Prepared by:
NH Department of
Environmental Services
February 2020

Long-Term Variable Milfoil Management Plan

Glen Lake
Goffstown, 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. 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 Glen Lake, Goffstown

Variable milfoil (*Myriophyllum heterophyllum*) was first documented in Glen Lake in Goffstown, New Hampshire in 2007, though we expect the new infestation of this waterbody was in 2006 or earlier, due to upstream sources of milfoil flowing downstream from Scobie Pond (aka, Haunted Lake) and infesting downstream basins along the river.

Due to the infestation being present in several areas of the Piscataquog River, it should be clearly understood that milfoil control efforts in Glen Lake will need to be well-coordinated (both in town and with other towns), long-term, multi-faceted, and done using integrated plant management techniques that also include a substantial monitoring and reporting effort by Weed Watchers.

Figure 1 illustrates the distribution of variable milfoil infestations in this waterbody over time. The following table provides a summary of variable milfoil growth as shown in Figure 1 (area name reference in table below is relative to grid overlay of Figure 1).

Area	Location/Area Description	Year	Description of Growth	Percent Cover
A2	Western end of lake, inlet channel above dam	2011	Milfoil growth above dam in scattered patches along shore, no growth immediately below dam due to high flow	Upstream- 25% Below dam- 0%
		2012	Milfoil growth	Upstream- 25%

Area	Location/Area Description	Year	Description of Growth	Percent Cover
			above dam in scattered patches along shore, no growth immediately below dam due to high flow	Below dam- 0%
		2013	Milfoil growth above dam in scattered patches along shore, no growth immediately below dam due to high flow	Upstream- 25% Below dam- 0%
		2014	Not surveyed	
		2015	Not surveyed	
		2016	Scattered patches of growth along channel	
		2017	Not surveyed	
		2018	Not surveyed	
		2019	Expansive variable milfoil growth along impounded pool area in a reach of the river, upstream of dam to Glen Lake	In reach: 60%
B2/B3	West-central portion of Glen Lake	2011	Moderate to dense patches of variable milfoil growth	40%
		2012	Moderate to dense patches of variable milfoil growth	40%
		2013	Moderate to dense patches of variable milfoil growth	40%
		2014	Scattered patches of growth throughout	<25%
		2015	Scattered patches of growth throughout	<25%
		2016	Scattered patches of growth throughout	<25%
		2017	Scattered patches of growth throughout	<25%
		2018	Scattered patches of growth throughout	<25%
		2019	Scattered patches of growth throughout	<25%
C2	East-central portion of Glen Lake	2011	Patches of growth extending in a strip along shore, in 5	15%

Area	Location/Area Description	Year	Description of Growth	Percent Cover
			feet of water	
		2012	Patch removed by diver	0%
		2013	Patches of growth extending in a strip along shore, in 5 feet of water	15%
		2014	Band of growth along shore in about 5’ of water	<15%
		2015	No milfoil observed in this area	0%
		2016	A few plants along shore	<1%
		2017	No milfoil observed in this area	0%
		2018	No milfoil observed in this area	0%
		2019	No milfoil observed in this area	0%
D2	Northern shoreline at eastern end of lake. Location of town swim beach as well as boat launch	2012	Area managed by diver	0%
		2013	No milfoil growth observed	0%
		2011	Small patches and single stems of growth	10%
		2012	A couple of plants along shore	<1%
		2013	A couple of plants along shore	<1%
		2014	A couple of plants along shore	<1%
		2015	A couple of plants along shore	<1%
		2016	No milfoil observed	0%
		2017	A couple of plants along shore	<1%
		2018	A couple of plants along shore	<1%
		2019	A couple of plants along shore	<1%
C3/D3	Southern shoreline along eastern half of lake	2012	A couple of plants observed in a small cove in C2, otherwise no other milfoil observed	<1%
		2013	None observed	0%
		2014	None observed	0%

Area	Location/Area Description	Year	Description of Growth	Percent Cover
		2015	A couple of plants observed in a small cove in C2, otherwise no other milfoil observed	<1%
		2016	A couple of plants observed in a small cove in C2, otherwise no other milfoil observed	<1%
		2017	A couple of plants observed in a small cove in C2, otherwise no other milfoil observed	<1%
		2018	None observed	0%
		2019	None observed	0%

In terms of the impacts of the variable milfoil in the system, there are several houses around the shoreline of Glen Lake, with mostly year round homes. There are also numerous back lots with lake rights via designated rights of ways going down to the lake edge.

Lake residents have expressed concerns about variable milfoil spreading further throughout the lake system to a level that could ultimately impede recreational uses of the waterbody. Additional concerns are that variable milfoil fragments could spread down through the Piscataquog River system and increase areas of milfoil infestation in the Merrimack River downstream. Figure 2 illustrates the sequence of exotic plant control actions over time, including one for the upcoming growing season.

Milfoil Management Goals and Objectives

The goal for Glen Lake is to greatly reduce the overall distribution and density of variable milfoil within the system using an Integrated Pest Management Approach.

Eradication in this system is not feasible at this time due to the presence of an upstream infestation in Scobie Pond in Francestown. Control activities have been ongoing in Scobie Pond for a number of years, and efforts have reduced the milfoil growth, however some growth persists, and fragments can easily flow downstream through the Piscataquog River and contribute to continued growth in Glen Lake.

Acting now in Glen Lake, before upstream infestations are fully controlled, is intended to provide relief to shorefront property owners who have experienced use impairments since the infestation began, and to keep milfoil growth restricted and at lower density to limit further downstream migration of fragments.

Local Support

Town or Municipality Support

The Town of Goffstown has been involved in the milfoil issue in the Piscataquog River and related impoundments. They have provided funding to both Glen Lake and Namaske Lake for control efforts.

Lake Resident Support

There is a specialy formed watershed association for Glen Lake that will be working to coordinate variable milfoil control efforts at the local level. NHDES will work with them to establish a Weed Watcher Program for the lake, and will also offer technical support and grants where feasible for control efforts.

Waterbody Characteristics

The following table summarizes basic physical and biological characteristics of Glen Lake, including the milfoil infestation. Note that a current review of the Natural Heritage Bureau (NHB) database was requested and the results from that search are included in the table below, as well as in other key sections of this report as they may pertain to the type of species (fish, wildlife, habitat, or macrophyte).

General Lake Information	
Lake area (acres)	118.8
Watershed area (acres)	129,428.0
Shoreline Uses (residential, forested, agriculture)	Residential, forested
Max Depth (ft)	52.1
Mean Depth (ft)	19.5
Trophic Status	Mesotrophic
Color (CPU) in Epilimnion	22
Clarity (ft)	5.9
Flushing Rate (yr^{-1})	80.0
Natural waterbody/Raised	Artificial

by Damming/Other	
Invasive Plants	Variable milfoil European naiad Purple loosestrife
Infested Area (acres)	See Figures
Distribution (ringing lake, patchy growth, etc)	See Figures
Sediment type in infested area (sand/silt/organic/rock)	Sandy/rocky/silty
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	2020 Review Brook Floater (*Alasmidonta varicosa*) Spotted Turtle (*Clemmys guttata*) Wood Turtle (*Glyptemys insculpta*) Historic Review: Northern Black Racer (*Coluber constrictor constrictor*) Redfin Pickerel (*Esox americanus americanus*) Smooth Green Snake (*Opheodrys vernalis*)

An aquatic vegetation map and key is shown in Figure 3. A bathymetric map is shown in Figure 4. The NHB map is shown in Figure 5.

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

Glen Lake is a man-made lake that was created by damming the Piscataquog River. According to the New Hampshire Fish and Game Department, there is excellent bottom structure in the form of submerged trees and stumps on one side, while the opposite side exhibits a rocky shoreline with a rapid drop-off. Fish species present include largemouth bass, smallmouth bass, golden shiner, pickerel, yellow perch, white perch, common white sucker, brown bullhead, and yellow bullhead. Brook trout and rainbow trout are also stocked each year. Fishing pressure is light during open-water and rare during winter.

The NHB historic review for this waterbody has previously listed one fish species of special interest or concern.

Redfin Pickerel (*Esox americanus americanus*): The redfin pickerel record dates from 1996, when one individual was observed below Glen Lake. This species is listed as a species of concern in New Hampshire, due to rarity or vulnerability.

Wildlife Information

A Natural Heritage Inventory review showed that there were several species of interest and/or concern in the area, including the Brook Floater (*Alasmidonta varicosa*). The 2019 review listed the Northern Black Racer (*Coluber constrictor constrictor*), Smooth Green Snake (*Opheodrys vernalis*), Spotted Turtle (*Clemmys guttata*) and Wood Turtle (*Glyptemys insculpta*) as species of concern.

Brook floater: The brook floater mussel is listed as state endangered, and the record dates to 1993, when about 50 individuals were observed in a portion of the main stem of the river.

Northern black racer: This snake is listed as threatened in NH due to rarity and vulnerability. It was documented in 2011 in a power line corridor near Glen Lake.

Smooth green snake: This snake is listed as a species of concern in NH, where it is rare or uncommon. It was last documented in 2009 in the vicinity of a power line.

Spotted Turtle: This turtle is listed as state threatened. Specimens were observed in various locations around Glen Lake in 1974, 1982 and 2005.

Wood turtle: The wood turtle is listed as a species of conern in New Hampshire. Individuals were observed in 1997, 2011 and 2012 in sand pits and vernal pools near Glen Lake.

DES and the contractors are glad to work with the Fish and Game Department to identify strategies (timing, setback, etc) that are appropriate to protect the integrity of each of these species of concern while milfoil mitigation activities are conducted.

Figure 5 shows the locations of the species documented in the NHB review.

Recreational Uses and Access Points

Glen Lake is used for numerous recreational activities by both lakefront residents and transient boaters. There is one designated public access for boats on the northeastern side of the pond. Motor boats, as well as kayaks and canoes can use this facility. There is ample parking for vehicles with trailers across the street from the ramp. Figure 6 shows the location of the public access site.

There is one picnic area with a sandy beach near the public access site that is used by local residents (Figure 6). There are a few small private swim beaches located on private properties around the pond.

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 Glen Lake is characterized by a mix of native and non-native (variable milfoil and European naiad) plant growth (Figure 3). Native species include a mix of floating plants (floating heart, watershield, duckweed), emergent plants (grassy arrowhead, pipewort), and submergent plants (water naiad, tapegrass, muskgrass, pondweeds). Native plant communities are mixed around the entire lake, and are characterized as 'scattered' by the DES.

There are no records of state threatened or endangered plant species.

The invasive plants, European naiad and purple loosestrife, were also found in and around Glen Lake. European naiad was present in one cover on the south-central side of Glen Lake. It was scattered in nature, and can be

removed by simple hand-removal and bottom barrier placement. The European naiad was more prominent in 2008, but it has been present in much reduced abundance since that time. DES will work with the lake residents to educate them about the purple loosestrife, and how to effectively hand-remove it.

Wells and Water Supplies

Figure 7 shows the location of wells, water supplies, well-head protection areas, and drinking water protection areas around Glen Lake, based on information in the DES geographic information system records. Note that it is likely that Figure 7 does not show the location of all private wells.

Note that the map in Figure 7 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 7.

Historical Control Activities and Progress Yield

MANAGEMENT ACTION	DATE	TARGET SPECIES	ACRES/GALLONS	CONTRACTOR
2,4-D TREATMENT	17-Jun-08	VARIABLE MILFOIL	2.5 ACRES	AQUATIC CONTROL TECHNOLOGY, INC.
HAND REMOVAL	JULY/AUGUST 2011	VARIABLE MILFOIL	<1 ACRE NEAR SWIM BEACH (NO DATA REPORTED ON YIELD)	LARRY PILOTE

MANAGEMENT ACTION	DATE	TARGET SPECIES	ACRES/GALLONS	CONTRACTOR
HAND REMOVAL	JULY/AUGUST 2012	VARIABLE MILFOIL	<1 ACRE NORTH SHORELINE (NO DATA REPORTED ON YIELD)	LARRY PILOTE
HAND REMOVAL	JULY/AUGUST 2013	VARIABLE MILFOIL	<1 ACRE ABOVE DAM INTO LAKE ON WEST SIDE (NO DATA REPORTED ON YIELD)	LARRY PILOTE
2,4-D TREATMENT	8/7/2014	VARIABLE MILFOIL	30 ACREAS AT 2990 LBS TOTAL	ACT
HAND REMOVAL	7/30/2015	VARIABLE MILFOIL	60 GALLONS	AQUALOGIC
HAND REMOVAL	8/14/2015	VARIABLE MILFOIL	90 GALLONS	AQUALOGIC
DASH	7/6/2016	VARIABLE MILFOIL	30 GALLONS	AB AQUATICS
DASH	7/7/2016	VARIABLE MILFOIL	40 GALLONS	AB AQUATICS
DASH	7/8/2016	VARIABLE MILFOIL	45 GALLONS	AB AQUATICS
DASH	8/10/2017	VARIABLE MILFOIL	40 GALLONS	AB AQUATICS
DASH	8/11/2017	VARIABLE MILFOIL	80 GALLONS	AB AQUATICS
DASH	8/14/2017	VARIABLE MILFOIL	60 GALLONS	AB AQUATICS
DASH	8/15/2017	VARIABLE MILFOIL	15 GALLONS	AB AQUATICS
DASH	8/15/2017	VARIABLE MILFOIL	60 GALLONS	AB AQUATICS
DASH	8/16/2017	VARIABLE MILFOIL	10 GALLONS	AB AQUATICS
DASH	8/16/2017	VARIABLE MILFOIL	10 GALLONS	AB AQUATICS
DASH	8/17/2017	VARIABLE MILFOIL	80 GALLONS	AB AQUATICS
DASH	8/17/2017	VARIABLE MILFOIL	5 GALLONS	AB AQUATICS
DASH	10/22/2018	VARIABLE MILFOIL	60 GALLONS	AQUALOGIC

MANAGEMENT ACTION	DATE	TARGET SPECIES	ACRES/GALLONS	CONTRACTOR
DASH	10/23/2018	VARIABLE MILFOIL	45 GALLONS	AQUALOGIC
DASH	10/13/2019	VARIABLE MILFOIL	15 GALLONS	AQUALOGIC

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

DES has evaluated the feasibility of potential control practices in Glen Lake. The following table summarizes DES' control strategy recommendations for Glen Lake.

Control Method	Use on Glen Lake
Restricted Use Areas/Fragment Barrier	At this point in time a fragment barrier or restricted use area is not feasible due to the flow regime in this system. Upstream water flows too fast for a fragment barrier to stay in place with high flows.
Hand-pulling/Diver Assisted Suction Harvesting (DASH)	Hand pulling and/or DASH is recommended for areas that have sparser and smaller scale growth. There are growths around Glen Lake that can feasibly be managed by hand

Control Method	Use on Glen Lake
	pulling or DASH, and they are shown in maps in Figure 2.
Mechanical Harvesting/Removal	For Glen Lake, mechanical harvesting is not recommended due to the threat of spreading variable milfoil. This is a flowing system, and fragments that are generated will quickly flow downstream and further the spread of the plant.
Benthic Barriers	For Glen Lake, DES recommends installing small benthic barriers in areas of re-growth if small patches of variable milfoil re-grow and can adequately be contained by benthic barriers. Benthic barriers may also be used for the European naiad. Care should be taken to only put benthic barriers in locations where flow will not result in them being subject to uplifting or disturbance.
Herbicides	For Glen Lake, herbicide use is recommended as primary treatment in areas of denser or more widespread growth.
Extended Drawdown	Drawdown is not an effective control method for variable milfoil, and this dam is a hydro-power generator; therefore, drawdown regimes are infeasible.
Dredge	Not recommended due to nature of exotic plant distribution, the cost, or the ancillary ecological impacts that the dredge could have.
Biological Control	There are no approved biological controls for variable milfoil at this time in New Hampshire.
No Control	A no control option would lead to further spread of variable milfoil within this impoundment, and ultimately result in more fragments of milfoil flowing downstream to other portions or impoundments on the Piscataquog River.

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 by DES during September 21, 2007. Based on the evaluation, the following control actions are recommended:

Year	Activity	Responsible Party	Schedule
2020	Plant survey for determining growing season control actions/needs	NHDES	May/June

Year	Activity	Responsible Party	Schedule
	Hand removal or DASH of variable milfoil growths in the lake, in areas show in Figure 2 for the current year of control	Contract Diver	As needed during the growing season
	Herbicide treatment of areas shown in Figure 2 for the growing season.	SOLitude Lake Management, LLC	June
	Plant sure to map growth and plan for next growing season	NHDES	September/October
2021	Plant survey for determining growing season control actions/needs	NHDES	May/June
	Hand removal or DASH of variable milfoil growths in the lake, in areas show in Figure 2 for the current year of control	Contract Diver	As needed during the growing season
	Plant sure to map growth and plan for next growing season	NHDES	September/October
2022	Plant survey for determining growing season control actions/needs	NHDES	May/June
	Hand removal or DASH of variable milfoil growths in the lake, in areas show in Figure 2 for the current year of control	Contract Diver	As needed during the growing season
	Plant sure to map growth and plan for next growing season	NHDES	September/October
2023	Plant survey for determining growing season control actions/needs	NHDES	May/June
	Hand removal or DASH of variable milfoil growths in the lake, in areas show in Figure 2 for the current year of control	Contract Diver	As needed during the growing season
	Plant sure to map growth and plan for next growing season	NHDES	September/October
2024	Plant survey for determining growing season control actions/needs	NHDES	May/June

Year	Activity	Responsible Party	Schedule
	Hand removal or DASH of variable milfoil growths in the lake, in areas show in Figure 2 for the current year of control	Contract Diver	As needed during the growing season
	Plant sure to map growth and plan for next growing season	NHDES	September/October
2025	Management Plan Update	DES and interested parties	Fall

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 variable milfoil management in the subject waterbody.

Figure 1: Map of Variable Milfoil Infestations Over Time

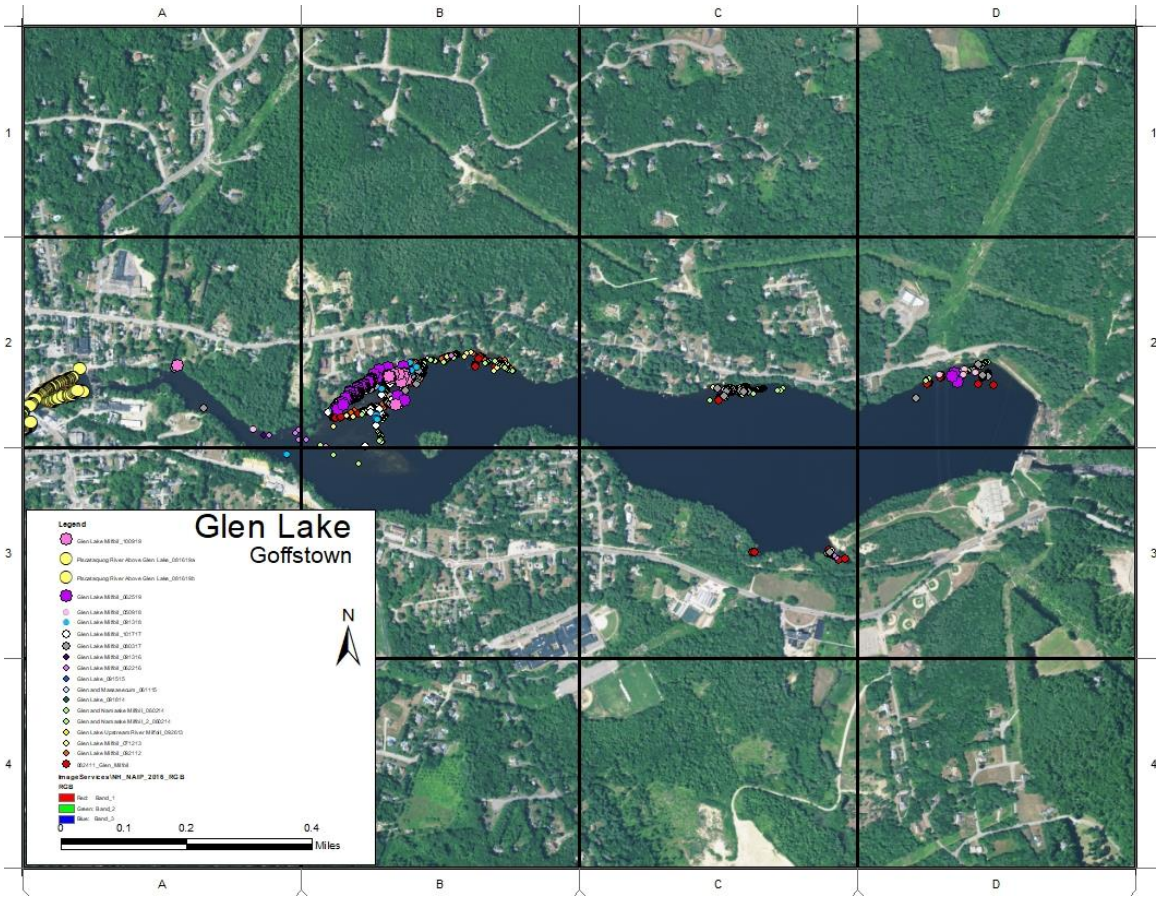
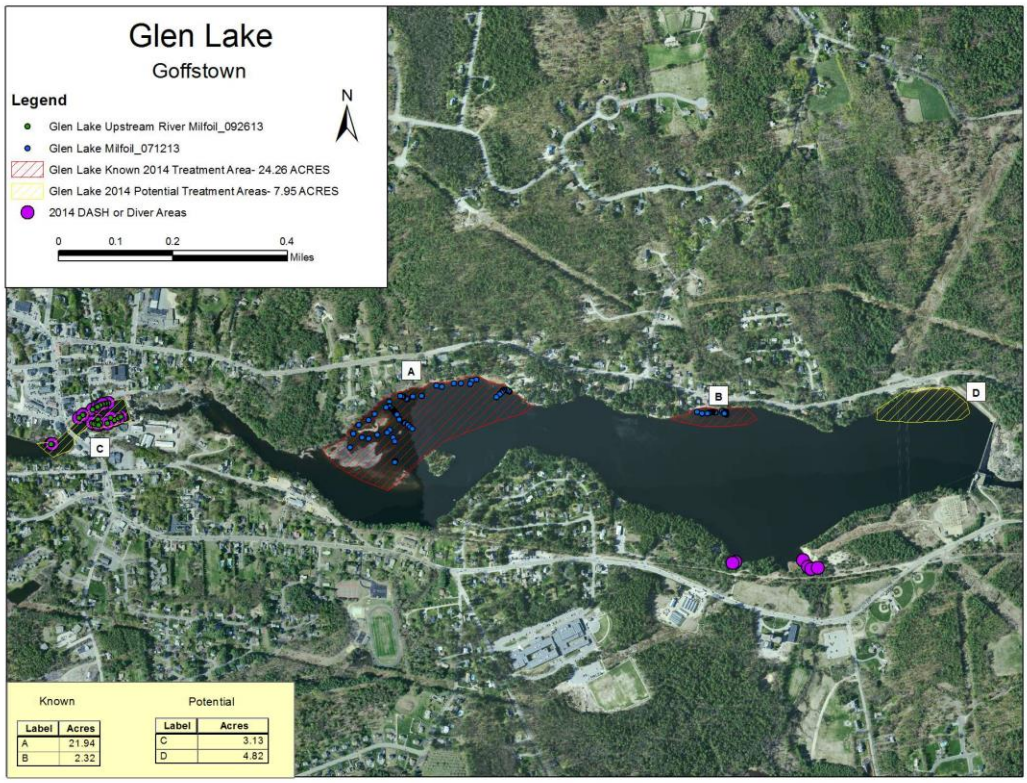
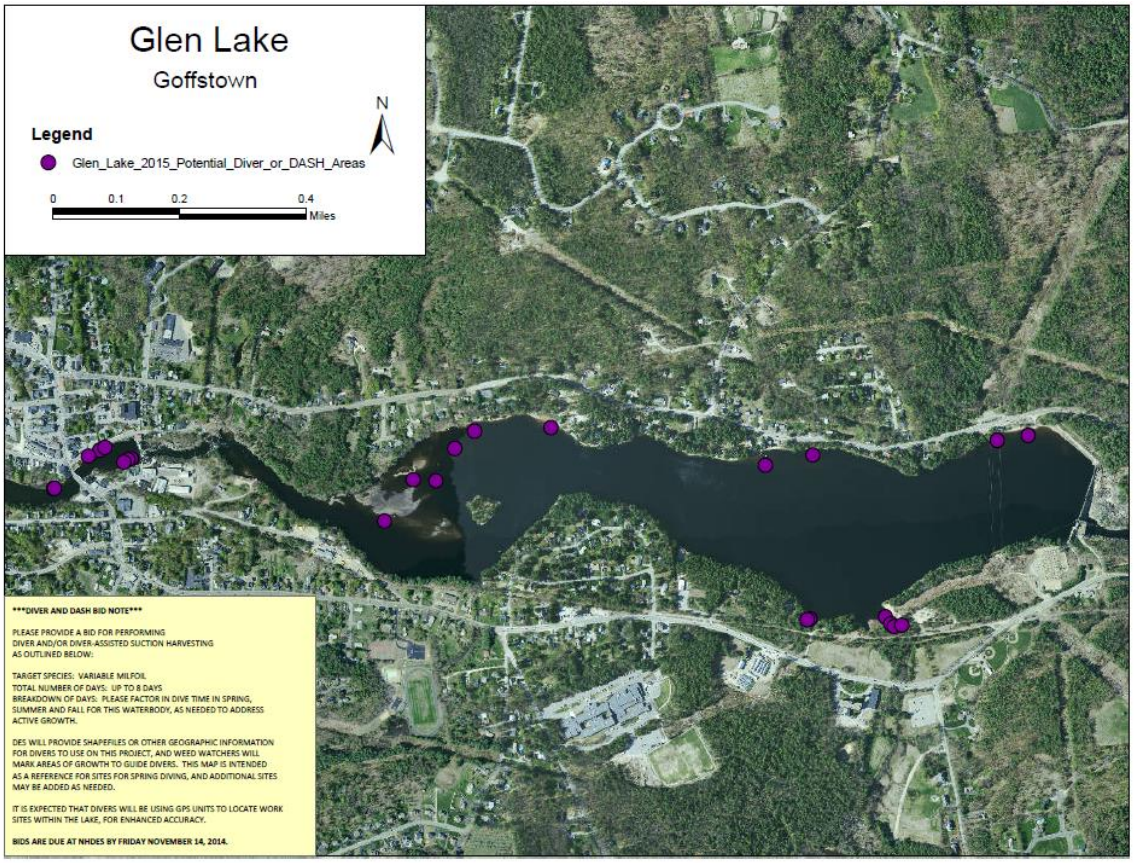


Figure 2: Map of Control Actions Over Time

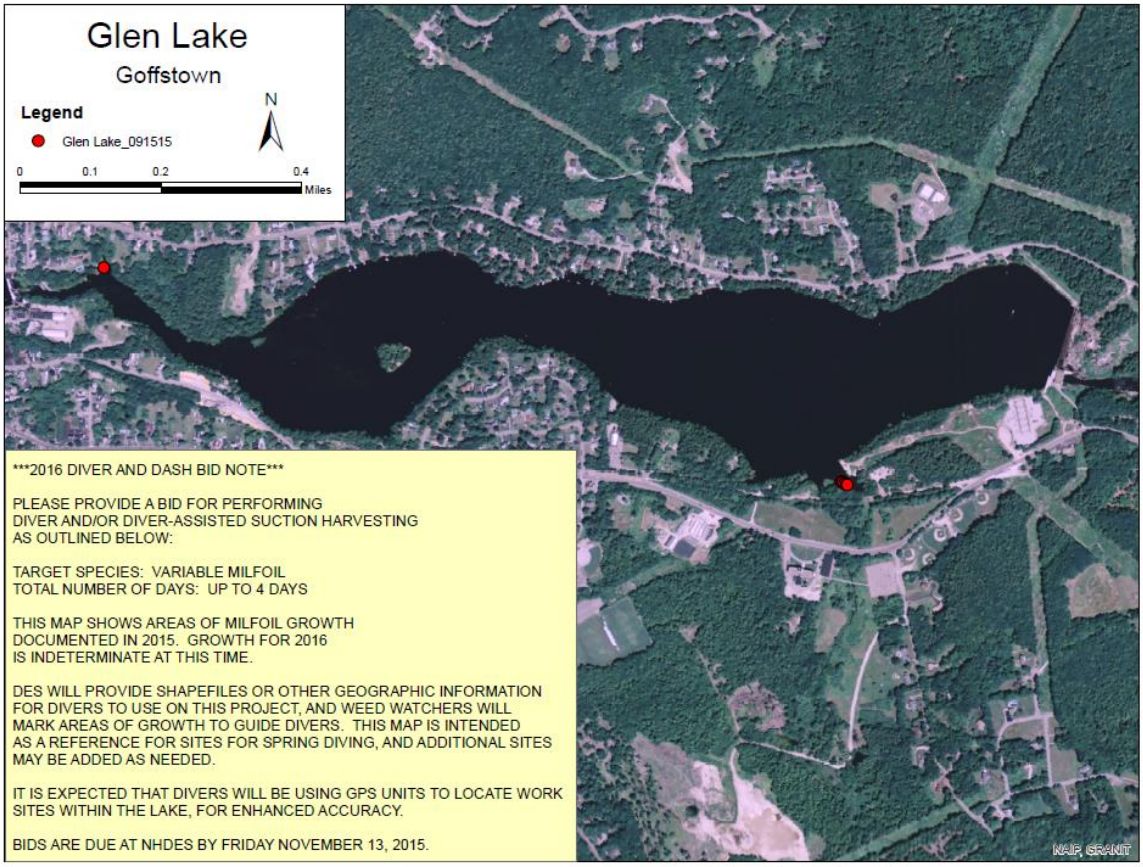
2014 Proposed



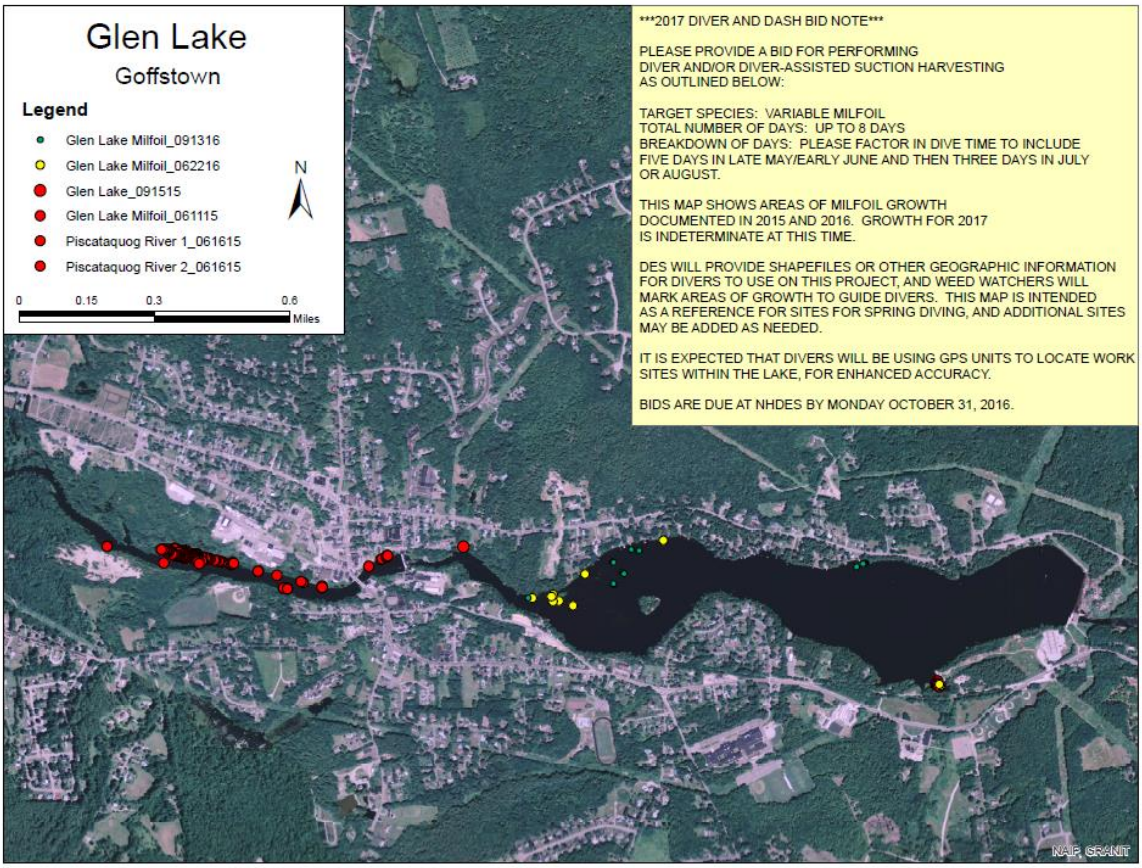
2015 Proposed



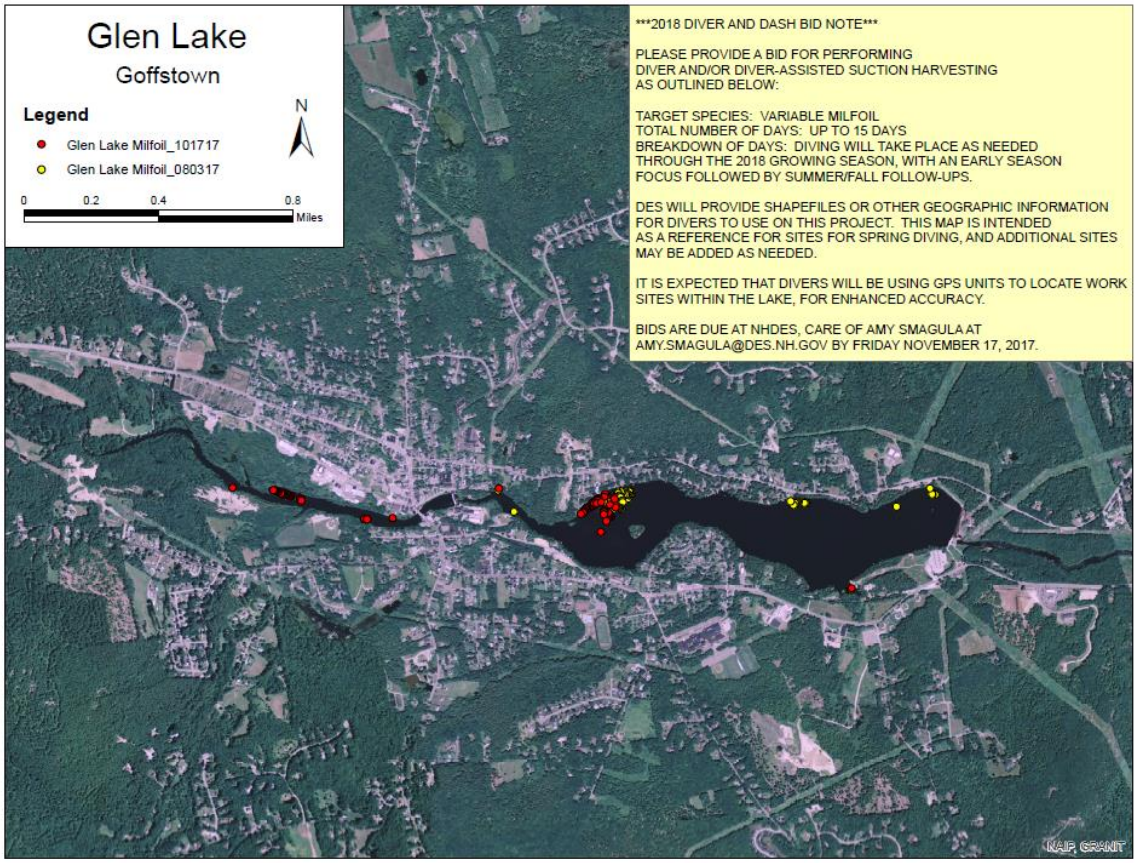
2016 Proposed



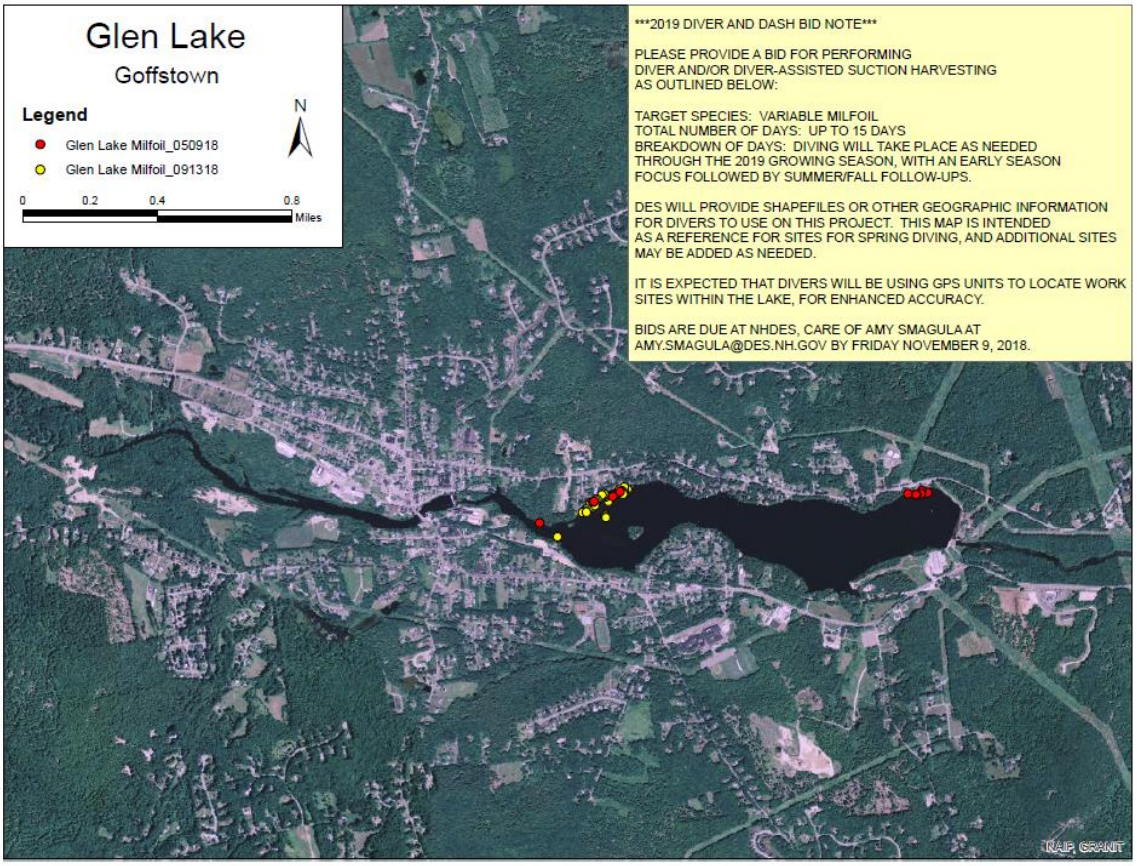
2017 Proposed



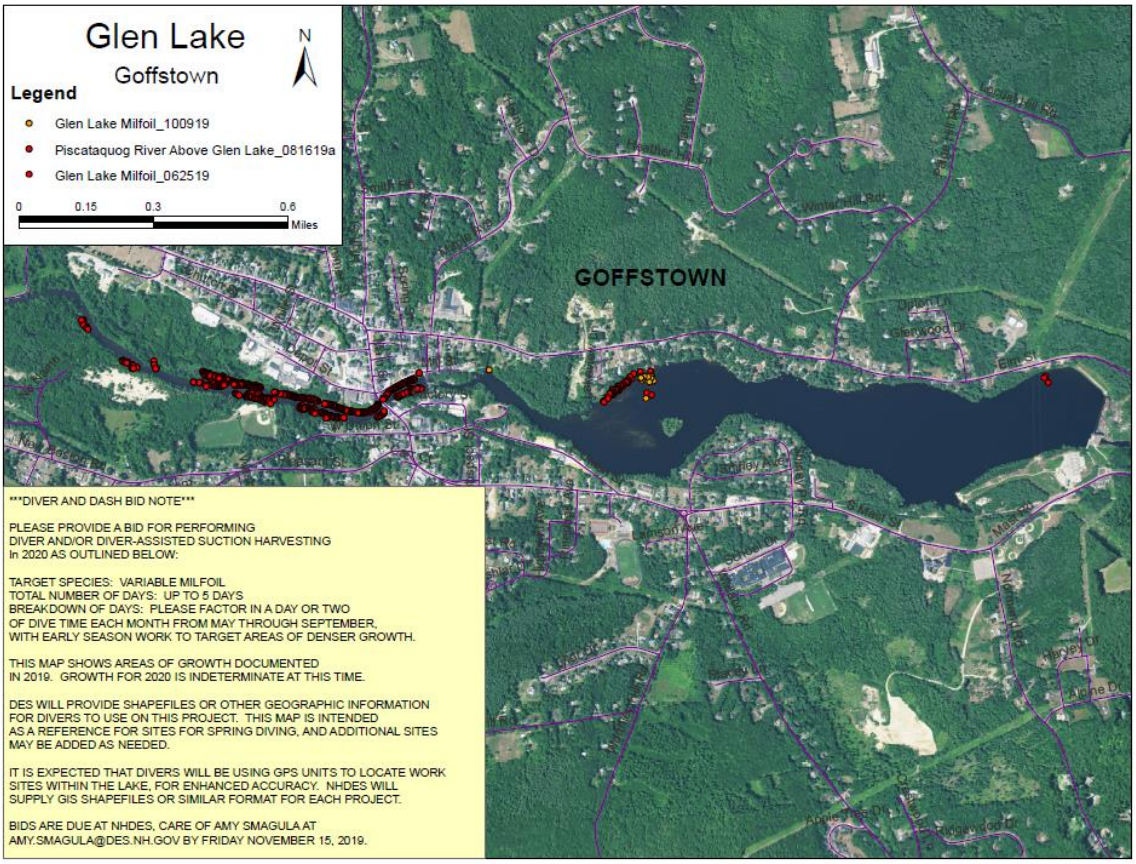
2018 Proposed



2019 Proposed



2020 Proposed



DIVER AND DASH BID NOTE

PLEASE PROVIDE A BID FOR PERFORMING
DIVER AND/OR DIVER-ASSISTED SUCTION HARVESTING
In 2020 AS OUTLINED BELOW:

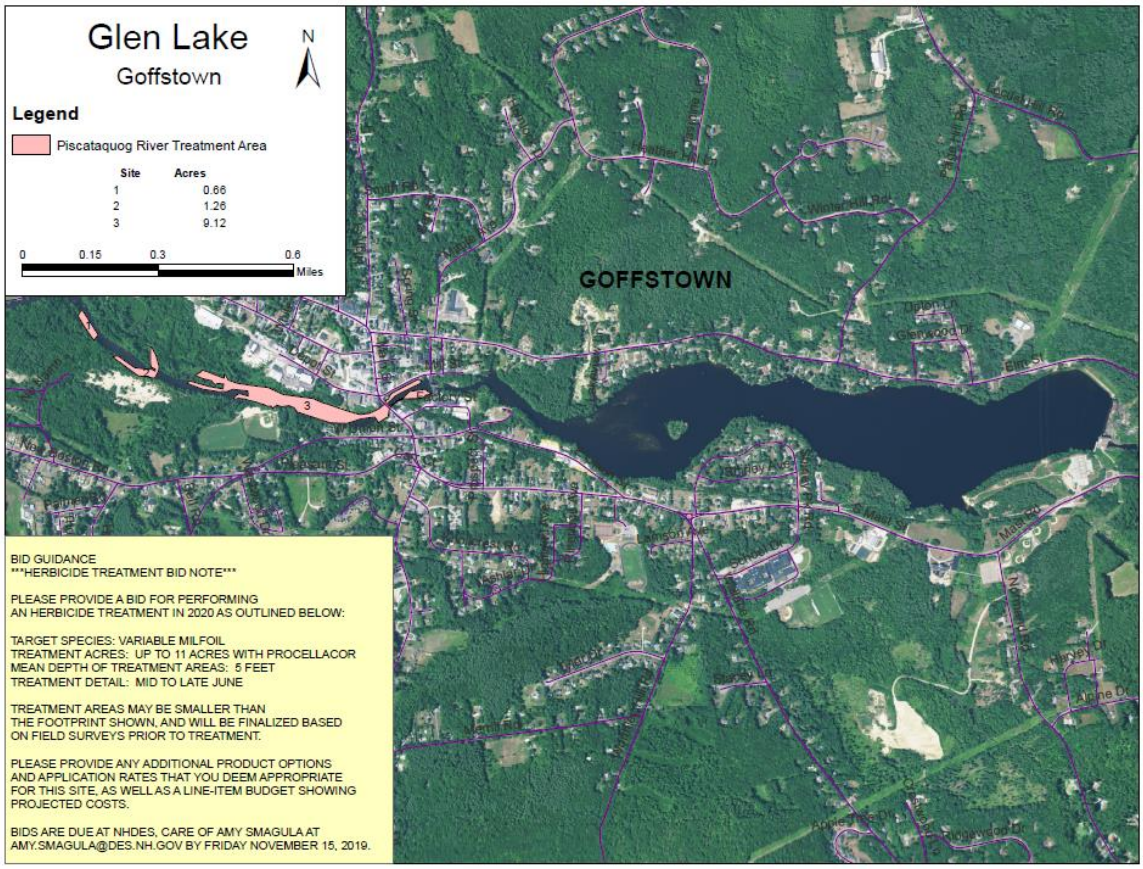
TARGET SPECIES: VARIABLE MILFOIL
TOTAL NUMBER OF DAYS: UP TO 5 DAYS
BREAKDOWN OF DAYS: PLEASE FACTOR IN A DAY OR TWO
OF DIVE TIME EACH MONTH FROM MAY THROUGH SEPTEMBER,
WITH EARLY SEASON WORK TO TARGET AREAS OF DENSER GROWTH.

THIS MAP SHOWS AREAS OF GROWTH DOCUMENTED
IN 2019. GROWTH FOR 2020 IS INDETERMINATE AT THIS TIME.

DES WILL PROVIDE SHAPEFILES OR OTHER GEOGRAPHIC INFORMATION
FOR DIVERS TO USE ON THIS PROJECT. THIS MAP IS INTENDED
AS A REFERENCE FOR SITES FOR SPRING DIVING, AND ADDITIONAL SITES
MAY BE ADDED AS NEEDED.

IT IS EXPECTED THAT DIVERS WILL BE USING GPS UNITS TO LOCATE WORK
SITES WITHIN THE LAKE, FOR ENHANCED ACCURACY. NHDES WILL
SUPPLY GIS SHAPEFILES OR SIMILAR FORMAT FOR EACH PROJECT.

BIDS ARE DUE AT NHDES, CARE OF AMY SMAGULA AT
AMY.SMAGULA@DES.NH.GOV BY FRIDAY NOVEMBER 15, 2019.



BID GUIDANCE
HERBICIDE TREATMENT BID NOTE

PLEASE PROVIDE A BID FOR PERFORMING
AN HERBICIDE TREATMENT IN 2020 AS OUTLINED BELOW:

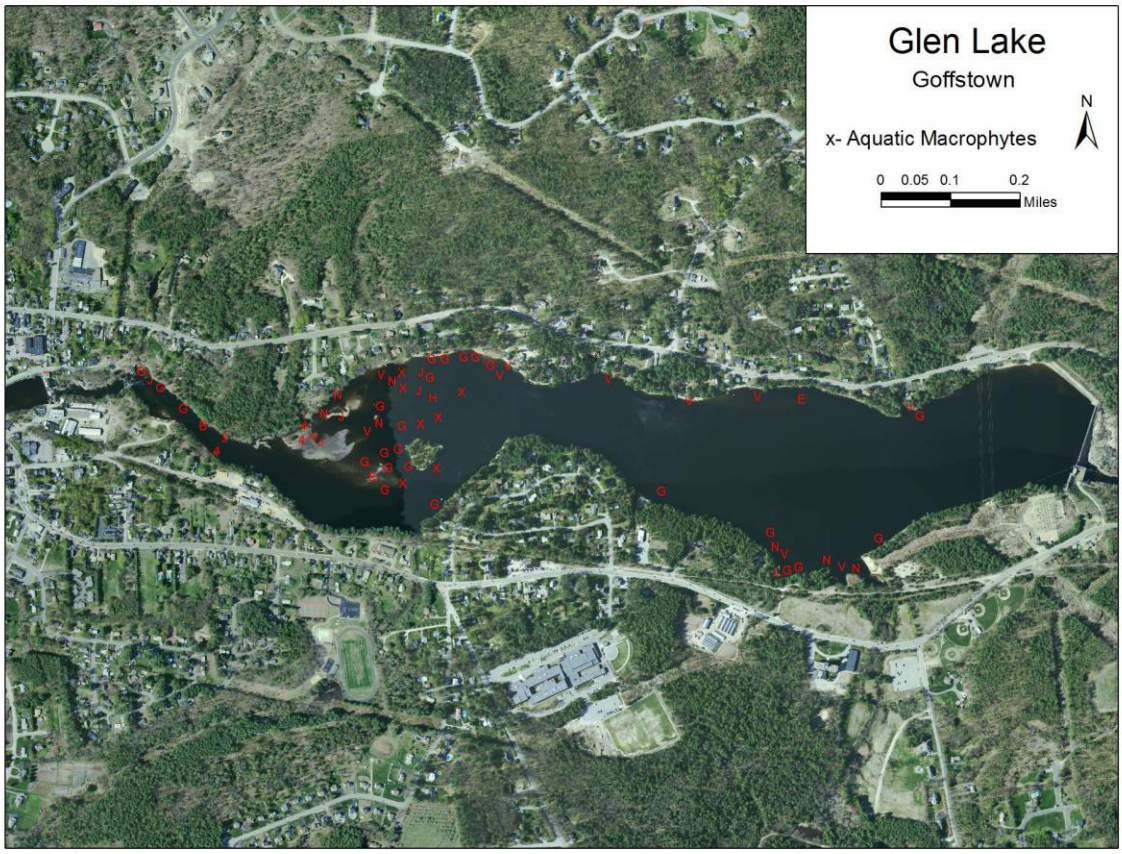
TARGET SPECIES: VARIABLE MILFOIL
TREATMENT ACRES: UP TO 11 ACRES WITH PROCELLACOR
MEAN DEPTH OF TREATMENT AREAS: 5 FEET
TREATMENT DETAIL: MID TO LATE JUNE

TREATMENT AREAS MAY BE SMALLER THAN
THE FOOTPRINT SHOWN, AND WILL BE FINALIZED BASED
ON FIELD SURVEYS PRIOR TO TREATMENT.

PLEASE PROVIDE ANY ADDITIONAL PRODUCT OPTIONS
AND APPLICATION RATES THAT YOU DEEM APPROPRIATE
FOR THIS SITE, AS WELL AS A LINE-ITEM BUDGET SHOWING
PROJECTED COSTS.

BIDS ARE DUE AT NHDES, CARE OF AMY SMAGULA AT
AMY.SMAGULA@DES.NH.GOV BY FRIDAY NOVEMBER 15, 2019.

Figure 3: Map of Native Aquatic Macrophytes



Key to Macrophyte Map

Symbol	Common Name	Latin Name
N	European naiad	*Najas minor*
J	Native naiad	*Najas sp.*
V	Tapegrass	*Vallisneria americana*
G	Grassy arrowhead	*Sagittaria graminea*
L	Duckweed	*Lemna*
3	Muskgrass	*Chara*
4	Purple loosestrife	*Lythrum salicaria*
B	Watershield	*Brasenia schreberi*
E	Pipewort	*Eriocaulon*
X	Pondweed	*Potamogeton sp.*
H	Floating heart	*Nymphoides cordata*

Figure 4: Bathymetric Map

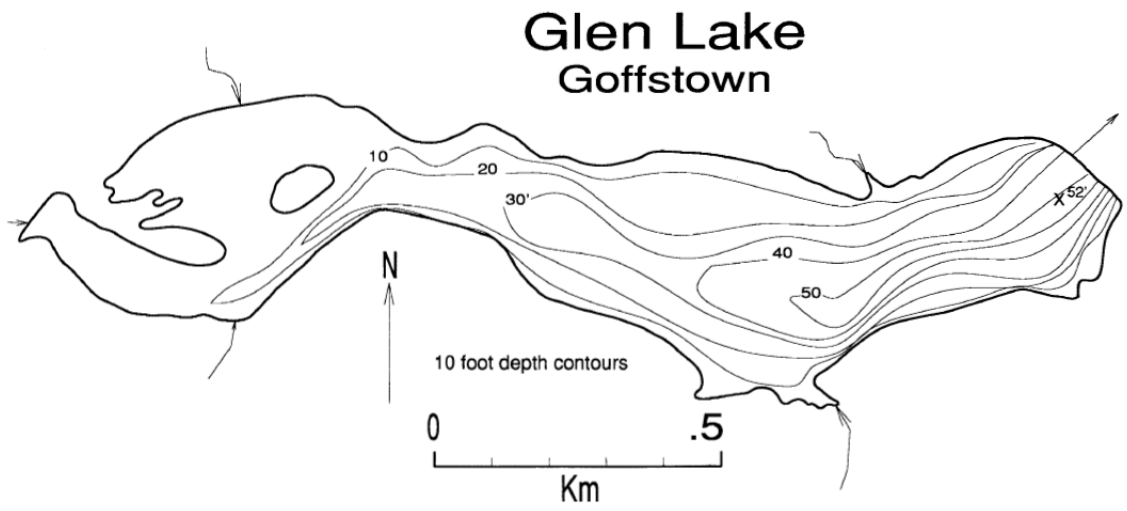


Figure 5: Critical Habitats or Conservation Areas

NHB19-3878

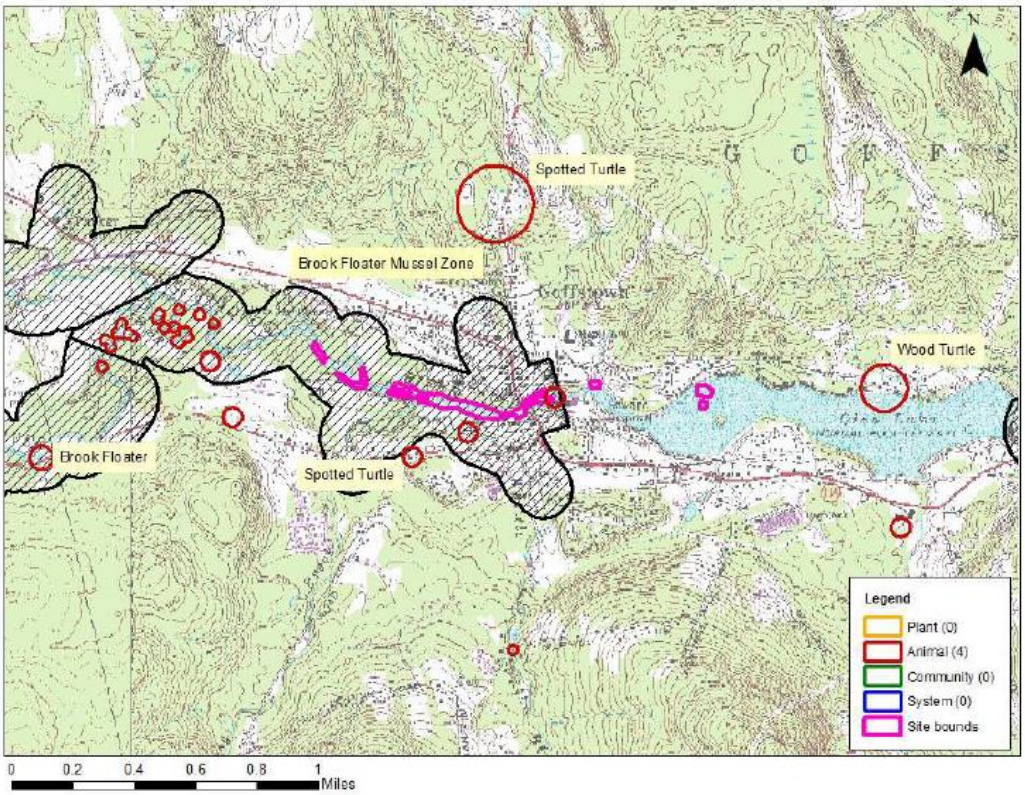
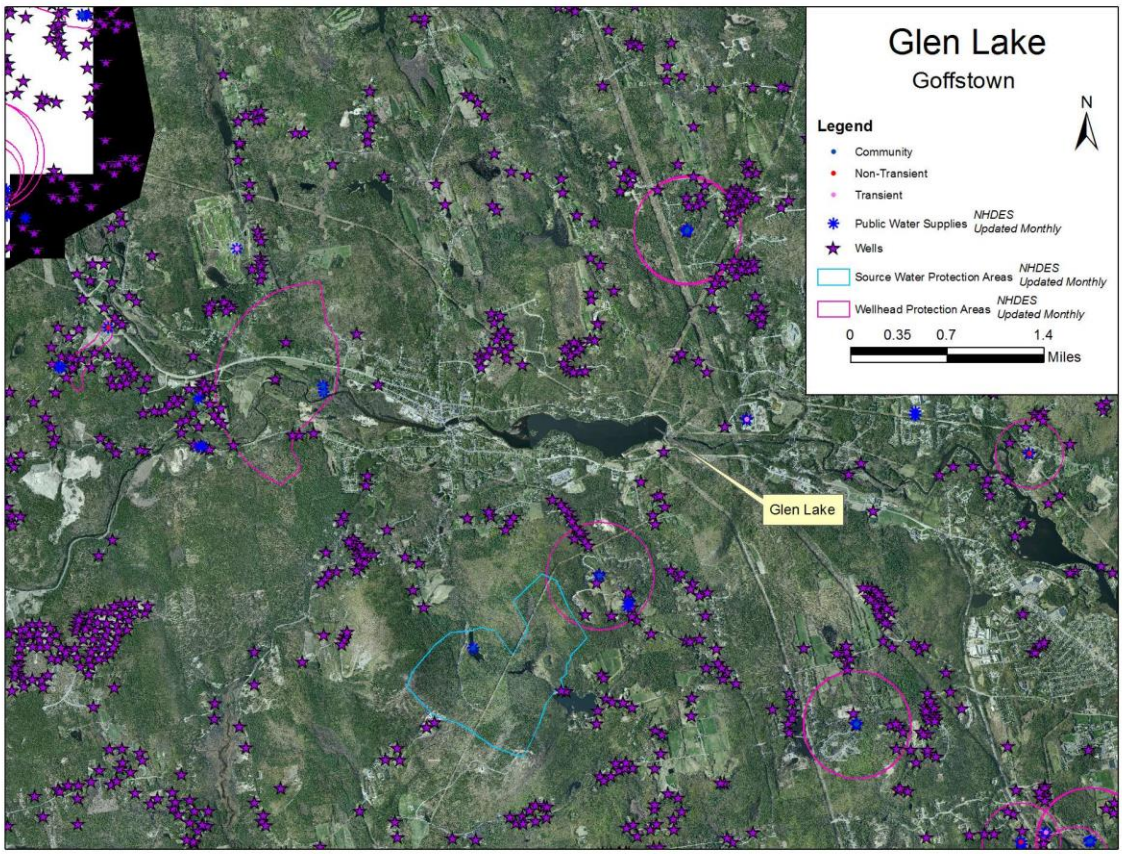


Figure 6: Public Access Sites and Swim Areas

Figure 7: Wells and Water Supplies, 1:48,000 scale



Appendix A Criteria to Evaluate 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.

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 Glen Lake 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.

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, ProcellaCOR or 2,4-D (Navigate formulation) are the herbicides that are recommended for control of variable milfoil. Based on laboratory and field trials, these are the most effective herbicides 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.

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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