Long-Term Variable Milfoil Management and Control Plan for LAKE WINNISQUAM- NORTH END Meredith, New Hampshire Belknap 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 Lake Winnisquam in Meredith, New Hampshire around 1995. Most variable milfoil growth is documented in the far northern and southern ends of the lake. Some growth is located within the central portion of the lake, between Mosquito Bridge on Route 3 and Mohawk Island in Tilton. Milfoil stands are primarily confined to Winnisquam Marine, which was successfully treated in 2006 and was not observed in 2007, Jays Marina, route 3, Tilton and Sunray Shores, a dredged channel to developed land in Belmont.. The immediate management approach for Lake Winnisquam is to focus on northern lake areas. Management and/or eradication of variable milfoil will occur from a north to south direction following the lake current pattern. The focus of this plan is solely on variable milfoil management in the northern section . Additional plans will be drafted for the central and the southern lake sections.

The management approach applied to Lake Winnisquam for the immediate timeframe is to focus on the northernmost, Meredith area of the lake. The work will focus on management and/or eradication of variable milfoil from a north to south direction, following the water flow direction through the system. This plan will focus on variable milfoil management in the northern portion of Lake Winnisquam. Additional plans will be drafted for the central portion of the lake, and the southern basin located in Tilton around the Lake discharge area..

Figure 1 illustrates the distribution of variable milfoil infestations in this waterbody as a whole, and Figure 1a shows the locations that will be the subject of this management plan for the northern end of the lake.

Following is a summary of the variable milfoil growth in Figure 1a:

Large Milfoil Area- The entire northern end of Lake Winnisquam, shown shaded in Figure 1a, is infested with dense variable milfoil growth. The area covers 38 acres, and variable milfoil is present at 75-90% cover throughout this area.

Individual Points- Figure 1a also shows numerous individual points along the Winnisquam northwestern and northeastern shorelines. These points indicate small to medium sized variable milfoil patches, or loose single stem groupings of the variable milfoil.

In terms of variable milfoil impacts in the system, there are 30 houses around the far northern shoreline of Lake Winnisquam, with mostly seasonal cottages, though there are a few year-round dwellings. There are also 30 back lots with lake rights. Many of these abut areas of dense variable milfoil growth.

Lake residents have expressed frustration with exotic plant growth, citing fouling of their swim beaches, swim impairments, difficult fishing, and impaired navigation. Additionally, large masses of variable milfoil fragments regularly wash up on shorefront areas.

PURPOSE

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

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

This plan also summarizes the current physical, biological, ecological, and chemical components of Lake Winnisquam and the social and ecological impacts of the milfoil infestation. The intent of this strategic plan is to reduce the overall acreage and percent cover of variable milfoil from Lake Winnisquam over time through the use of Integrated Pest Management Strategies (IPM), and to maintain this reduced level over time. 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 Lake Winnisquam is to reduce the overall acreage and percent cover of variable milfoil of variable milfoil from the system using an Integrated Pest Management Approach. To achieve this goal, we recommend the following:

1) Reduce the overall acreage and percent cover of variable milfoil bottom growth in the north end of Lake Winnisquam from 38 acres and 75-90% cover in 2008, with the use of 2,4-D, to less than 5 acres and 20% cover.

2) Reduce the number of individual points of variable milfoil growth along the northwestern and northeastern shorelines of Lake Winnisquam with the use of 2,-D in 2008.

3) Following a spring 2008 herbicide treatment, maintain variable milfoil cover below 10 acres and 25% cover with the use of integrated plant management strategies, including hand-pulling, benthic barrier placement, and diver-assisted suction harvesting activities.

4) Maintain a Weed Watcher program in the area to foster early detection and regular monitoring of the variable milfoil growth.

Town Support

The Town of Meredith is supportive of the variable milfoil treatment. The lake association is working with the town to finalize financial support from the town for the project in 2008.

Lake Winnisquam Improvement Association Support

Lake Winnisquam has an active lake association. They have divers that live on the lake that have mapped and tracked the extent of the variable milfoil infestation over time. Local divers will be available to assist with hand-removing and possibly suction harvesting variable milfoil following the herbicide treatment.

WATERBODY CHARACTERISTICS

The following table summarizes basic physical and biological characteristics of Lake Winnisquam.

General Lake Information	
Lake area (acres)	4,262.5
Watershed area (acres)	291,530.9
Shoreline Uses (residential, forested, agriculture)	Residential, forested, commercial
Max Depth (ft)	174.9
Mean Depth (ft)	50.2
Trophic Status	Oligotrophic
Color (CPU) in Epilimnion	13

Clarity (ft)	31.4
Flushing Rate (yr^{-1})	2.2
Natural waterbody/Raised by Damming/Other	Natural / Dam
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	*Myriophyllum heterophyllum*
Infested Area (acres)	Varies by location in lake: 38+ acres in the north end
Distribution (ringing lake, patchy growth, etc)	Dense area of infestation at northern tip. Several smaller scattered points along the northeast and northwest shorelines. Figure 1.
Sediment type in infested area (sand/silt/organic/rock)	Silty/sandy/rocky
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	Water marigold- State Endangered Common Loon- State Threatened Lake Whitefish- Rare Osprey- State Threatened
Area of Littoral Zone- North End (acres)	74
Area of Profundal Zone- North End (acres)	13
Area of Macrophyte Coverage (native or otherwise) of Plants in Littoral Zone- North End	45
% of Littoral Zone with Macrophyte Cover- North End	61
% of Macrophyte cover comprised of invasives- North End	84
% of Littoral Zone with Variable Milfoil Cover- North End	50

An aquatic vegetation map and key from an August 22, 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 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

Lake Winnisquam is a popular fishing location for many anglers. The primary coldwater fisheries in Lake Winnisquam include landlocked salmon, lake trout, and rainbow trout. The primary warmwater fisheries are largemouth and smallmouth bass. Figure 4 illustrates the common fishing areas in the north end of Lake Winnisquam, as presented by members of the lake association that track activity on the lake. Some of the areas indicated as prime fishing habitat by local fishing enthusiasts do fall within zones that are heavily impacted by variable milfoil growth.

A recent seine survey by the New Hampshire Fish and Game Department along the shores of the Chemung State Forest recorded largemouth bass, common sunfish, bluegill, yellow perch, eastern chain pickerel, and musk turtles.

As for species of interest or concern to the New Hampshire Fish and Game Department, lake trout, one of the coldwater fish, is a species of concern in Lake Winnisquam. Lake trout spend more time in the deeper waters of the lake, yet are indirectly influenced by the health and abundance of their prey populations. Also, there is an historic (1938) record of bridle shiners along the western shore of Lake Winnisquam.

The Fish and Game Department recognizes that the aquatic vegetation and wetland habitat at the north end of the lake is important habitat for fish (especially juvenile fish), amphibians, and turtles in Lake Winnisquam, and that it is one of the few more densely vegetated areas within this oligotrophic lake system. Fortunately, even though the variable milfoil abounds in the north end, native plants are still common throughout this area, and will still provide ample and diverse habitat for the fishery and other aquatic organisms once variable milfoil control actions are accomplished.

It is critical for all managers and lake enthusiasts to understand that the herbicide application is target specific at the dose used to control variable milfoil, and that native aquatic plants will not be affected by an herbicide treatment to control variable milfoil. In fact, native aquatic plants typically increase once dense variable milfoil cover is reduced, as the shading and nutrient competition that results from the rapid growth of this invasive aquatic plant is diminished.

The New Hampshire Natural Heritage Bureau lists three wildlife or fishery species of concern in the north end of Lake Winnisquam: the common loon, the lake whitefish, and the osprey.

There is a loon sanctuary in a small cove off from the northern end of Lake Winnisquam. This area is cordoned off to prevent boat traffic from entering the area. Nesting loon boxes have been established within this area. Variable milfoil is dense within this area, and it is an area that is proposed for treatment. DES has encouraged the lake association to make contact with the Loon Preservation Society, so that they can be notified of the proposed treatment. In the past, a Loon Preservation Society representative has been on site to observe treatments in loon habitat on other waterbodies. These representatives carry handheld radio to communicate with the applicator during the treatment of the subject areas. The loon staff member monitors the behavior of the loons (if they are in the area), and directs the actions of the applicator so as to

minimize any stress on the loons. The herbicides that are used are not toxic to the loons at the dose used to control milfoil, so toxicity effects are not an issue.

The lake whitefish is a reclusive fish that tends to spend most of its time in the deeper and colder waters of lakes. The whitefish does come into shallower waters to spawn in early winter. Spawning habitat is generally shallow rocky or sandy areas in waters that are less than 25 feet in depth. The young of the year fish spend time in shallow waters early on, then migrate deeper as they mature. Lake whitefish feed on small organisms due to a small mouth size. Prey includes small fish in the water column, and benthic organisms such as insects. Based on the habitat types and habits of this fish, there are no anticipated impacts as a result of the proposed herbicide treatment. The treatment is set to take place in the shallow, silty north end of the lake. Small fish species and benthic organisms are not expected to be impacted by the treatment.

The osprey has a nesting area in one known location around the shoreline of Lake Winnisquam, particularly in the Effraimes Cove area in the southern lake basin. The primary food for the osprey is fish. These birds are extremely territorial and do not stray too far from the nest. As the herbicides of choice do not bioaccumulate to toxic levels in the fish, or biomagnify along the food chain, impacts to the osprey as a result of the herbicide treatment are unlikely.

RECREATION USES AND ACCESS POINTS

Lake Winnisquam is used for numerous recreational activities, including motor boating, sailing, kayaking, canoeing, fishing, swimming, and water skiing, among others, by both lake residents and transient boaters.

Access to the lake can be achieved at commercial or private launches around the lake. A new pubic boat launce will open in 2008 on the Winnipesaukee River. There are an estimated 200-400 motorboats on the lake each day, and roughly 30-40 non-motorized craft. Figure 5 illustrates the typical boat paths for the pond.

There are no public beaches in the vicinity of the north end of the lake; however, there are a number of small private beaches along shorefront properties around this end of the lake. Figure 6 shows the locations commonly used for swimming, and the locations of docks on this portion of Lake Winnisquam.

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 Lake Winnisquam littoral zone 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), emergent plants (pickerelweed, cardinal flower, St. John's wort, arrow arum, spike rush, cattail, swamp loosestrife, grassy arrowhead, pipewort, water lobelia), and

submergent plants (water naiad, waterweed, bladderwort, grassy spike rush, tape-like bur-reed, quillwort, tapegrass, and various pondweed species). Native plant communities are mixed around the entire lake and in this northern end of the lake. Native plant growth in this cove is classified as common by the DES.

The New Hampshire Natural Heritage Bureau lists one plant as endangered in New Hampshire. Water marigold (*Megalodonta* (or *Bidens*) *beckii*) has an historic record at the north end of the lake. Based on field inspections by DES biologists across the state, water marigold is more common than previously documented around the state. During the August 2007 survey, water marigold was not observed in the north end of Lake Winnisquam. DES biologists have been in contact with the Natural Heritage Bureau and plan to conduct a site inspection before the herbicide treatment to determine if this plant is present, and if so, at what abundance level.

HISTORICAL CONTROL ACTIVITIES AT NORTH END OF LAKE WINNISQUAM:

Entity	Management Type:	Date	Area (acres)
Aquatic Control Technology, Inc.	Herbicide: 2,4-D	6/10/98	2
Lycott Environmental, Inc.	Herbicide: Diquat	6/12/01	15
Lycott Environmental, Inc.	Herbicide: Diquat	6/10/02	15
Local Divers	Handpulling	Summer 2007	Scattered patches

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 Lake Winnisquam. The following table summarizes DES' control strategy recommendations for Lake Winnisquam.

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	Use on Lake Winnisquam
Restricted Use Areas	Not recommended as variable milfoil is too widespread in the area to successfully contain.
Hand-pulling	DES recommends hand-pulling as a follow-up technique to herbicide treatment, particularly along the eastern and western shorelines at the northern end of the lake.
Diver-Assisted Suction Harvesting	Following herbicide application, DES recommends that Diver-Assisted Suction Harvesting be the primary means of further reducing variable milfoil in the north end of the lake.
Mechanical Harvesting/Removal	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	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	Herbicide use is recommended as primary treatment in the north end of the lake in 2008 due to extent of the variable milfoil infestation. The aquatic herbicide 2, 4-D is recommended due to more tannic waters in the north end of the lake, and small degree of suspended organic material in the water column in the area. Diquat efficacy is somewhat reduced under these conditions. Diquat is still recommended, however, as a secondary herbicide option if 2,4-D is not approved. Future herbicide treatments may be needed, but at 2-3 year intervals if non-chemical approaches are not fully effective in maintaining lowered percent coverages of variable milfoil.
Extended Drawdown	Drawdown is not an effective control method for variable milfoil, nor is it feasible in this area.
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	Variable milfoil is widespread and still expanding within Lake Winnisquam. A 'no control' option will foster the further encroachment of this exotic aquatic plant into currently uninfested areas. The DES strategy is to work from the north end of the lake to the south end, reducing the overall footprint of variable milfoil, and following herbicide treatments to accomplish this, to then maintain variable milfoil at low percent cover levels using non-chemical approaches, as feasible.

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 August 22, 2007. Based on the evaluation, the following control actions are recommended:

Year	Action	Responsible Party	Schedule
2008	2,4-D treatment of areas highlighted in Figure 1	Lycott Environmental, Inc.	May/June
	SCUBA inspection and diver hand-removal of variable milfoil at individual points and at areas of reduced percent coverage as a result of herbicide application	Lake Winnisquam Association divers or contracted divers	June through September
	Installation of benthic barriers, as may be appropriate	DES and Lake Winnisquam divers	July/August
	Diver-Assisted Suction Harvesting	DES and/or contracted divers	June through September
	Weed Watching and Lake Hosting Activities	Lake Winnisquam Association and lake residents	June through September
	Site assessment and remapping of variable milfoil infestation	DES	August/September
2009	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	Lake Winnisquam Association divers or contracted divers	June through September
	Installation of benthic barriers, as may be appropriate	DES and Lake Winnisquam divers	June through September
	Diver-Assisted Suction Harvesting	DES and/or contracted divers	June through September
	Weed Watching and Lake Hosting Activities	Lake Winnisquam Association and lake residents	June through September
	Site assessment and remapping of variable milfoil infestation	DES	August/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	Lake Winnisquam Association divers or contracted divers	June through September
	Installation of benthic barriers, as may be appropriate	DES and Lake Winnisquam divers	June through September
	Diver-Assisted Suction Harvesting	DES and/or contracted divers	June through September

Year	Action	Responsible Party	Schedule
	Weed Watching and Lake Hosting Activities	Lake Winnisquam Association and lake residents	June through September
	Site assessment and remapping of variable milfoil infestation, and determination of need for spring 2011 herbicide treatment	DES	August/September
2011	Herbicide treatment, if needed, based on 2010 site inspection.	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	Lake Winnisquam Association divers or contracted divers	June through September
	Installation of benthic barriers, as may be appropriate	DES and Lake Winnisquam divers	June through September
	Diver-Assisted Suction Harvesting	DES and/or contracted divers	June through September
	Weed Watching and Lake Hosting Activities	Lake Winnisquam Association and lake residents	June through September
	Site assessment and remapping of variable milfoil infestation	DES	August/September
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	Lake Winnisquam Association divers or contracted divers	June through September
	Installation of benthic barriers, as may be appropriate	DES and Lake Winnisquam divers	June through September
	Diver-Assisted Suction Harvesting	DES and/or contracted divers	June through September
	Weed Watching and Lake Hosting Activities	Lake Winnisquam 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	Fall

- Approximately 38 acres of the waterbody will be targeted for herbicide treatment (less than 1% of the overall surface area of the lake).

- 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 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 in Lake Winnisquam

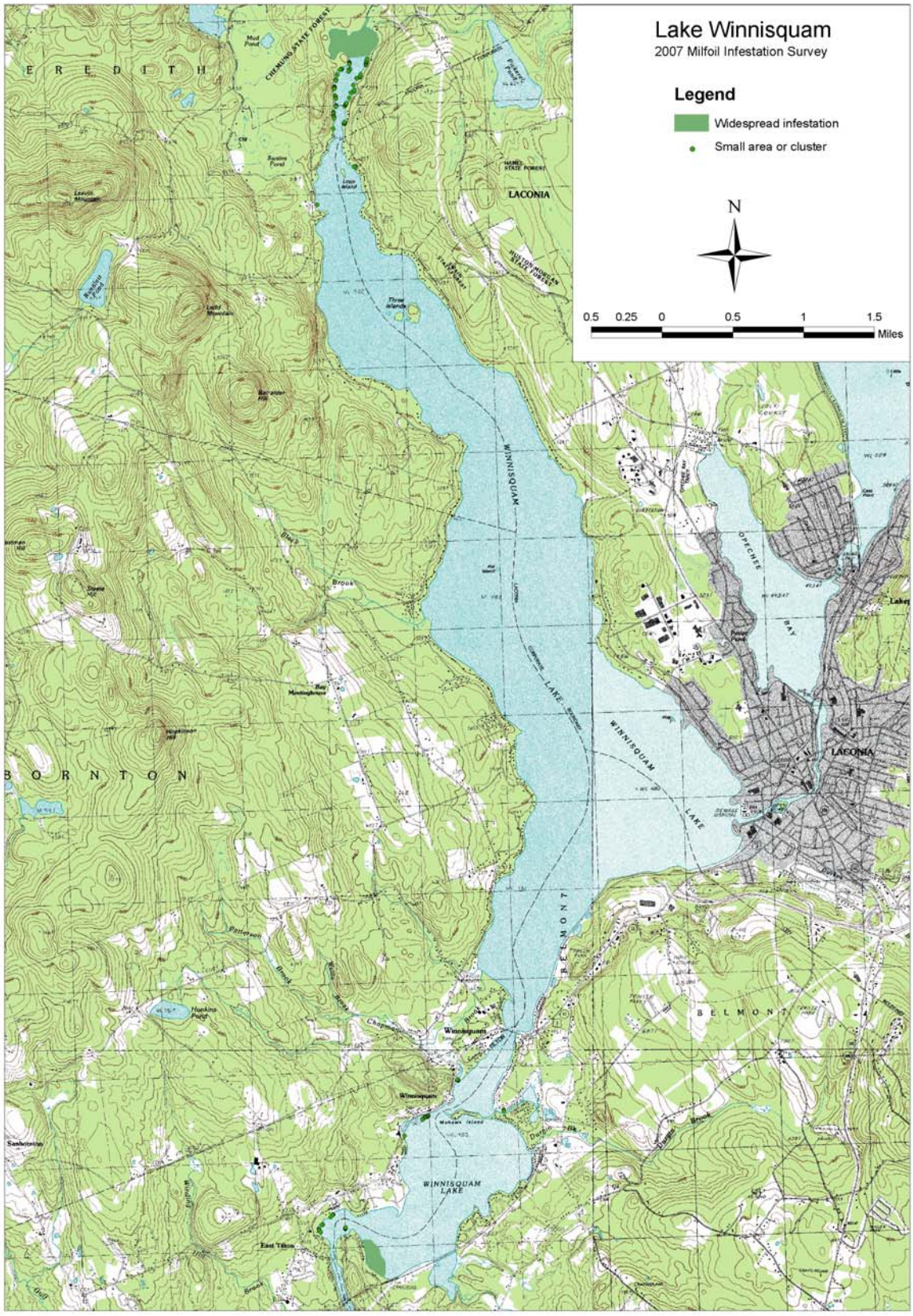


Figure 1a- Variable Milfoil Growth in the North End of Lake Winnisquam

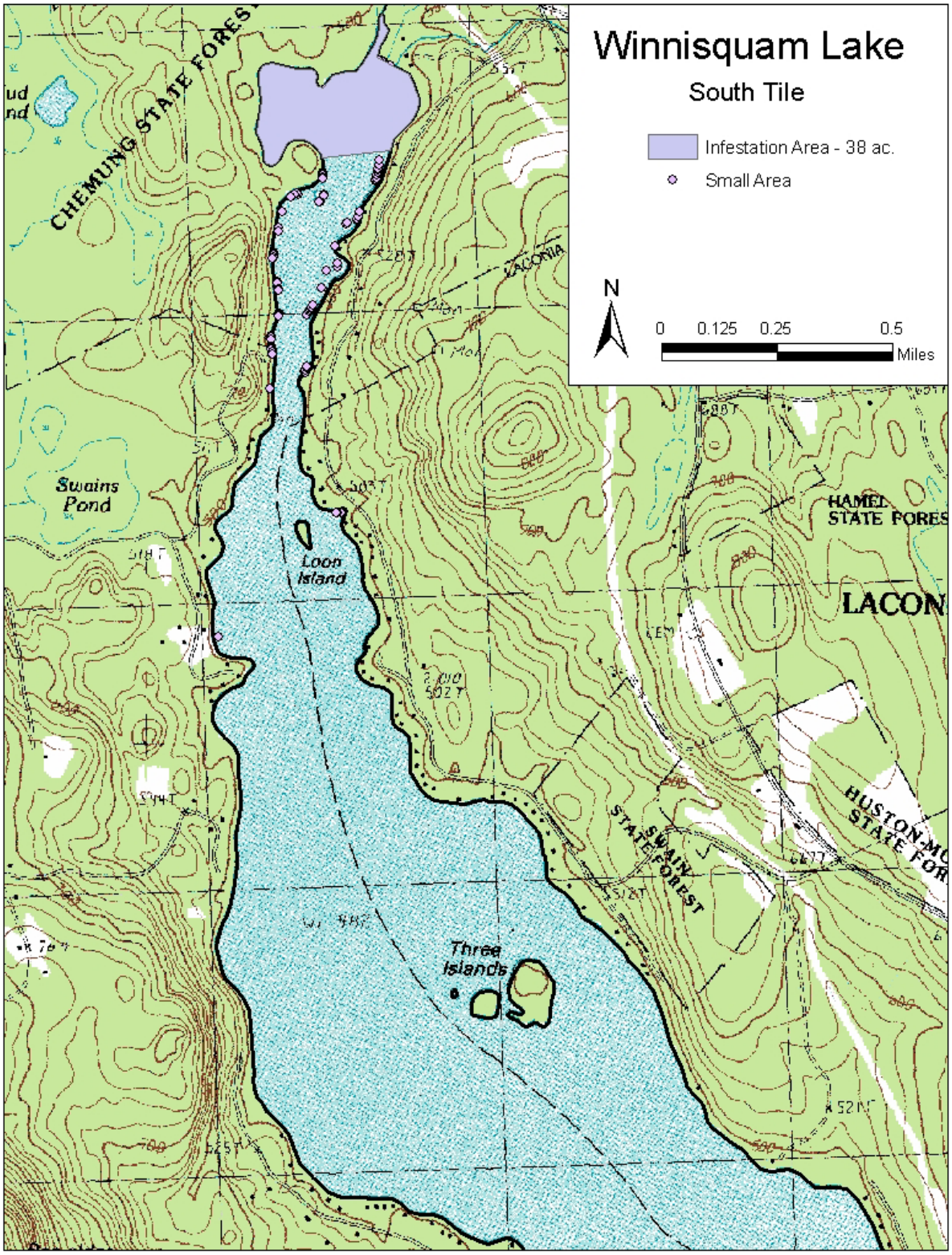
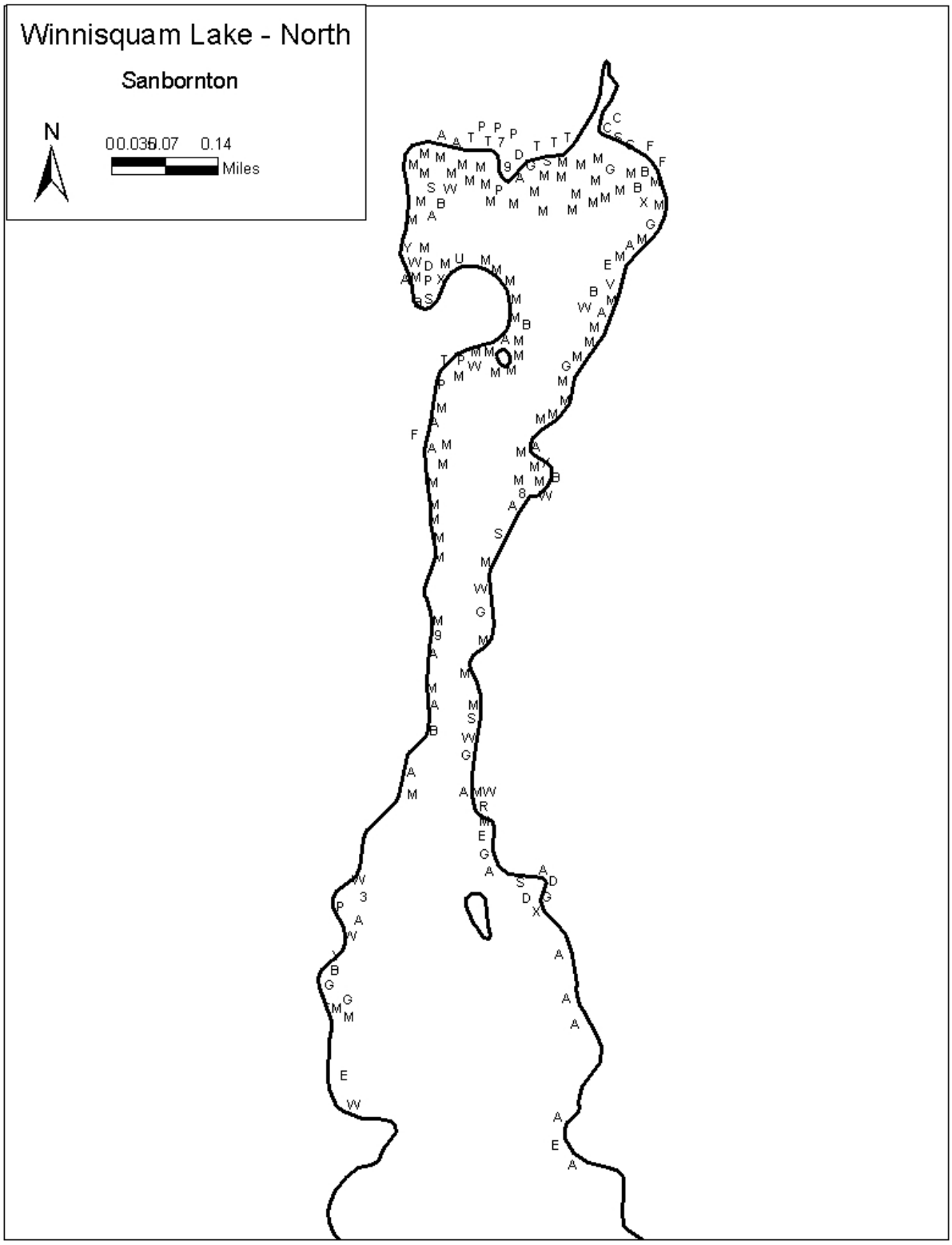


Figure 2- Aquatic Vegetation Map and Key



Symbol	Common Name	Latin Name
P	Pickerelweed	*Pontedaria cordata*
N	Water naiad	*Najas*
B	Watershield	*Brasenia schreberi*
8	Waterweed	*Elodea*
C	Cardinal flower	*Lobelia cardinalis*
Y	Yellow water-lily	*Nuphar*
9	St. John's wort	*Hypericum*
U	Bladderwort	*Utricularia*
7	Arrow arum	*Peltandra virginica*
6	Spike rush	*Eleocharis sp.*
z	Grassy spike rush	*Eleocahris sp.*
T	Cattail	*Typha*
S	Tape-like bur-reed	*Sparganium sp.*
M	Variable water-milfoil	*Myriophyllum heterophyllum*
D	Swamp loosestrife	*Decodon verticillata*
Q	Quillwort	*Isoetes*
G	Grassy arrowhead	*Sagittaria graminea*
F	Filamentous green algae	Various
E	Pipewort	*Eriocaulon*
V	Tapegrass	*Vallisneria americana*
X	Pondweed sp.	*Potamogeton sp.*
L	Water lobelia	*Lobelia dortmanna*
4	Purple loosestrife	*Lythrum salicaria*
2	Common reed	*Phragmites australis*
3	Clasping-leaf pondweed	*Potamogeton perfoliatus*
A	Bass weed	*Potamogeton amplifolius*
W	White water-lily	*Nymphaea*
R	Robbins pondweed	*Potamogeton robbinsii*

Figure 3- Bathymetric Map of North End of Lake Winnisquam, Meredith

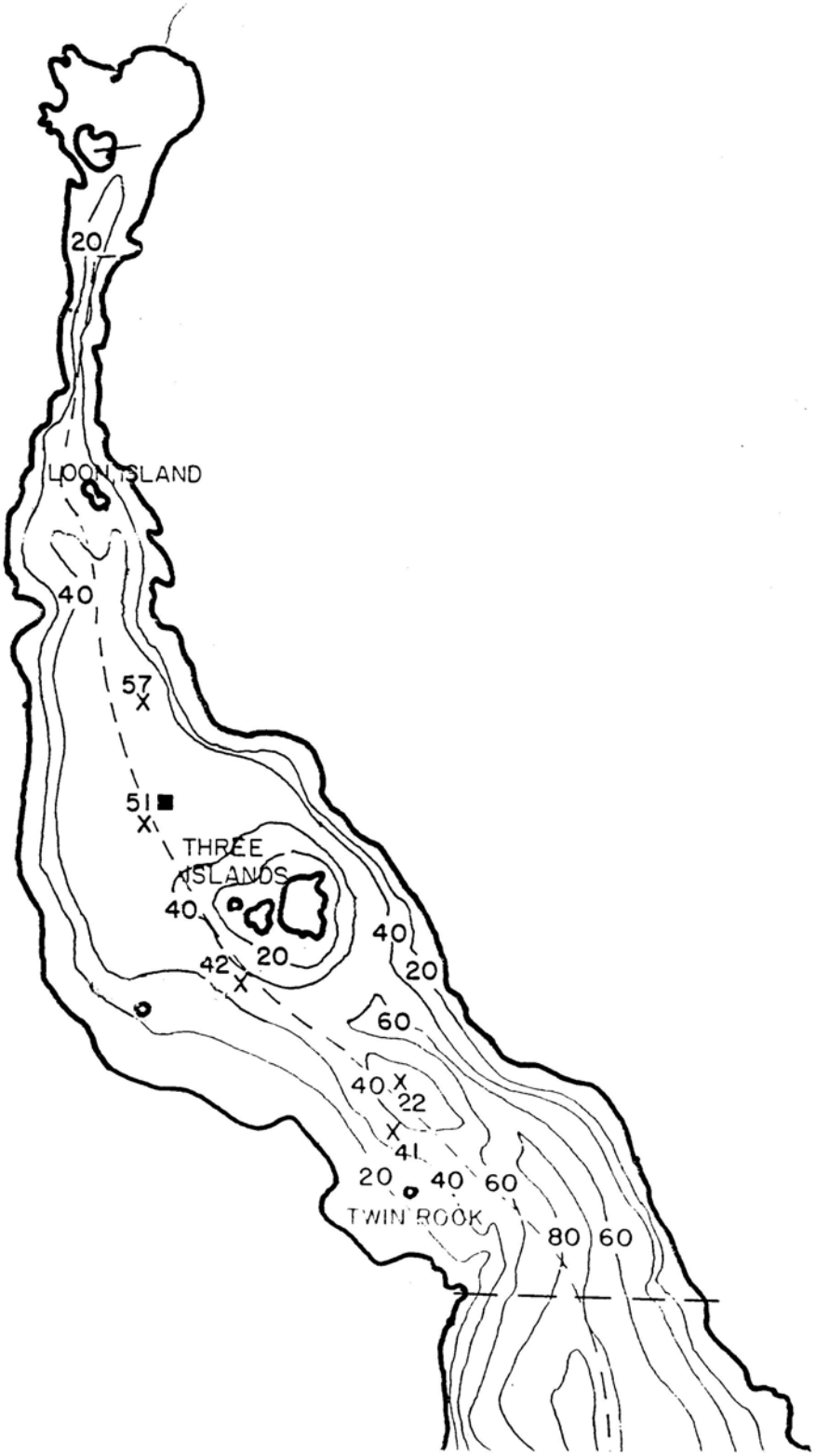


Figure 4- Common Fishing Locations (based on knowledge of lake residents)

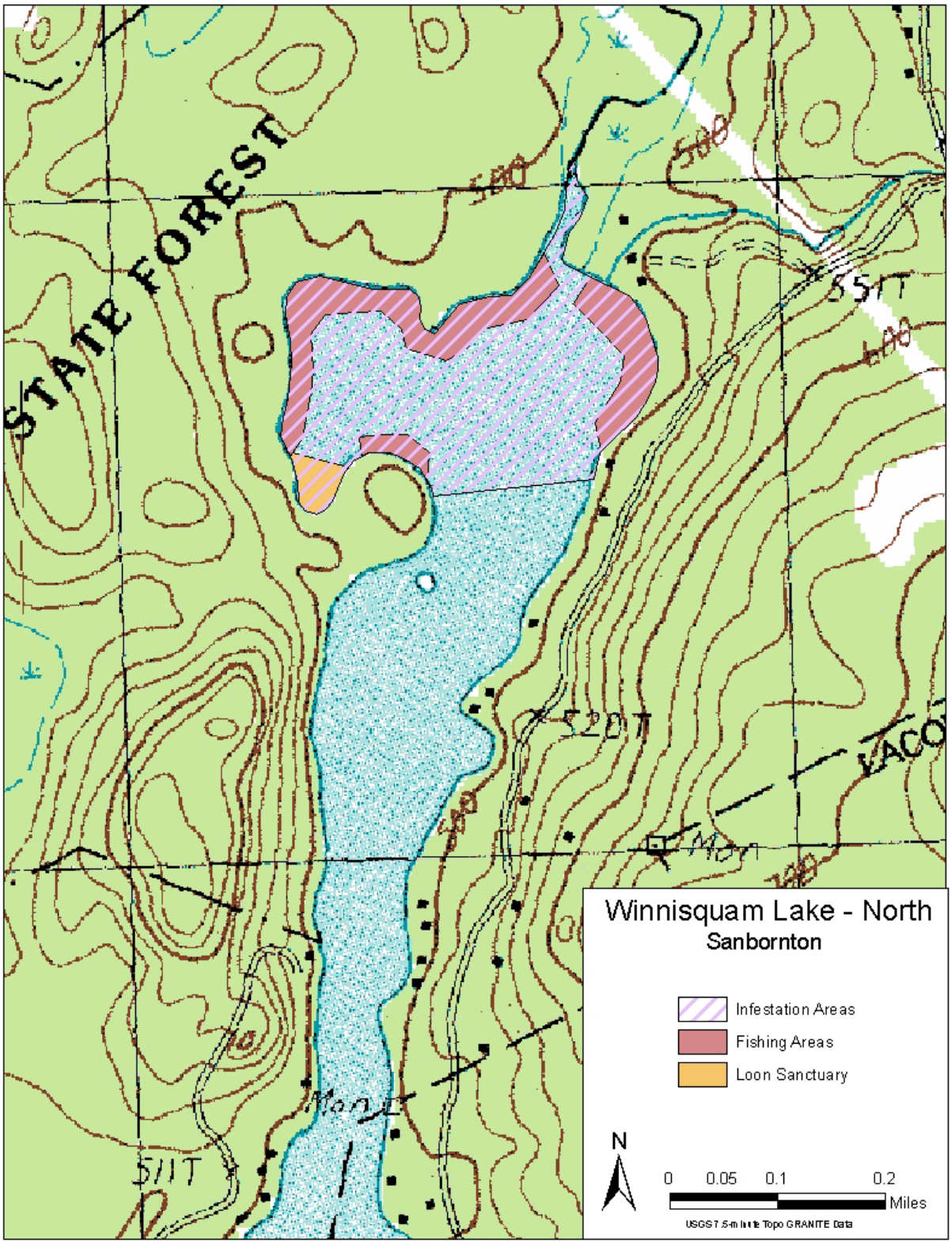


Figure 5- Common Boating Lanes

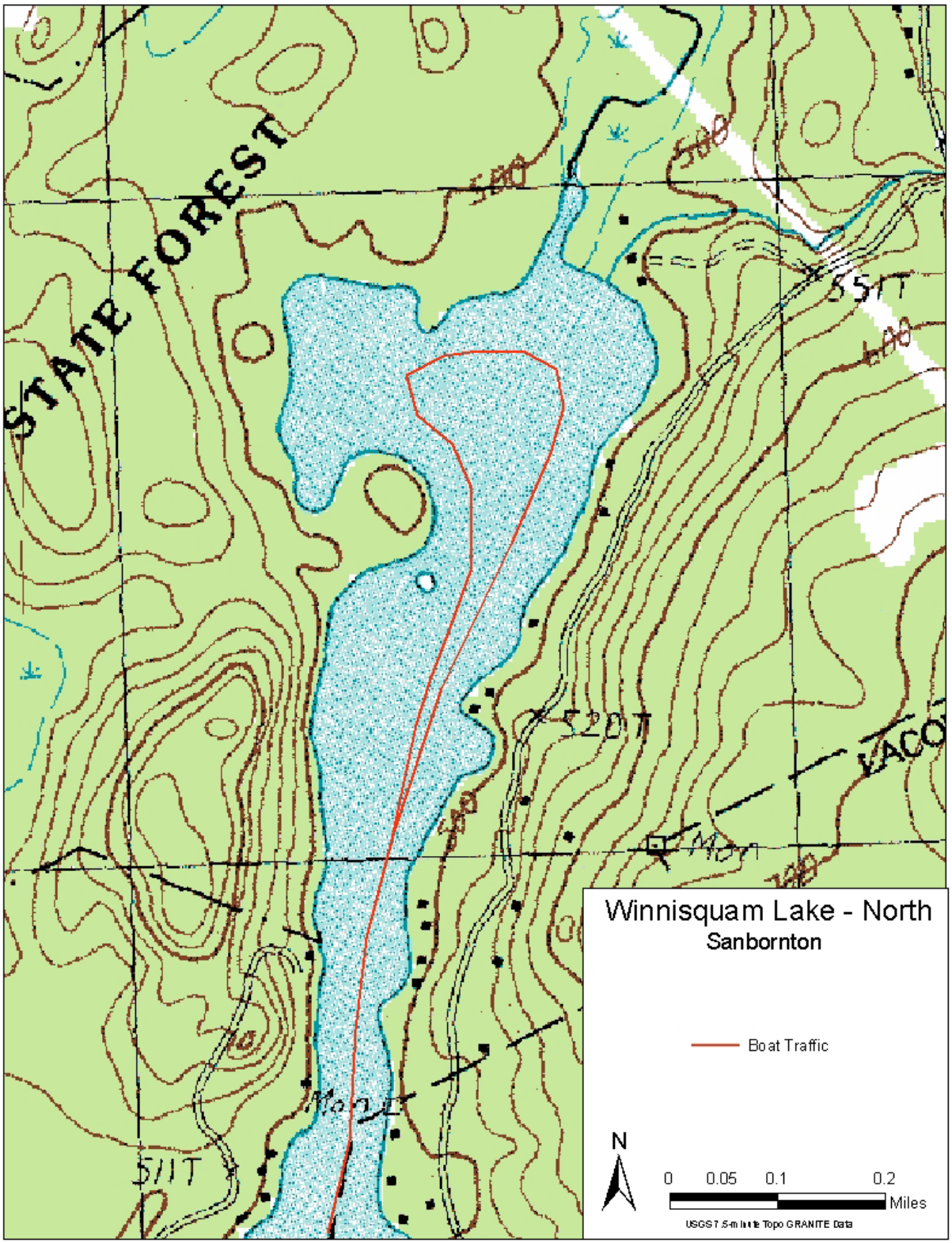
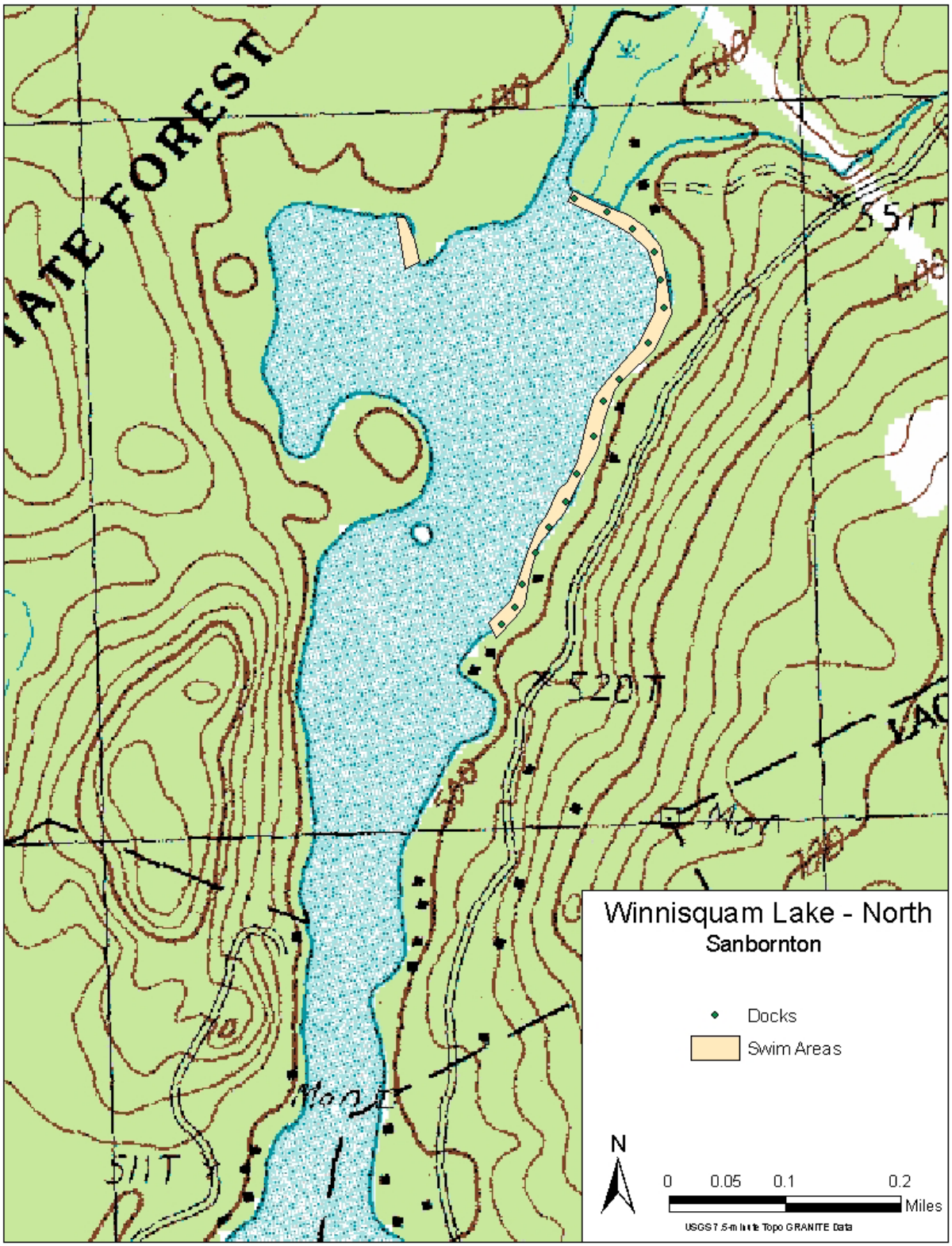


Figure 6- Private Swim Beaches and Docks



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.

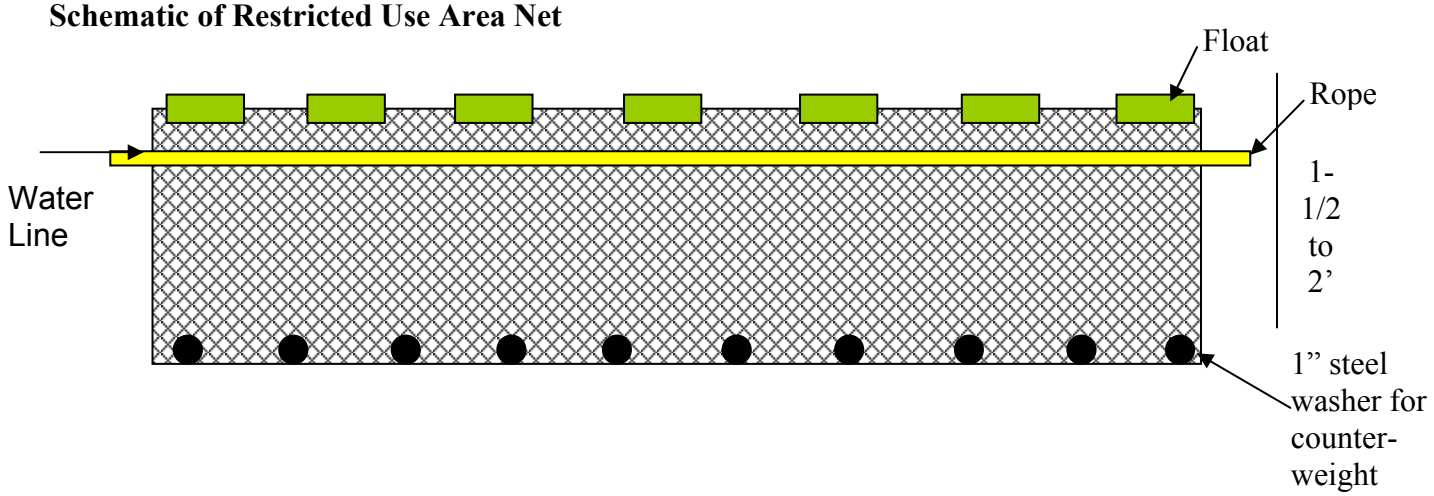
APPENDIX B

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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