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NH Department of
Environmental Services
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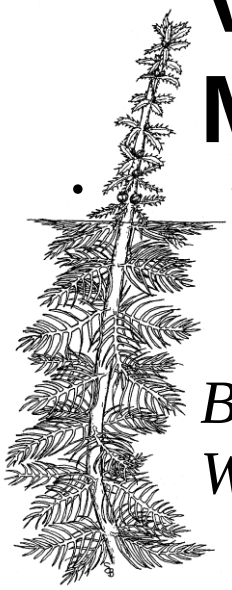
Long-Term Variable Milfoil Management Plan



Belleau Lake
Wakefield, New Hampshire

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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 Belleau Lake, Wakefield

Variable milfoil (*Myriophyllum heterophyllum*) became established in Belleau Lake in Wakefield, New Hampshire in 2000. In three years, the plant has colonized several areas along the southwestern and northwestern shoreline. Figure 1 illustrates the distribution of variable milfoil infestations in this waterbody.

Following is a summary of each area indicated in Figure 1:

Area 1- Located at the northern end of the lake, Area 1 covers just over 6 acres, with milfoil densities of 65% throughout this area. There are some areas within this cove that are more sparsely covered with milfoil, however, for treatment to be effective in this area, DES recommends considering this entire area, rather than smaller portions or patches in this cove.

Area 2- This is a segment of the pond's shoreline with roughly 30% variable milfoil densities in the 1.3 acre area. The infestation ranges from small to large patches throughout this area, with single stems interspersed between the patches.

Area 3- Area 3 is the largest single infested area in the lake. The variable milfoil growth is present in large continuous patches throughout this area which totals 11.35 acres. Variable milfoil densities are 75% on average, however some areas are 100% variable milfoil. This is the location where variable milfoil was first found to be rooted in 2003, and today, it is clear that the original patch has expanded greatly, both through expansion of the rhizomes, and through fragmentation. This area abuts a transitional zone to

the shoreline that is comprised of emergent wetland vegetation (mostly rushes and sedges). There is some milfoil scattered throughout the stand of wetland plants.

Area 4- This small cove on the lake is approximately 1.77 acres, with variable milfoil densities averaging 65% for the cove. The variable milfoil occurs as moderately sized dense patches throughout the cove, and for mapping purposes, and subsequent management options, it is appropriate to consider the whole cove, rather than smaller patches within the cove.

Individual Points- The individual points around the pond indicate areas where small patches or groupings of a few stems of milfoil are present.

In terms of the impacts of the variable milfoil in the system, there are several (19) houses around the shoreline of Belleau Lake, with mostly seasonal cottages, though there are a few year-round dwellings. There are also four back lots with lake rights. Many of these abut areas of dense variable milfoil growth (particularly Area 3 and Area 4).

Lake residents have expressed frustration with the exotic plant growth, citing fouling of their swim beaches, swim impairments, and concerns about the whole pond being choked with the invasive plant. Additionally, the invasive plant infestation in this waterbody is a continuous threat to the Piscataquog River, which has Belleau Lake as its headwater.

The invasive plant infestation in this pond has increased exponentially in three years, with only a few rooted plants found in 2003 (sparsely covering an area of roughly 1-2 acres) to now nearly 20 acres only three years later. Belleau Lake is shallow, with organic substrates, essentially creating prime variable milfoil habitat across nearly the whole pond. DES biologists predict that in less than 10 years the entire pond will be dominated by variable milfoil. As the infestation continues to expand, rhizomatous growth and fragments will continue to expand the infested areas at an increasingly faster rate.

At this time, there are no data and no observed problems with the biological integrity of the aquatic community as a result of the variable milfoil infestation; however, the variable milfoil infestation is still somewhat localized. No biological integrity surveys have been conducted, however, as part of this plan preparation.

It should be clearly understood that milfoil control efforts in Belleau Lake will need to be well-coordinated, long-term, multi-faceted, and done using integrated plant management techniques that also include a substantial monitoring and reporting effort by Weed Watchers and Lake Hosts.

Figure 2 illustrates, over several maps, the sequence of exotic plant control actions over time, including one for the upcoming growing season.

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

Milfoil Management Goals and Objectives

The aquatic plant management plan for Belleau Lake outlines actions to reduce growths (both density and distribution) of variable milfoil (*Myriophyllum heterophyllum*) while maintaining native plant communities whenever variable milfoil control actions are being implemented.

The goal for Belleau Lake is the eventual eradication of variable milfoil from the system using an Integrated Pest Management Approach. To achieve this goal, we recommend the following:

1) To reduce the overall acreage and percent cover of variable milfoil bottom growth in Area 1 from 6.04 acres and 65% cover in 2007, with the use of 2,4-D, to less than 2 acres and 20% cover. In 2008, conduct another herbicide application, if needed, to further reduce the variable milfoil growth in Area 1 to less than ½ acre and 5% cover, to allow for the integration of non-herbicide approaches to control variable milfoil.

2) To reduce the overall acreage and percent cover of variable milfoil in Area 2 from 1.31 acres and 30% cover to less than ½ acre and 10% cover with the use of 2,4-D in 2007. Further reduce the growth of variable milfoil in 2008, if needed, with 2,4-D, to reduce variable milfoil to less than ¼ acre and 5% cover in this area.

3) To reduce the overall acreage and percent cover of variable milfoil in Area 3 from 11.35 acres and 75% cover to less than 5 acre and 15% cover with the use of 2,4-D in 2007. Further reduce the growth of variable milfoil in 2008, if needed, with 2,4-D, to reduce variable milfoil to less than 1 acre and 5% cover in this area.

4) To reduce the overall acreage and percent cover of variable milfoil in Area 4 from 1.77 acres and 65% cover to less than ½ acre and 20% cover with the use of 2,4-D in 2007. Further reduce the growth of variable milfoil in 2008, if needed, with 2,4-D, to reduce variable milfoil to less than ¼ acre and 5% cover in this area.

5) To eradicate variable milfoil infestations located at individual points by hand-removal, suction harvesting, and/or and benthic barrier placement.

6) To eradicate variable milfoil infestations throughout the pond by 2012 by performing variable milfoil control actions on any exotic plants remaining after actions 1 through 5 above, using hand-removal, benthic barriers, and/or diver-assisted suction harvesting in August 2007, and annually thereafter if new stems or localized patches are present.

To maintain a Weed Watcher program and Lake Host Program for the pond.

Local Support

Town or Municipality Support

The Town of Wakefield has been very supportive of variable milfoil control efforts in

Belleau Lake. This is the only infested waterbody in the town at this point, and the town officials recognize the need to protect other nearby waterbodies.

The town has/has not been supportive financially by offering matching funds for herbicide applications, including a proposal for matching funds in 2007 and future years for herbicide applications and diver time.

Lake Resident Support

Belleau Lake has an active and newly formed lake association. They have divers that live on the pond that have been mapping and tracking the extent of the variable milfoil infestation over time. In 2006, local divers hand-picked variable milfoil at pioneering sites within the lake, to prevent further establishment of this plant in new areas. They plan to continue these efforts as part of this management initiative.

The lake association is also committed to performing follow-up monitoring for milfoil re-growth, and working with DES to coordinate hand-removal and benthic barrier placement for further variable milfoil control.

Waterbody Characteristics

The following table summarizes basic physical and biological characteristics of Belleau 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)	206.60
Watershed area (acres)	3776.0
Shoreline Uses (residential, forested, agriculture)	Residential, forested
Max Depth (m)	5.2
Mean Depth (m)	2.4
Trophic Status	Mesotrophic
Color (CPU) in Epilimnion	49
Clarity (m)	2.2

Flushing Rate (yr^{-1})	5.4
Natural waterbody/Raised by Damming/Other	Natural
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	*Myriophyllum heterophyllum*
Infested Area (acres)	Approximately 21 acres
Distribution (ringing lake, patchy growth, etc)	Dense areas of infestation in several locations of pond, with new smaller colonies starting in smaller patches between Areas 1-4 denoted in Figure 1.
Sediment type in infested area (sand/silt/organic/rock)	Silty/organic
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	None on record
Area of Littoral Zone (acres)	86.2
Area of Profundal Zone (acres)	53.1
Area of Macrophyte Coverage (native or otherwise) of Plants in Littoral Zone	60
% of Littoral Zone with Macrophyte Cover	70%
% of Macrophyte cover comprised of invasives	35%
% of Littoral Zone with Variable Milfoil Cover	24%

An aquatic vegetation map (showing native vegetation) and key for Belleau Lake is shown in Figure 3 (data from summer 2007). 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

This lake has never been surveyed by the Fish and Game Department as it is an artificial, private-access lake. Primary fisheries are likely largemouth bass, black crappie, and chain pickerel.

Recreational Uses and Access Points (information provided by DES, local entities and from GIS coverages)

Belleau Lake is used for numerous recreational activities, including boating, fishing, swimming, and water skiing by both pond residents and transient boaters. Figure 5 illustrates key elements of the pond and watershed that may be of interest in this evaluation, including the location of the public access site. There is one designated public access for boats on the northwestern side of the pond. Small motor boats, as well as kayaks and canoes can use this facility. There is limited parking for about two vehicles with trailers. There are generally less than 10 resident owned powerboats on the lake each year, and numerous canoes, kayaks, and row boats. Figure 6 illustrates the typical boat paths for the pond.

There are some private wells along the shoreline of the lake, and black pipes connected to water intakes for some homes which use the water for toilets and showers.

There is one public (town) beach on the pond (also called "designated beach"). A designated beach is described in the CALM as an area on a waterbody that is operated for bathing, swimming, or other primary water contact by any municipality, governmental subdivision, public or private corporation, partnership, association, or educational institution, open to the public, members, guests, or students whether on a fee or free basis. Env-Wq 1102.14 further defines a designated beach as *"a public bathing place that comprises an area on a water body and associated buildings and equipment, intended or used for bathing, swimming, or other primary water contact purposes. The term includes, but is not limited to, beaches or other swimming areas at hotels, motels, health facilities, water parks, condominium*

complexes, apartment complexes, youth recreation camps, public parks, and recreational campgrounds or camping parks as defined in RSA 216-I:1, VII. The term does not include any area on a water body which serves 3 or fewer living units and which is used only by the residents of the living units and their guests.

In addition to the designated beach, there are a few small private swim beaches located on private properties around the pond. There are 8 floating docks and swim platforms around the pond as well. Figure 6 shows the locations commonly used for swimming, and the locations of swim platforms and docks on Belleau Lake.

Figure 7 shows the common boating paths throughout the pond.

Macrophyte Community Evaluation (information obtained from DES field surveys and NHB reviews)

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 Belleau Lake is characterized by a mix of native and non-native (variable milfoil) plant growth (Figure 2). Native species include a mix of floating plants (yellow and white lilies, watershield), emergent plants (swamp candle, horsetail, purple loosestrife, arrowhead, pickerelweed, swamp loosestrife, spike rush, cattail, bur-reed, soft stem rush, bulrush, blue flag iris), and submergent plants (bladderwort, pondweed, tapegrass). Native plant communities are mixed around the entire lake, and are characterized as 'common/abundant' by the DES.

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

Wells and Water Supplies

Figure 7 shows the location of wells, water supplies, well-head protection areas, and drinking water protection areas around Belleau 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

Contractor	**Management Type:**	**Cost:**	**Chemical Application/ Treatment Date**	**Treatment Area (acres)**	**Effectiveness of treatment (if data are available in folder, summarize)**
Lycott Environmental Inc.	Chemical: 2,4-D	$12,800.00 (total) $6,400.00 (DES 50%)	June 11th 2001	48 Acres	
	Chemical: Diquat		June 11th 2001		
Lycott Environmental Inc.	Chemical: Diquat (file says 2,4 D was used)	$6,000.00 (total) 3,300.00 (DES)	June 10th 2002	50 Acres	
	Chemical: 2,4-D		June 12th 2003		
	Chemical: 2,4-D		June 16th 2004		
	Chemical: Diquat		June 9th 2005		

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 Belleau Lake. The following table summarizes DES' control strategy recommendations for Wakefield.

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	Use on Belleau Lake
Restricted Use Areas	Not recommended as variable milfoil patches are too widely distributed throughout pond.
Hand-pulling	DES recommends that the individual stems or small patches of variable milfoil should be hand pulled when encountered, particularly those along the southeastern shoreline between Areas 3 and 4. DES also recommends that the lake residents follow up the herbicide application with hand-pulling of re-growth, if that re-growth is small and scattered. Members of the lake association already started some hand-removal projects in 2006 on the smaller patches, and plan to continue this in the future, with town support.

Control Method	Use on Belleau Lake
Mechanical Harvesting/Removal	For Belleau Lake, mechanical harvesting is not recommended due to the threat of spreading variable milfoil to uninfested areas of the lake through the generation of fragments.
Benthic Barriers	For Belleau 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. We do not recommend installing benthic barriers throughout the lake, however. The patches or single stems of milfoil between Area 2 and Area 3 are suitable for benthic barriers following herbicide treatment, if the herbicide treatment is too dilute in those areas to achieve control.
Herbicides	For Belleau Lake, herbicide use is recommended as primary treatment due to extent of infestation. The aquatic herbicide 2,4-D is recommended in 2007 and in 2008 due to the nature of the pond. Diquat was previously used, but because the pond is colored and somewhat turbid with detritus, this chemical was not effective in controlling the milfoil as it quickly binds to the organic material in the water column and the sediments.
Extended Drawdown	Drawdown is not an effective control method for variable milfoil.
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	In order to allow for a healthy stand of mixed native aquatic vegetation, as well as areas of bare substrate in the shallows, a 'No Control' option is not recommended. Without control, variable milfoil will eventually take over 100% of the littoral zone of Belleau Lake, and could extend into slightly deeper waters. Milfoil has been showing exponential growth in Belleau Lake, therefore action to manage the plants in needed.

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
2012	Weed Watching and marking/reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Survey and planning for summer/fall milfoil control actions	DES	May/June
	Diver/DASH work as needed and recommended (areas to be determined based on updated spring survey)	Contract Diver	June-September as needed
	Herbicide treatment, if needed, based on diver progress as monitored by DES (areas to be determined based on updated spring survey)	Aquatic Control Technology, Inc.	June or September
	Survey waterbody and planning for next season's control actions	DES	September
2013	Weed Watching and marking/reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Survey and planning for summer/fall milfoil control actions	DES	May/June
	Diver/DASH work as needed and recommended (areas to be determined based on need)	Contract Diver	June-September as needed
	Herbicide treatment, if needed, based on diver progress as monitored by DES (areas to be determined based on need)	TBD	June or September

Year	Action	Responsible Party	Schedule
	Survey and planning for next season's control actions	DES	September
2014	Weed Watching and marking/reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Survey and planning for summer/fall milfoil control actions	DES	May/June
	Diver/DASH work as needed and recommended (areas to be determined based on need)	Contract Diver	June-September as needed
	Survey and planning for next season's control actions	DES	September
2015	Weed Watching and marking/reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Survey and planning for summer/fall milfoil control actions	DES	May/June
	Diver/DASH work as needed and recommended (areas to be determined based on need)	Contract Diver	June-September as needed
	Survey and planning for next season's control actions	DES	September
2016	Weed Watching and marking/reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Survey and planning for summer/fall milfoil control actions	DES	May/June
	Diver/DASH work as needed and recommended (areas to be determined based on need and updated survey)	Contract Diver	June-September as needed
	Survey and planning for next season's control actions	DES	September

Year	Action	Responsible Party	Schedule
2017	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 variable milfoil management in the subject waterbody.

Figure 1: Map of Variable Milfoil Infestations Over Time

Figure 2: Map of Control Actions Over Tim

Figure 3: Map of Native Aquatic Macrophytes
(prepared in…updated…)

Key to Macrophyte Map

Figure 4: Bathymetric Map

Figure 5: Critical Habitats or Conservation Areas (data provided by NHB or F&G)

Figure 6: Public Access Sites, Swim Areas, Docks and Swim Platforms

Figure 7: Wells and Water Supplies, 1:48,000 scale (note that this map may be incomplete relative to data on private water supply wells.

Appendix A Criteria to Evaluate the 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.

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, Belleau 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 not 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 the State of New Hampshire for Exotic Aquatic Plants

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.

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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