Long-Term Variable Milfoil Management and Control Plan for CAPTAINS POND
Salem, New Hampshire
Rockingham County

Prepared by: New Hampshire Department of Environmental Services (DES),
in consultation with the
New Hampshire Fish and Game Department (F&G)
Developed: January 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 Captains Pond in Salem, New Hampshire in the mid 1990s. The plant quickly colonized several areas along the entire shoreline of the pond, and historical data showed that up to 60 acres of the pond were infested with variable milfoil in the past. Targeted herbicide applications have greatly reduced the overall infestation, however. Figure 1 illustrates the summer 2007 distribution of variable milfoil infestations in this waterbody. As shown in Figure 1, only one small portion of Captains Pond is currently infested with variable milfoil. This 3.75 acre area is in the outlet channel of the pond, and is characterized by 75-85% variable milfoil cover. Other native plants abound in the area, including a few species of pondweeds, and yellow and white water-lilies. As this is the outlet channel of the lake, the dense milfoil may be posing an impediment to open flow through the system.

In terms of the impacts of the variable milfoil to the lake ecosystem, there are several (40) houses around the shoreline of Captains Pond, with a mix of seasonal and year-round dwellings. There are also 120 back lots with lake rights. Three children's camps are located on the pond as well. As mentioned above, historical milfoil growth ringed the pond, but the August 2007 plant survey only revealed milfoil in the one small area shown in Figure 1. There are several houses in is area, however, and their recreational use, primarily ease of access with boats, is restricted due to dense growths of milfoil that are forming canopies on the lake surface.

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 been well controlled for the last few years, and DES biologists believe that the use of a systemic herbicide, like the one proposed here, may lead to a further reduction of milfoil growth in the pond, to a level that could be controlled with non-chemical approaches for several years. Captains Pond is shallow, with a mix of sandy, silty, and organic substrates, essentially creating prime variable milfoil habitat across much of the pond.

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 currently somewhat localized. No biological integrity surveys have been conducted, however, as part of this plan preparation.

PURPOSE

In July 2007, the Captains Pond Protective Association, Inc. requested matching funds from the Department of Environmental Services to conduct an aquatic plant control project during the spring of 2008 to control variable milfoil. Additionally, NH has the unique opportunity to work with a chemical manufacturing company (SePRO Corporation) to conduct a small field analysis of a new formulation of a systemic aquatic herbicide, Renovate OTF (On Target Flake). Laboratory data have shown that the herbicide can be effective in the long-term control of 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 Captains Pond and the social and ecological impacts of the milfoil infestation. The intent of this strategic plan is to possibly eradicate variable milfoil from Captains Pond over time through the use of Integrated Pest Management Strategies (IPM), or at the very least, provide a longer-term control of the milfoil with the use of a systemic herbicide like Renovate. 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 Captains Pond outlines actions to provide long-term control or possibly the eradication of variable milfoil while maintaining native plant communities whenever variable milfoil control actions are being implemented.

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

1) To reduce the overall acreage and percent cover of variable milfoil bottom growth in the outlet cove from 3.75 acres and 75% cover in 2008, with the use of Renovate OTF (or alternatively 2,4-D or Diquat), to less than 0.5 acres and 15% cover.

2) To eradicate variable milfoil infestations throughout the pond by 2013 by performing variable milfoil control actions on any exotic plants remaining after action 1 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

To this date, the Town of Salem has not offered financial support for the control of variable milfoil in the pond, but they are supportive in concept of the project, according to the lake association officials.

Captains Pond Protective Association Support

Captains Pond has an active protective association. They have been involved in the Volunteer Lake Assessment Program (VLAP) for a number of years, and continually track water quality and watershed development around the pond. Since the variable milfoil became a problem in the pond, shorefront residents have been providing matching funds to control the growths of the plant, before the entire shoreline of the pond became affected.

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

WATERBODY CHARACTERISTICS

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

General Lake Information	
Lake area (acres)	90.3
Watershed area (acres)	959.6
Shoreline Uses (residential, forested, agriculture)	Residential, children's camps, forested
Max Depth (ft)	28.4

Mean Depth (ft)	803
Trophic Status	Mesotrophic
Color (CPU) in Epilimnion	46.5
Clarity (ft)	5.6
Flushing Rate (yr^{-1})	2.10
Natural waterbody/Raised by Damming/Other	Natural
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	*Myriophyllum heterophyllum*
Infested Area (acres)	Approximately 3.75 acres
Distribution (ringing lake, patchy growth, etc)	Variable milfoil growth with about 75% cover in 3.75 acre area in and around outlet cove of the waterbody
Sediment type in infested area (sand/silt/organic/rock)	Organic/muck
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	None on record
Area of Littoral Zone (acres)	60.6
Area of Profundal Zone (acres)	26.1
Area of Macrophyte Coverage (native or otherwise) of Plants in Littoral Zone	30.35
% of Littoral Zone with Macrophyte Cover	50
% of Macrophyte cover comprised of invasives	12.4
% of Littoral Zone with Variable Milfoil Cover	6.2

An aquatic vegetation map and key from a July 25, 2007 survey by DES limnologists 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

This pond supports an assemblage of warm water fish species including largemouth bass, pickerel, sunfish, bluegills, and bullheads. American eels were also found to be present in the last fish survey conducted in 1981. Potential fish species of concern, according to the NH Fish and Game Department, include redfin pickerel, banded sunfish, and swamp darter.

A Natural Heritage Inventory review yielded no records on file of sensitive wildlife species in this area.

According to members of the Captains Pond Protective Association, fishing activities occur around most of the pond by mostly local residents and by visitors at the children's camps on the pond.

RECREATION USES AND ACCESS POINTS

Captains Pond is used for numerous recreational activities, including boating, fishing, swimming, and water skiing by mostly pond residents and nearby community residents with designated access to the pond (the pond does not have public access or public beaches). Visitors to the children's camps also use the pond for various water sports.

There is one gated access for boats on the northern side of the pond (shown in Figure 1), which is used primarily by residents of a private community across from the pond. Small motor boats, as well as kayaks and canoes can use this facility. There is limited parking for vehicles with trailers. There are generally less than 12 resident owned powerboats on the lake each year, and numerous canoes, kayaks, and row boats. Figure 4 illustrates the typical boat paths for the pond.

There are three public beaches on the pond (also called "designated beach"), each associated with one of the children's camps on the pond (one near the outlet, and two on the opposite end of the pond). 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 beaches, there are a several small private swim beaches located on private properties around the pond. There are approximately 4 floating docks and swim platforms around the pond as well, and several docks. Figure 5 shows the locations commonly used for swimming, and the locations of swim platforms and docks on Captains 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 Captains 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, watershield, floating heart), emergent plants (arrow arum, bur-reed, grassy arrowhead, cattail, pipewort, swamp loosestrife, soft-stem rush, and pickerelweed), and submergent plants (bladderwort, pondweed, tapegrass, Robbins pondweed). Native plant communities are mixed around the entire pond, and were characterized as 'scattered' by the DES in a 2002 lake assessment. According to the findings of the 2007 plant survey, the plants have increased slightly in cover and can now be characterized as "scattered/common" around the pond.

There are no records of state threatened or endangered plant species, according to the New Hampshire Department of Resources and Economic Development, Natural Heritage Bureau.

In addition to the plans listed above, purple loosestrife and common reed were also noted along various shoreline sections of the pond. These are both non-native and invasive wetland/shoreline plant species. DES will work with the lake association on non-chemical control actions to control these plants.

HISTORICAL CONTROL ACTIVITIES ON THIS WATERBODY:

Contractor	Management Type:	Chemical Application/Treatment Date	Treatment Area (acres)
Aquatic Control Technology, Inc.	Chemical: Diquat	5/19/1998	51 acres
Aquatic Control Technology, Inc.	Chemical: Diquat	5/24/1999	25 acres
Aquatic Control Technology, Inc.	Chemical: Diquat	5/21/2001	50 acres
Aquatic Control Technology, Inc.	Chemical: Diquat	5/21/2002	25 acres
Aquatic Control Technology, Inc.	Chemical: Diquat	5/20/2004	50 acres
Aquatic Control Technology, Inc.	Chemical: Diquat	5/26/2006	60 acres

MILFOIL MANAGEMENT OPTIONS

The control practices used should be as specific to variable 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 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 Captains Pond. The following table summarizes DES' control strategy recommendations for Captains Pond.

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	**Use on Captains Pond**
Restricted Use Areas	Due to the fact that the existing infestation is an isolated 3.75 acres on the pond, located in the outlet cove of the waterbody, a Restricted Use Area (RUA) is recommended to limit boat traffic to this area to reduce any chances of fragmentation of the milfoil. The variable milfoil is growing in relatively shallow water (<5 ft. depths), and is reaching the surface and forming a canopy in the cove. Any boat traffic or fishing activities in this area could fragment the plants and cause their spread. With the proximity of a children's camp to the area, the infestation also poses an entanglement hazard to the children if they fall from a boat, thus an RUA would also serve the purpose of restricting access and preventing potential harm to small children in the area (i.e. entanglement issues).
Hand-pulling	DES recommends that the individual stems or small patches of variable milfoil should be hand pulled when encountered. A Weed Watcher Program should be formally established on the pond to ensure that routine monitoring of currently uninfested areas is conducted, and that there is a means for regular follow-up in the infested area of the pond post-treatment. The DES Exotic Species Program can provide training for such a group in 2008. DES also recommends that the lake residents follow up the herbicide application with hand-pulling of re-growth, if that re-growth is small and scattered. DES divers can assist with this.
Mechanical Harvesting/Removal	For Captains 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	At this time, benthic barriers are not recommended in the area of milfoil growth, due to the abundance of native vegetation and organic bottom sediments.
Herbicides	For Captains Pond, the use of a systemic herbicide, such as Renovate OTF (or alternatively, 2,4-D) is recommended as

Control Method	Use on Captains Pond
	primary treatment for the area of infestation (though Diquat is recommend as an alternate if Renovate OTF or 2,4-D are not permitted). As mentioned previously, laboratory data have shown that Renovate OTF can be effective in the long-term control of variable milfoil. This small sample site is an optimal location for a field trial of this herbicide on variable milfoil. Diquat was previously used in Captains Pond, but because the pond is colored and somewhat turbid with detritus, this chemical is not optimal for use in controlling the milfoil as it quickly binds to the organic material in the water column and the sediments.
Extended Drawdown	Drawdown is not an effective control method for variable milfoil, nor is it feasible in this waterbody due to the lack of a dam or other stage regulating device.
Dredge	Not recommended for use in this pond.
Biological Control	There are no approved biological controls for variable milfoil at this time in New Hampshire.
No Control	Variable milfoil has been a problem in Captains Pond since the mid-1990s. With the use of well-timed herbicide applications, that infestation has been reduced from 60+ acres down to less than 4 acres. With the use of a systemic herbicide, DES believes that the one last larger area of milfoil growth in the pond could be successfully controlled. We are fortunate in that the infestation is in the outlet cove of the pond, which helps in preventing the spread through regular flow patterns throughout the pond; however, wind and boat traffic could move the milfoil through the pond once again, causing another full-lake infestation. A "no control" option is not recommended here.

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 July 25, 2007. Based on the evaluation, the following control actions are recommended:

Year	Treatment Type	Responsible Party	Schedule
2008	Renovate OTF (or other herbicide) treatment of 3.75 acres as indicated in Figure 1.	Aquatic Control Technology, Inc.	May/June
	Inspection and diver hand-removal of variable milfoil in outlet cove.	DES or contracted divers	July through September
	Installation of RUA across mouth of outlet cove	DES	June

Year	Treatment Type	Responsible Party	Schedule
	Weed Watching	Captains Pond Association and lake residents	June through September
	Site assessment and remapping of variable milfoil infestation	DES	August/September
2009	Inspection and diver hand-removal of variable milfoil in outlet cove.	DES or contracted divers	May through September
	Installation of RUA across mouth of outlet cove	DES or lake association	May
	Weed Watching	Captains Pond Association and lake residents	June through September
2010	Inspection and diver hand-removal of variable milfoil in outlet cove.	DES divers or contracted divers	May through September
	Installation of RUA across mouth of outlet cove	Lake association	May
	Weed Watching	Captains Pond Association and lake residents	June through September
	Site assessment and remapping of variable milfoil infestation	DES	August/September
2011	Herbicide treatment, if needed	TBD	May/June
	Inspection and diver hand-removal of variable milfoil in outlet cove.	DES divers or contracted divers	May through September
	Installation of RUA across mouth of outlet cove	DES	May
	Weed Watching	Captains Pond Association and lake residents	June through September
	Site assessment and remapping of variable milfoil infestation	DES	August/September
2012	Inspection and diver hand-removal of variable milfoil in outlet cove.	Captains Pond Association divers or contracted divers	May through September
	Installation of RUA across mouth of outlet cove (if needed)	Lake association	May

Year	Treatment Type	Responsible Party	Schedule
	Weed Watching	Captains Pond Association and lake residents	June through September
	Site assessment and remapping of variable milfoil infestation	DES	August/September
2013	Update and revise Long-Term Variable Milfoil Control Plan	NH DES, F&G, and interested parties	Spring 2013

- Approximately 3.75 acres of the waterbody will be impacted by the herbicide treatment (approximately 4% 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.

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

- 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 affected as a result of an herbicide treatment.*

- 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. Yellow and white water-lilies, tapegrass, pondweed species, and Robbins pondweed are common in the cove with the variable milfoil, and are expected to persist during and post-herbicide treatment.

Figure 1- Map of Milfoil Infestation

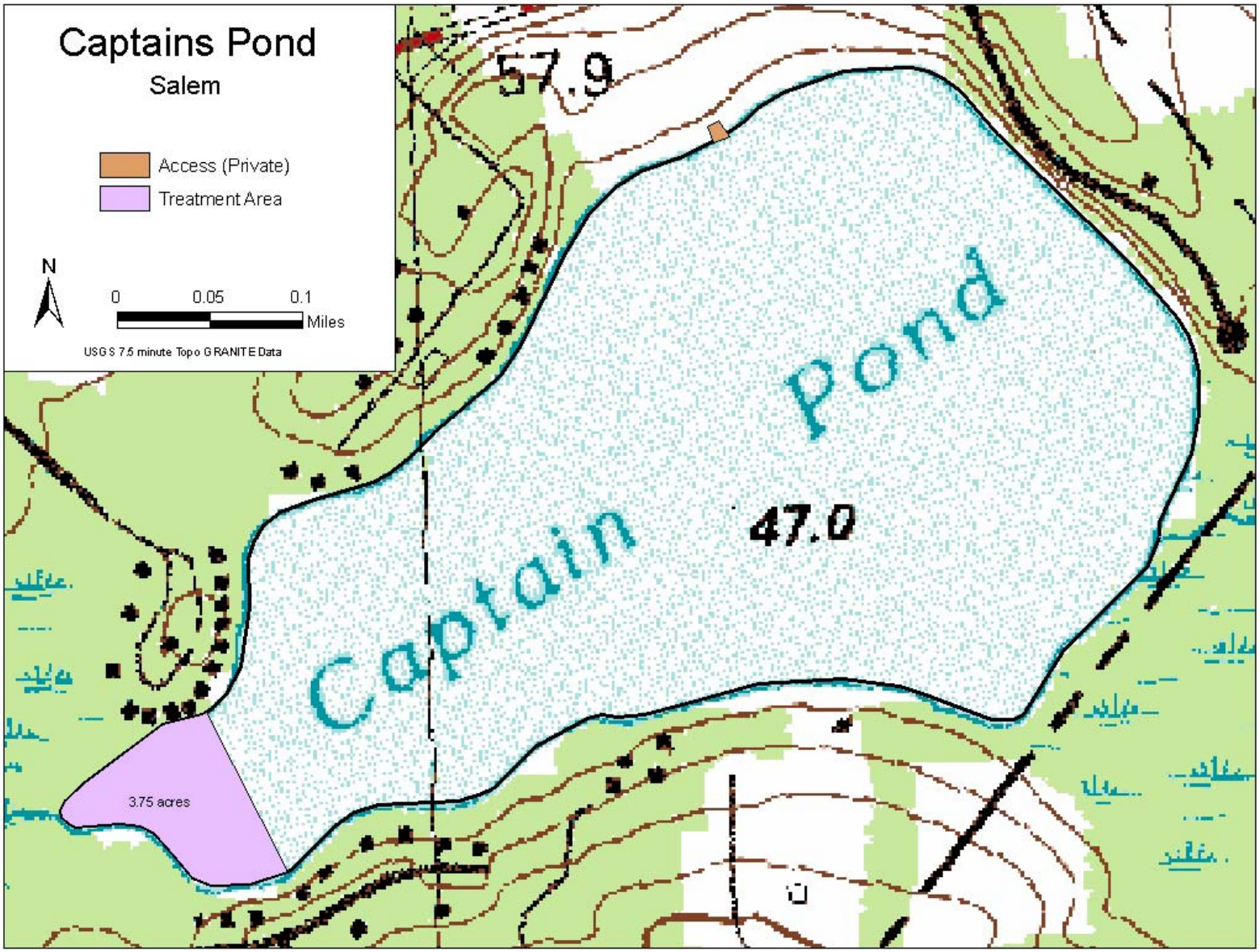
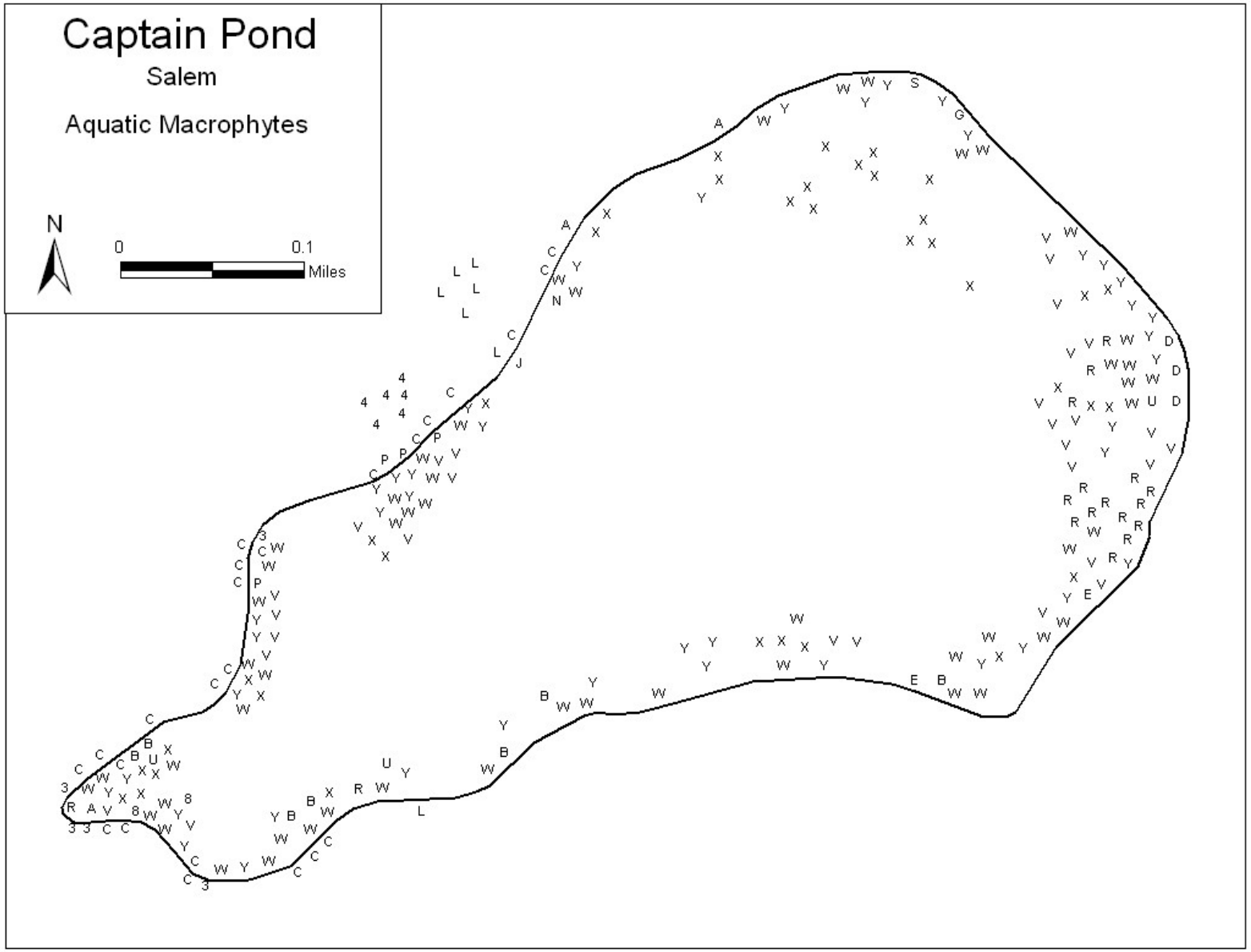


Figure 2- Aquatic Vegetation Map and Key



Plant Key for Captains Pond, Salem

July 25, 2007

Symbol	Common Name	Latin Name
R	Robbins Pondweed	*Potamogeton robbinsii*
4	Common Reed	*Phragmites australis*
A	Arrow arum	*Peltandra virginica*
S	Bur-reed species	*Sparganium*
G	Grassy arrowhead	*Sagittaria graminea*
L	Purple loosestrife	*Lythrum salicaria*
U	Bladderwort	*Utricularia*
W	White water-lily	*Nymphea*
Y	Yellow water-lily	*Nuphar*
C	Cattail	*Typha*
B	Watershield	*Brasenia schreberi*
X	Pondweed species	*Potamogeton*
V	Tapegrass	*Vallisneria americana*
E	Pipewort	*Eriocaulon*
D	Swamp loosestrife	*Decodon verticillatus*
3	Soft-stem rush	*Juncus effusus*
P	Pickerelweed	*Pontedaria cordata*
8	Floating heart	*Nymphoides cordata*

Figure 3- Bathymetric Map of Captains Pond, Salem

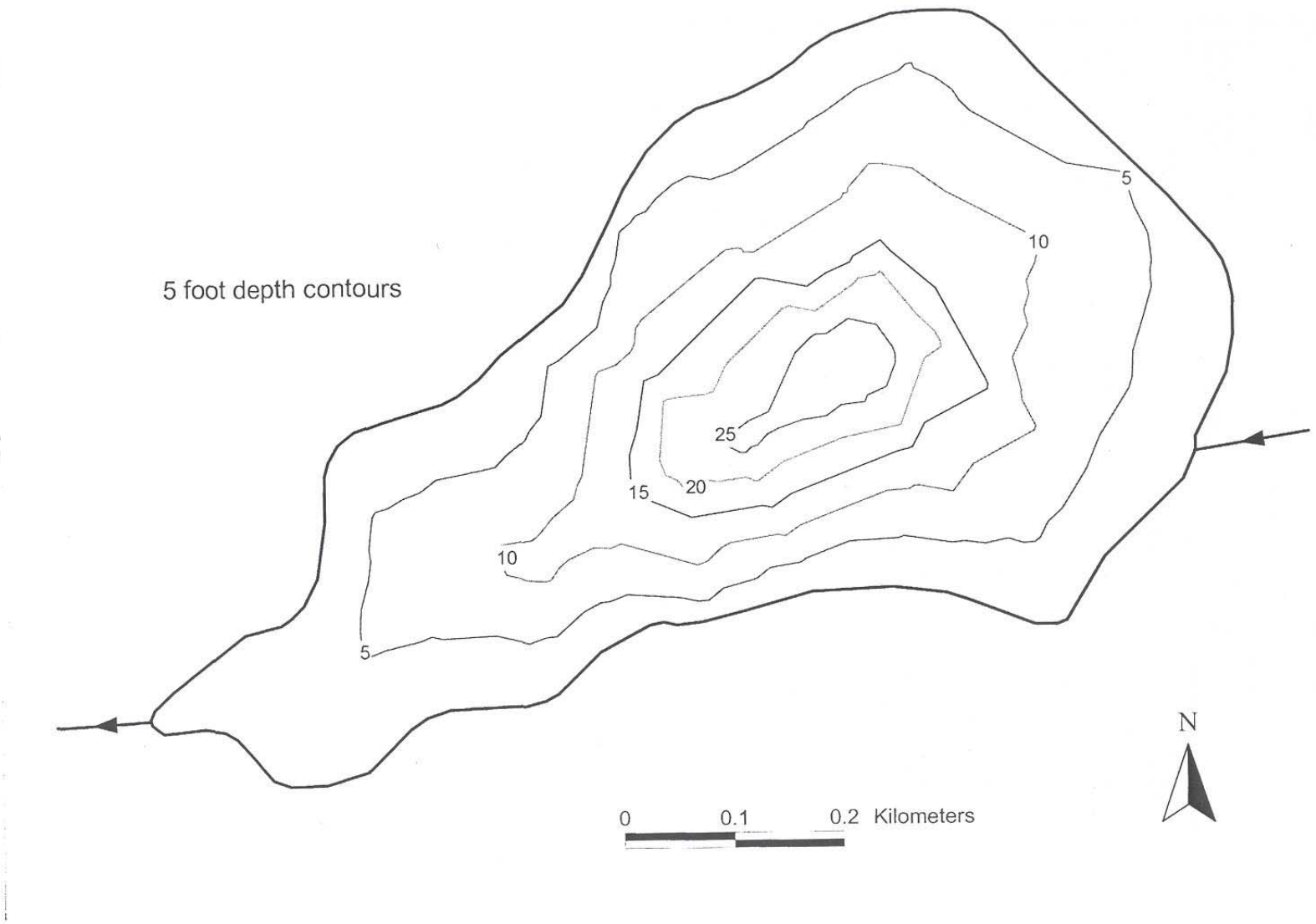


Figure 4- Boat Paths

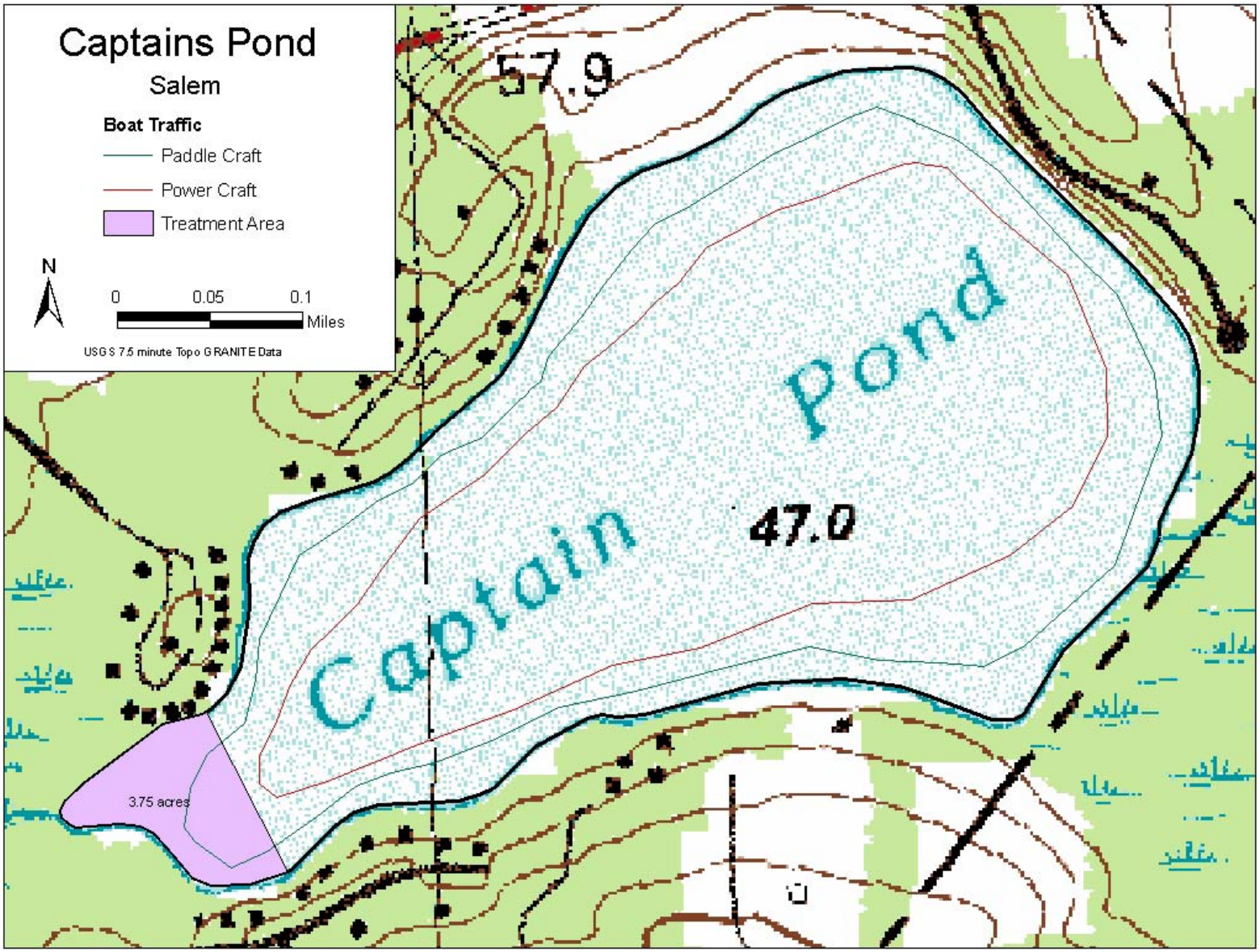
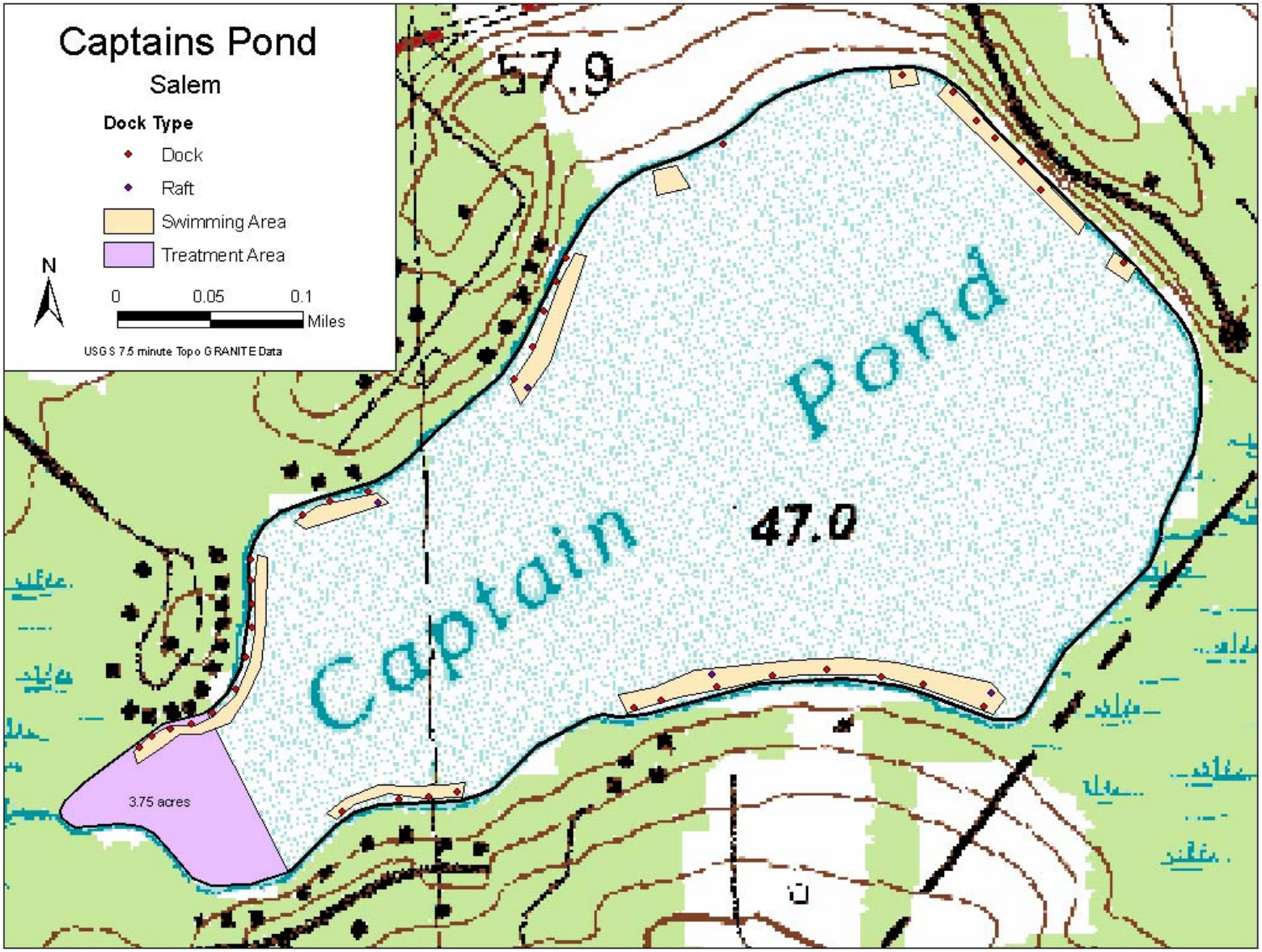


Figure 5- Swim Areas, Swim Platforms, and Docks



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.

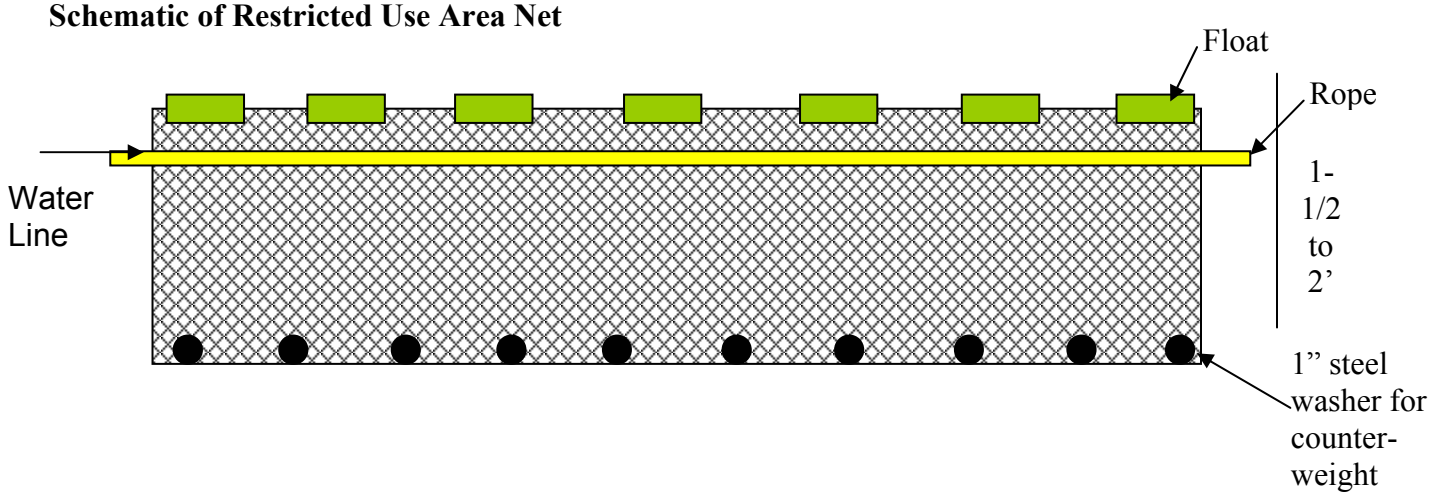
APPENDIX B

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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