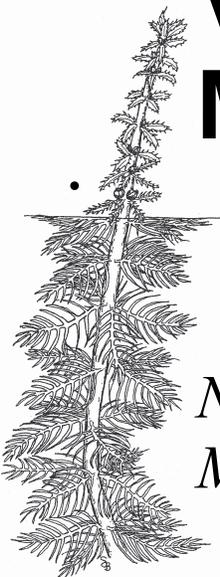


Long-Term Variable Milfoil Management Plan



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

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

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

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

Variable Milfoil Infestation in Naticook Lake

Variable milfoil (*Myriophyllum heterophyllum*) was documented in Naticook Lake in Merrimack, New Hampshire in 2012. The infestation was reported by a lake resident who was concerned about the rapid growth and expansion of a new plant in the lake. DES performed an initial site inspection on July 9, 2012 and verified that variable milfoil was present in the lake. A full survey showed that milfoil infested the cove where the public access site is located, and had expanded down the eastern shoreline towards the outlet. The infestation was likely 2-3 years old at the time of discovery based on the size, density and distribution of growth in 2012. Notable expansion took place during the summer of 2012, as shown in Figure 1.

Figure 1 illustrates the distribution of variable milfoil infestation in this waterbody. 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 on Figure 1).

Area	Location/Area Description	Year	Description of Growth	Milfoil %Cover
D1, D2	Northeastern end/outlet end. Sandy/silty substrates.	2012	Variable milfoil present as small patches in front of dam and along shore.	15%
C3	Southern cove. Sandy/silty substrates.	2012	Variable milfoil present as large dense patches, and as small new pioneering patches.	65%
A3, B3	Southwestern section of pond. Shallow	2012	No milfoil in this area in 2012.	0%

Area	Location/Area Description	Year	Description of Growth	Milfoil %Cover
	(<4 feet) with silty substrates.			
B2	Northwestern shoreline. Silty substrates.	2012	No milfoil in this area in 2012.	0%
C2	Northern shoreline, silty/sandy	2012	No milfoil along northern shore of lake in this area. Some scattered milfoil patches along the southeastern tip of the island in this zone.	15%

In terms of the impacts of the variable milfoil in the system, there are two children's camps on the lake, several houses, and a town recreation and public access area adjacent to the lake.

Milfoil Management Goals and Objectives

The goal for Naticook Lake is the eradication (if feasible) of the variable milfoil using an Integrated Pest Management Approach.

Local Support

Town or Municipality Support

This is the second documented variable milfoil infestation in the Town of Merrimack (the first was Horseshoe Pond), and the town is very aware of the problem of invasive aquatic plants, and has committed time and resources towards control and management. The town voted in October 2012 to close public access (on town property) to the lake in an effort to prevent further spread of the milfoil by boat activity in Naticook Lake, and to help prevent further spread of the milfoil to other nearby waterbodies by transient boaters.

Lake Resident Support

The Lake Naticook Conservation Association has met as a group with DES staff to discuss the problem of variable milfoil in the lake. They formed a Weed Watcher group in fall 2012 and posted signage and information around the lake. The lake association also worked with the town of Merrimack to close the public access site where the densest infestation is, to prevent fragmentation and further spread of the plant in the lake.

Waterbody Characteristics

The following table summarizes basic physical and biological characteristics of Naticook 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).

Parameter/Measure	Value/Description
Lake area (acres)	71.7
Watershed area (acres)	369.3
Shoreline Uses (residential, forested, agriculture)	Children's camps (2), residential, town park, scattered woods
Max Depth (ft)	21.1
Mean Depth (ft)	5.9
Trophic Status	Mesotrophic
Color (CPU) in Epilimnion	15.5
Clarity (ft)	11.6
Flushing Rate (yr-1)	1.3
Natural waterbody/Raised by Damming/Other	Natural with dam
Invasive Plants (Latin name)	Variable milfoil (<i>Myriophyllum heterophyllum</i>)
Infested Area (acres)	See attached maps
Distribution (ringing lake, patchy growth, etc)	See attached maps
Sediment type in infested area (sand/silt/organic/rock)	Sandy/gravelly
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Bureau (NHB) Inventory review)	Blanding's Turtle (<i>Emydoidea blandingii</i>) Eastern Hognose Snake (<i>Heterodon platirhinos</i>) Northern Black Racer (<i>Coluber constrictor</i>)

A native aquatic vegetation map and key from a September 2012 survey by the DES Biology Section is shown in Figure 3. A bathymetric map is shown in Figure 4.

Beneficial (Designated) Uses of Waterbody

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

Of these, Aquatic Life, Wildlife and Recreation are the ones most often affected by the presence of invasive plants, though drinking water supplies can also be affected as well in a number of ways.

Following is a general discussion of the most potentially impacted designated uses, including water supplies and near shore wells, as they relate to this system and the actions proposed in this long-term plan.

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

Aquatic Life

Fisheries Information (information obtained from an NHB review and information provided by the NH F&G Department)

According to the NH Fish and Game Department, Naticook Lake is managed for warmwater species under general regulations. Fish species present include brown bullhead, black crappie, bluegill, common sunfish, chain pickerel, largemouth bass, yellow bullhead, and yellow perch.

Wildlife Information (information obtained from an NHB review)

A Natural Heritage Bureau review of rare, threatened and endangered species in and near this project site yielded three records of species of concern in or near this waterbody, including the Blanding's turtle (*Emydoidea blandingii*), eastern hognose snake (*Heterodon platirhinos*) and the northern black racer (*Coluber constrictor*). The Blanding's turtle and the eastern hognose snake are listed as endangered in New Hampshire, and the northern black racer is listed as threatened. Figure 5 shows the locations documented for each species, according to NHB records.

The Blanding's turtle was last documented in 2006. The Fish and Game Department has requested that contractors avoid direct herbicide application in scrub shrub dominated wetland coves, in order to minimize impacts.

The eastern hognose snake was last documented in 2009. The Fish and Game Department has requested that applicators avoid direct treatment of areas with concentrated American toad eggs (paired gelatinous strands many feet long) and tadpoles, as toads are the primary prey of Eastern hognose snake.

The northern black racer was last documented in 2007. As this is a terrestrial species, impacts to it are not expected as a result of control activities within the waterbody.

Recreational Uses and Access Points

Naticook Lake is used for numerous recreational activities, particularly fishing and swimming, by the Lake residents and visitors. There are two children's day camps on Naticook Lake, one on the eastern shoreline and one on the northern shoreline. Children have been observed swimming in groups across the pond and in the designated swim areas at the camps.

Naticook Lake is fairly small and shallow, yet it does receive a fair amount of transient boaters, and local residents use both motorized and non-motorized craft on the waterbody.

Public access can be achieved via the park on the southwestern shoreline, and via an old access at the northwestern edge of the lake. Both access sites have been closed to transient trailered boats until the milfoil infestations are reduced. Car top access (for non-motorized boats) is still available at both sites.

Figure 6 shows the location of the public access sites, children's camps, swim areas and other pertinent information.

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 Naticook Lake is characterized by a mix of native and non-native (variable milfoil) plant growth (Figure 3). Native species include a mix of floating plants (white water-lily, yellow water-lily, floating heart), emergent plants (cattail, pickerelweed, pipewort, sedges, bur-reed, arrow arum, bulrush), and submergent plants (pondweed species, waterweed, bladderwort species, native milfoil). Native plant communities are mixed around the entire lake, and are characterized as 'abundnat' by the DES.

There are no NHB 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 the subject waterbody, 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

DATE	TARGET	ACTION	EFFORT/MATERIAL REMOVED	ENTITY
8/22/2012	Variable milfoil	Areas near launch and around point.	3 hours/210 gallons	DES Divers
8/28/2012	Variable milfoil	Outlet and far shore area re-picked, as well as areas near launch	3 hours/90 gallons removed	DES Divers
9/27/2012	Variable milfoil	Northeastern shoreline hand removal	3 hours/90 gallons removed	DES Divers

To date only diver and Diver Assisted Suction Harvesting (DASH) work have been used to control the variable milfoil in the lake. Three separate diver efforts by DES dive staff were conducted in 2012, mainly to reduce the infestation at the access site, and to remove expanding/pioneering milfoil from

new locations in the waterbody. Divers acknowledged that an herbicide treatment is needed before additional dive work can be deemed valuable.

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 Lakes, available at <http://www.mass.gov/dcr/watersupply/lakeLake/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 on the subject waterbody. The following table summarizes DES' control strategy recommendations for the subject waterbody:

Control Method	Use on Naticook Lake
Restricted Use Areas (RUAs) and/or Fragment Barriers	<p>The purpose of RUAs and fragment barriers is to contain small areas of exotic aquatic plant growth to prevent them from spreading further in a system.</p> <p>If variable milfoil is reduced by other integrated approaches outlined in this plan, then RUAs and fragment barriers may be a future consideration based on the size, configuration and location of remaining areas of growth.</p>
Hand-pulling	Hand pulling and DASH are recommended as a primary means of control for scattered and lower

Control Method	Use on Naticook Lake
	<p>density growths of variable milfoil.</p> <p>When milfoil densities become too high for simple diving to work, DASH is recommended as needed to keep densities low.</p> <p>Ideally, Weed Watching should be performed monthly to mark locations of growth to help guide diver activity.</p> <p>It is recommended that 2-3 diver days or DASH days be scheduled each month during the growing season for the next several years to keep the milfoil densities low, and to build on any reductions realized through larger-scale controls such as herbicide treatments.</p> <p>There are over 100 trained Weed Control Divers in New Hampshire, many of whom are “for hire” as needed. There are also several DASH service providers working in New Hampshire. Contact information can be obtained from the DES website at www.des.nh.gov, on the Exotic Species program page. NH DES divers will continue to offer support if they are available, but the town is strongly encouraged to have divers/DASHers on retainer to perform monthly “clean up” activities when the need arises.</p>
Mechanical Harvesting/Removal	Not recommended due to the risk of fragmentation and drift, and subsequent further spread of the invasive plant.
Benthic Barriers	Recommended for small patches that are 20' x 20' in size or less, and where practical.
Herbicides	Herbicide treatment is recommended as a primary means of control only where infestations of the exotic plant are too widespread and/or dense for non-chemical means of control to be effective.
Extended Drawdown	Not feasible or practical for this waterbody due to lack of an impoundment structure.
Dredge	Cost prohibitive and not often effective for controlling invasive aquatic plants.
Biological Control	No biological controls are yet approved for use on variable milfoil.
No Control	The variable milfoil infestation has expanded rapidly

Control Method	Use on Naticook Lake
	in Naticook Lake in 2-3 years, and because the lake is relatively shallow it can provide good habitat across much of the area of the lake. Milfoil growth in Naticook is also a threat to downstream waterbodies that are currently uninfested. For these reasons a 'no control' method is not recommended.

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	Treatment Type	Responsible Party	Schedule
2013	Early season survey to determine final extent of treatment areas	DES	May
	Herbicide treatment of areas shown in Figure 2 (2013 treatment areas) for 2013 control	Aquatic Control Technology, Inc.	May/June
	Weed Watching	Local residents	May through September
	Diving/DASH	DES or contract divers	Throughout growing season as needed
	Benthic barrier placement/maintenance as needed	DES	As needed/appropriate
	Field survey	DES	July/October
2014	Early season survey to map variable milfoil growth	DES	May/June
	Herbicide treatment if needed	TBD	Spring or fall
	Weed Watching	Local residents	May through September
	Diving/DASH	DES or contract divers	Throughout growing season as needed
	Benthic barrier placement/maintenance as needed	DES	As needed/appropriate
	Field survey	DES	July/October

Year	Treatment Type	Responsible Party	Schedule
2015	Weed Watching	Local residents	May through September
	Diving/DASH	DES or contract divers	Throughout growing season as needed
	Benthic barrier placement/maintenance as needed	DES	As needed/appropriate
	Field survey	DES	July/October
2016	Weed Watching	Local residents	May through September
	Diving/DASH	DES or contract divers	Throughout growing season as needed
	Benthic barrier placement/maintenance as needed	DES	As needed/appropriate
	Field survey	DES	July/October
2017	Weed Watching	Local residents	May through September
	Diving/DASH	DES or contract divers	Throughout growing season as needed
	Benthic barrier placement/maintenance as needed	DES	As needed/appropriate
	Field survey	DES	July/October
2018	Update Long-Term Management 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 and fanwort management in the subject waterbody.

Figure 1: Map of Variable Milfoil Infestations Over Time

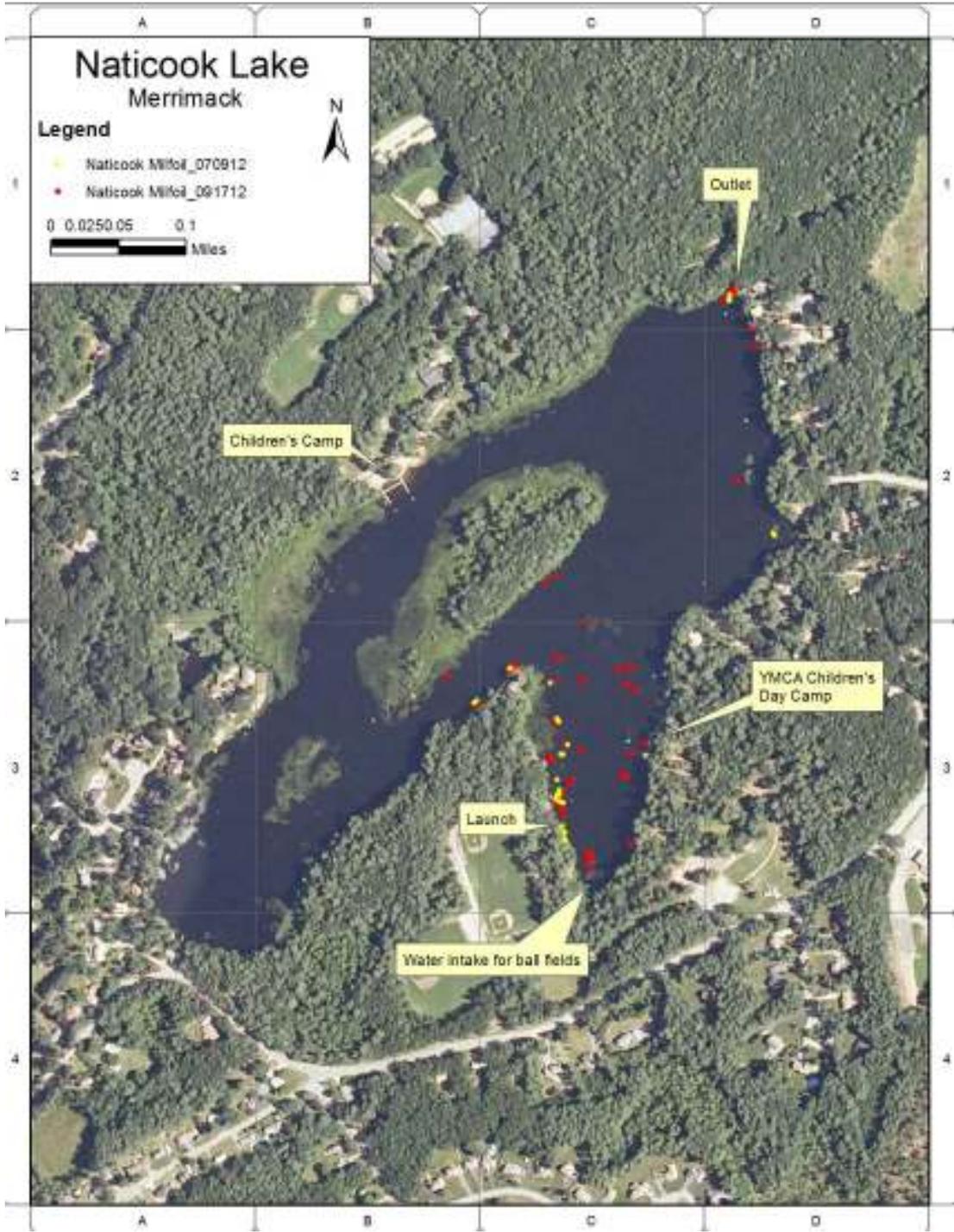
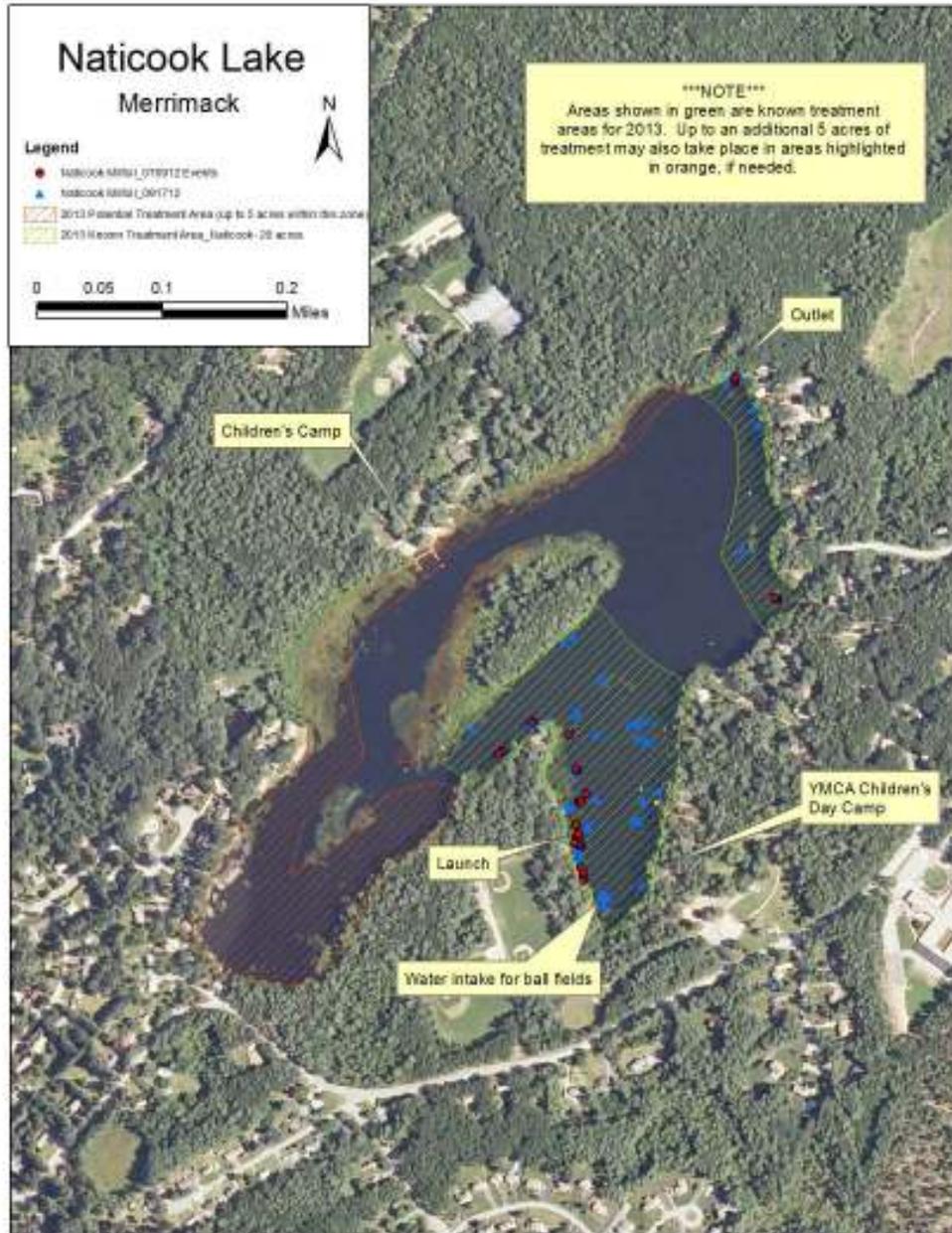


Figure 2: Map of Control Actions

2013 (proposed)



Key to Macrophyte Map

Symbol	Common Name	Latin Name
T	Cattail	<i>Typha sp.</i>
P	Pickerelweed	<i>Pontedaria cordata</i>
N	Pondweed	<i>Potamogeton</i>
W	White water-lily	<i>Nymphaea</i>
E	Pipewort	<i>Eriocaulon</i>
C	Sedge	<i>Carex</i>
Y	Yellow water-lily	<i>Nuphar</i>
S	Bur-reed	<i>Sparganium</i>
a	Arrow arum	<i>Peltandra virginica</i>
F	Floating heart	<i>Nymphoides cordata</i>
b	Bulrush	<i>Scirpus</i>
e	Waterweed	<i>Elodea</i>
U	Bladderwort	<i>Utricularia intermedia, U. vulgaris, U. purpurea, U. radiata</i>

Figure 4: Bathymetric Map

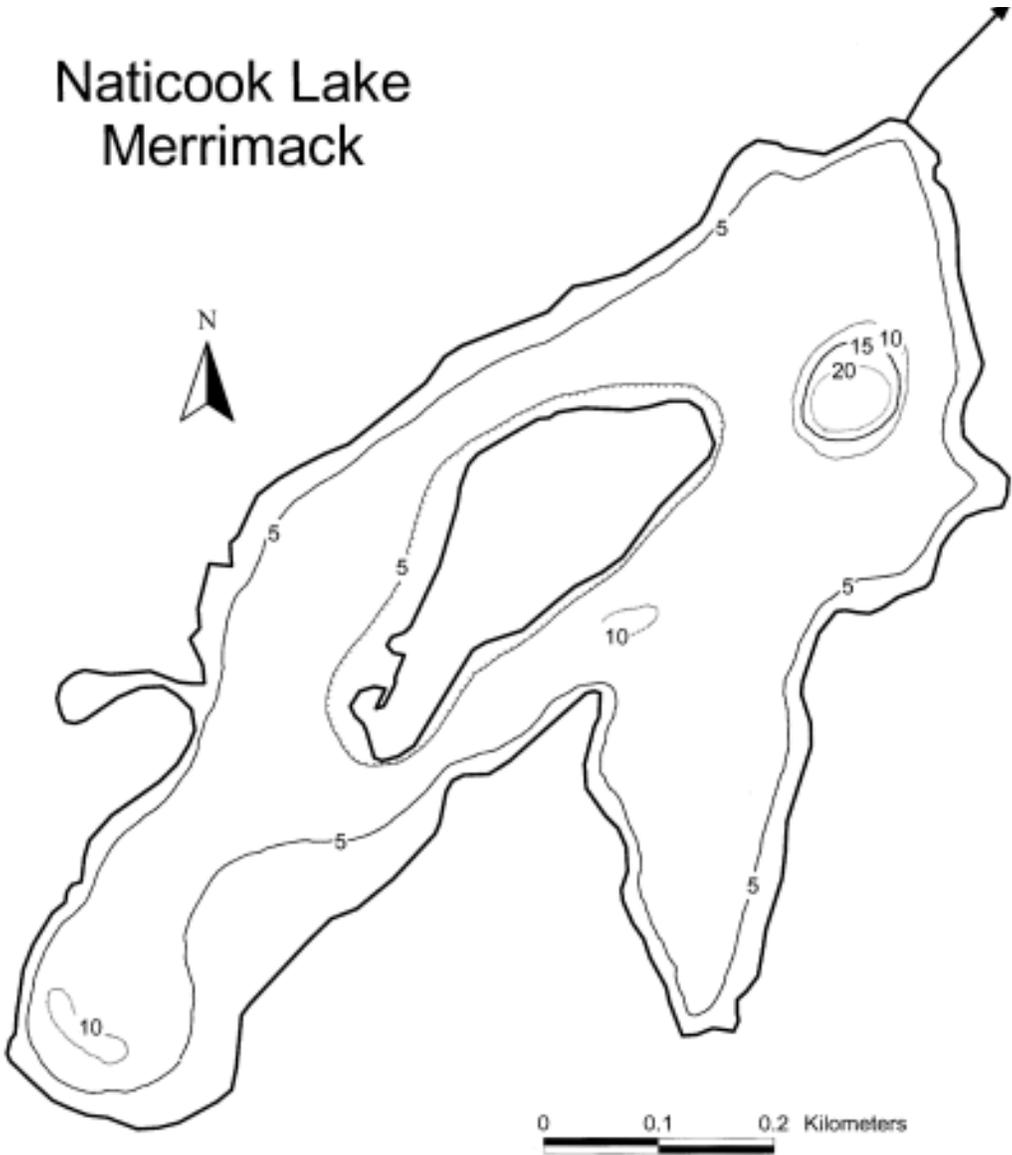
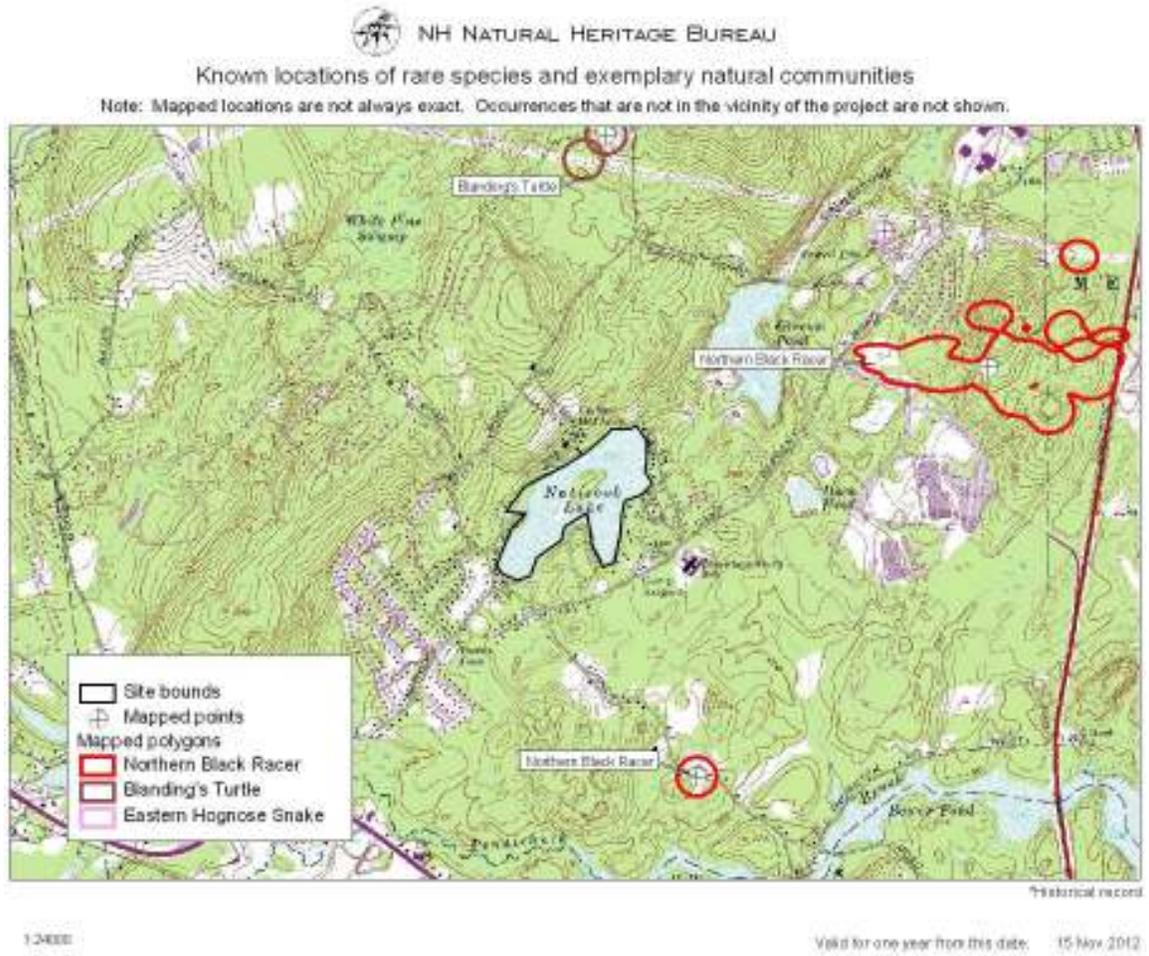


Figure 5: Fishing Information, Critical Habitats or Conservation Areas



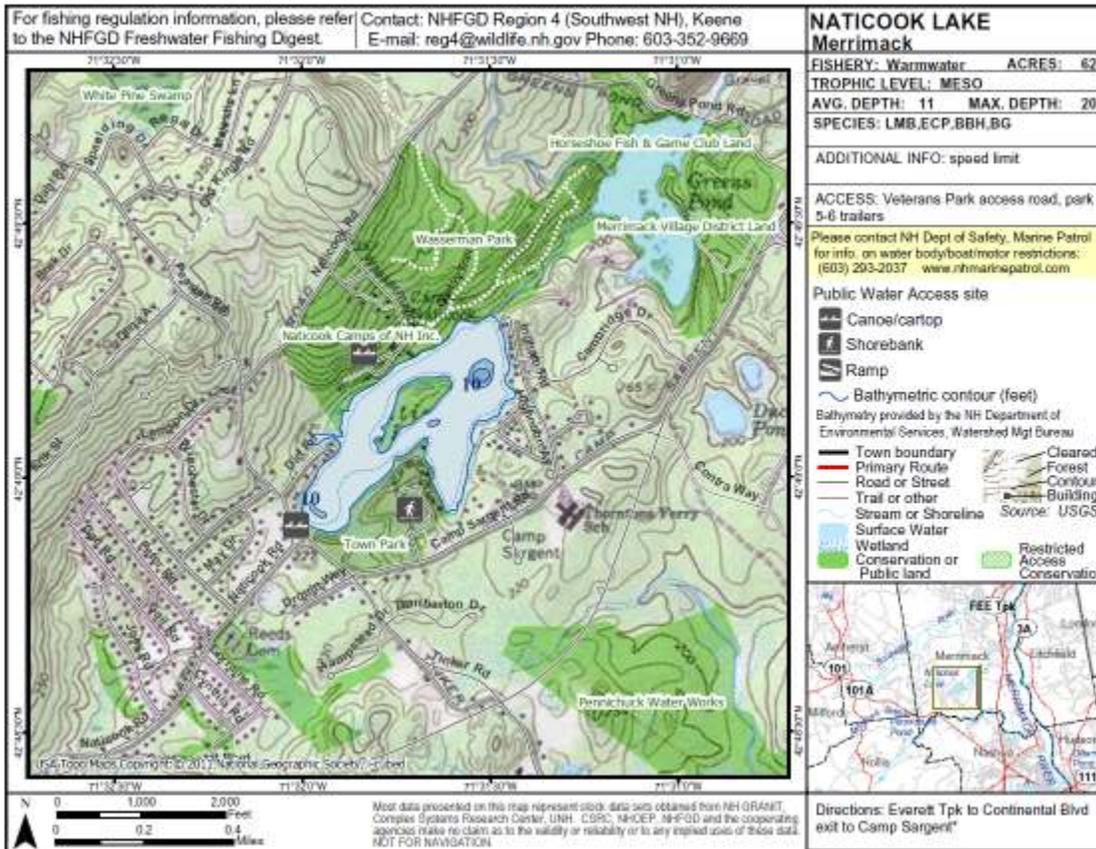


Figure 6: Public Access Sites, Swim Areas, Docks and Swim Platforms

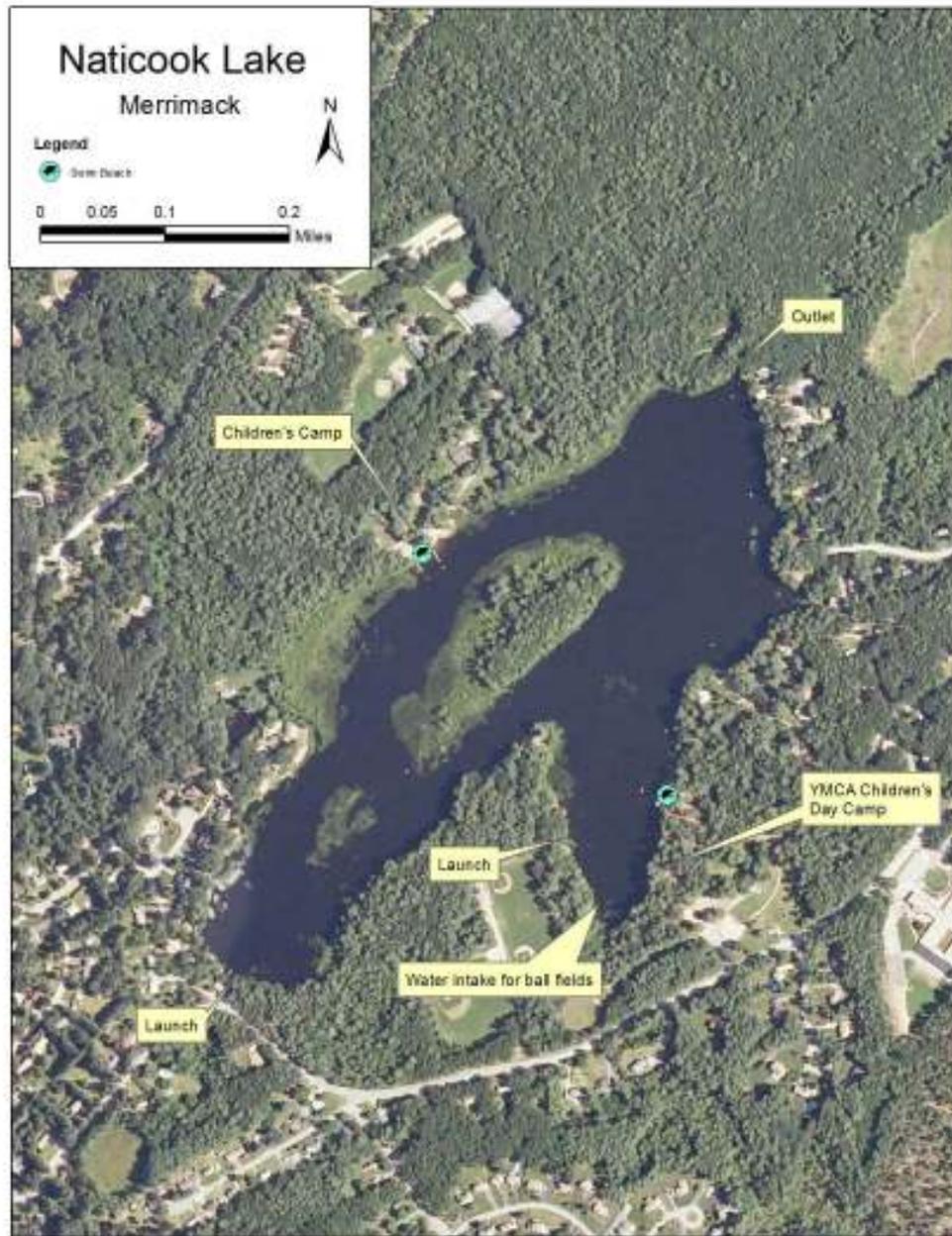
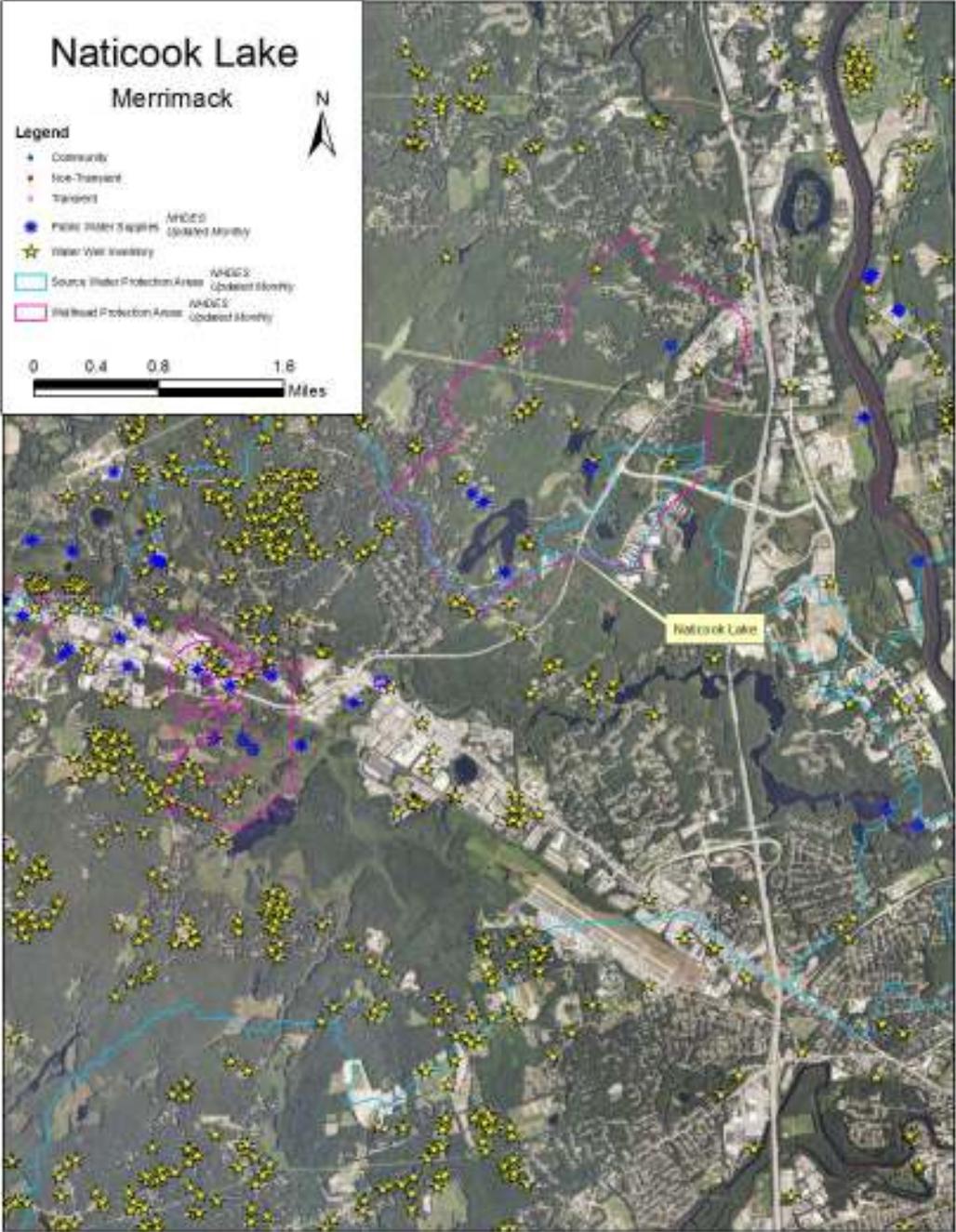


Figure 7: Wells and Water Supplies, 1:48,000 scale



Appendix A Selection of Aquatic Plant Control Techniques

Preliminary Investigations

I. Field Site Inspection

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

II. Office/Laboratory Research of Waterbody Characteristics

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

Overall Control Options

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

- 1) **Eradication:** The goal is to completely remove the exotic plant infestation over time. In some situations this may be a rapid response that results in an eradication event in a single season (such as for a new infestation), in other situations a longer-term approach may be warranted given the age and distribution of the infestation. Eradication is more feasible in smaller systems without extensive expanded growth (for example, Lake Winnepesaukee 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.
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- 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.
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Appendix B Summary of Control Practices

Restricted Use Areas and Fragment Barrier:

Restricted Use Areas (RUAs) are a tool that can be used 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 collection 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 Lake 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 resLake 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 Lake (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.

References

Department of Environmental Services. 2006: 2006 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology. November 2005. New Hampshire Department of Environmental Services. NHDES-R-WD-05-29. Available at <http://des.nh.gov/WMB/swqa/calm.html>

Halstead, J.M., J. Michaud, S. Hallas-Burt, and J.P. Gibbs. 2003. “An Hedonic Analysis of Effects of a Nonative Invader (*Myriophyllum heterophyllum*) on New Hampshire (USA) Lakefront Properties.” *Environmental Management*. 32 (3): 391 – 398

Luken, J.O. and J.W. Thieret. 1997. *Assessment and Management of Plant Invasions*. Springer-Verlag, New York. 324 pages.

Netherland, M.D. 2010. Evaluation of the Seed Viability of Variable Milfoil (*Myriophyllum heterophyllum*) as a Potential Source for Plant Recovery Following Management with Herbicides. U.S. Army Engineer Research Development Center. Final Project Report (draft manuscript for publication currently confidential).
