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

Prepared by: New Hampshire Department of Environmental Services (DES),
in consultation with the
New Hampshire Fish and Game Department (F&G)
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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. 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 Melendy Pond in Brookline, New Hampshire in 2002. Since then, the plant has become widely distributed throughout the pond, with areas of dense growths of variable milfoil. 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- Covering 5.46 acres, this area lines the southern and western shoreline of the pond. The area contains a public access ramp and several private shorefront swimming areas. Milfoil is at the 45-50% cover level in this area.

Area 2- This area covers 2.96 acres and lines the mid-northern and northeastern shoreline. The area contains private shorefront swimming areas. Variable milfoil is present at a 60%-65%

In terms of the impacts of the variable milfoil on the system, there are several (23) houses around the shoreline of Melendy Pond, with mostly seasonal cottages, though there are a few year-round dwellings. Many of these abut areas of dense variable milfoil growth. There are also five back lots with lake rights.

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.

The invasive plant infestation in this pond has increased over time. Melendy Pond is shallow, with a mix of sandy, silty, and 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

In August 2007, the Melendy Pond Association requested matching funds from the Department of Environmental Services to conduct an aquatic plant control project during the spring of 2008 to control areas infested with variable milfoil.

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 Melendy Pond and the social and ecological impacts of the milfoil infestation. The intent of this strategic plan is to eventually eradicate variable milfoil from Melendy 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 goal for Melendy Pond 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 in Area 1 from 5.46 acres and 40-50% cover in 2008, with the use of 2,4-D, to less than 1 acre and 20% cover.

2) To reduce the overall acreage and percent cover of variable milfoil in Area 2 from 2.96 acres and 60-65% cover to less than ½ acre and 10% cover with the use of 2,4-D in 2008.

3) 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 2 above, using hand-removal, benthic barriers, and/or diver-assisted suction harvesting in August 2008, and annually thereafter if new stems or localized patches are present.

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

Town Support

The Town of Brookline, through the Melendy Pond Authority, has been very supportive of variable milfoil control efforts in Melendy Pond. This is one of two infested waterbodies in the town at this point (Lake Potanipo is the other infested waterbody), 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 a proposal for matching funds in 2008 and future years. Additionally, the town will likely supply drinking water, for a short duration, to shorefront residents on Melendy Pond if 2,4-D is the permitted herbicide.

WATERBODY CHARACTERISTICS

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

General Lake Information	
Lake area (acres)	16.7
Watershed area (acres)	204.8
Shoreline Uses (residential, forested, agriculture)	Residential, forested
Max Depth (ft)	22.4
Mean Depth (ft)	8.9
Trophic Status	Mesotrophic
Color (CPU) in Epilimnion	11
Clarity (ft)	11.6
Flushing Rate (yr^{-1})	2.2
Natural waterbody/Raised by Damming/Other	Natural
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	*Myriophyllum heterophyllum*
Infested Area (acres)	Approximately 8.5 acres
Distribution (ringing lake, patchy growth, etc)	Dense areas of infestation lining the majority of the shoreline. Figure 1.
Sediment type in infested area (sand/silt/organic/rock)	Mix of sand, silt, organics
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	None on record
Area of Littoral Zone (acres)	16
Area of Profundal Zone (acres)	1.5

Area of Macrophyte Coverage (native or otherwise) of Plants in Littoral Zone	9.4
% of Littoral Zone with Macrophyte Cover	59
% of Macrophyte cover comprised of invasives	90
% of Littoral Zone with Variable Milfoil Cover	53

An aquatic vegetation map and key from an August 16, 2007 survey by the DES biologists is shown in Figure 2. 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

Melendy Pond is managed for warmwater species under general regulations. Fish species present include largemouth bass, chain pickerel, yellow perch, pumpkinseed, and hornpout.

Fishing pressure is moderate, and most areas of the pond are fished regularly in both the open water season, and during the winter through the ice.

Potential fish species of concern include redfin pickerel, banded sunfish, and swamp darter; however, the New Hampshire Natural Heritage Bureau does not have any listings of Rare, Threatened, or Endangered Species for Melendy Pond.

RECREATION USES AND ACCESS POINTS

Melendy Pond is used for numerous recreational activities, including boating, fishing, and swimming by both pond residents and transient boaters. Because the pond is fairly small, only smaller motorized boats are realistic for the pond. Figure 4 shows 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 only about one or two motorized craft on the pond on a daily basis, and about one to ten local and transient canoes, kayaks, and row boats. Figure 5 illustrates the typical boat paths for the pond.

There are some shallow 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. The Town of Brookline has been contacted about supplying drinking water for the short-term during herbicide treatment if 2,4-D is approved for use.

There are a few small private swim beaches located on private properties around the pond. There are about 4 floating docks and swim platforms around the pond as well. Figure 6 shows the locations commonly used for swimming, and the locations of docks on Melendy 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 Melendy 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 (yellow and white lilies, floating heart, watershield), emergent plants (buttonbush, blue-flag iris, spike rush, meadow beauty, swamp loosestrife, sedges, arrow arum, grassy arrowhead, pickerelweed, pipewort, bur-reed), and submergent plants (pondweeds, whorled bladderwort, tapegrass). Native plant communities are mixed around the entire lake, and are characterized as 'common/abundant' by the DES.

There are some areas of purple loosestrife growth (emergent invasive species) around the shoreline of Melendy Pond. DES will work with local residents to address this plant in a non-chemical manner.

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

HISTORICAL CONTROL ACTIVITIES ON THIS WATERBODY:

Contractor	Management Type:	Treatment Date	Treatment Area (acres)
Aquatic Control Technology, Inc.	Chemical: Diquat	May 26th 2004	10
Aquatic Control Technology, Inc.	Chemical: Diquat	May 25th 2005	10

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 Melendy Pond. The following table summarizes DES' control strategy recommendations for Melendy Pond.

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	Use on Melendy Pond
Restricted Use Areas	Not recommended as variable milfoil patches are too widely distributed throughout pond.
Hand-pulling	DES 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.
Mechanical Harvesting/Removal	For Melendy Pond, 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 Melendy 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.
Herbicides	For Melendy Pond, herbicide use is recommended as primary treatment due to extent of infestation. The aquatic herbicide 2,4-D is recommended 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	Infeasible in this system.
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	Without control, variable milfoil will eventually take over 100% of the littoral zone of Melendy Pond, and could extend into slightly deeper waters. Milfoil has been showing exponential growth in Melendy Pond, therefore action to manage the plants in needed.

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 on August 16, 2007. Based on the evaluation, the following control actions are recommended:

Year	Treatment Type	Responsible Party	Schedule
2008	2,4-D treatment of Area 1 and Area 2 in Melendy Pond (Figure 1)	Aquatic Control Technology, Inc.	May/June
	Hand-pulling, benthic barrier placement, and/or suction harvesting to control any re-growth or areas missed by the herbicide treatment.	DES/Contract Divers	July through September
	Weed Watching Activities	Local residents	July through September
	Public access monitoring/education efforts	Local residents	June through September
2009	Hand-pulling, benthic barrier placement, and/or suction harvesting	DES/Contract Divers	July through September
	Weed Watching Activities	Local residents	July through September
	Public access monitoring/education efforts	Local residents	June through September
	Site inspection to determine 2010 monitoring strategies	DES	August/September
2010	2,4-D treatment of Area 1 and Area 2 in Melendy Pond (Figure 1)	TBD	May/June
	Hand-pulling, benthic barrier placement, and/or suction harvesting to control any re-growth or areas missed by the herbicide treatment.	DES/Contract Divers	July through September
	Weed Watching Activities	Local residents	July through September
	Public access monitoring/education efforts	Local residents	June through September
2011	Hand-pulling, benthic barrier placement, and/or suction harvesting	DES/Contract Divers	July through September
	Weed Watching Activities	Local residents	July through September
	Public access monitoring/education efforts	Local residents	June through September

Year	Treatment Type	Responsible Party	Schedule
	Site inspection to determine 2010 monitoring strategies	DES	August/September
2012	Hand-pulling, benthic barrier placement, and/or suction harvesting	DES/Contract Divers	July through September
	Weed Watching Activities	Local residents	July through September
	Public access monitoring/education efforts	Local residents	June through September
	Site Inspection for updating of management plan	DES	August/September
2013	Update Management Plan	DES and interested parties	Fall

- Approximately 8.42 acres of the waterbody will be impacted by the herbicide treatment (approximately 58% of the surface area).

- The Department of Agriculture will impose standard short-term use restrictions for specified days depending on the use (irrigation, contact, etc) and the herbicide used. The shoreline will be posted and public notice will be made.

- The Town of Brookline will look into and possibly supply drinking water to any homes around the pond edge that have shallow dug wells that may be under use restrictions during a 2,4-D treatment.

- By recommending follow-up management practices that utilize integrated plant management strategies such as benthic barrier placement and hand-pulling re-growth, variable milfoil re-growth or population expansion can be slowed.

- 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. It is expected that a well distributed stand of native aquatic plants will remain following herbicide application.

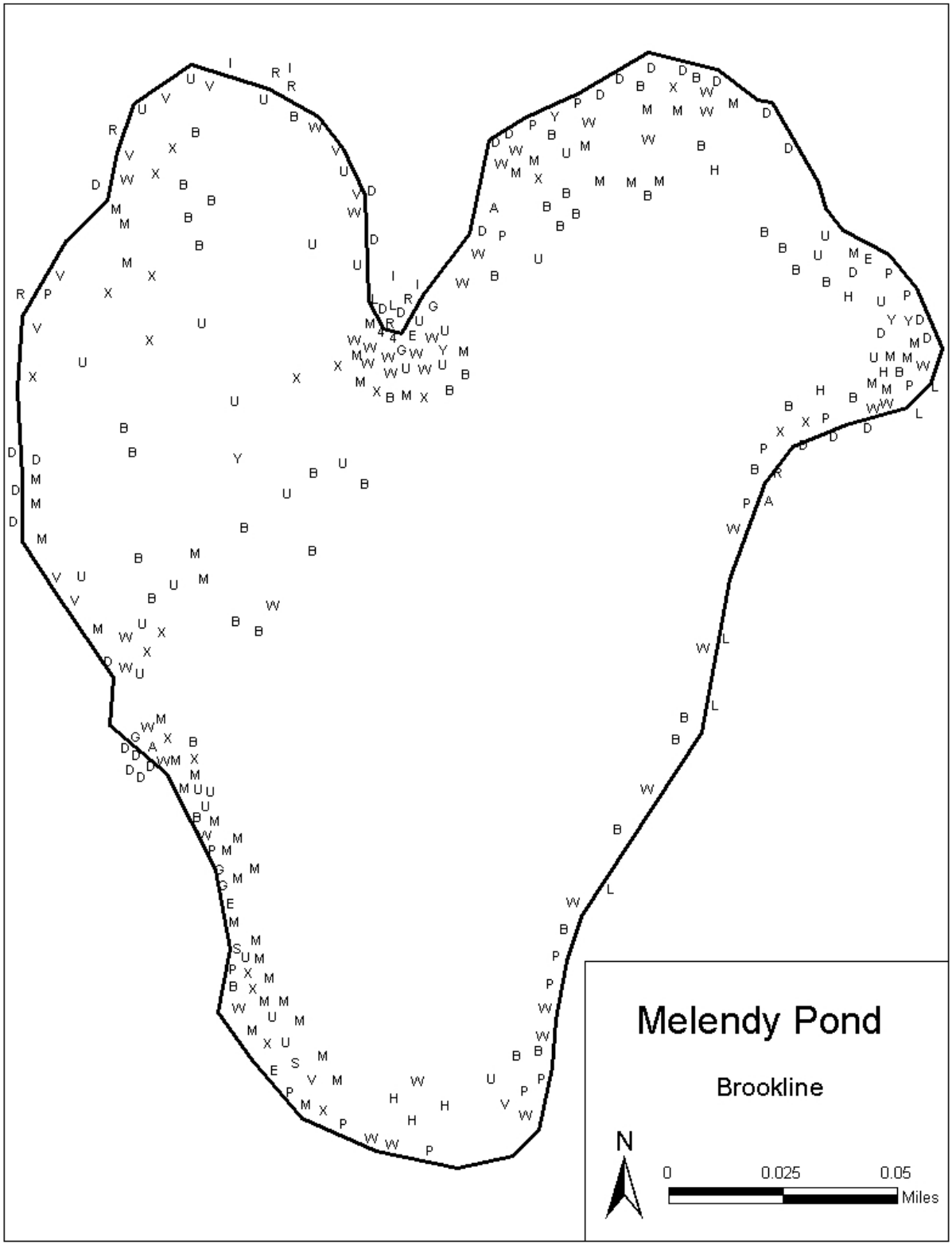
- It is important to realize that aquatic herbicide applications are conducted in a specific and scientific manner, and that the herbicides that are used can be target-specific when used at appropriate doses/concentrations: this means that the invasive plant can be removed and native plants favored in 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

Figure 2- Aquatic Vegetation Map and Key



Symbol	Common Name	Latin Name
C	Buttonbush	*Cephalanthus occidentalis*
I	Blue-flag iris	*Iris versicolor*
4	Spike rush	*Eleocharis sp.*
R	Meadow beauty	*Rhexia*
D	Swamp loosestrife	*Decodon verticillatus*
W	White water-lily	*Nymphea*
M	Variable water-milfoil	*Myriophyllum heterophyllum*
B	Watershield	*Brasenia schreberi*
J	Sedges	*Juncus*
X	Pondweed sp.	*Potamogeton sp.*
A	Arrow arum	*Peltandra virginica*
G	Grassy arrowhead	*Sagittaria graminea*
U	Whorled bladderwort	*Utricularia purpurea*
P	Pickerelweed	*Pontedaria cordata*
E	Pipewort	*Eriocaulon*
S	Bur-reed	*Sparganium*
V	Tapegrass	*Vallisneria americana*
H	Floating heart	*Nymphoides cordata*
L	Purple loosestrife	*Lythrum salicaria*
Y	Yellow water-lily	*Nuphar*

Figure 3- Bathymetric Map of Melendy Pond, Brookline

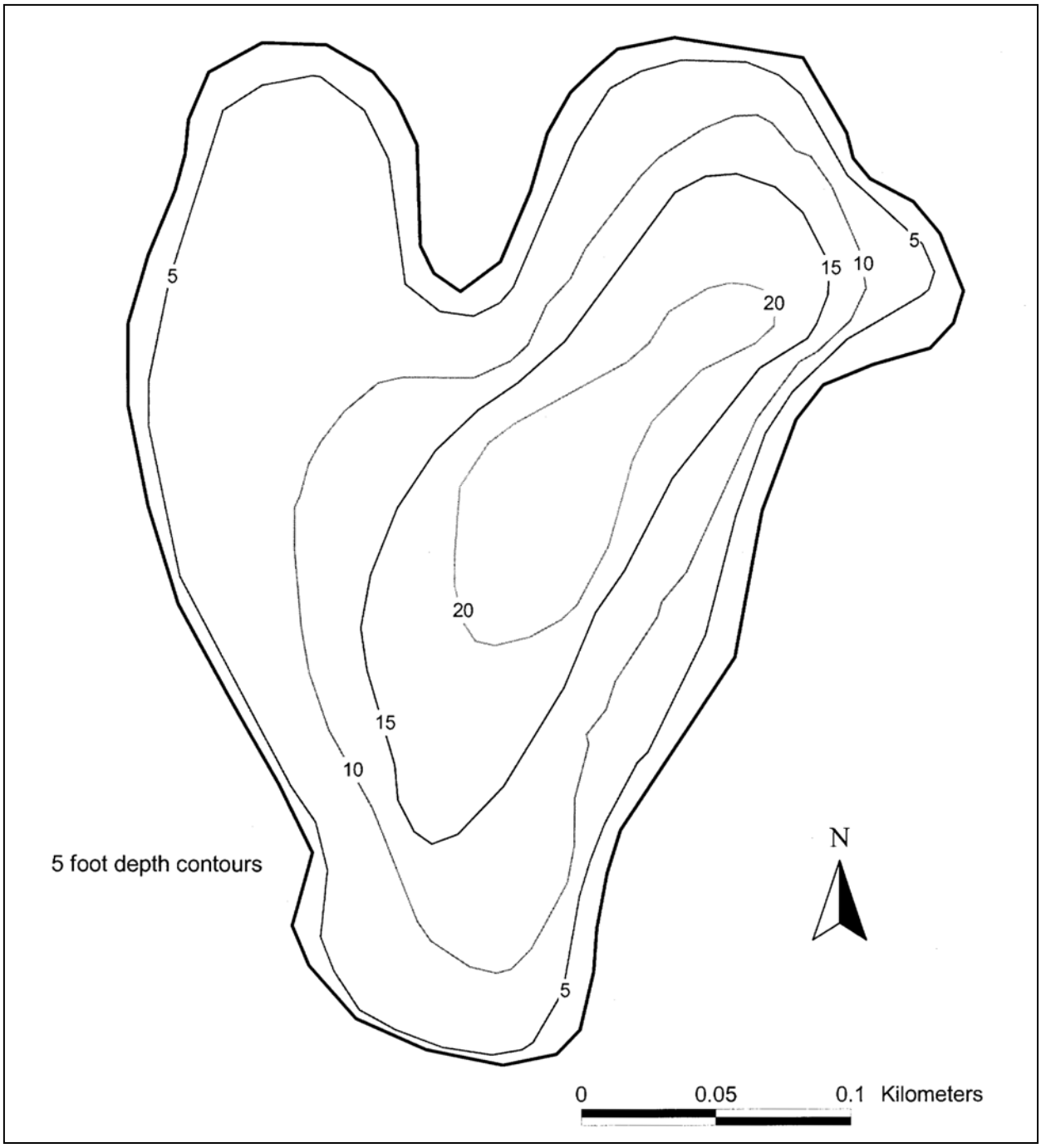


Figure 4- Public Access Points

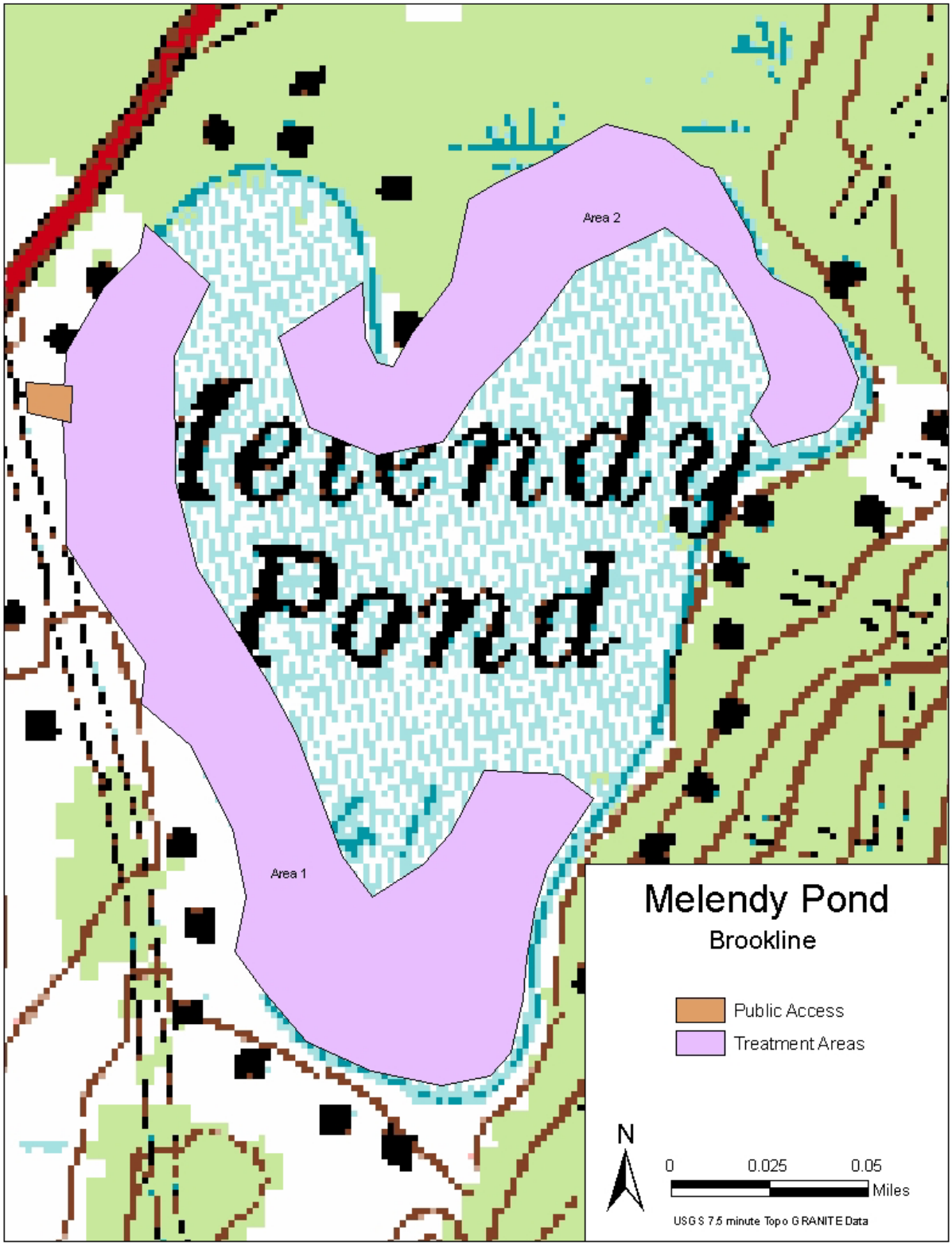


Figure 5- Common Boating Patterns

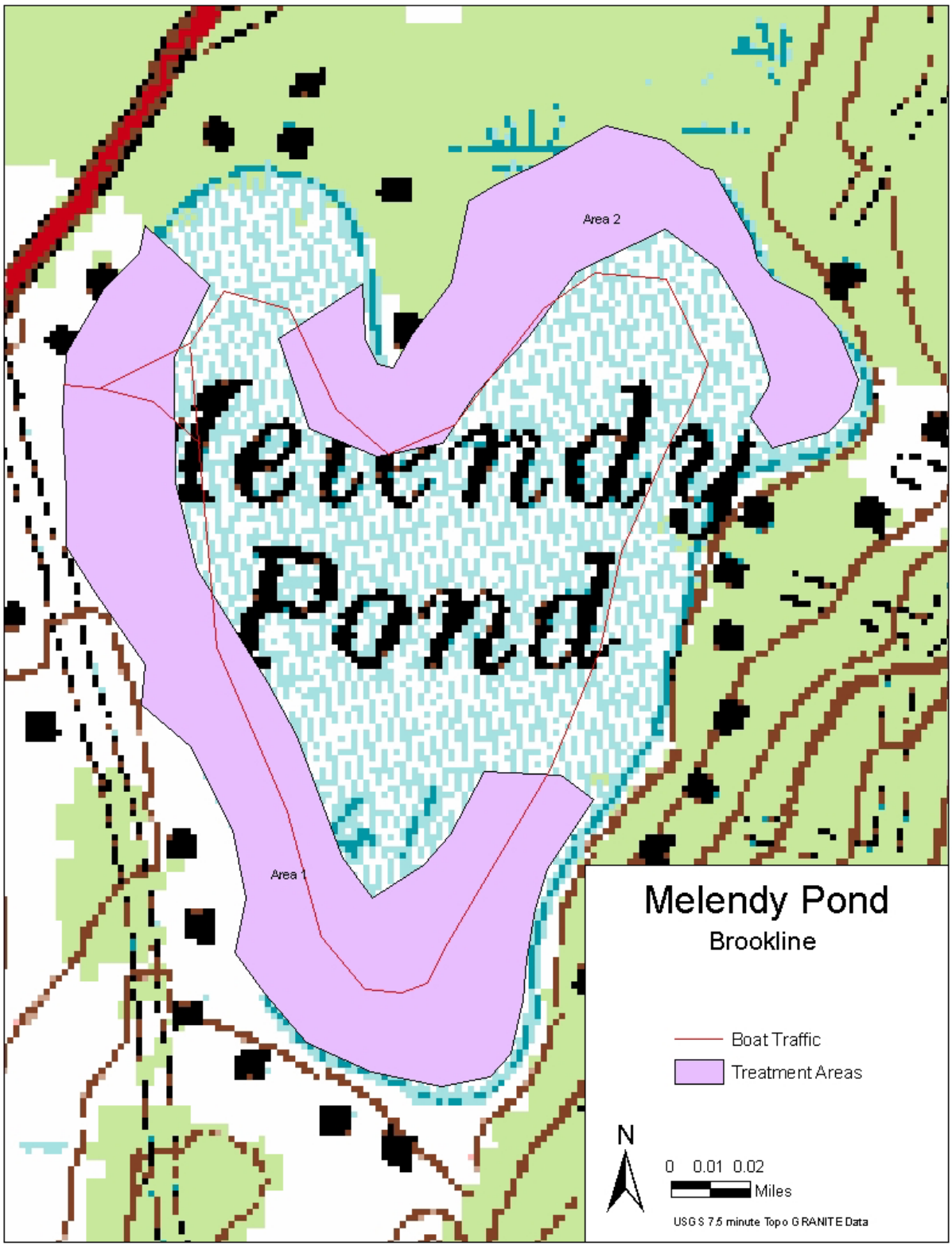
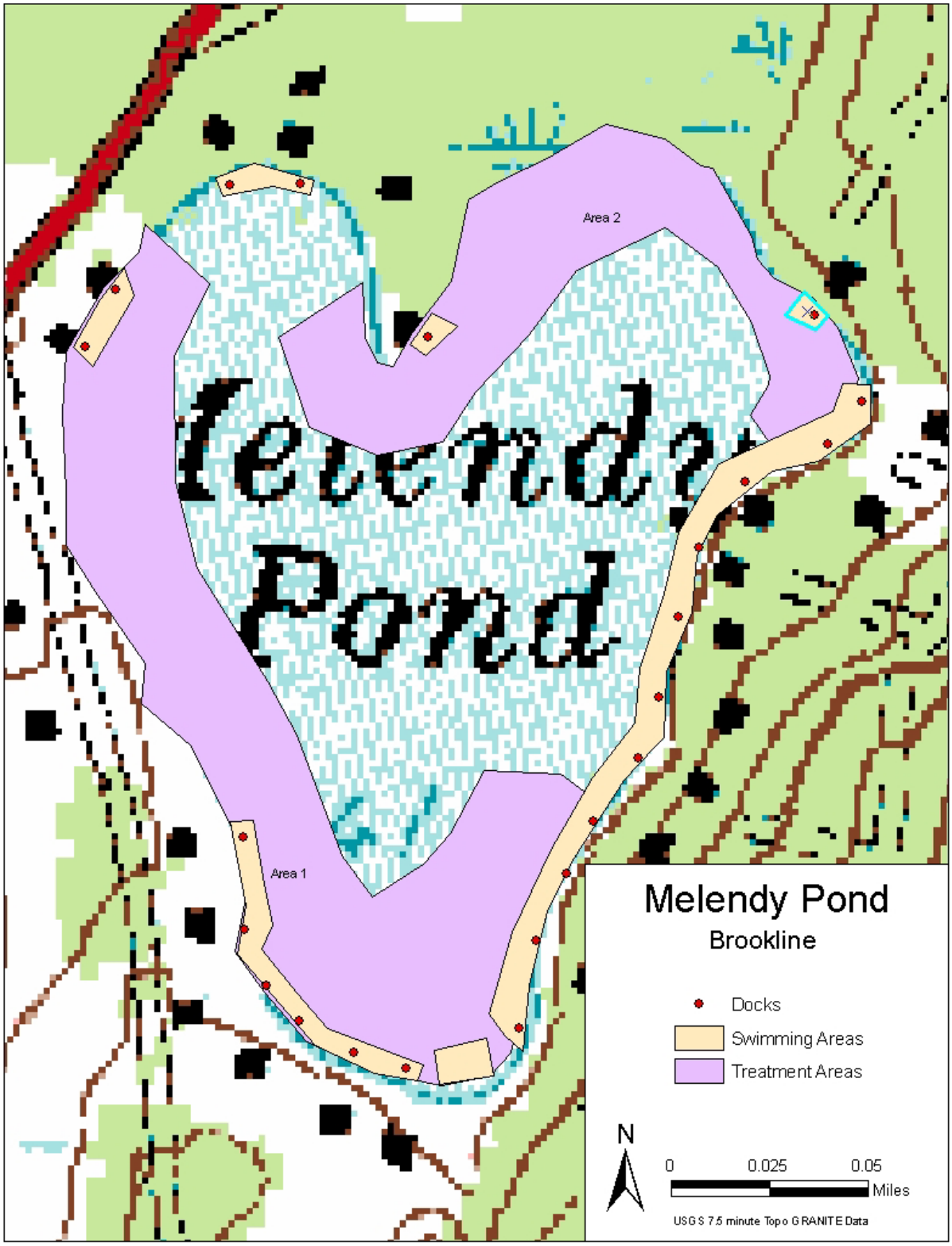


Figure 6- Swim Areas, Docks, and Swim Rafts



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.

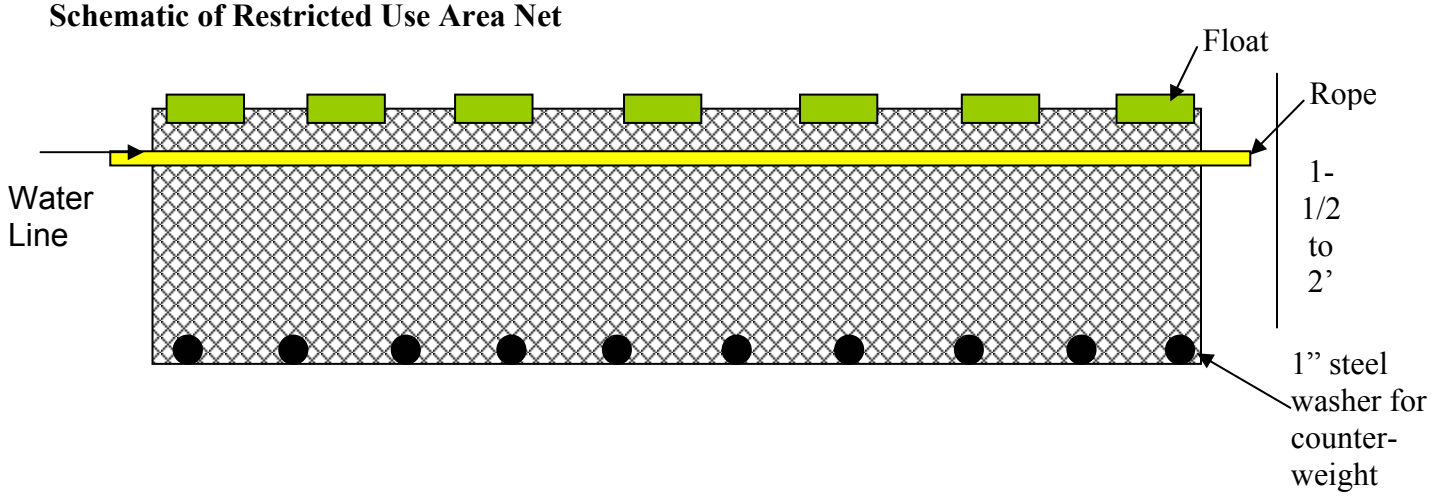
APPENDIX B

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.

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 sediments and taken up through the root system, killing both the roots and the plant biomass above the sediments. Label restrictions for aquatic application currently limit its use in New Hampshire to waterbodies with no water intakes, and with no wells adjacent to the shoreline.

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.

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.