Long-Term Variable Milfoil Management and Control Plan for Danforth Ponds
Freedom, New Hampshire
Carroll County

Prepared by: New Hampshire Department of Environmental Services (DES),
August 2008

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 Danforth Ponds in Freedom, New Hampshire around 2000. The plant has quickly colonized several areas of the different basins that make up the chain of Danforth Ponds. Figure 1 illustrates the distribution of variable milfoil infestations in this waterbody.

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

Area A- Located between the Lower and Middle Pond. This area is a total of approximately 10 acres in size, with large dense patches of variable milfoil throughout the area.

Area B- Located at the northern end of Middle Danforth Pond. This is patchy growth that covers an area of five acres.

Area C- This small area is slightly smaller than 2 acres in size and is located along the northern shoreline of Middle Danforth. The variable milfoil growth is comprised of small patches of milfoil distributed throughout this area.

Area D&E- Area D and Area E are two nearly contiguous areas along the western shoreline of Middle Danforth, starting in the cove where the campground is, and extending southeast towards the channel connecting Middle Danforth with Lower Danforth. The variable milfoil is present in moderate to large-sized patches throughout this area, in depth ranging from a few feet to about

12-15 feet due to water clarity in this area. The milfoil covers an area of just over six acres between these two areas.

Area F- Area F is a small patch along the eastern shoreline of Lower Danforth. The area is approximately ½ acre in size, and is comprised of small patches of variable milfoil growth.

Areas G-I- Areas G-I are small areas that have sparse to scattered growths of variable milfoil covering just over 1 acre between the three sites.

No variable milfoil was found in Upper Danforth Pond, though area G shows some small localized growth in the stream channel connecting Upper and Middle Danforth Ponds.

In terms of the impacts of the variable milfoil in the system, there are several (64) houses around the shoreline of Danforth Ponds, with mostly seasonal cottages, though there are a few year-round dwellings. There are also 23 back lots with lake rights. Many of these abut areas of dense variable milfoil growth (particularly Areas A, D, and E).

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 Lake Ossipee, which is immediately downstream of the Danforth Pond chain of lakes. There is much boat traffic migrating through the channel connecting Ossipee with the Danforth chain of lakes, not to mention continuous outflow of water and possibly plant fragments through the river as well.

The invasive plant infestation in this pond has increased continually throughout the years, and now has reached a total of just over 24 acres of growth. The periphery of the Danforth Ponds is shallow with suitable sediments for growth, not to mention excellent clarity so that plants could root deeper down in the water and still gain adequate sunlight for growth. DES biologists predict continued expansion of the variable milfoil is steps are not taken to adequately reduce the overall biomass of the plant, and to keep the variable milfoil from expanding again through Weed Watching activities and integrated management strategies. As the infestation continues to expand, rhizomatous growth and fragments will continue to expand the infested areas at an increasingly faster rate.

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

PURPOSE

In September 2007, residents of the Danforth Ponds 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 Danforth Ponds and the social and ecological impacts of the milfoil infestation. The intent of this strategic plan is to greatly reduce the variable milfoil in Danforth Ponds with an herbicide treatment in 2009, and then to use integrated plant management strategies to eliminate or control patches of variable milfoil for the long-term. 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 Danforth Ponds outlines actions to eradicate and/or control variable milfoil (*Myriophyllum heterophyllum*, referred to as "variable milfoil" in this plan) while maintaining native plant communities whenever variable milfoil control actions are being implemented.

The goal for Danforth Ponds is the eventual eradication or long-term control of variable milfoil from the system using an Integrated Pest Management Approach. To achieve this goal, we recommend the following:

1) To reduce the overall acreage and percent cover of variable milfoil bottom growth in Areas A-F with the use of 2,4-D in 2009.

2) To reduce the overall acreage and percent cover of variable milfoil in Areas G-I with the use of diver-assisted suction harvesting or simple hand-pulling in 2009.

3) To eradicate or greatly reduce variable milfoil infestations throughout the pond by 2013 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.

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

Town Support

The town of Freedom appreciates the importance of keeping Danforth usable and controlling the variable milfoil.

The town has allocated funds for milfoil hand-removal for the past four years. In 2007 the town budgeted approximately $10,000 for this type of control practice.

Danforth Ponds Improvement Association Support

Comment: What is the group's official name?

TO BE COMPLETED FOR FINAL DRAFT.

WATERBODY CHARACTERISTICS

The following table summarizes basic physical and biological characteristics of Danforth Ponds.

General Lake Information	
Lake area (acreage for Lower and Middle Danforth Ponds)	82.9
Watershed area (acres)	11,771.03
Shoreline Uses (residential, forested, agriculture)	Residential, forested
Max Depth (m)- Lower/Middle	55.4/32.01
Mean Depth (m)- Lower/Middle	166.4/15.51
Trophic Status- Lower/Middle	Mesotrophic/Mesotrophic
Color (CPU) in Epilimnion- Lower/Middle	19.5/20.5
Clarity (m)- Lower/Middle	15.51/16.17
Flushing Rate (yr^{-1})- Lower/Middle	31.6/29.7
Natural waterbody/Raised by Damming/Other	Natural
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	*Myriophyllum heterophyllum*
Infested Area (acres)	Approximately 24 acres
Distribution (ringing lake, patchy growth, etc)	Dense areas of infestation in several locations of pond, with new smaller colonies starting in smaller patches
Sediment type in infested area (sand/silt/organic/rock)	Sandy/rocky/silty
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	
Area of Littoral Zone (acres)	
Area of Profundal Zone (acres)	
Area of Macrophyte Coverage (native or otherwise) of Plants in Littoral Zone	
% of Littoral Zone with Macrophyte Cover	
% of Macrophyte cover comprised of invasives	
% of Littoral Zone with Variable Milfoil Cover	

Comment: To be completed in fall 08

An aquatic vegetation map and key from a summer 2007 survey by the DES Biology Section 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 categorized 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

The primary fishery in Danforth Pond is for largemouth bass, white perch, and black crappie. Other species present include yellow perch, chain pickerel, brown bullhead, smallmouth bass, rainbow trout, burbot, and American eel. A species of conservation concern, bridle shiners, were recorded in 2005 at Trout Pond, which is directly upstream of the Danforth Ponds, and at Purity Lake, which is directly downstream. Although the Danforth Ponds have not been surveyed, it is highly probable that bridle shiners are present.

RECREATION USES AND ACCESS POINTS

The Danforth Ponds are used for numerous recreational activities, including boating, fishing, swimming, and water skiing by both pond residents and transient boaters. There is much transient boating between Lake Ossipee and the Danforth Ponds through the river channel that connects the ponds with the big lake.

There are no designated public access sites on the Danforth Ponds, other than at a privately owned campground, or through the river channel from Lake Ossipee.

Comment: Is this true?

There are generally less than five power boats from 'off the lake' that come in each day, though more come in on holiday weekends or during fishing tournaments. Canoeing and kayaking are more common on the pond, as the campground owns 50+ non-motorized craft. Figure 4 illustrates the typical boat paths for the pond.

There is one designated beach on Middle Danforth which is owned by the campground. 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 20 floating docks and swim platforms around the pond as well. Figure 5 shows the locations commonly used for swimming, and the locations of swim platforms and docks on Lower and Middle Danforth Ponds.

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 Danforth Ponds is characterized by a mix of native and non-native (variable milfoil) plant growth (Figure 2). Native species include a mix of floating plants (white and yellow water-lilies, floating heart, watershield), emergent plants (cattail, bur-reed, pipewort, water lobelia, grassy arrowhead, spike rush, pickerelweed, arrowhead, swamp loosestrife, and three-way sedge), and submergent plants (water naiad, alternate-leaf milfoil, water marigold, hedge hyssop, tape-like bur-reed, various pondweeds, bladderwort, tape-grass, waterweed, grassy spike rush). Native plant communities are mixed around the entire lake, and are characterized as 'scattered/common' by the DES.

In addition to the variable milfoil in the pond, the only other invasive aquatic plant that was observed was purple loosestrife, which was scattered in small areas around the shoreline of the ponds.

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

Comment: Need to verify this

HISTORICAL CONTROL ACTIVITIES ON THIS WATERBODY:

Contractor	Management Type:	Chemical Application/Treatment Date	Treatment Area (acres)
Lycott Environmental	Chemical: Diquat	June 10th 2002	1.5 acres

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 Danforth Ponds. The following table summarizes DES' control strategy recommendations for Danforth Ponds.

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	Use on Danforth Ponds
Restricted Use Areas	Not recommended as variable milfoil is distributed in several areas throughout the pond
Hand-pulling	Recommended for Areas G-I on the pond, plus in any areas where there is new growth, or stems remaining following an herbicide treatment.
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 area 20' x 14' in size or less, and where practical.
Herbicides	Herbicide treatment is recommended in 2009 in Areas A-F as a primary means of reducing the overall footprint of variable milfoil in Lower and Middle Danforth Ponds. The patches of milfoil are too large for non-chemical control at this point.
Extended Drawdown	Not feasible or practical for this waterbody.
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.

Control Method	Use on Danforth Ponds
No Control	The variable milfoil infestation in the Danforth Pond system has been expanding annually. A no control option would only allow for further spread of this plant.

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 August 27, 2007. Based on the evaluation, the following control actions are recommended:

Year	Treatment Type	Responsible Party	Schedule
2009	2,4-D treatment of Areas A-F	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	DES/Lake Association/Contract Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Contract Divers	July/August
	Weed Watching and Lake Hosting Activities	Danforth Pond volunteers	June through September
2010	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	DES/Lake Association/Contract Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Contract Divers	July/August
	Weed Watching and Lake Hosting Activities	Danforth Pond volunteers	June through September
2011	Herbicide treatment, if needed and determined by DES	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	DES/Lake Association/Contract Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Contract Divers	July/August
	Weed Watching and Lake Hosting Activities	Danforth Pond volunteers	June through September

Year	Treatment Type	Responsible Party	Schedule
2012	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	DES/Lake Association/Contract Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Contract Divers	July/August
	Weed Watching and Lake Hosting Activities	Danforth Pond volunteers	June through September
2013	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	DES/Lake Association/Contract Divers	June through September
	Installation of benthic barriers, as may be appropriate	DES or Contract Divers	July/August
	Weed Watching and Lake Hosting Activities	Danforth Pond volunteers	June through September
	Site assessment and remapping of variable milfoil infestation	DES	August/September
2014	Update and revise Long-Term Variable Milfoil Control Plan	NH DES, F&G, and interested parties	Spring

- Approximately 24 acres of the waterbody will be impacted by the herbicide treatment (approximately 28% of the surface area of Lower and Middle Danforth).

- 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.

- 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

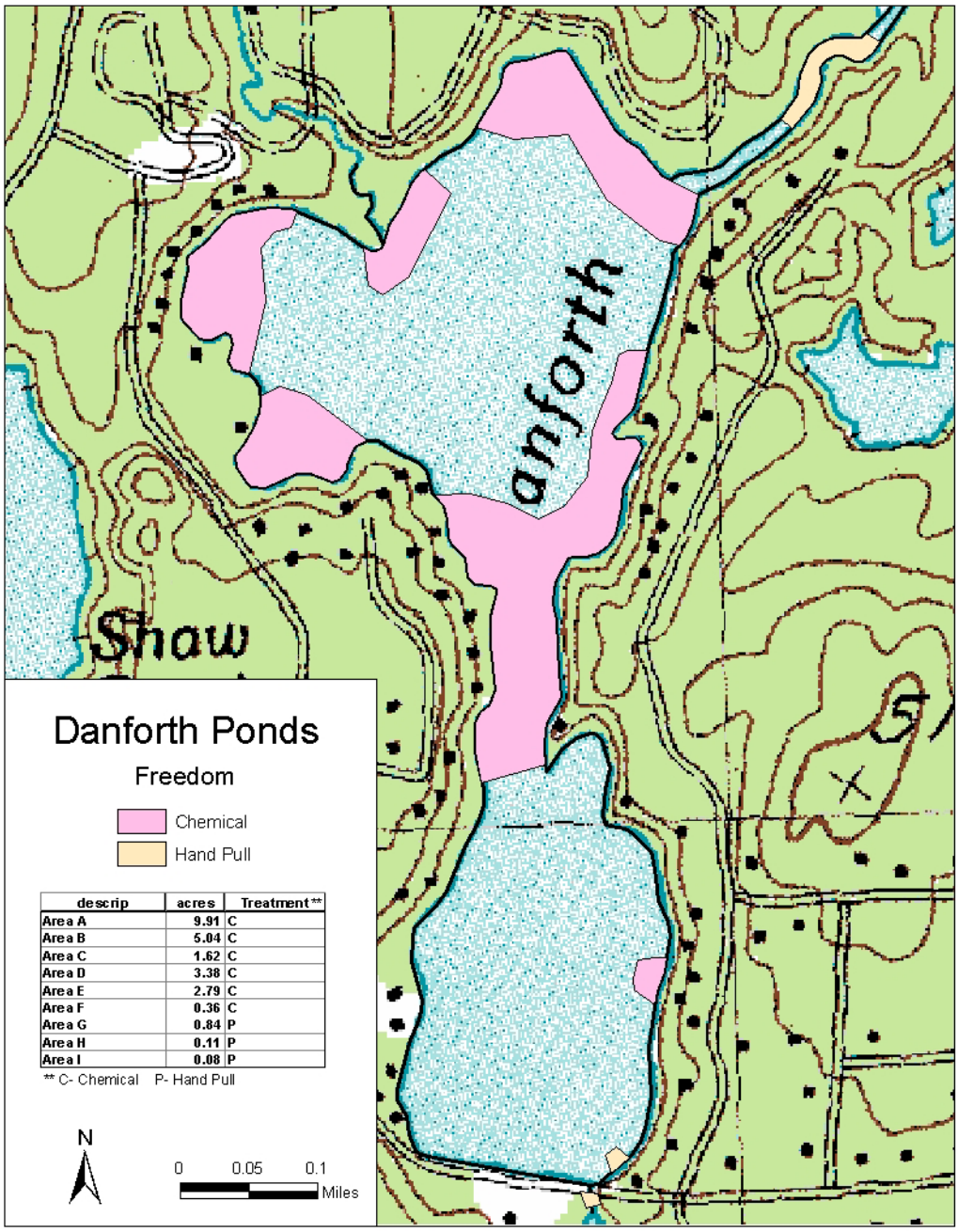


Figure 2- Aquatic Vegetation Map and Key

Field notes not yet formatted into clean electronic map…fall 2008 for this.

Plant Key for Danforth Ponds		
Symbol	**Common Name**	**Latin Name**
T	Cattail	*Typha*
b	Water naiad	*Najas*
a	Alternate-leaved milfoil	*Myriophyllum alterniflorum*
d	False loosestrife/water purslane	*Ludwigia*
9	Native milfoil	*Myriophyllum humile*
c	Water marigold	*Megalodonata beckii*
8	Hedge hyssop	*Gratiola*
7	Bur-reed	*Sparganium sp.*
6	Tape-like bur-reed	*Sparganium sp.*
W	White water-lily	*Nymphaea*
X	Big-leaved pondweed	*Potamogeton natans*
E	Pipewort	*Eriocaulon*
M	Variable milfoil	*Myriophyllum heterophyllum*
U	Bladderwort	*Utricularia*
L	Water lobelia	*Lobelia dortmanna*
H	Floating heart	*Nymphoides cordata*
G	Grassy arrowhead	*Sagittaria sp.*
V	Tapegrass	*Vallisneria americana*
3	Spike rush	*Eleocharis sp.*
f	Filamentous green algae	*n/a*
A	Bassweed	*Potamogeton amplifolius*
N	Waterweed	*Elodea sp.*
R	Robbins pondweed	*Potamogeton robbinsii*
4	Grassy spike rush	*Eleocharis sp.*
P	Pickerelweed	*Pontedaria cordata*
L	Purple loosestrife	*Lythrum salicaria*
J	Arrowhead	*Sagittaria sp.*
K	Swamp loosestrife	*Decodon verticillatus*
Y	Yellow water-lily	*Nuphar*
D	Three-way sedge	*Dulichium arundinaceum*

Figure 3- Bathymetric Map

NOT YET COMPLETE

Figure 4- Common Boat Paths

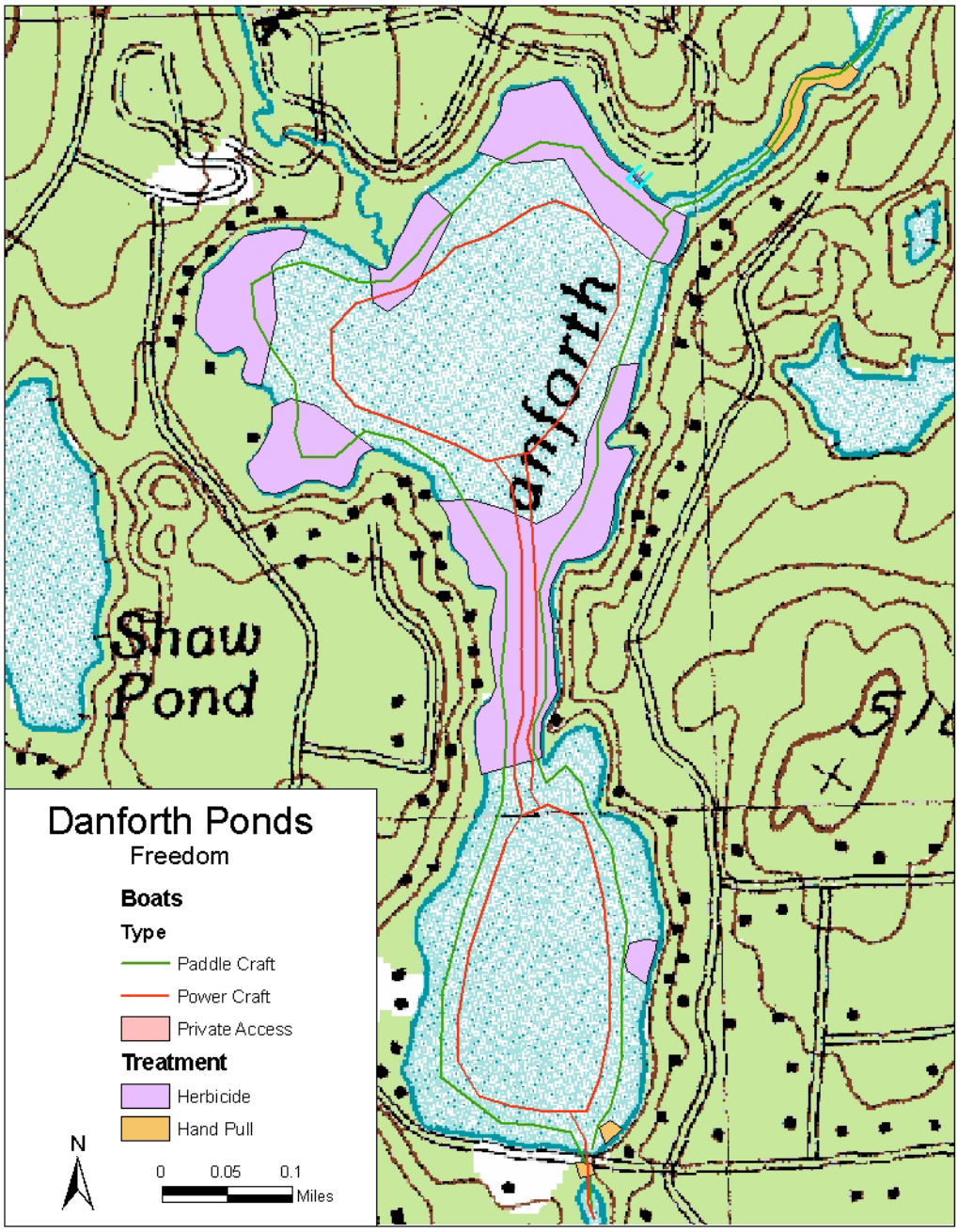
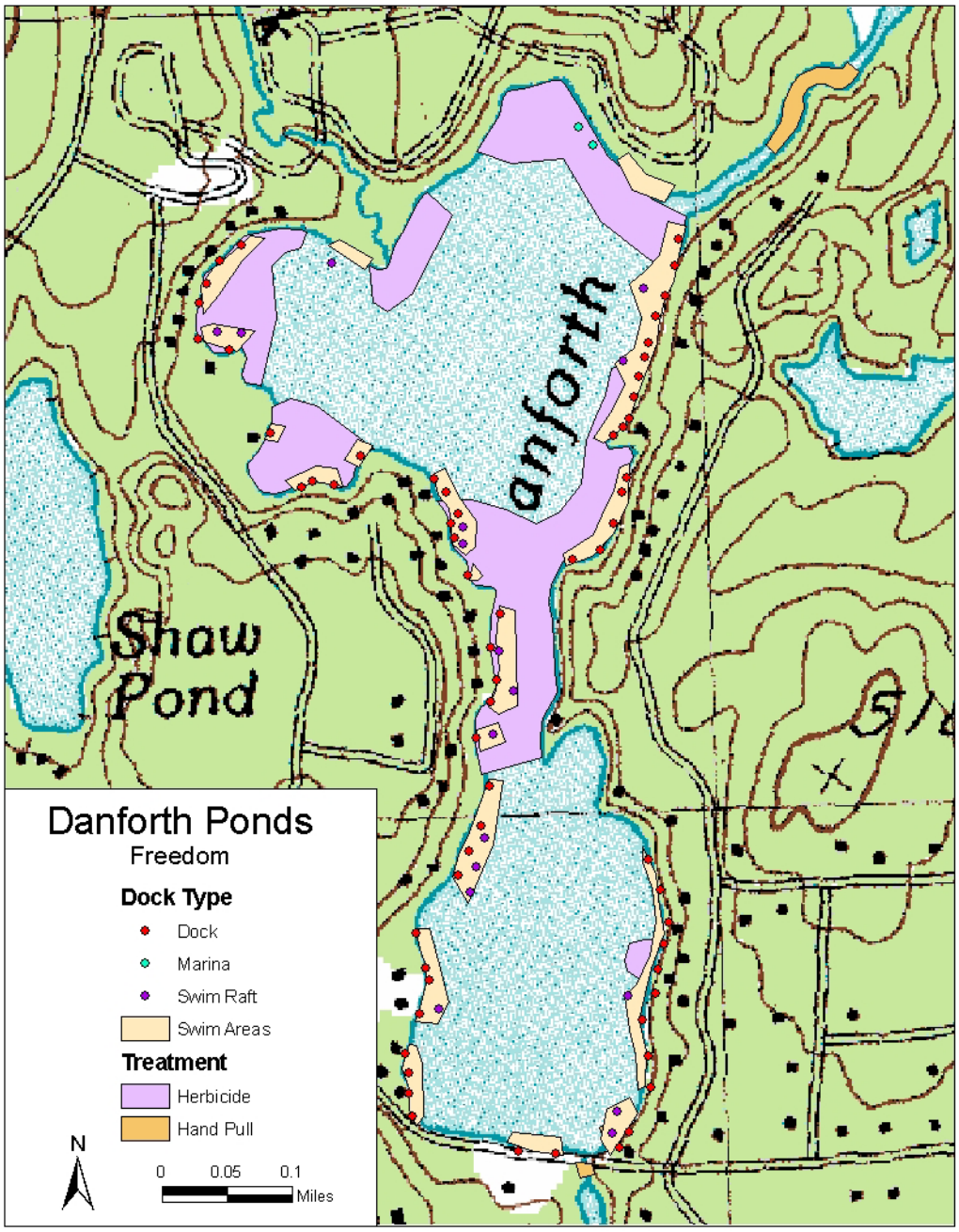


Figure 6- Swim Areas, Docks, and Swim Rafts



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.

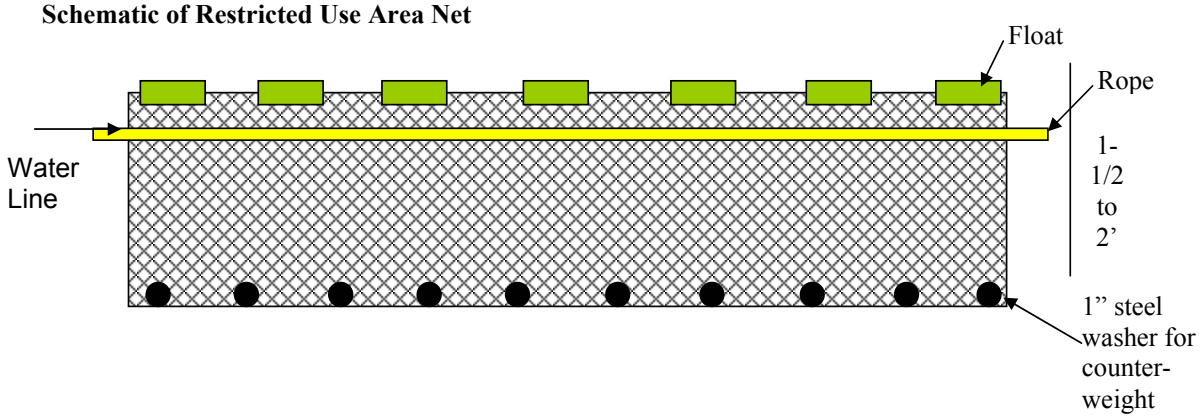
APPENDIX B

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.

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