survey and planning for variable milfoil control activities	NHDES	May

Year	Action	Responsible Party	Schedule
	Weed Watching	Local Weed Watchers	Once a month from May through September
	Lake Hosting at public access site	Local Lake Hosts	Popular Boating Use Times
	Diving/DASH if needed	Local divers	As needed during growing season
	Survey waterbody and planning for next season's control actions	NHDES	September
2027	Survey and planning for variable milfoil control activities	NHDES	May
	Weed Watching	Local Weed Watchers	Once a month from May through September
	Lake Hosting at public access site	Local Lake Hosts	Popular Boating Use Times
	Diving/DASH if needed	Local divers	As needed during growing season
	Survey waterbody and planning for next season's control actions	NHDES	September
2028	Update and revise Long-Term Variable Milfoil Control Plan	DES and Interested Parties	Fall/ Winter

Notes

Target Specificity

It is important to realize that aquatic herbicide applications are conducted in a specific and scientific manner. To the extent feasible, the permitting authority favors the use of selective herbicides that, where used appropriately, will control the target plant with little or no impact to non-target species, such that the ecological functions of native plants for habitat, lake ecology, and chemistry/biology will be maintained. *Not all aquatic plants will be impacted as a result of an herbicide treatment.*

Adaptive Management

Because this is a natural system that is being evaluated for management, it is impossible to accurately predict a management course over five years that could be heavily dependent on uncontrolled natural circumstances (weather patterns, temperature, adaptability of invasive species, etc).

This long-term plan is therefore based on the concept of adaptive management, where current field data (from field survey work using DES established field survey standard operating procedures) drive decision making, which may result in modifications to the recommended control actions and timeframes for control. As such, this management plan should be considered a dynamic document that is geared to the actual field conditions that present themselves in this waterbody.

If circumstances arise that require the modification of part or all of the recommendations herein, interested parties will be consulted for their input on revisions that may be needed to further the goal of invasive aquatic plant management in the subject waterbody.

Figure 1: Map of Variable Milfoil Infestations Over Time

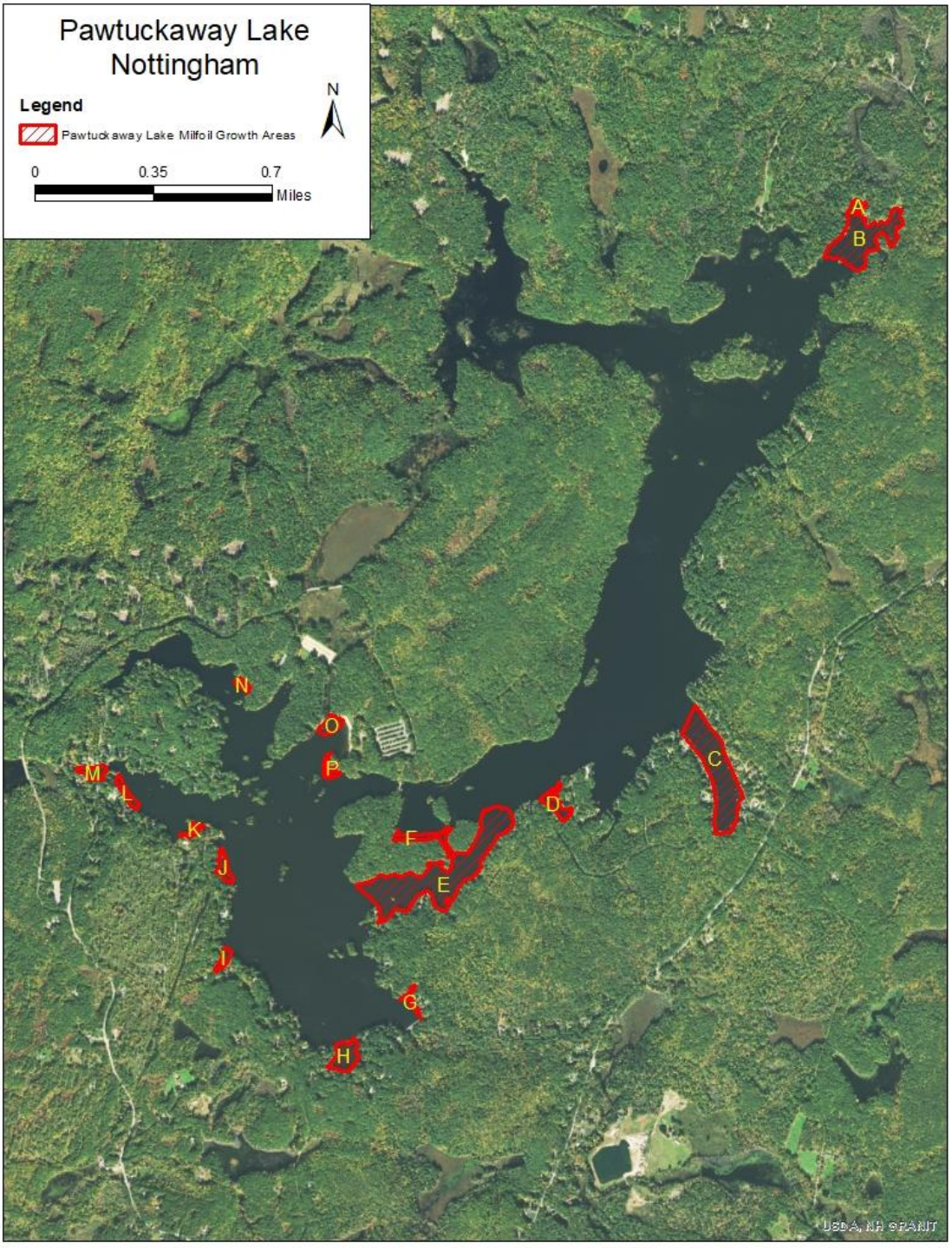
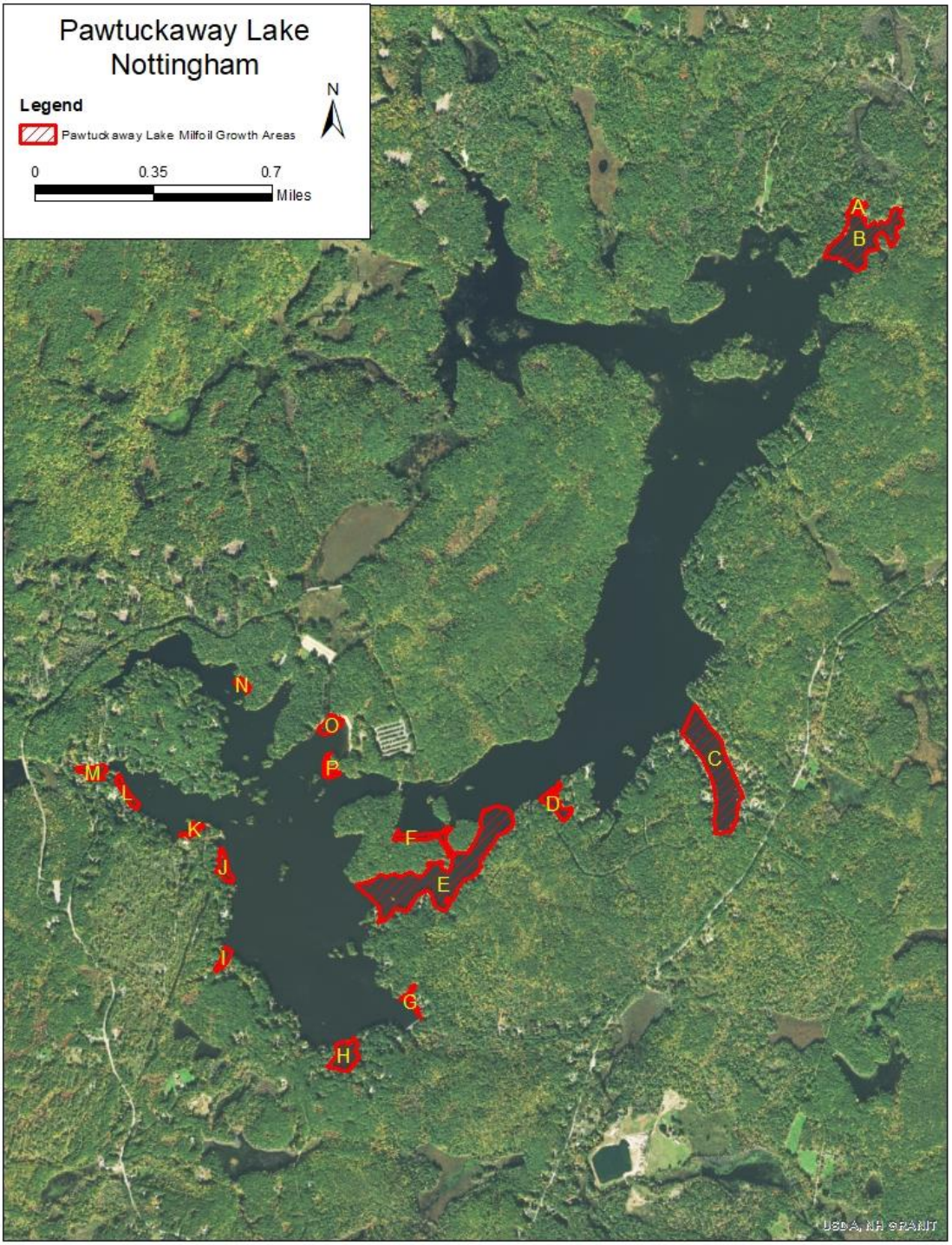


Figure 2: Map of Control Actions Over Time

Diving Locations Over Time (2015-2022)



2023 Proposed

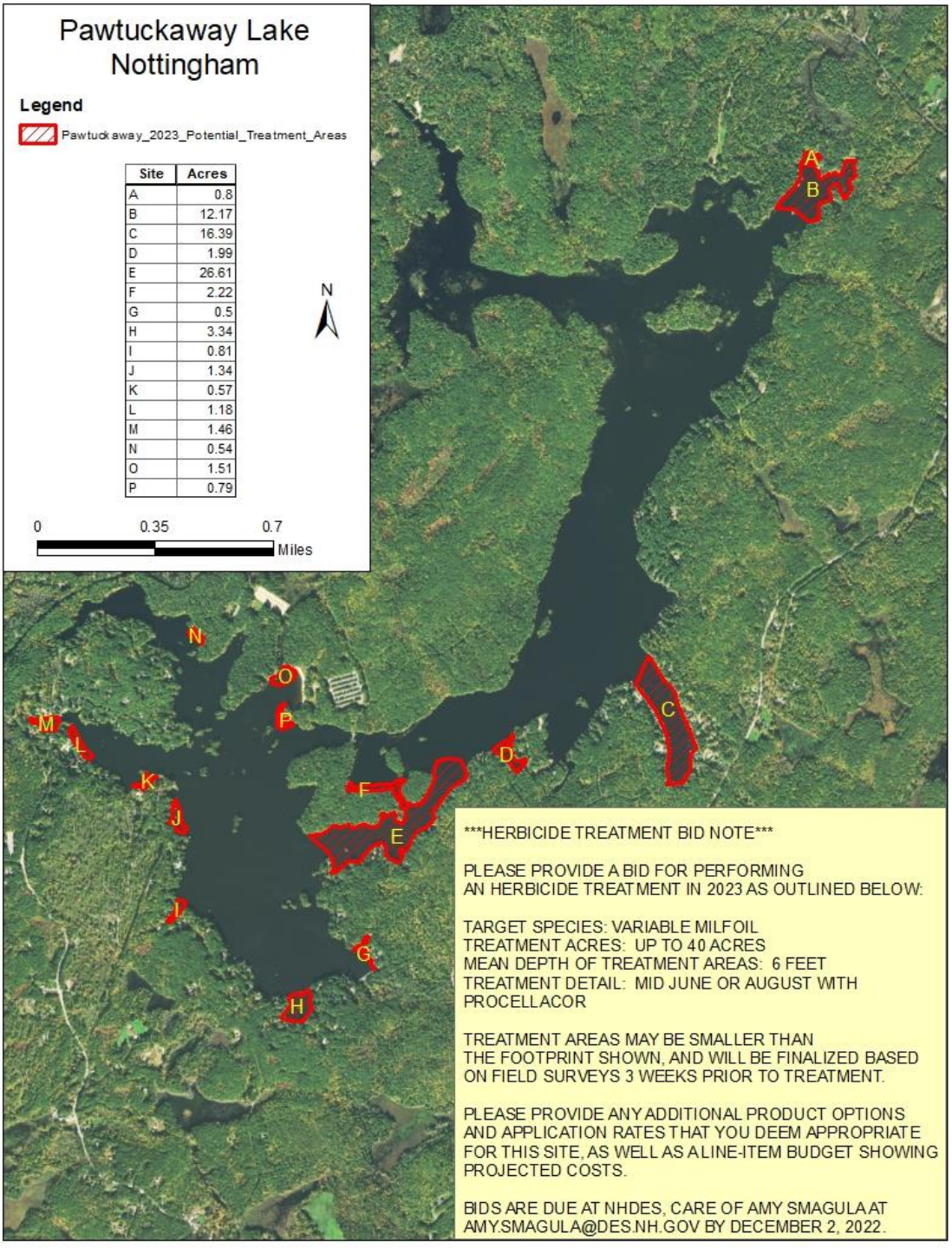
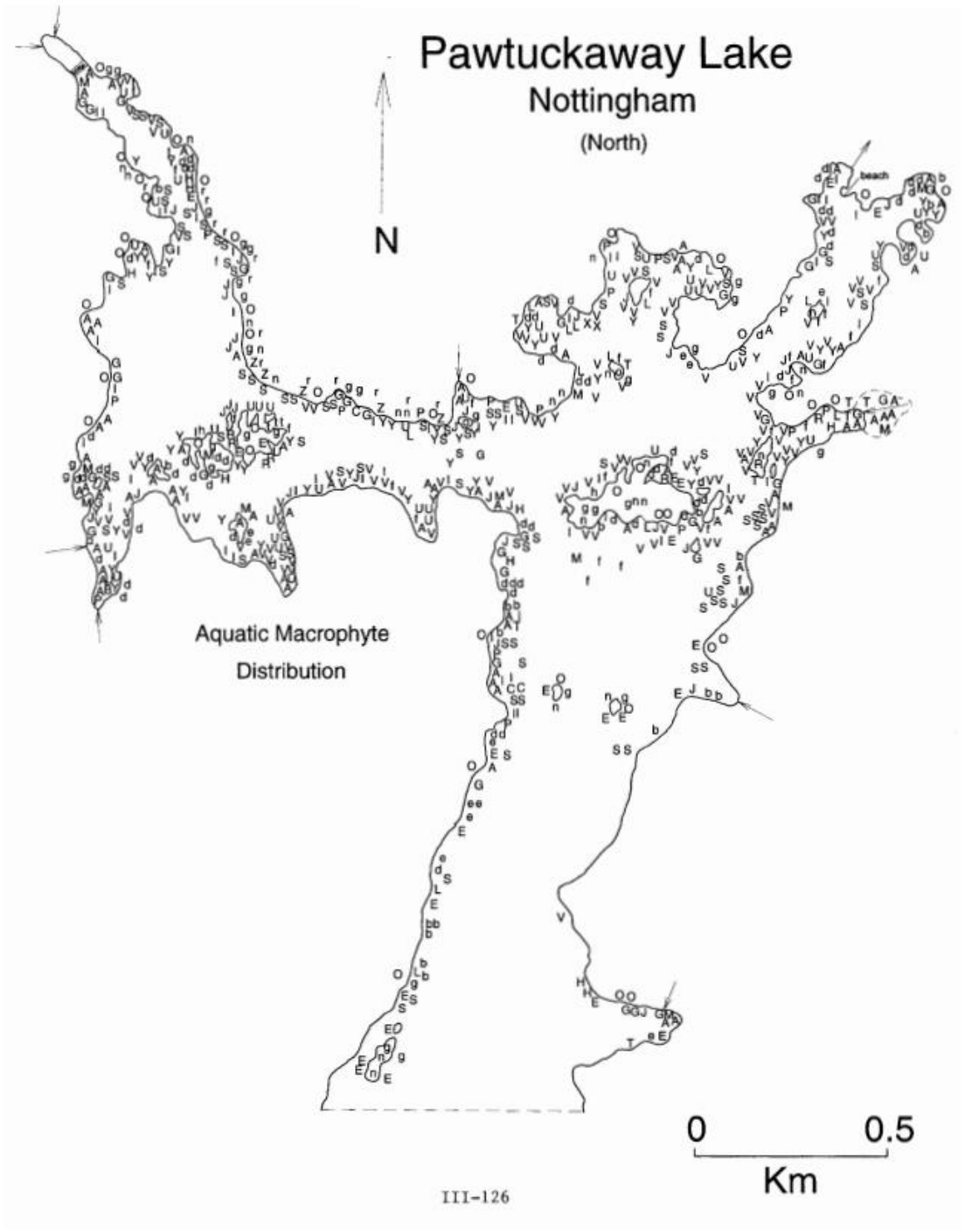
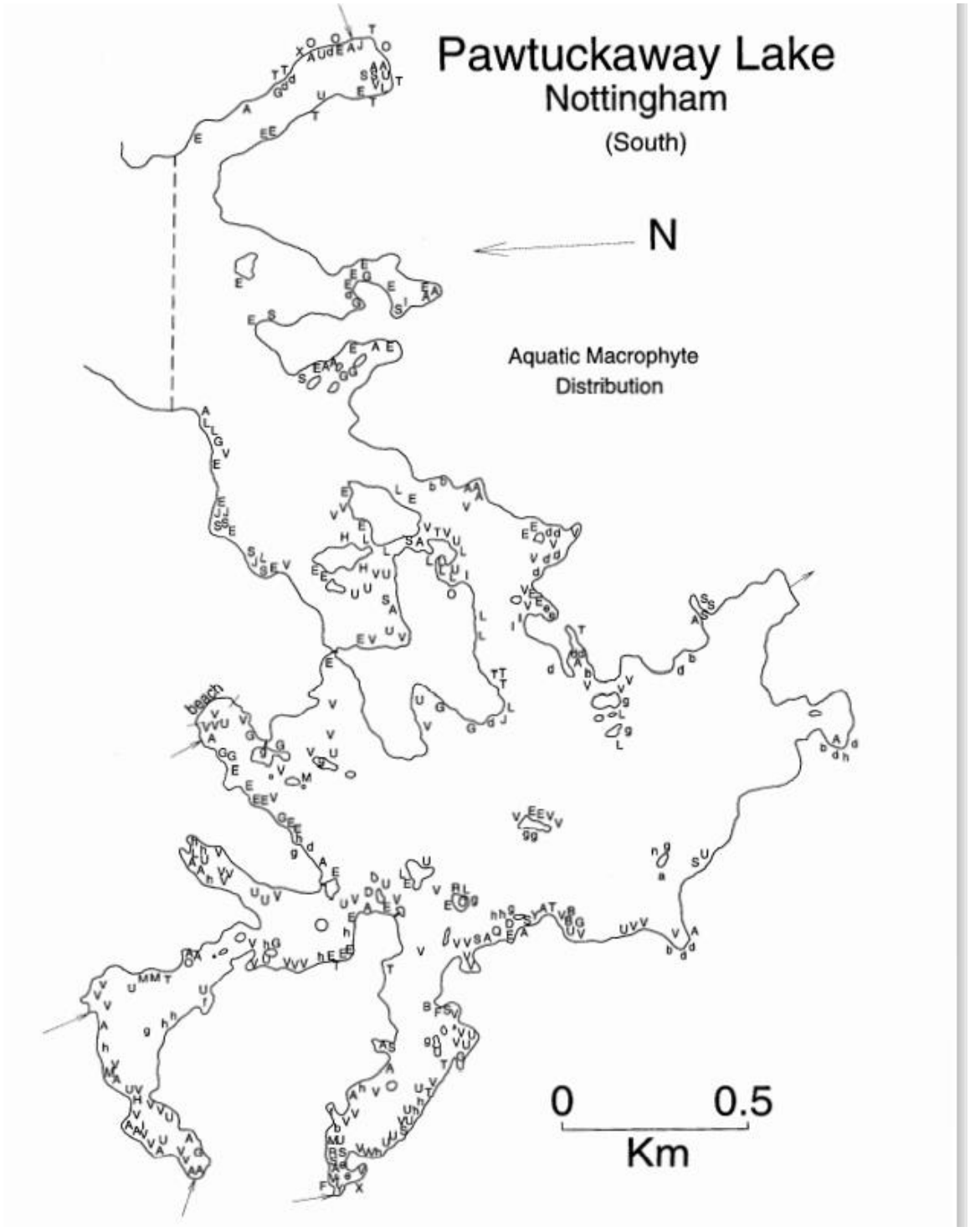


Figure 3: Native Macrophyte Map




Pawtuckaway Lake
Nottingham
(South)
N
Aquatic Macrophyte
Distribution
0
0.5
Km

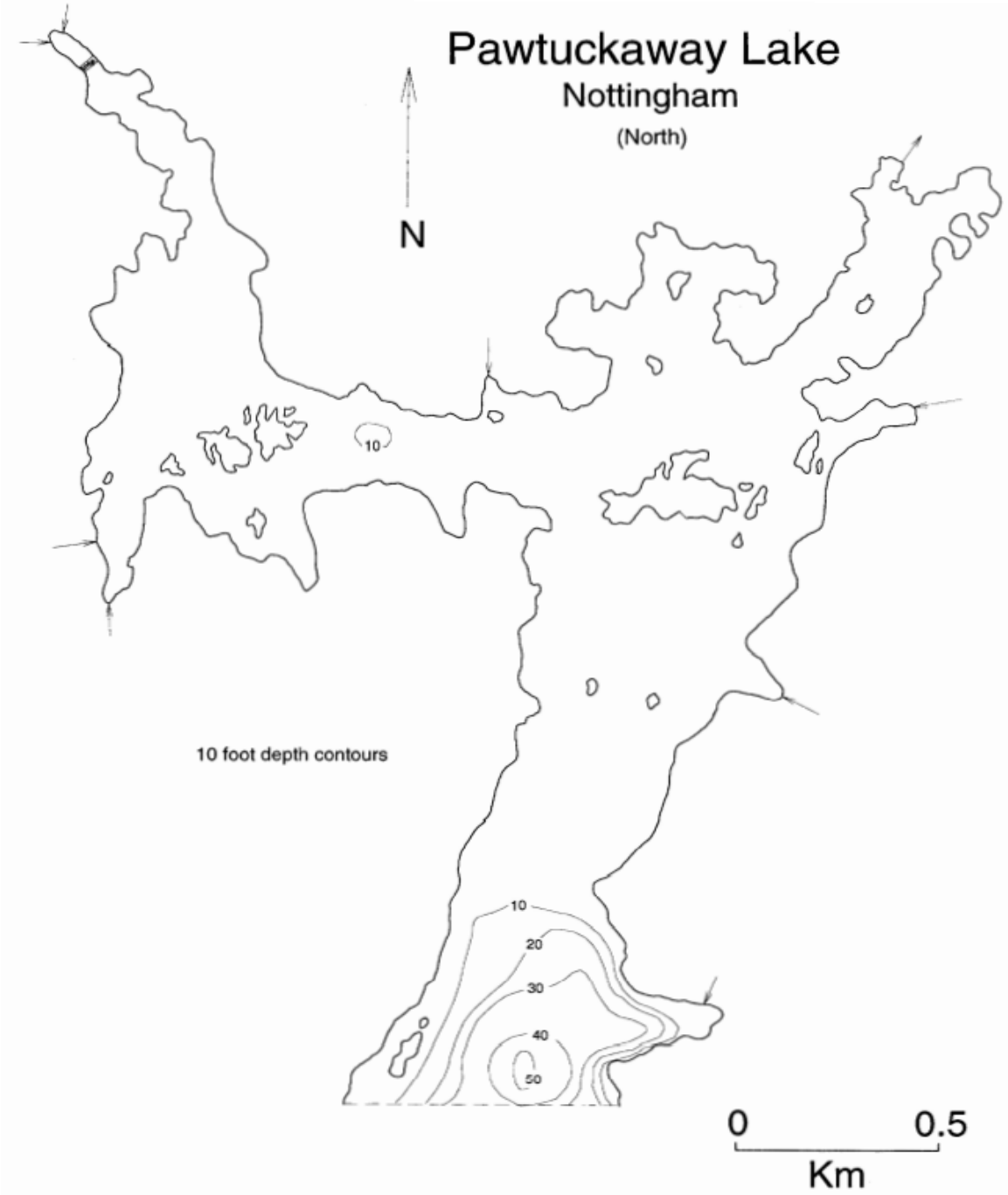
Key to Macrophyte Map

AQUATIC PLANT SURVEY

LAKE: PAWTUCKAWAY LAKE TOWN: NOTTINGHAM DATE: 08/11/1998

Key	PLANT NAME		ABUNDANCE
	GENERIC	COMMON	
A	Sagittaria	Arrowhead	Scat/Common
B	Brasenia schreberi	Water shield	Sparse
T	Typha	Cattail	Scattered
d	Dulichium arundinaceum	Three-way sedge	Scattered
D	Elodea nuttallii	Waterweed	Sparse
f		Filamentous algae	Scat/Common
G	Gramineae	Grass family	Common
F	Nymphoides cordatum	Floating heart	Sparse
M	Scirpus validus	Softstem bulrush	Sparse
O	Cephalanthus occidentalis	Buttonbush	Common/Abun
E	Eriocaulon septangulare	Pipewort	Common/Abun
Q	Isoetes	Quillwort	Sparse
b	Scirpus	Bulrush	Scattered
S	Sparganium	Bur reed	Abundant
V	Vallisneria americana	Tape grass	Abundant
U	Utricularia	Bladderwort	Abundant
a	Myrica asplenifolia	Sweet fern	Sparse
h	Gratiola	Hedge hyssop	Sparse
R	Potamogeton robbinsii	Robbins pondweed	Scattered
g	Myrica gale	Sweet gale	Common/Abun
n	Vaccinium corymbosum	High-bush blueberry	Scattered
K		Unknown woody flower	Sparse
e	Eleocharis	Spike rush	Scattered
I	Potamogeton nodosus	Pondweed	Scattered
Y	Nuphar	Yellow water lily	Sparse
P	Pontederia cordata	Pickerelweed	Sparse
k	Scutellaria	Skullcap	Sparse
Z	Solanum	Nightshade	Sparse
t	Ceratophyllum demersum	Coontail	Sparse
r	Clethra alnifolia	Sweet pepperbush	Scattered
C	Cyperaceae	Non-flowering sedge	Sparse
H	Hypericum	St. John's-wort	Sparse
X	Carex	Sedge	Sparse

Figure 4: Bathymetric Map



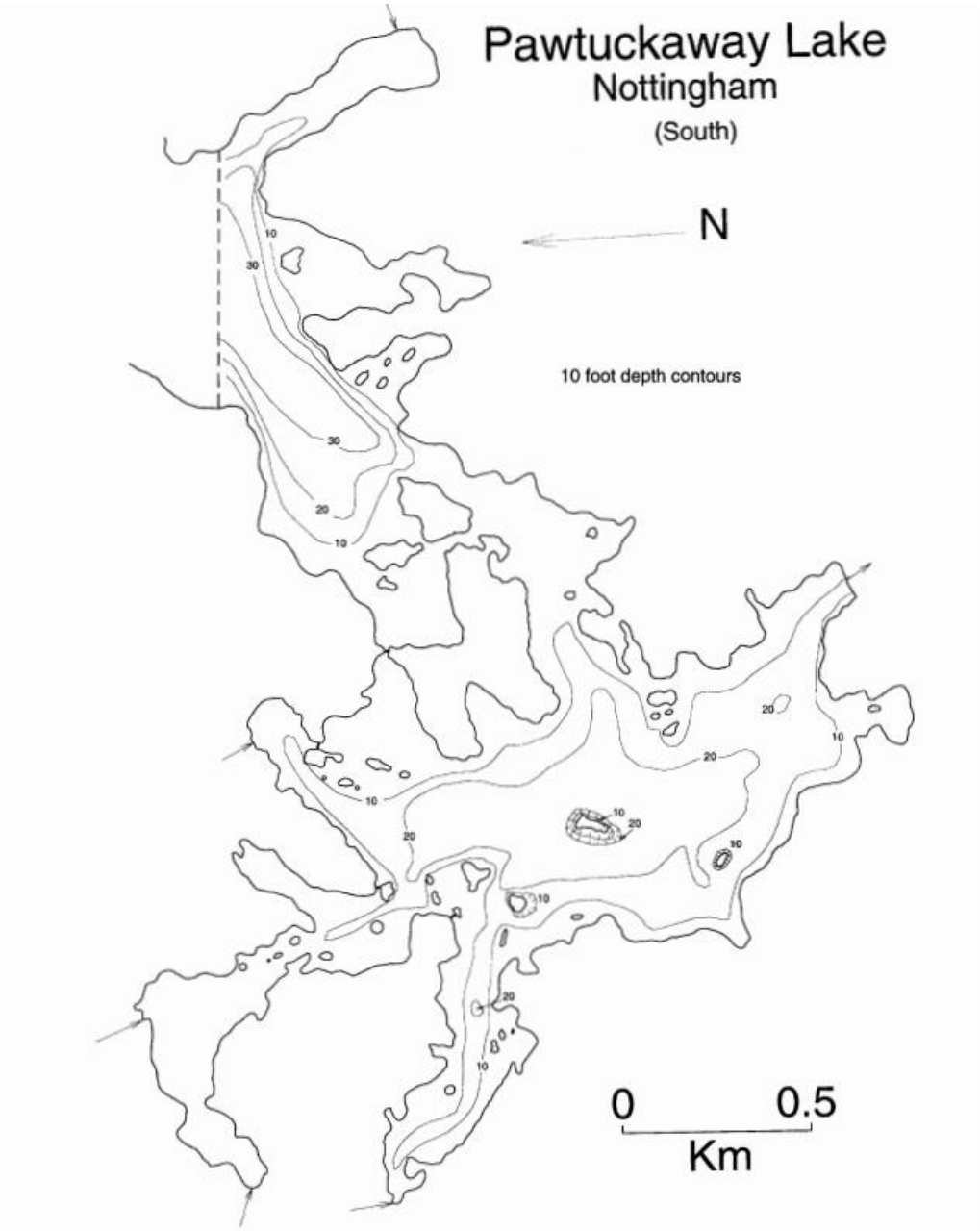

Pawtuckaway Lake
Nottingham
(South)
N
10 foot depth contours
0
0.5
Km

Figure 5: Public Access, Fishing Information, and Conservation Lands

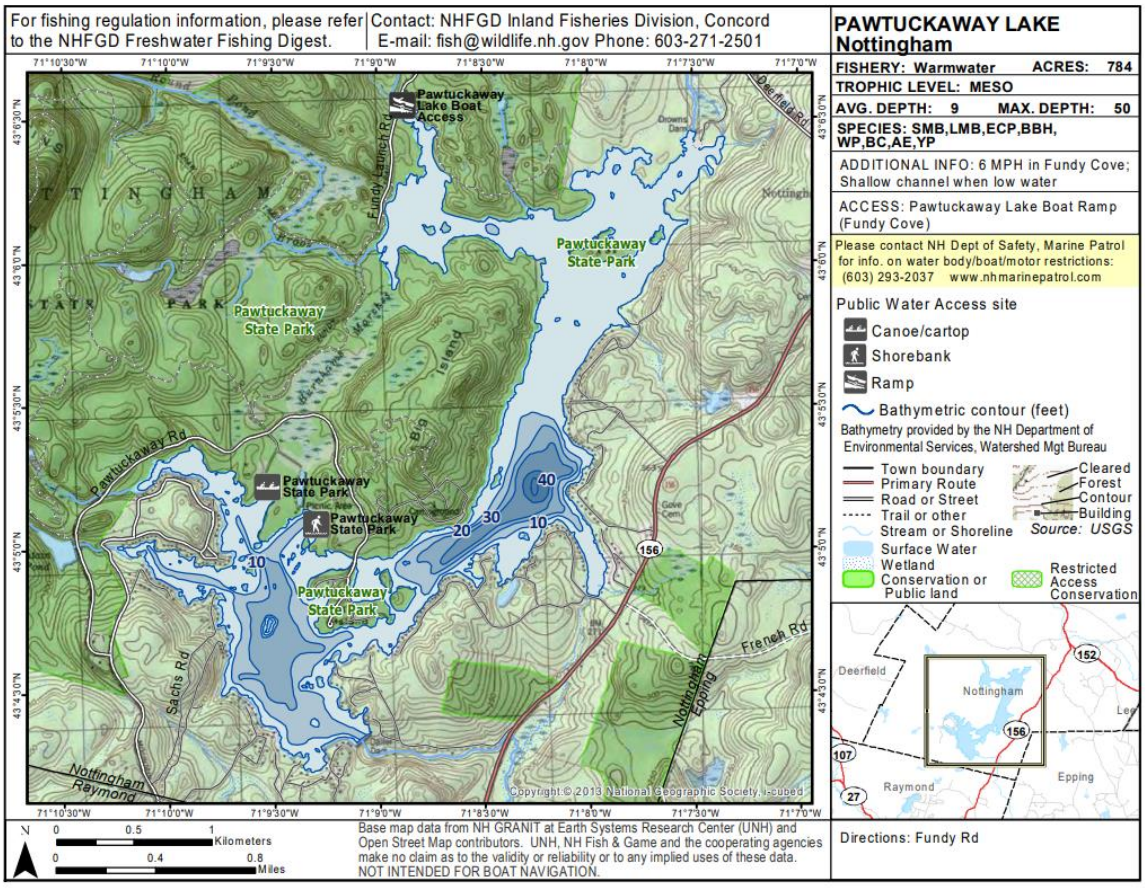
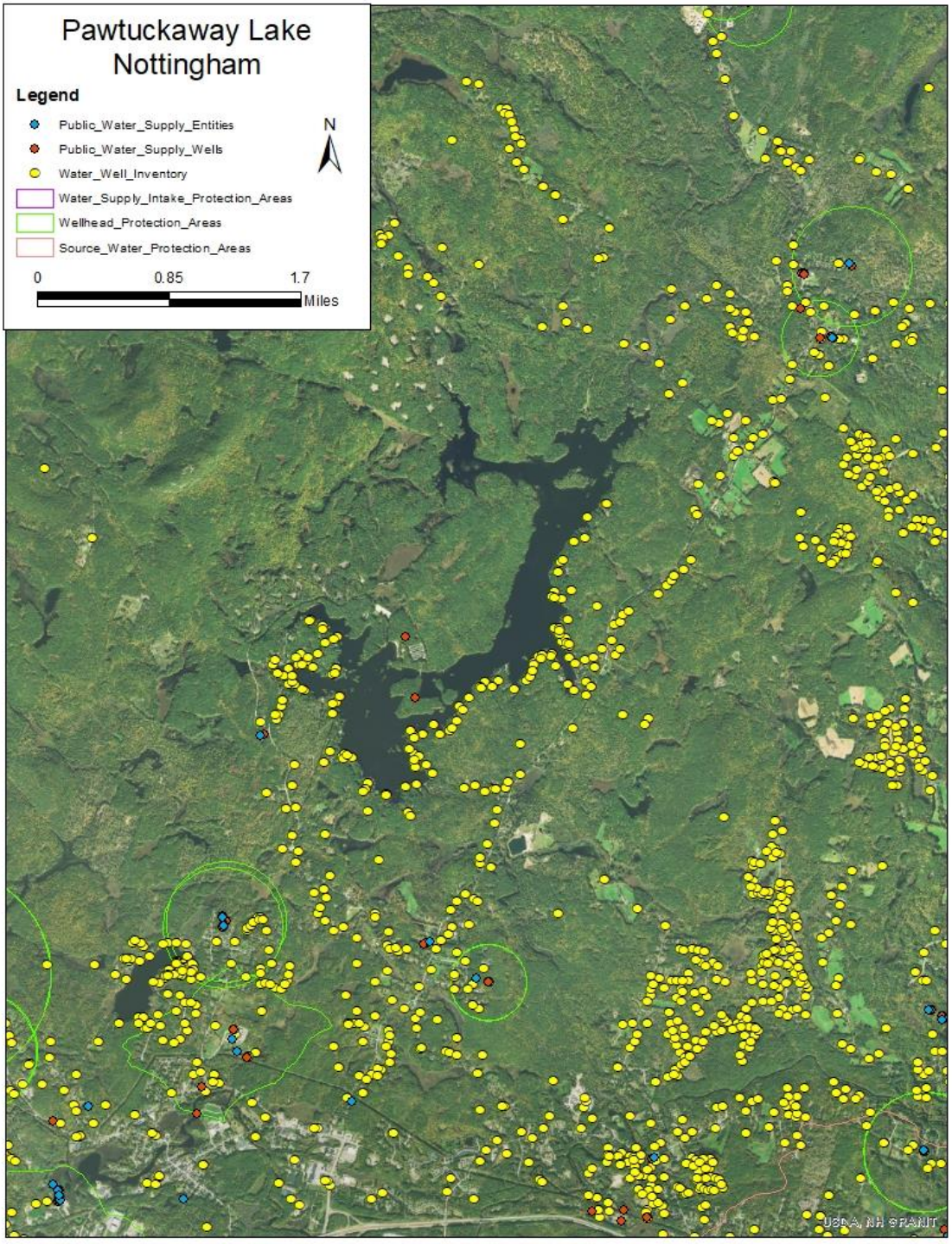


Figure 6: Wells and Water Supplies, 1:48,000 scale



Appendix A Selection of Aquatic Plant Control Techniques

Preliminary Investigations

I. Field Site Inspection

- Verify genus and species of the plant.
- Determine if the plant is a native or exotic species per RSA 487:16, II.
- Map extent of the exotic aquatic plant infestation (area, water depth, height of the plant, density of the population).
- Document any native plant abundances and community structure around and dispersed within the exotic/nuisance plant population (provide updated native plant map after review of milfoil in the Fall or after treatment)

II. Office/Laboratory Research of Waterbody Characteristics

- Contact the appropriate agencies to determine the presence of rare or endangered species in the waterbody or its prime wetlands.
- Determine the basic relevant limnological characteristics of the waterbody (size, bathymetry, flushing rate, nutrient levels, trophic status, and type and extent of adjacent wetlands).
- Determine the potential threat to downstream waterbodies from the exotic aquatic plant based on limnological characteristics (water chemistry, quantity, quality as they relate to movement or support of exotic plant growth).

Overall Control Options

For any given waterbody that has an infestation of exotic plants, one of four options will be selected, based on the status of the infestation, the available management options, and the technical knowledge of the DES Limnologists and other key resource managers who have conducted the field work and who are preparing or contributing to this plan. The options are as follows:

1) Eradication: The goal is to completely remove the exotic plant infestation over time. In some situations this may be a rapid response that results in an eradication event in a single season (such as for a new infestation), in other situations a longer-term approach may be warranted given the age and distribution of the infestation. Eradication is more feasible in smaller systems without extensive expanded growth (for example, Lake Winnipesaukee is unlikely to achieve eradication of its variable milfoil), or without upstream sources of infestation in other connected systems that continually feed the lake.

2) Maintenance: Waterbodies where maintenance is specified as a goal are generally those with expansive infestations, that are larger systems, that have complications of extensive wetland complexes on their periphery, or that have upstream sources of the invasive plant precluding the possibility for eradication. For waterbodies where maintenance is the goal, control activities will be performed on the waterbody to keep an infestation below a desirable threshold. For maintenance projects, thresholds of percent cover or other measurable classification will be indicated, and action will occur when exotic plant growth exceeds the threshold.

3) Containment: The aim of this approach is to limit the size and extent of the existing infestation within an infested waterbody if it is localized in one portion of that waterbody (such as in a cove or embayment), or if a whole lake is infested action may be taken to prevent the downstream migration of fragments or propagules. This could be achieved through the use of fragment barriers and/or Restricted Use Areas or other such physical means of containment. Other control activities may also be used to reduce the infestation within the containment area.

4) No action. If the infestation is too large, spreading too quickly, and past management strategies have proven ineffective at controlling the target exotic aquatic plant, DES, in consultation with others, may elect to recommend 'no action' at a particular site. Feasibility of control or control options may be revisited if new information, technologies, etc., develop.

If eradication, maintenance or containment is the recommended option to pursue, the following series of control techniques may be employed. The most appropriate technique(s) based on the determinations of the preliminary investigation will be selected.

Guidelines and requirements of each control practice are suggested and detailed below each alternative, but note that site specific conditions will be factored into the evaluation and recommendation of use on each individual waterbody with an infestation.

A. Hand-Pulling and Diver-Assisted Suction Harvesting

- Hand-pulling can be used if infestation is in a small localized area (sparsely populated patch of up to 5' X 5', single stems, or dense small patch up to 2' X 2'). For larger areas Diver-Assisted Suction Harvesting (DASH) may be more appropriate.
- Can be used if plant density is low, or if target plant is scattered and not dense.

- Can be used if the plant could effectively be managed or eradicated by hand-pulling or DASH
- Use must be in compliance with the Wetlands Bureau rules.

B. Mechanically Harvest or Hydro-Rake

- Can not be used on plants which reproduce vegetatively by fragmentation (e.g., milfoil, fanwort, etc.) unless containment can be ensured.
- Can be used only if the waterbody is accessible to machinery.
- Can be used if there is a disposal location available for harvested plant materials.
- Can be used if plant depth is conducive to harvesting capabilities (~ <7 ft. for mower, ~ <12 ft. for hydro-rake).
- If a waterbody is fully infested and no other control options are effective, mechanical harvesting can be used to open navigation channel(s) through dense plant growth.

C. Herbicide Treatment

- Can be used if application of herbicide is conducted in areas where alternative control techniques are not optimum due to depth, current, use, or density and type of plant.
- Can be used for treatment of exotic plants where fragmentation is a high concern.
- Can be used where species specific treatment is necessary due to the need to manage other plants
- Can be used if other methods used as first choices in the past have not been effective.
- A licensed applicator should be contacted to inspect the site and make recommendations about the effectiveness of herbicide treatment as compared with other treatments.

D. Restricted Use Areas (per RSA 487:17, II (d))

- Can be established in an area that effectively restricts use to a small cove, bay, or other such area where navigation, fishing, and other transient activities may cause fragmentation to occur.
- Can <u>not</u> be used when there are several “patches” of an infestation of exotic aquatic plants throughout a waterbody.
- Can be used as a temporary means of control.

E. Bottom Barrier

- Can be used in small areas, preferably less than 10,000 sq. ft.
- Can be used in an area where the current is not likely to cause the displacement of the barrier.
- Can be used early in the season before the plant reaches the surface of the water.
- Can be used in an area to compress plants to allow for clear passage of boat traffic.
- Can be used in an area to compress plants to allow for a clear swimming area.
- Use must be in compliance with the Wetlands Bureau rules.

F. Drawdown

- Can be used if the target plant(s) are susceptible to drawdown control.
- Can be used in an area where bathymetry of the waterbody would be conducive to an adequate level of drawdown to control plant growth, but where extensive deep habits exist for the maintenance of aquatic life such as fish and amphibians.
- Can be used where plants are growing exclusively in shallow waters where a drawdown would leave this area "in the dry" for a suitable period of time (over winter months) to control plant growth.
- Can be used in winter months to avoid encroachment of terrestrial plants into the aquatic system.
- Can be used if it will not significantly impact adjacent or downstream wetland habitats.
- Can be used if spring recharge is sufficient to refill the lake in the spring.
- Can be used in an area where shallow wells would not be significantly impacted.
- Reference RSA 211:11 with regards to drawdown statutes.

G. Dredge

- Can be used in conjunction with a scheduled drawdown.
- Can be used if a drawdown is not scheduled, though a hydraulic pumping dredge should be used.
- Can only be used as a last alternative due to the detrimental impacts to environmental and aesthetic values of the waterbody.

H. Biological Control

- Grass carp cannot be used as they are illegal in New Hampshire.
- Exotic controls, such as insects, cannot be introduced to control a nuisance plant

unless approved by Department of Agriculture.

- Research should be conducted on a potential biological control prior to use to determine the extent of target specificity.

Appendix B Summary of Control Practices Used in NH

Restricted Use Areas and Fragment Barrier:

Restricted Use Areas (RUAs) are a tool that can be use to quarantine a portion of a waterbody if an infestation of exotic aquatic plants is isolated to a small cove, embayment, or section of a waterbody. RUAs generally consist of a series of buoys and ropes or nets connecting the buoys to establish an enclosure (or exclosure) to protect an infested area from disturbance. RUAs can be used to prevent access to these infested areas while control practices are being done, and provide the benefit of restricting boating, fishing, and other recreational activities within these areas, so as to prevent fragmentation and spread of the plants outside of the RUA.

Hand-pulling:

Hand-pulling exotic aquatic plants is a technique used on both new and existing infestations, as circumstances allow. For this technique divers carefully hand-remove the shoots and roots of plants from infested areas and place the plant material in mesh dive bags for collect and disposal. This technique is suited to small patches or areas of low density exotic plant coverage.

For a new infestation, hand-pulling activities are typically conducted several times during the first season, with follow-up inspections for the next 1-2 years or until no re-growth is observed. For existing infestations, hand-pulling may be done to slow the expansion of plant establishment in a new area or where new stems are removed in a section that may have previously been uninfested. It is often a follow-up technique that is included in most management plans.

In 2007 a new program was created through a cooperative between a volunteer monitor that is a certified dive instructor, and the DES Exotic Species Program. A Weed Control Diver Course (WCD) was developed and approved through the Professional Association of Dive Instructors (PADI) to expand the number of certified divers available to assist with hand-pulling activities. DES has only four certified divers in the Limnology Center to handle problems with aquatic plants, and more help was needed. There is a unique skill involved with hand-removing plants from the lake bottom. If the process is not conducted correctly, fragments could spread to other waterbody locations. For this reason, training and certification are needed to help ensure success. Roughly 100 divers were certified through this program through the 2010 season. DES maintains a list of WCD divers and shares them with waterbody

groups and municipalities that seek diver assistance for controlling exotic aquatic plants. Classes are offered two to three times per summer.

Diver Assisted Suction Harvesting

Diver Assisted Suction Harvesting (DASH) is an emerging and evolving control technique in New Hampshire. The technique employs divers that perform hand removal actions as described above, however, instead of using a dive bag a mechanical suction device is used to entrain the plants and bring them topside where a tender accumulates and bags the material for disposal. Because of this variation divers are able to work in moderately dense stands of plants that cover more bottom area, with increased efficiency and accuracy.

Mechanical Harvesting

The process of mechanical harvesting is conducted by using machines which cut and collect aquatic plants. These machines can cut the plants up to twelve feet below the water surface. The weeds are cut and then collected by the harvester or other separate conveyer-belt driven device where they are stored in the harvester or barge, and then transferred to an upland site.

The advantages of this type of weed control are that cutting and harvesting immediately opens an area such as boat lanes, and it removes the upper portion of the plants. Due to the size of the equipment, mechanical harvesting is limited to water areas of sufficient size and depth. It is important to remember that mechanical harvesting can leave plant fragments in the water, which if not collected, may spread the plant to new areas. Additionally harvesters may impact fish and insect populations in the area by removing them in harvested material. Cutting plant stems too close to the bottom can result in re-suspension of bottom sediments and nutrients. This management option is only recommended when nearly the entire waterbody is infested, and harvesting is needed to open navigation channels through the infested areas.

Benthic Barriers:

Benthic barriers are fiberglass coated screening material that can be applied directly to the lake bottom to cover and compress aquatic plant growth. Screening is staked or weighted to the bottom to prevent it from becoming buoyant or drifting with current. The barriers also serve to block sunlight and prevent photosynthesis by the plants, thereby killing the plants with time. While a reliable method for small areas of plants (roughly 100 sq. ft. or less), larger areas are not reasonably controlled with this method due to a variety of factors (labor intensive installation, cost, and gas accumulation and bubbling beneath the barrier).

Targeted Application of Herbicides:

Application of aquatic herbicides is another tool employed for controlling exotic aquatic plants. Generally, herbicides are used when infestations are too large to be controlled using other alternative non-chemical controls, or if other techniques have been tried and have proven unsuccessful. Each aquatic plant responds differently to different herbicides and concentrations of herbicides, but research performed by the Army Corps of Engineers has isolated target specificity of a variety of aquatic herbicides for different species.

Generally, 2,4-D (Navigate formulation) is the herbicide that is recommended for control of variable milfoil. Based on laboratory data this is the most effective herbicide in selectively controlling variable milfoil in New Hampshire's waterbodies.

A field trial was performed during the 2008 summer using the herbicide Renovate to control variable milfoil. Renovate is a systemic aquatic herbicide that targets both the shoots and the roots of the target plant for complete control. In this application it was dispersed as a granular formulation that sank quickly to the bottom to areas of active uptake of the milfoil plants. A small (<5 acre) area of Captains Pond in Salem was treated with this systemic herbicide. The herbicide was applied in pellet form to the infested area in May 2008, and showed good control by the end of the growing season. Renovate works a little more slowly to control aquatic plants than 2,4-D and it is a little more expensive, but presents DES with another alternative that could be used in future treatments.

During the summer of 2010, DES worked with other researchers to perform field trials of three different formulations of 2,4-D in Lake Winnisquam, to

determine which product was most target-specific to the variable milfoil. Navigate formulation was used, as were a 2,4-D amine formulation, and a 2,4-D amine and triclopyr formulation (MaxG). Although the final report has not been completed for this study, preliminary results suggest that all three products worked well, but that Navigate formation may be the most target specific of all three.

Another herbicide, Fluridone, is sometimes also used in New Hampshire, mainly to control growths of fanwort (*Cabomba caroliniana*). Fluridone is a systemic aquatic herbicide that inhibits the formation of carotenoids in plants. Reduced carotenoids pigment ultimately results in the breakdown of chlorophyll and subsequent loss of photosynthetic function of the plants.

Other aquatic herbicides are also used in New Hampshire when appropriate (glyphosate, copper compounds, etc). The product of choice will be recommended based on what the target species is, and other waterbody-specific characteristics that are important to consider when selecting a product.

In 2018, a new aquatic formulation of an herbicide was labeled and licensed for use. ProcellaCOR is a reduced-risk liquid formulation herbicide that is a systemic. Based on New Hampshire field data, it works well on variable milfoil, it is taken up very quickly following treatment (hours) and it degrades quickly in the water column, with typical non-detect readings within 24-48 hours post treatment.

Extended Drawdown

Extended drawdown serves to expose submersed aquatic plants to dessication and scouring from ice (if in winter), physically breaking down plant tissue. Some species can respond well to drawdown and plant density can be reduced, but for invasive species drawdown tends to yield more disturbance to bottom sediments, something to which exotic plants are most adapted. In waterbodies where drawdown is conducted exotic plants can often outcompete native plants for habitat and come to dominate the system.

Some waterbodies that are heavily infested with exotic plants do conduct drawdowns to reduce some of the invasive aquatic plant density. During this reporting period both Northwood Lake (Northwood) and Jones Pond (New Durham) coordinated deep winter drawdowns to reduce growths of variable milfoil (the drawdown on Northwood Lake is primarily for flood control

purposes, but they do see some ancillary benefits from the technique for variable milfoil control).

Dredging

Dredging is a means of physical removal of aquatic plants from the bottom sediments using a floating or land-based dredge. Dredging can create a variety of depth gradients creating multiple plant environments allowing for greater diversity in lakes plant, fish, and wildlife communities. However due to the cost, potential environmental effects, and the problem of sediment disposal, dredging is rarely used for control of aquatic vegetation alone.

Dredging can take place in to fashion, including drawdown followed by mechanical dredging using an excavator, or using a diver-operated suction dredge while the water level remains up.

Biological Control

There are no approved biological controls for submersed exotic aquatic plant at this time in New Hampshire.

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