Long-Term Variable Milfoil Management and Control Plan for HORSESHOE POND
Merrimack, New Hampshire
Hillsborough County

Prepared by: New Hampshire Department of Environmental Services (DES)
January 2008, updated 2012

PROBLEM STATEMENT

Exotic aquatic plants pose a threat to the ecological, aesthetic, recreational, and economic values of lakes and ponds (Luken & Thieret, 1997, Halstead, 2000). According to the 2006 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 Env-Ws 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).

Though exotic aquatic plants can negatively impact an aquatic system, native aquatic plants are beneficial to the aquatic ecology of waterbodies, and are thus not a focus of management efforts in this waterbody. Diverse assemblages of native aquatic plants are a source of oxygen to the system, they provide stabilizing root systems to minimize erosion and turbidity, and they provide food and habitat for aquatic life.

Variable milfoil (*Myriophyllum heterophyllum*) became established in Horseshoe Pond in Merrimack, New Hampshire in 2000. The plant has colonized several shoreline segments and wetland areas associated with this shallow pond. Figure 1 illustrates the distribution of variable milfoil infestations in this waterbody as of 2007, and Figure 1a illustrates the distribution as of summer 2011.

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

Area	2007 (Figure 1)	2011 (Figure 1a)
A	Located at the southeastern corner of the pond, Area A covers 6.97 acres, and has a variable milfoil coverage of roughly 60%. The area contains 4 popular fishing areas and a public access ramp. This is the largest area targeted for treatment, and likely the most important, due to the risk of transient boaters entraining variable milfoil from the shallows near the launch site and then transporting them to other nearby waterbodies.	This area has regrown and has expanded to form contiguous growth with other infested areas around the waterbody.

Area	2007 (Figure 1)	2011 (Figure 1a)
B	This section spans 1.61 acres and is located just north of Area A, in the northeast quadrant of the pond. It runs along roughly 0.15 miles of shoreline. One fishing area lies within Area B. The variable milfoil is widely scattered through the area, resulting in a 20% variable milfoil coverage in this zone.	This area has regrown and has expanded to form contiguous growth with other infested areas around the waterbody.
C	This is the northern most area in the pond. It spans 0.37 acres and abuts one fishing spot. The milfoil is scattered in moderately sized clumps in this area.	This area has regrown and has expanded to form contiguous growth with other infested areas around the waterbody.
D	This area is located in the southwest corner of the pond. It spans approximately 0.9 acres, and variable milfoil is present in large patches.	This area has regrown and has expanded to form contiguous growth with other infested areas around the waterbody.
E	This section spans 0.66 acres and is located in the southwest corner of the pond near Area D. The variable milfoil is scattered in nature.	This area has regrown and has expanded to form contiguous growth with other infested areas around the waterbody.
F	This is the smallest area, spanning 0.3 acres and is located in the eastern half of the pond. There are some larger patches in this area, that are widespread throughout the 0.3 acres.	This area has regrown and has expanded to form contiguous growth with other infested areas around the waterbody.

In terms of the impacts of the variable milfoil in the system, there are several (61) houses around the shoreline of Horseshoe Pond, with mostly year-round dwellings. There are also 32 back lots with lake rights. Many of these abut areas of dense variable milfoil growth.

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 Merrimack River, which Horseshoe Pond flows into.

Horseshoe Pond 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.

PURPOSE

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

1. To identify the waterbody's beneficial use areas, including essential aquatic habitat, designated conservation zones, swimming areas, boat access sites, and boating use areas;
2. To present the aquatic macrophyte distribution map, including both native and exotic species;
3. To identify short-term and long-term exotic aquatic plant control goals that protect and conserve the lake's beneficial uses;
4. To recommend exotic plant control actions that meet the goals outlined in this plan; and
5. To recommend monitoring strategies to determine the success of the control practices over time in meeting the goals.

This plan also summarizes the current physical, biological, ecological, and chemical components of Horseshoe Pond and the social and ecological impacts of the milfoil infestation. The intent of this strategic plan is to provide long-term management of variable milfoil in Horseshoe Pond over time through the use of Integrated Pest Management Strategies (IPM). Appendix A details the strategies available for waterbodies with exotic species, and provides more information on each of the activities that are recommended within this plan.

GOALS/OBJECTIVES OF MILFOIL CONTROL ACTIONS

The aquatic plant management plan for Horseshoe Pond outlines actions to reduce the overall coverage of variable milfoil while maintaining native plant communities whenever variable milfoil control actions are being implemented.

The goal for Horseshoe Pond is for long-term management of variable milfoil from the system using an Integrated Pest Management Approach.

Town Support

The Town of Merrimack has been very supportive of variable milfoil control efforts in Horseshoe Pond. 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 been supportive financially by offering matching funds for herbicide applications, including control actions in 2008 and those proposed in 2012.

Island Drive Association

Horseshoe Pond has an active lake association. DES will work with lake residents to encourage them to perform follow-up monitoring for milfoil re-growth, and coordinate hand-removal and benthic barrier placement for further variable milfoil control.

The lake association recognized that milfoil was again expanding in 2010, but due to lack of resources on the state and local level control actions were not performed.

WATERBODY CHARACTERISTICS

The following table summarizes basic physical and biological characteristics of Horseshoe Pond.

General Lake Information	
Lake area (acres)	52
Watershed area (acres)	46.2
Shoreline Uses (residential, forested, agriculture)	Residential, commercial, forested
Max Depth (ft)	23.1
Mean Depth (ft)	7.9
Trophic Status	Eutrophic
Color (CPU) in Epilimnion	16
Clarity (ft)	8.9
Flushing Rate (yr^{-1})	0.2
Natural waterbody/Raised by Damming/Other	Natural
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	*Myriophyllum heterophyllum*
Infested Area (acres)	Varies from year to year with 46.5 acres in 2011.
Distribution (ringing lake, patchy growth, etc)	Dense growth throughout much of the pond (Figure 1a)
Sediment type in infested area (sand/silt/organic/rock)	Silty/organic
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	Brook Floater (Endangered)- Merrimack River Bald Eagle (Endangered)- Merrimack River Banded Sunfish (Rare)- Horseshoe Pond Eastern Hognose Snake (Threatened)

An aquatic vegetation map and key from a September 6, 2007 survey by the DES Biology Section is shown in Figure 2. The map was verified in summer 2011, and very little change was observed in native plant community. A bathymetric map is shown in Figure 3.

BENEFICIAL (DESIGNATED) USES

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

Of these, Aquatic Life and Recreation are the ones affected by the presence of invasive plants like variable milfoil.

AQUATIC LIFE

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.

FISHERIES AND WILDLIFE

Horseshoe Pond is managed for warmwater species under general regulations. The pond is actually an oxbow lake created by a change of course in the Merrimack River. During high water conditions, the Merrimack River overflows into this pond. Due to these occurrences, there is a wide variety of fish species present in the pond. Fish species include: largemouth bass, black crappie, yellow perch, white perch, American eel, pumpkinseed, carp, common white sucker, brown bullhead, chain pickerel, and bluegill.

Fishing pressure is moderate during open water and ice fishing season. There is a record of banded sunfish in the pond from 1938. Although banded sunfish were not detected in the 2005 seine survey, the dense submerged aquatic vegetation in the pond is ideal habitat for the species. Banded sunfish seem to exist at relatively low densities compared to other sunfish species in most water bodies, therefore it is possible that they were present but not captured in this survey. The abundant sunfish in the pond combined with good public access provided by a boat launch, make this waterbody an excellent introduction to fishing for children.

The New Hampshire Natural Heritage Program lists four species of concern from their survey relative to this treatment program: Brook Floater (Endangered) is in the Merrimack River downstream of the treatment site; the Bald Eagle (Endangered) is located along the Merrimack River Corridor; the Banded Sunfish (Rare) has historical records showing its presence in Horseshoe Pond, and the Eastern Hognose Snake (Threatened) has been found on the 'island' in the center of the oxbow.

In terms of impacts of these management practices on the above listed species of concern, DES does not anticipate that impacts will be seen as a direct result of the herbicide application to any of these species. Specifically, for the Brook Floater, this is located downstream in the Merrimack River, and the concentration of the herbicide will dissipate as it flows downstream, through a function of both dilution and breakdown of the herbicide molecules. For the bald eagle, which could prey on fish in Horseshoe Pond, 2,4-D, which is the recommended herbicide, does not bioaccumulate in fish, and therefore would not be a health risk for the eagle. For the banded sunfish, which seems to inhabit areas of dense aquatic vegetation, the habitat structure of the pond will not significantly change. Horseshoe Pond is characterized by stands of dense and diverse native plant communities, including submergent, emergent, and floating species. These will be unimpacted by the target-specific herbicide treatment proposed here for the variable milfoil. For the hognose snake, this is a terrestrial species, and should not be impacted by this aquatic management practice.

RECREATION USES AND ACCESS POINTS

Horseshoe Pond is used for numerous recreational activities, including boating, fishing, and swimming by both pond residents and local transient boaters. Figure 1 shows the location of the public access site. There is one designated public access for boats on the southeastern side of the

pond. Small motor boats, as well as kayaks and canoes can use this facility. There is limited parking for about two to three vehicles with trailers. There are generally 2-3 powerboats on the lake during the open water season, and up to about 12 using the pond on weekends. There are approximately 13 local canoes, kayaks, and row boats on the pond, and about 8 transient users on average during the day.

There are three beaches 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 2 floating docks and swim platforms around the pond as well. Figure 4 shows the locations commonly used for swimming, and the locations of swim platforms and docks on Horseshoe Pond.

MACROPHYTE 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 Horseshoe Pond is characterized by a mix of native and non-native (variable milfoil) plant growth (Figure 2). Native species include a mix of floating plants (duckweed, yellow and white water-lilies, watershield), emergent plants (arrow arum, bur-reed, pickerelweed, bulrush, smartweed, grassy arrowhead, turtlehead), and submergent plants (Robbins pondweed, bassweed, coontail, nitella, filamentous green algae, bladderwort, 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.

Purple loosestrife, an invasive wetland plant species, was noted in several locations around the pond. DES will work with lake residents to make them aware of this problem, and educate them about non-chemical approaches at management.

WELLS AND WATER SUPPLIES

Figure 5 shows the location of wells, water supplies, well-head protection areas, and drinking water protection areas around the pond. The applicator 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. *Due to DES restrictions for providing water supply data under Homeland Security restrictions, note that the map in Figure 5 cannot be provided on a finer scale than 1:48,000.*

HISTORICAL CONTROL ACTIVITIES ON THIS WATERBODY:

MANAGEMENT ACTION	DATE	TARGET SPECIES	ACRES	CONTRACTOR
2,4-D TREATMENT	06-Jun-01	VARIABLE MILFOIL	27	ACT
2,4-D TREATMENT	01-Jun-05	VARIABLE MILFOIL	33	ACT
2,4-D TREATMENT	16-Jun-08	VARIABLE MILFOIL	11	LYCOTT

Due to the abundance of native plant growth in the waterbody, as well as tannic nature of the water column, diver removal has not been implemented at this site. Should milfoil densities be reduced to a level where non-chemical means of control are feasible DES will work with the town and lake association to step up efforts with contract divers to provide these services as well as is feasible given the conditions in this pond.

MILFOIL MANAGEMENT OPTIONS

The control practices used should be as specific to milfoil 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/aquatic_bmp.pdf.
Criteria for the selection of control techniques are presented in Appendix A. Appendix B includes a summary of the exotic aquatic plant control practices used by the State of New Hampshire. DES has evaluated the feasibility of potential control practices on Horseshoe Pond. The following table summarizes DES' control strategy recommendations for Horseshoe Pond.

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	Use on Horseshoe Pond
Restricted Use Areas	Not feasible due to configuration of pond and distribution of variable milfoil.
Hand-pulling	DES recommends that the lake residents follow up the herbicide

Control Method	Use on Horseshoe Pond
	application with hand-pulling (through trained Weed Control Divers) if variable milfoil re-growth is small and scattered.
Mechanical Harvesting/Removal	For Horseshoe Pond, mechanical harvesting is not recommended due to the threat of spreading variable milfoil to uninfested areas through the generation of fragments.
Benthic Barriers	For Horseshoe Pond, 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. If benthic barriers are used, only small areas should be covered (no larger than 10' x 14' sections) due to the abundance of the native plants and the organic nature of the sediments. Covering large areas of the bottom in this pond may result in uplifting of the benthic barrier due to gas release from the sediments.
Herbicides	For Horseshoe Pond, herbicide use is recommended as primary treatment due to the extent and distribution of the infestation, tannic nature of the water column, and to enhance the target specificity of the milfoil control. DES further recommends that herbicides only be used when variable milfoil exceeds a level of 30% cover in the waterbody.
Extended Drawdown	Drawdown is not an effective control method for variable milfoil, and would be infeasible in this system due to lack of an impoundment structure.
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 Horseshoe Pond. This pond is used frequently by transient boaters, and could serve as a source of milfoil to other nearby waterbodies, due to the dense infestation around the boat launch.

EXOTIC AQUATIC PLANT CONTROL PLAN

An evaluation of the size, location, and type of variable milfoil infestation, as well as the waterbody uses was conducted by DES during September 6, 2007 and again on August 23, 2011. Based on the evaluation, the following control actions are recommended:

Year	Treatment Type	Responsible Party	Schedule
2012	Herbicide treatment of areas shown in Figure 1a.	Aquatic Control Technology, Inc.	May/June
	SCUBA inspection and diver hand-removal of variable milfoil at individual points and at areas of reduced percent coverage as a result of herbicide application	Contracted Weed Control Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Weed Control Divers	July/August
	Weed Watching and Lake Hosting Activities	Association	June through September
	Field survey	DES	September
2013	Herbicide treatment of small/persistent areas, if needed	TBD	May/June
	SCUBA inspection and diver hand-removal of variable milfoil at individual points and at areas of reduced percent coverage as a result of herbicide application	Contracted Weed Control Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Weed Control Divers	July/August
	Weed Watching and Lake Hosting Activities	Association	June through September
2014	SCUBA inspection and diver hand-removal of variable milfoil at individual points and at areas of reduced percent coverage as a result of herbicide application	Contracted Weed Control Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Weed Control Divers	July/August
	Weed Watching and Lake Hosting Activities	Association	June through September
	DES survey to determine need for variable milfoil control through herbicide application	DES	August/September
2015	Herbicide treatment, if needed	TBD	May/June

Year	Treatment Type	Responsible Party	Schedule
	SCUBA inspection and diver hand-removal of variable milfoil at individual points and at areas of reduced percent coverage as a result of herbicide application	Contracted Weed Control Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Weed Control Divers	July/August
	Weed Watching and Lake Hosting Activities	Island Pond Association	June through September
2016	SCUBA inspection and diver hand-removal of variable milfoil at individual points and at areas of reduced percent coverage as a result of herbicide application	Contracted Weed Control Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Weed Control Divers	July/August
	Field survey and planning for future	DES	September
2017	Update and revise Long-Term Variable Milfoil Control Plan	NH DES, F&G, and interested parties	Fall

- Based on the types of native plants that are mixed in with the stands of variable milfoil (Figure 2) where herbicide application is recommended there are no significant impacts to native plant communities expected as a result of this treatment. It is expected that a well distributed stand of native aquatic plants will remain following herbicide application.

- It is important to realize that aquatic herbicide applications are conducted in a specific and scientific manner, and that the herbicides that are used can be target-specific when used at appropriate doses/concentrations: this means that the invasive plant can be removed and native plants favored in this type of control practice. *Not all aquatic plants will be impacted as a result of an herbicide treatment.*

- 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, etc). 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 outline here, all 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 Milfoil Infestation (2007)

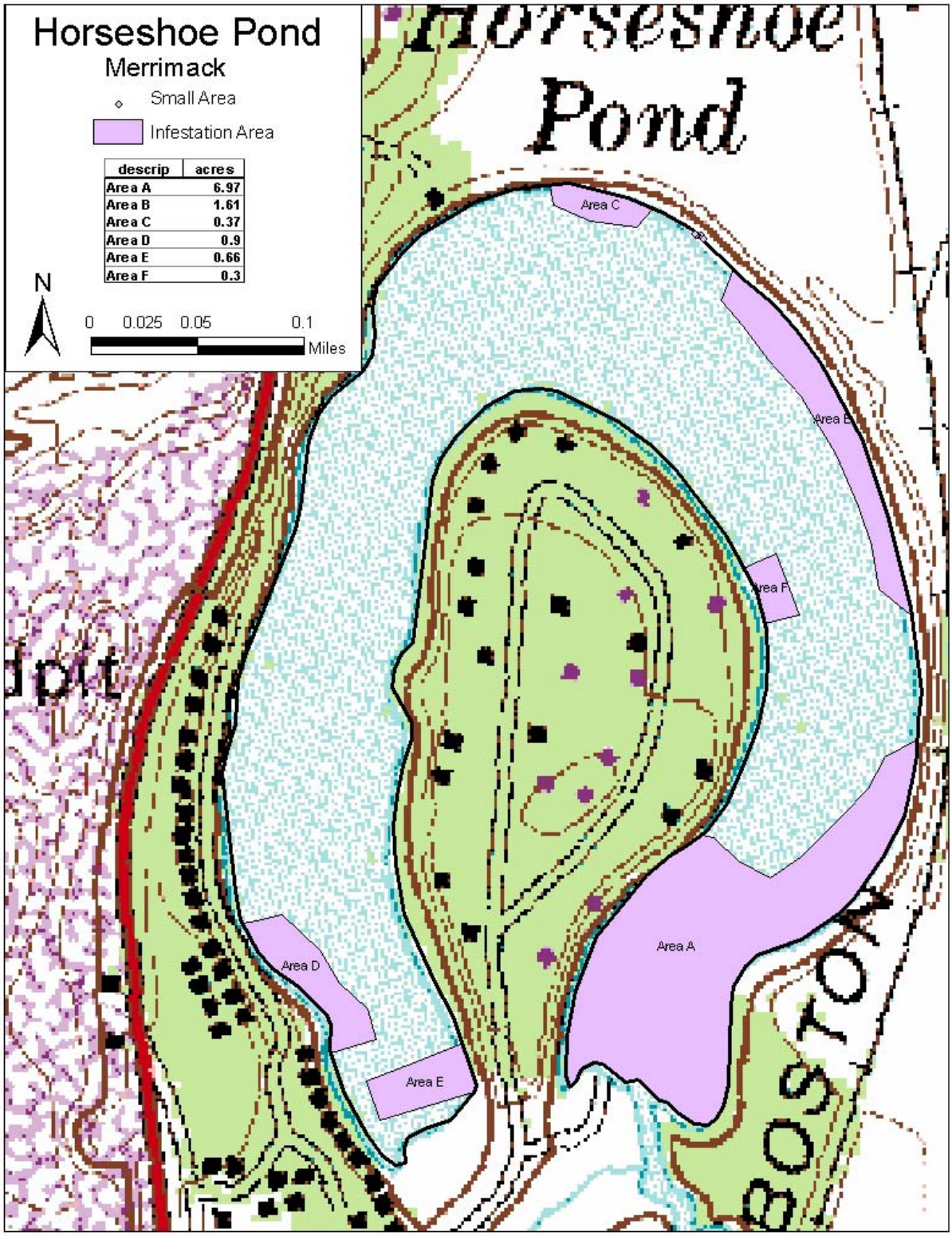


Figure 1a- Map of Milfoil Infestation (2011)

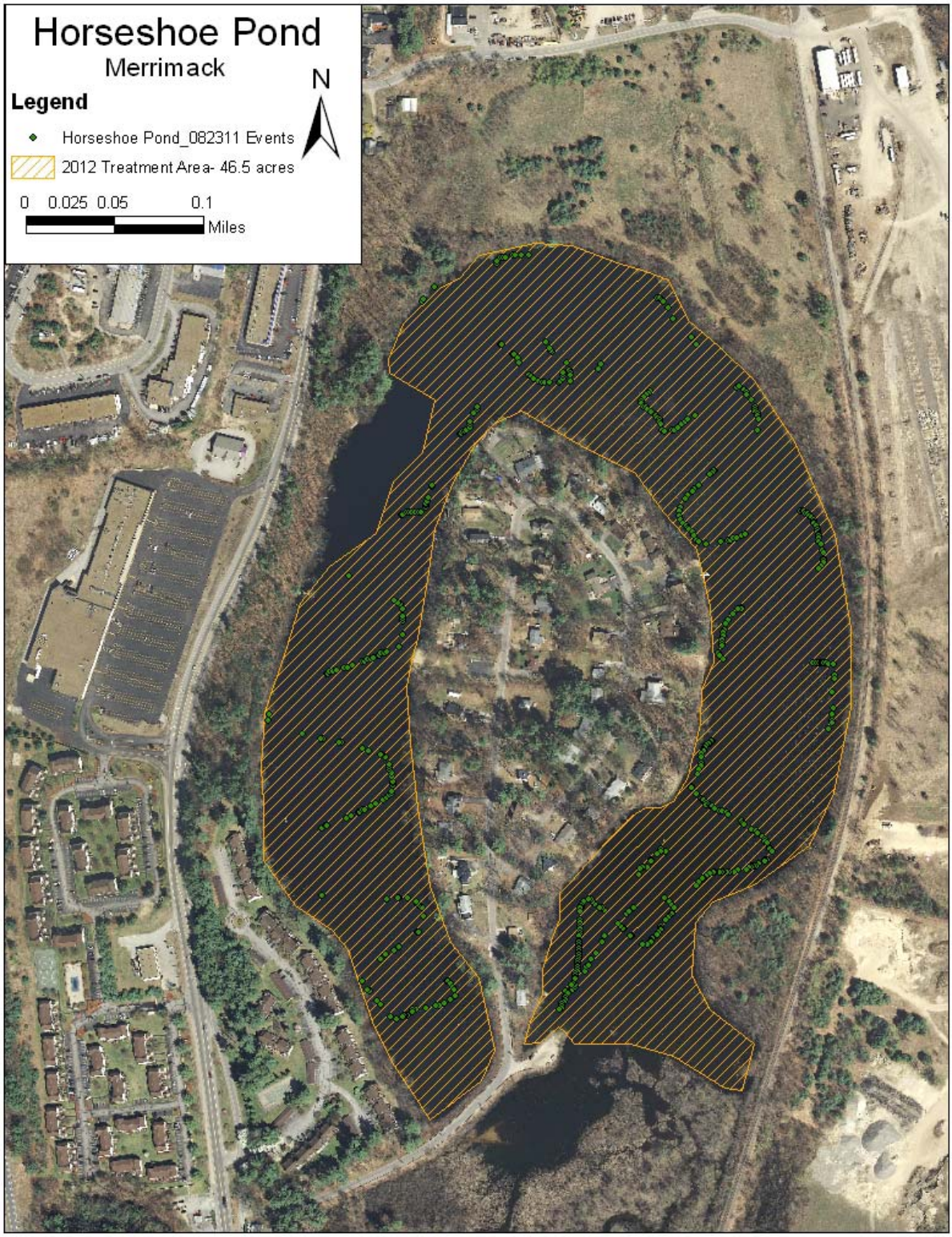
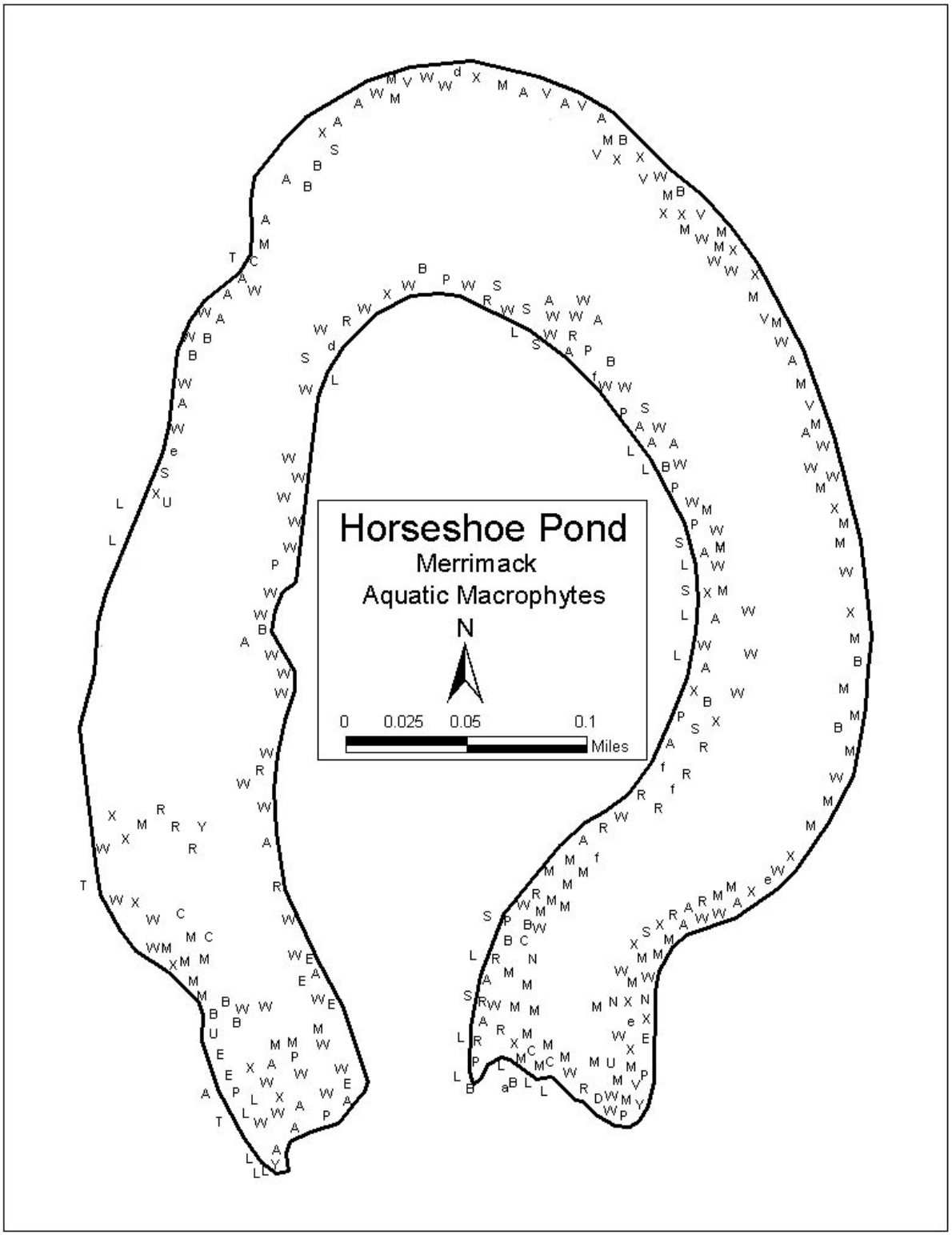


Figure 2- Aquatic Vegetation Map and Key



Symbol	Common Name	Latin Name
L	Purple loosestrife	*Lythrum salicaria*
M	Variable water-milfoil	*Myriophyllum heterophyllum*
A	Arrow arum	*Peltandra virginica*
B	Bur-reed	*Sparganium sp.*
R	Robbins Pondweed	*Potamogeton robbinssii*
X	Bassweed	*Potamogeton amplifolius*
P	Pickerelweed	*Pontedaria cordata*
C	Coontail	*Ceratophyllum*
a	Bulrush	*Scirpus*
N	Nitella	*Nitells*
W	White water-lily	*Nymphea*
f	Filamentous green algae	
S	Smartweed	*Polygonum sp.*
B	Watershield	*Brasenia*
d	Grassy arrowhead	*Sagittaria graminea*
e	Duckweed	*Lemna*
Y	Yellow water-lily	*Nuphar*
U	Bladderwort	*Utricularia*
T	Turtlehead	*Chelone*
V	Tapegrass	*Vallisneria americana*

Figure 3- Bathymetric Map of Horseshoe Pond, Merrimack

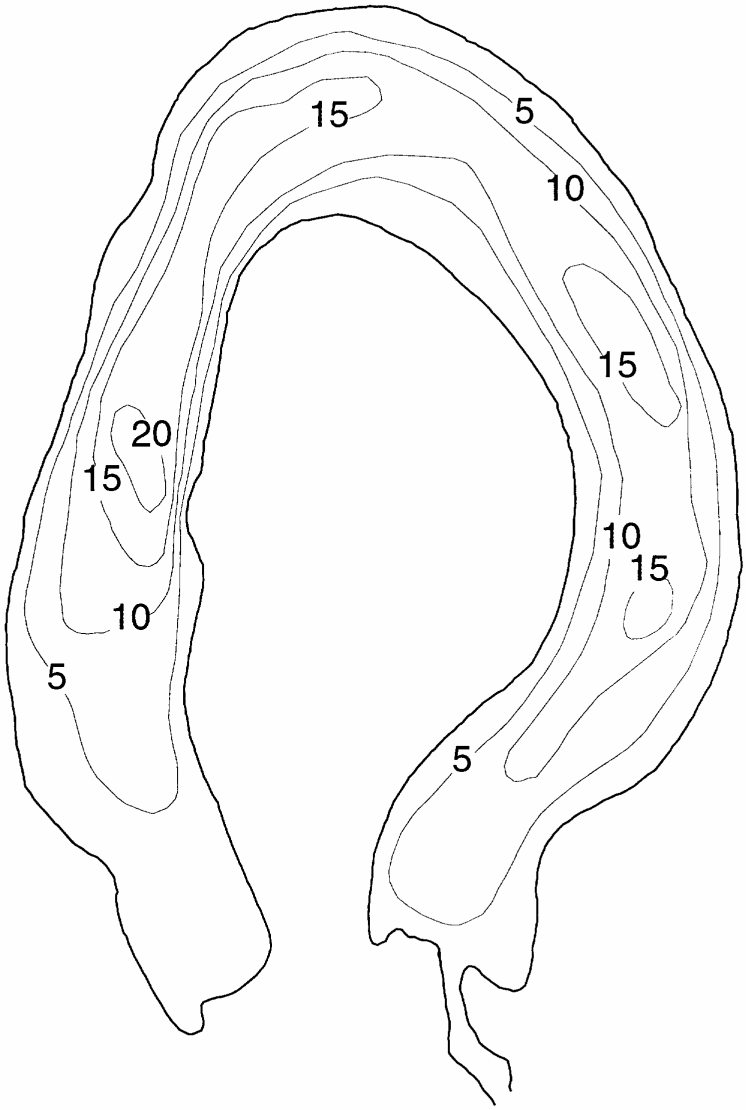


Figure 4- Access Points, Docks and Swim Beaches

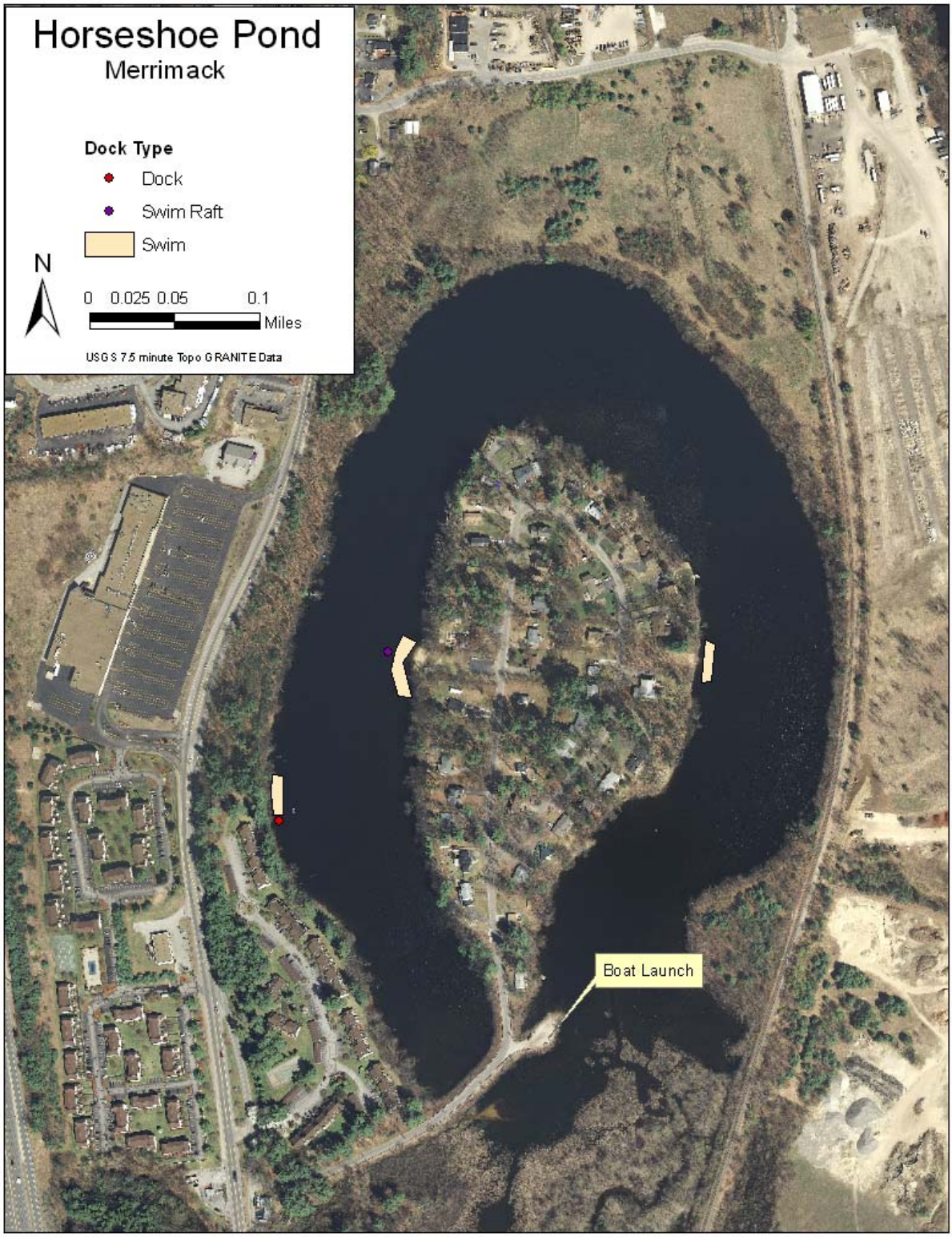
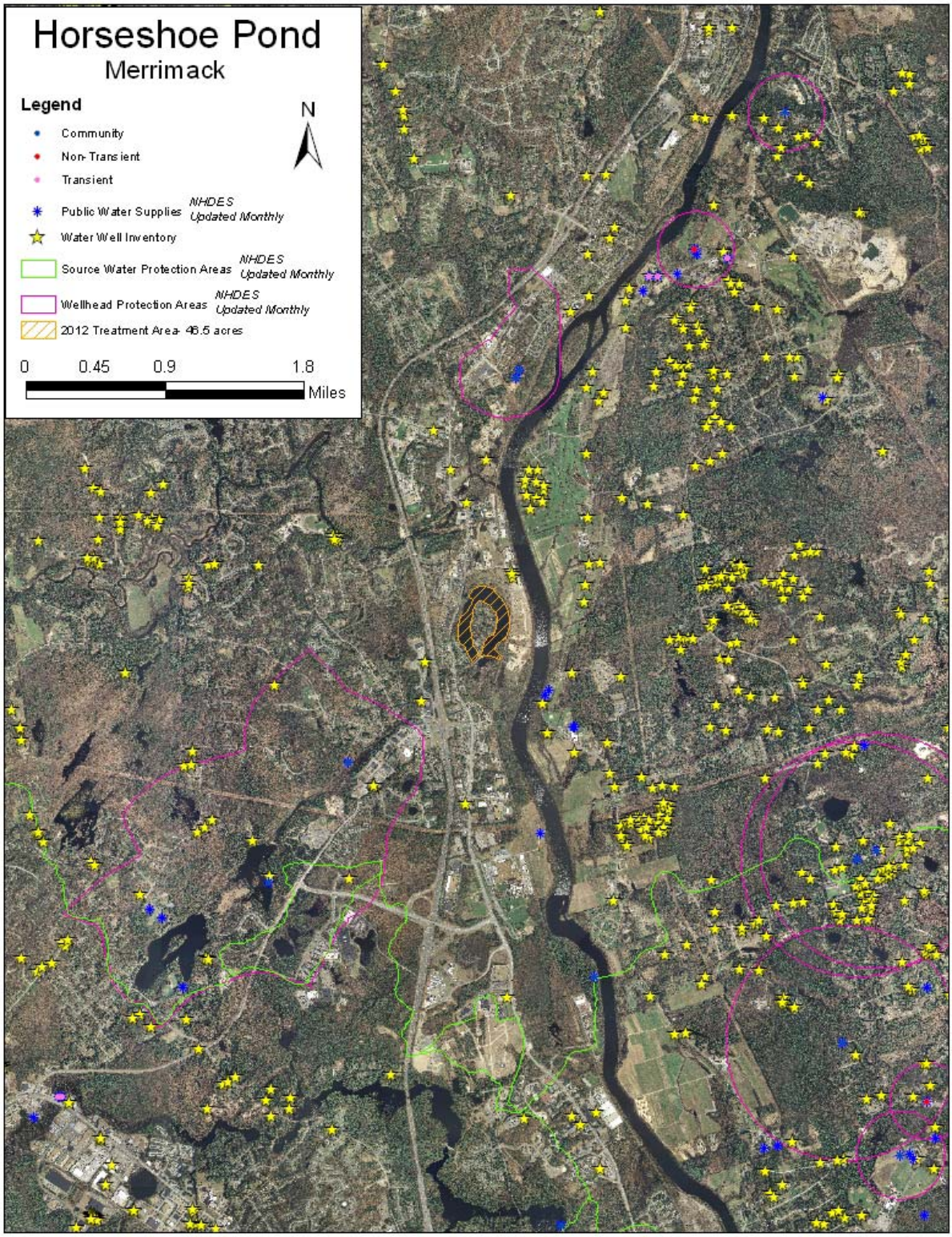


Figure 5- Wells and Water Supplies



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 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 impacts to downstream waterbodies based on limnological characteristics (water chemistry, quantity, quality).

Overall Control Options

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

1) Eradication: Herbicide application targeted at exotic aquatic plant to be eradicated, to either eradicate the plant or to reduce overall biomass to a point where alternative non-chemical strategies may be used. This action will be followed by thorough annual monitoring for regrowth and the use of non-chemical actions to achieve the eradication.

2) Containment: The aim of this approach is to limit the size and extent of the existing infestation. An herbicide application may be used to reduce specified areas down to a percent cover of the exotic species so that it can be maintain or contained with alternative management strategies, including Restricted Use Areas, benthic barriers, and others. Subsequent herbicide applications may be necessary if the target species shows exponential growth and further spread.

3) 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. All efforts will instead be made towards containment of the target species to that specific waterbody, so that downstream migration of the plant can be prevented.

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

Guidelines and requirements of each control practice are detailed below each alternative.

A. Hand-Pulling

- Can be used for exotic or native species.
- 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').
- 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 a few scattered plants.
- 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).
- Funds are available for repeated harvesting activities in that season.
- A navigation channel is required through dense plant growth.

C. Chemical Treatment

- Can be used if application of chemical is conducted in areas where alternative control techniques are not optimum due to depth, current, use, or 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 (rare or endangered that will not be impacted by chemical treatment).
- 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 chemical treatment as compared with

other treatments.

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

- Can be used for exotic species only.
- Can be established in an area that effectively restricts use to a small cove, bay, or other such area where navigation, fishing, and other 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 for exotic or native species.
- 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.

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 RSA211:11 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.
- Exotic controls, such as insects, cannot be introduced to control a nuisance plant.
- Research should be conducted on a potential biological control prior to use to determine the extent of host specificity.

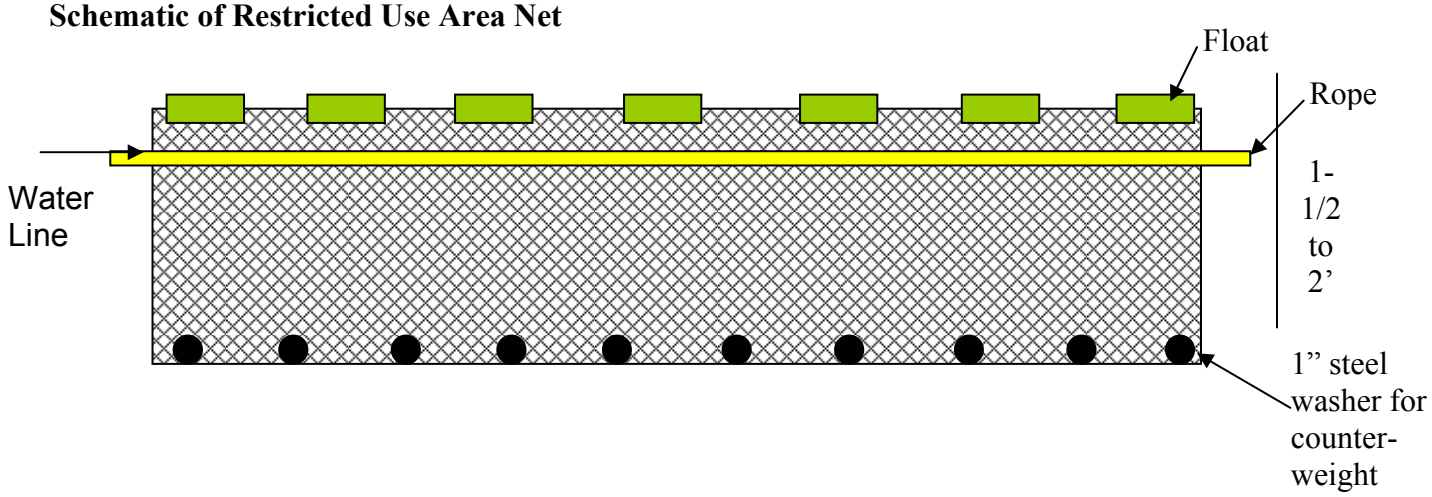
APPENDIX B

SUMMARY OF CONTROL PRACTICES USED IN THE STATE OF NEW HAMPSHIRE FOR EXOTIC AQUATIC PLANTS

Restricted Use Areas:

Restricted Use Areas (RUAs) are a regular control option for lakes with small, contained infestations of exotic plants, limited to small patches or embayments. This is often the case in waterbodies with newly-discovered infestations. RUAs restrict access to all recreational activities in a delineated area to minimize plant fragmentation and thereby reduce the spread of milfoil. As an additional method of protection from fragment migration, RUAs are encircled with a shallow net that is suspended vertically in the water column. The net is approximately 1.5-2.0 feet in height. The top of the net is set to extend four inches above the surface of the water, while the remainder is positioned below the surface of the water (see figure below). This configuration prevents the movement of fragments from infested areas to uninfested areas. Due to the size and nature of net construction, there is no impediment to fish migratory patterns or spawning activities.

Schematic of Restricted Use Area Net



Hand-pulling:

When infestations of exotic aquatic plants begin as single scattered stems or small patches, DES biologists SCUBA dive to hand-pull the plants (and DES can train other certified divers to also perform this management practice). Guidelines for determining feasibility and effective for hand-removal are site specific, but generally sparsely populated patches of up to 5' X 5', single stems, or dense small patch up to 2' X 2' are reasonable.

The whole plant including the roots should be removed in this process, while leaving the beneficial native species intact. This technique works best in softer sediments, with shallow rooted species and for smaller, scattered infestation areas. When hand pulling nuisance species, the entire root system and all fragments of the plants must be collected since small root or stem fragments could result in additional growth of the species. The process must be repeated often to control re-growth of the exotic plants. For a new infestation, hand-pulling activities are typically

conducted several times during the first season, with follow-up inspections for the next 2-5 years or until no re-growth is observed. This control practice has proven successful in many waterbodies.

Diver Assisted Suction Harvesting

Diver Assisted Suction Harvesting (DASH) is a method whereby a diver works to hand remove exotic plants from the bottom sediments, and rather than depositing them into a dive bag for containment, they are fed into a suction tube that brings the materials topside for containment, de-watering, and disposal. This method can allow for larger-scale removal projects and potentially lower turbidity than simple diving and hand-removal with a dive bag.

Generally, the DASH unit is comprised of a floating platform that is set up with a suction pump and associated hoses, and some type of catchment basin that is lined with fine mesh net to entrain the plants and to filter the water through and back into the lake.

A team comprised of one or two divers and one or two topside tenders are needed to operate the DASH unit.

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:

When a small infestation of exotic aquatic plants occurs in clusters of growth (generally areas >5 ft^2), as opposed to scattered stems, a permeable fiberglass screen can be placed over the area of infested lake sediments. The permeable fabric screening allows for gas release from the sediments while effectively blocking sunlight and compressing the plants into the sediment, inhibiting photosynthesis and eventually killing the plant. Occasionally, in some lakes, gas release from the sediments or boating activity cause the uplifting of screening. Benthic barriers can effectively control small infestations of less than approximately 10,000 square feet.

Benthic barriers have two basic applications. These practices are used to cover pioneering infestations and prevent the spread of the plant. Bottom barriers are installed across small portions of lake bottoms infested with invasive aquatic plants. The disadvantage of benthic barriers is their non-selectivity and limitation of cover to less than 10,000 square feet. Additionally, these physical barriers prevent the growth of all vegetation, which is a necessary component of fish and wildlife habitat.

Bottom barriers are attached to the bottom of a water body by re-bar attached to the edges and across the middle of the material. Bottom barriers are transported to the shoreline adjacent to where installation is to occur. They are then cut to fit the treatment site and rolled onto a length of pipe. Divers carry the roll into the water at the start of the treatment site and secure one edge of the material to the lake bottom. The divers then roll out the remainder of the material and continue to secure it to the bottom sediments. This process is repeated until the plants in the treatment are covered.

Bottom barriers are generally considered for small localized areas rather than lakewide application. Bottom barriers provide 100% control of this weed in areas where they are installed. They also provide long-term control. An ongoing maintenance operation is required to inspect the bottom barrier and clear the mats of sediment buildup.

Benthic barriers are not recommended for application in river systems, as flow can easily uplift the barrier.

Targeted Application of Herbicides:

The use of chemicals, such as herbicides, for the control of noxious and nuisance plant species represents one of the most widely known and effective management options available. Herbicide control of invasive aquatic plants is often the first step in a long-term integrated control program. In the last 15 to 20 years the use and review of herbicides has changed significantly in order to accommodate safety, health, and environmental concerns. Currently no herbicide product can be labeled for aquatic use if it has more than a one in a million chance of causing significant harmful effects to human health, wildlife, or the environment. Because of this, the number of effective and U.S. Environmental Protection Agency (EPA) approved herbicides for aquatic weeds are limited. In most cases the cost and time of testing and registration, rather than environmental issues, limits the number of potentially effective compounds.

All herbicide applications in New Hampshire are performed under permits issued by the New Hampshire Department of Agriculture, Division of Markets and Food, Bureau of Pesticide Control.

Two herbicides have been used in New Hampshire for the control of milfoil. Diquat (trade name Reward), the most often-used herbicide, is a contact herbicide that can generally provide one season of control for milfoil. Because this herbicide does not target the root systems, the plants eventually re-grow from established roots.

The second herbicide, 2, 4-D (trade name Navigate or Aqua Kleen), is a systemic herbicide. It is absorbed into the plant, killing both the roots and the plant biomass above the sediments.

The aquatic herbicide SONAR has been used in New Hampshire to control growths of fanwort. The chemical acts by limiting photosynthesis when chlorophyll-a is affected by the active ingredient of the herbicide.

Extended Drawdown

Water drawdown is used for control of some species of aquatic macrophytes. Drawdown requires some type of mechanism to lower water levels, such as dams or water control structures and use is thus limited. It is most effective when the drawdown depth exceeds the depth or invasion level of the target plant species.

In northern areas, drawdown will result in plant and root freezing during the winter for an added degree of control. Drawdown is typically inexpensive and has intermediate effects (2 or more years). However, drawdown can have other environmental effects and interfere with other functions of the water body (e.g. drinking water, recreation, or aesthetics). Drawdown can result in the rapid spread of highly opportunistic annual weed species, which in most cases is the plant that is targeted for control.

Drawdowns have been used in the past for plant control. In theory, the drying of the plants in the summer, or the freezing of the plants in the winter, will eliminate or limit plant growth. However, milfoil often forms a more succulent terrestrial form during drawdown conditions and the succulent form of the plant can remain viable for long periods of time without submergence, making the practice ineffective. This strategy can be used for control of some native plant species.

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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