Long-Term Variable Milfoil Management and Control Plan for SILVER LAKE Tilton, 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)
March 2007

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 Silver Lake in 1994. The plant has established itself in one larger patch and several smaller patches in the lake. Figure 1 illustrates the distribution of variable milfoil infestations in Silver Lake, and following is a summary of each area indicated in Figure 1:

Area A is a 6.2 acre patch in the northwestern corner of Silver Lake. The milfoil covers roughly 30% of the area in this patch. Lake residents indicate that this area is impaired for most uses due to thick variable milfoil growth.

Area B- This is a small patch of milfoil, roughly 30' in diameter and 50% milfoil density. Lake residents indicate that boating and swimming are difficult in this area due to variable milfoil growth.

Area C- This patch is roughly 20' in diameter and 60% milfoil density. Lake residents indicate that landowners in this area have difficulty docking their boats due to dense variable milfoil growth.

Area D- This patch is 30' in diameter and roughly 40% milfoil density. Lake residents indicate that landowners in this area have difficulty docking their boats due to dense variable milfoil growth.

Area E- This area is approximately ½ acre between the two points shown on Figure 1. This area is a public access site, and lake residents indicate that boats that enter and leave the lake through this area frequently break up the variable milfoil and cause fragments to form.

In terms of the variable milfoil impacts to shorefront property owners, there are approximately 105 houses surrounding the Silver Lake shoreline or that have lake access, as well as an additional 97 campground units that have access.

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, as part of this plan preparation.

PURPOSE

In September 2006, the Silver Lake Association requested matching funds from the Department of Environmental Services to conduct an exotic aquatic plant control project during the spring of 2007.

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 Silver Lake and the social and ecological impacts of the milfoil infestation. The intent of this strategic plan is to control variable milfoil in Silver Lake over time through the use of Integrated Pest Management Strategies (IPM), and to try to maintain the plants at very low levels, despite continuous sources of the plant from upstream sites in Lake Winnipesaukee and Lake Winnisquam. 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 VARIABLE MILFOIL CONTROL ACTIONS

The aquatic plant management plan for Silver Lake outlines actions to eradicate 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 Silver Lake is the reduction of variable milfoil cover and the maintenance of variable milfoil at lower levels than they now exist in the lake. Because Lake Winnipesaukee and Lake Winnisquam, upstream of Silver Lake, are both heavily infested with variable milfoil,

we do not anticipate that eradication will be possible in Silver Lake. We recommend the following:

1) To reduce the overall acreage and percent cover of variable milfoil in Area A from 6.2 acres to less than 1 acre, and from 30% cover to less than 10% cover with the use of 2,4-D in spring 2007. Following this, hand-removal and benthic barriers may be used to further contain this site.

2) To minimize the overall size and percent cover of variable milfoil in Area B from 50% cover to less than 10% cover, and from approximately a 30' diameter spot to a 10' diameter spot with the use of 2,4-D in a one acre surrounding this site (if needed based on site inspection immediately prior to treatment) in spring 2007.

3) To minimize the overall size and percent cover of variable milfoil at Area C and D from 60% cover and 20' diameter and 40% cover and 30' diameter, respectively, to less than 10% cover and 10' diameter using 2,4-D in spring 2007 to treat in a one acre surrounding this site (if needed based on site inspection immediately prior to treatment).

4) To eradicate variable milfoil growth in Area E using 2,4-D by hand-removal and benthic barriers.

5) To control variable milfoil infestations throughout the Lake by 2012 by reducing all areas to less than 10% variable milfoil cover, performing variable milfoil control actions on any exotic plants remaining after actions 1 through 4 above, and using hand-removal, benthic barriers, and/or diver-assisted suction harvesting in August 2007, and annually thereafter if new stems or localized patches are present.

6) To maintain a Weed Watcher program for the lake, and a Lake Host Program at the public access site.

Town Support

Both the Towns of Belmont and Tilton surround Silver Lake. Both towns are supportive of the variable milfoil management activities in Silver Lake. Both towns have made financial contributions to the Lake Association for varying control practices.

Silver Lake Association Support

The member of the Silver Lake Association, and residents of the shorefront areas, are supportive of the efforts to control variable milfoil in Silver Lake, and to prevent the further spread of this plant.

The members of the lake association have volunteered to perform Weed Watching activities, and 7 certified SCUBA divers on the lake plan to take part in the certification program that DES is working to develop with Dive Masters in 2007.

The Silver Lake Association has a website to keep members informed of the need for ongoing control efforts and to receive any notifications of new or suspected exotic aquatic plant growth.

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

Table 1 summarizes basic physical and biological characteristics of Silver Lake.

General Lake Information	
Lake area (acres)	216.2
Watershed area (acres)	294,399.9
Shoreline Uses (residential, forested, agriculture)	Residential, forested
Max Depth (ft)	22.44
Mean Depth (ft)	6.27
Trophic Status	Mesotrophic
Color (CPU) in Epilimnion	9
pH (Epilmnion/Hypolimnion)	6.7 units/6.7 units
Clarity (ft)	16.5
Flushing Rate (yr^{-1})	328.0
Natural waterbody/Raised by Damming/Other	Natural
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	*Myriophyllum heterophyllum*
Infested Area (acres)	8
Distribution (ringing lake, patchy growth, etc)	Patches scattered around lake of variable size, with milfoil densities ranging from 10-60%.
Sediment type in infested area (sand/silt/organic/rock)	Sandy/rocky/organic
Rare, Threatened, or Endangered Species in Waterbody (based on NH Natural Heritage Bureau database)	Bald eagle, Osprey, and arrowhead species (see body of text for more detail)
Area of Littoral Zone (acres)- using photic zone estimate	216.2
Area of Profundal Zone (acres)	0
Area of Macrophyte Coverage (native or otherwise) of Plants in Littoral Zone	68.7
% of Littoral Zone with Macrophyte Cover	32%
% of Macrophyte cover comprised of invasives	12%
% of Littoral Zone with Variable Milfoil Cover	4%

An aquatic vegetation map and key from a summer 2006 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 placed 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 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

Silver Lake is a classic example of a "pond in the river", as it is a rather wide expanse of water that is actually the Winnipesaukee River. A mesotrophic water, with extensive sand flats (mean depth 6.2 feet), it is characterized by an abundant warmwater fish population. The primary fisheries are small and largemouth bass, respectively, white perch, yellow perch, black crappie, chain pickerel, bluegill, pumpkinseed, and brown bullhead.

The American eel, a catadromous species, resides up to 4-9 years in our inland lakes where they reach sexual maturity and migrate down the rivers and outlets of our inland lakes to the Atlantic Ocean. Silver Lake is a major migration route for eels during the summer and fall that originate in the greater Winnipesaukee watershed.

The Winnipesaukee inlet and outlet channels of Silver Lake are important areas for American eel migration in June and in October. The inlet from the Winnipesaukee River is good habitat for white perch, yellow perch, and common sucker spawning. The littoral zone areas that are less than 10 feet in depth are indicated as spawning habitat for large and smallmouth bass populations. Fallfish spawning sites can be found in the Lake Winnipesaukee outlet area.

A review of the Natural Heritage records for rare species and exemplary communities in and immediately around Silver Lake yielded that both the bald eagle (listed as Endangered in NH and Threatened federally) and the Osprey (listed as Threatened in NH) can be found in this area. There were observations of Osprey nesting and feeding in the area (particularly Ephraim's Cove) in 1998 and 2005 in the Natural Heritage database. Bald eagles were observed in the area, but notes yield that there are no good perches or roost data for the area. Bald eagles were noted throughout the whole area, but generally on an unnamed island near Lochmere. The bald eagle was last reported in the area in 1993 according to Natural Heritage data.

Figure 4 illustrates the common fishing areas on Silver Lake, 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.

RECREATION USES AND ACCESS POINTS

Silver Lake is used for recreational activities including boating, fishing, swimming, and water skiing by both lake and town residents and campground visitors.

Figure 5 illustrates the public access points on Silver Lake. There are two public access points on the lake, and one private access site at the campground. Figure 5 also shows an approximation of the boating lanes on the lake. There are many lake-resident owned powerboats on the lake each year, and numerous canoes, kayaks, and row boats. Roughly 10 powerboat visitors go to Silver Lake during weekdays, and there are about 15 on weekends. Boat engines, propellers, and paddles can further promote fragmentation of the variable milfoil in the shallows.

There are no public (also called "designated") beaches on Silver Lake, but there are some areas that are considered common swimming locations by locals on the lake (Figure 6). 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.*

Figure 6 shows the locations commonly used for swimming, and also the locations of swim platforms and docks that are privately owned on the shores of Silver Lake.

Figure 7 illustrates some other key elements of the pond and watershed that may be of interest in this evaluation. At the northern end of the lake along the inlet channel is a parcel of conservation land. There are a few private wells around Silver Lake, particularly in the southern basin. There are also two drilled public wells located around the shoreline of Silver Lake.

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, and for Silver Lake, due to its overall shallow basin, the entire lake is considered to be the littoral zone.

The littoral zone of Silver Lake 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 water-lilies, water shield, floating heart), emergent plants (cattail, horsetail, pickerelweed, bulrush, non-flowering sedge, three-way sedge, bur-reed, spike rush, and aquatic grasses), and submergent plants (Robbin's pondweed, native waterweed, and miscellaneous pondweed species). Native plant communities are mixed around the entire lake, and are characterized as 'common/abundant' by the DES. Filamentous green algae growth was noted as common along much of the bottom of the pond, and particularly in the western shoreline area.

Variable milfoil occurs in mixed size patches and densities at five locations around the lake (reference Figure 1).

A review of the Natural Heritage records for rare species and exemplary communities in and immediately around Silver Lake yielded that a state threatened plant species, sessile-fruited arrowhead (*Sagittaria rigida*) can be found in and adjacent to Silver Lake. The records are historical in nature, and no known current locations occur at this time. A general location is within 1.5 miles of Silver Lake, near the Tilton interchange, in a pond ditch beside the road. The last report of this species was in 1970.

HISTORICAL CONTROL ACTIVITIES ON SILVER LAKE:

Year	Control Activity	Acreage	Concentration	Efficacy	Effectiveness
1996	Herbicide 2,4-D	1.5	100 lbs per acre	Good first summer	Regrowth next summer

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

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	Use on Silver Lake
Restricted Use Areas	The locations of the infestations in Silver Lake are not conducive to the use of Restricted Use Areas, therefore they are not recommended here.
Hand-pulling	DES recommends hand-removal (or diver-assisted suction harvesting) as the primary means of management of variable milfoil in areas C and D. The flow of water in these two areas is likely to obviate any benefits of using an herbicide here. DES recommends hand-removal of any re-growth of milfoil in the herbicide treatment areas (A, B, and E).
Mechanical Harvesting/Removal	For Silver Lake, mechanical harvesting is not recommended due to the threat of spreading variable milfoil to uninfested areas of the lake through the generation of fragments and the high flow rate through this system.
Benthic Barriers	For Silver Lake, DES recommends installing small benthic barriers in areas of re-growth if small patches of variable milfoil persist after treatment. This would be secondary to an initial herbicide treatment in areas A, B, C, and D.
Herbicides	For Silver lake, herbicide use is recommended as primary treatment in 2007 due to extent of infestation. DES recommends the use of 2,4-D in areas A, B, C, and D. Though Areas B, C, and D are each less than an acre in size, DES recommends treating a full acre around Area B, and around Areas C&D combined, to account for any spread of the plants from these initial clusters, and to mitigate any dilution effects from the flow through the lake.
Extended Drawdown	For Silver Lake, this is not a recommended or feasible strategy for this lake due to the high flow through the area, and the riverine nature of this system.
Dredge	Not recommended due to nature of exotic plant distribution and ecological impacts that would result from a dredge.
Biological Control	There are no approved biological controls for variable milfoil at this time in New Hampshire.
No Control	In order to allow for a healthy stand of mixed native aquatic vegetation, as well as areas of bare substrate in the shallows, a 'No Control' option is not recommened. Without control, variable milfoil will eventually take over Silver Lake as a result of its shallow nature and optimal sediment composition. This would result in an increase in the number of fragments flowing downstream into the Winnipeasukee River and ultimately the Merrimack River.

EXOTIC AQUATIC PLANT CONTROL PLAN

An evaluation of the size, location, and type of variable milfoil infestation, as well as the waterbody uses was conducted by DES during September 22, 2006. Based on the evaluation, the following control actions are recommended:

Year	Treatment Type	Responsible Party	Schedule
2007	2,4-D treatment of Areas A, B, C, and D on Silver Lake to reduce areal coverage and percent cover	Aquatic Control Technology, Inc.	May/June
	Hand-removal of variable milfoil at Area E, followed with benthic barriers in this area if needed.	Silver Lake Association Divers or contracted divers	July through September
	Weed Watcher activities to monitor re-growth/success of treatment.	Silver Lake Association Members	June through September
	Diver hand-removal of isolated patches/stems/regrowth	Silver Lake Association Divers or contracted divers	July through September
	Site visit to assess success of control actions and re-map of area	DES	August/September
2008	Weed Watcher activities to monitor re-growth/success of treatment.	Silver Lake Association Members	June through September
	Diver hand-removal of isolated patches/stems/regrowth	Silver Lake Association Divers or contracted divers	July through September
2009	Weed Watcher activities to monitor re-growth/success of treatment.	Silver Lake Association Members	June through September
	Diver hand-removal of isolated patches/stems/regrowth	Silver Lake Association Divers or contracted divers	July through September
	Site visit to assess success of control actions and re-map of area, and to determine need for 2010 herbicide application	DES	August/September
2010	2,4-D treatment of Areas A, B, C, and D on Silver Lake to reduce areal coverage and percent cover, if needed based on 2009 survey by DES	Licensed herbicide applicator	May/June
	Weed Watcher activities to monitor re-growth/success of treatment.	Silver Lake Association Members	June through September
	Diver hand-removal of isolated patches/stems/regrowth	Silver Lake Association Divers or contracted divers	July through September
2011	Weed Watcher activities to monitor re-growth/success of treatment.	Silver Lake Association Members	June through September

Year	Treatment Type	Responsible Party	Schedule
	Diver hand-removal of isolated patches/stems/regrowth	Silver Lake Association Divers or contracted divers	July through September
	Site visit to assess success of control actions and re-map of area	DES	August/September
2012	Update and revise Long-Term Variable Milfoil Control Plan	NH DES, F&G, and interested parties	Spring 2012

The herbicide application will be targeted to the specific areas of milfoil growth shown in Figure 1. Plant assemblages that are strictly comprised of native plant species will not be subject to control practices. Only areas with milfoil growth will be targeted for control activities. Approximately 3% of the lake is slated for herbicide treatment, based on the locations of variable milfoil growth mapped in 2006. This leaves the balance of the lake and associated native plant communities untouched.

CONSIDERATIONS FOR SELECTED MANAGEMENT PRACTICE

- Approximately 8 acres of 2,4-D treatment are being recommended in this 216 acre lake (3% of the lake surface area). Targeted herbicide applications can be achieved by boat in the recommended areas. Area E will be managed by hand pulling or non-chemical strategies in 2007.

- 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/suction harvesting of variable milfoil 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 due to the proposed herbicide treatment. It is expected that a well distributed stand of native aquatic plants will remain following herbicide application. The actual herbicide applications are very small relative to the size of the native plant communities and the lake area as a whole.

- A contingency for a 2010 herbicide application is added here, but is to be conducted only if needed. The decision for treatment will be based on a 2009 site assessment by DES where milfoil areal coverage and percent coverage will be measured.

Figure 1- Map of Milfoil Infestation

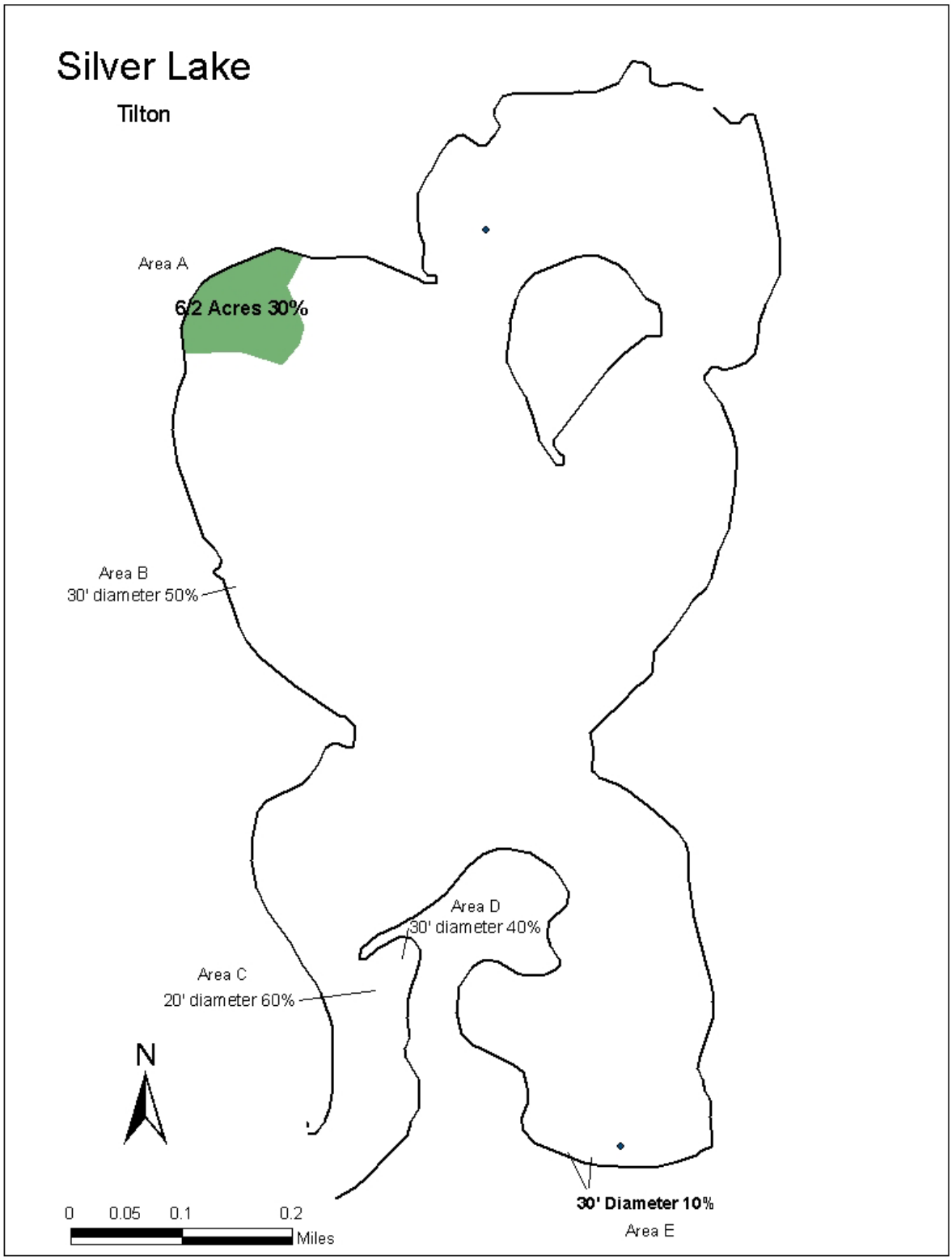
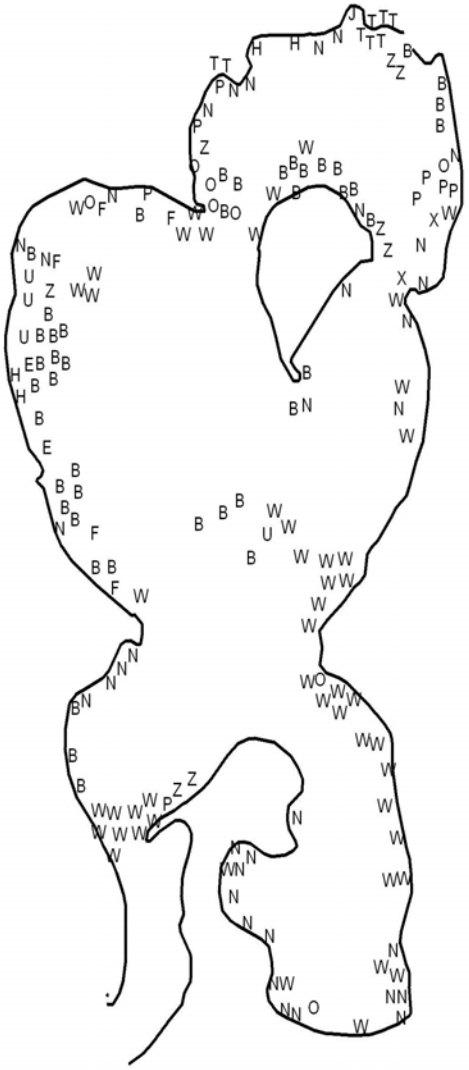


Figure 2- Aquatic Vegetation Map and Key



Symbol	Common Name	Latin Name
W	Pondweed sp.	*Potamogeton*
N	White water-lily	*Nymphaea*
X	Sterile thread-like leaves	*Eleocharis sp.*
P	Pickerelweed	*Pontedaria cordata*
O	Coontail	*Ceratophyllum*
b	Bassweed	*Potamogeton amplifolius*
Z	Bottom growth (filamentous green algae)	*n/a*
T	Cattail	*Typha*
H	Horsetail	*Equisetum*
F	Floating heart	*Nymphoides*
B	Watershield	*Brasenia schreberi*
M	**Variable milfoil**	***Myriophyllum heterophyllum***
U	Bladderwort	*Utricularia*
E	Waterweed	*Elodea*

Figure 3- Bathymetric Map

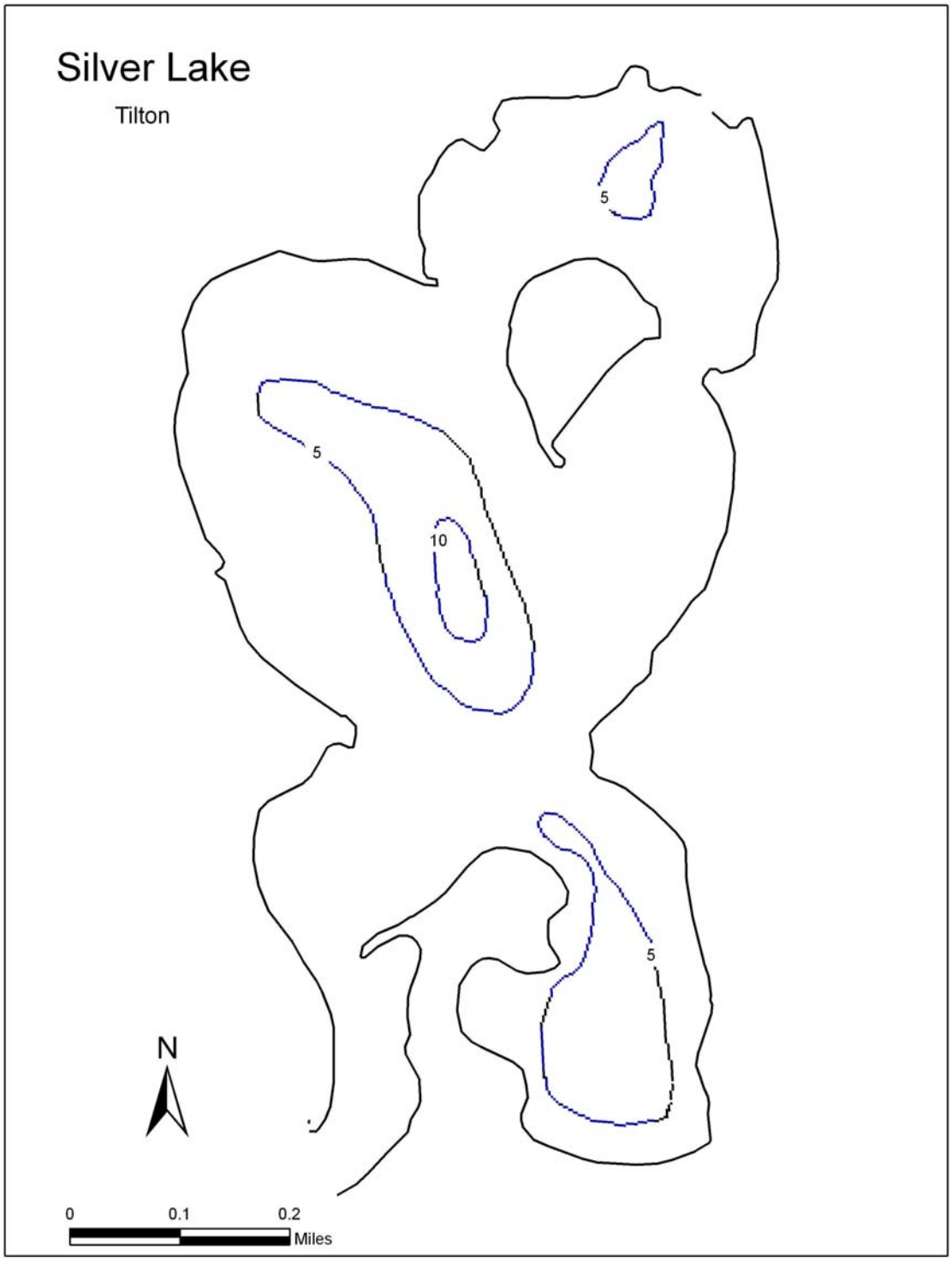


Figure 4- Common Fishing Locations (based on knowledge of lake residents)

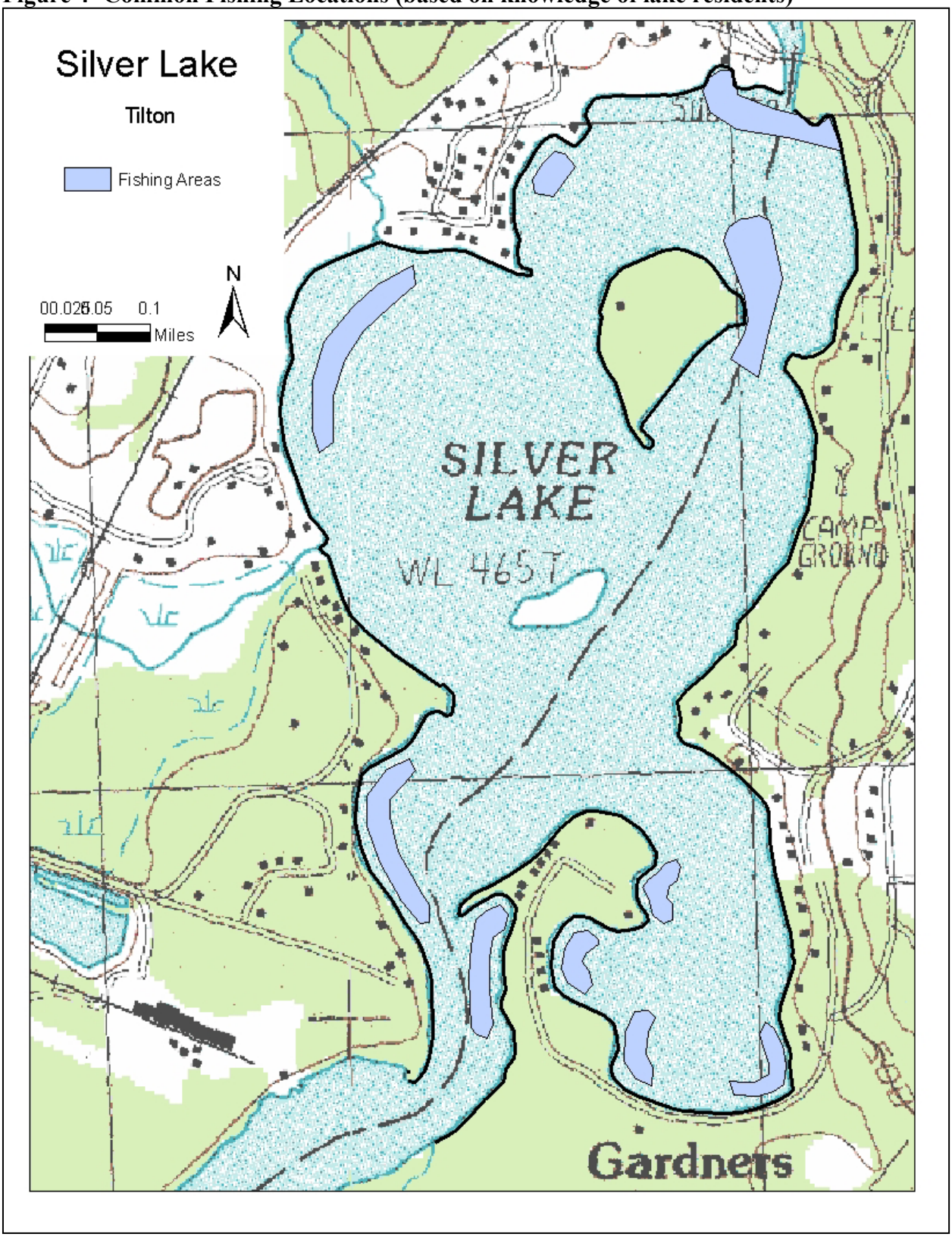


Figure 5- Public Access Points

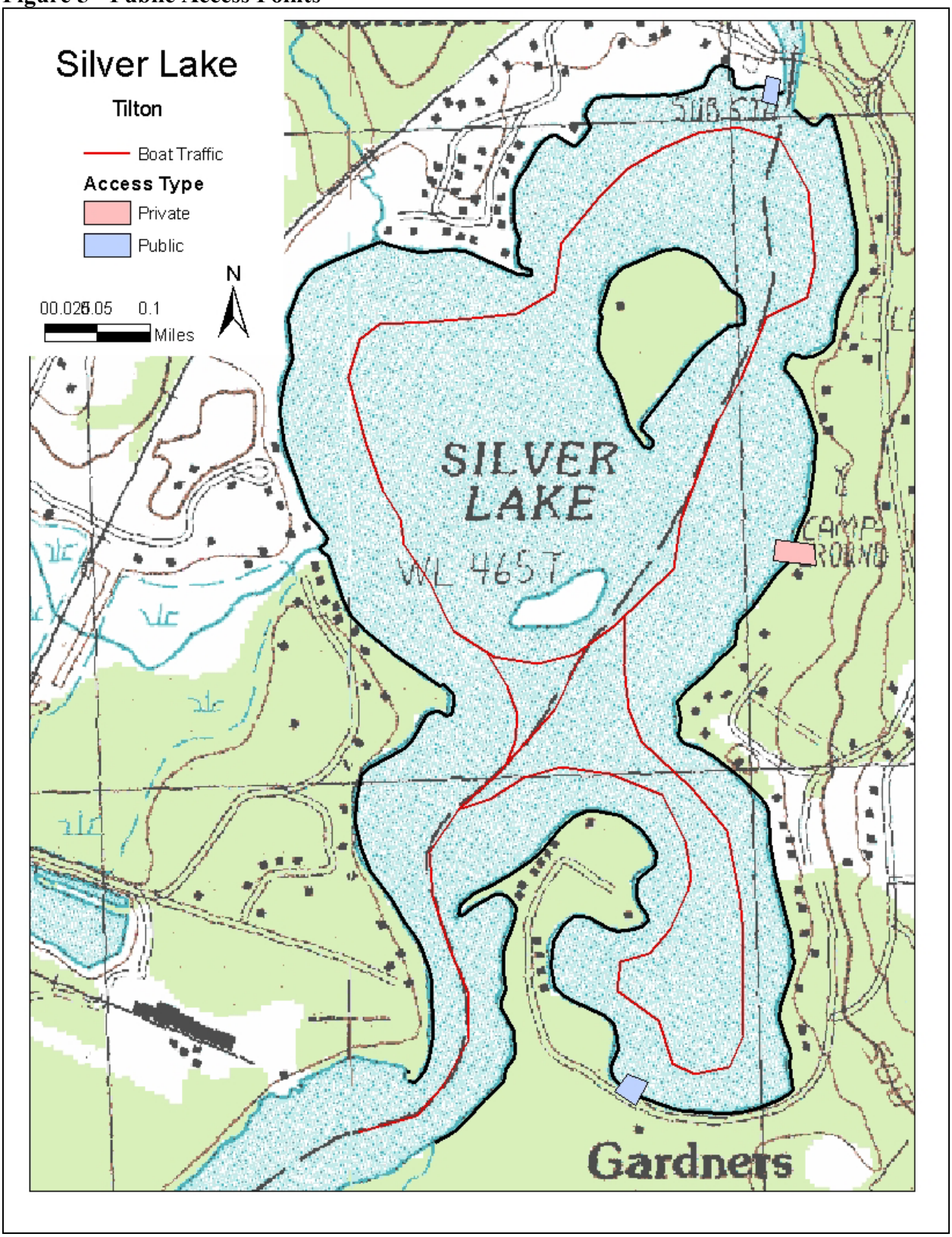


Figure 6- Swim Areas

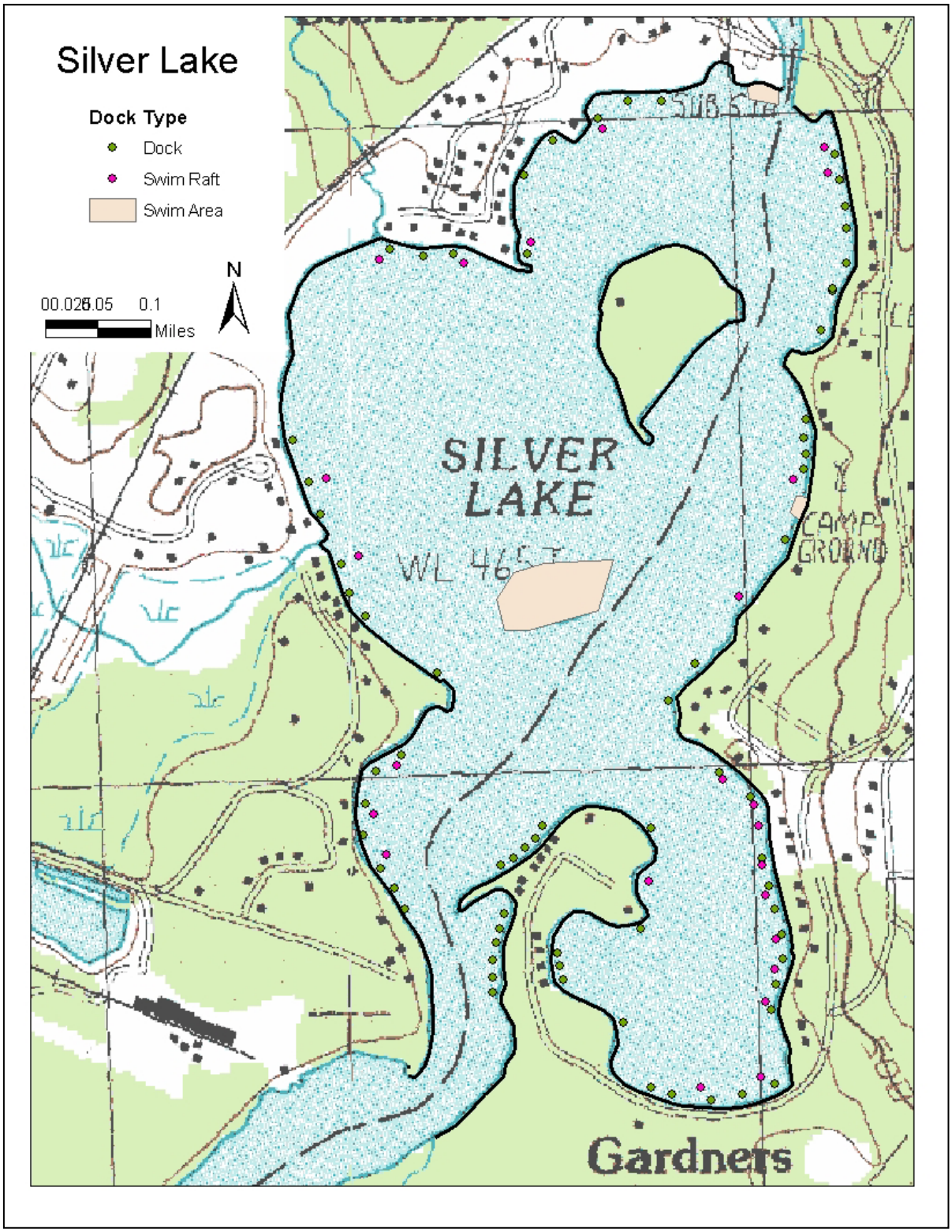
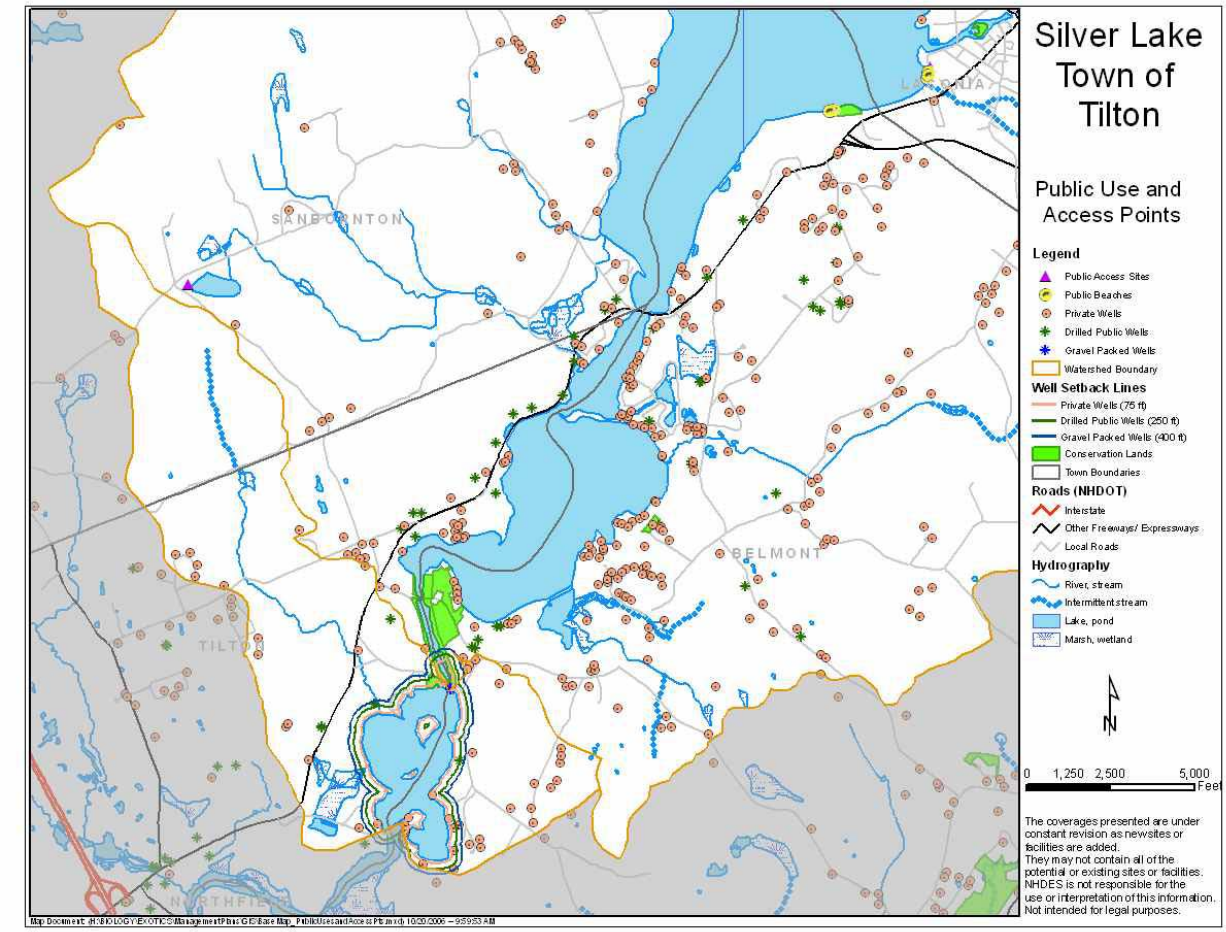


Figure 7- Public Uses and Setbacks



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.

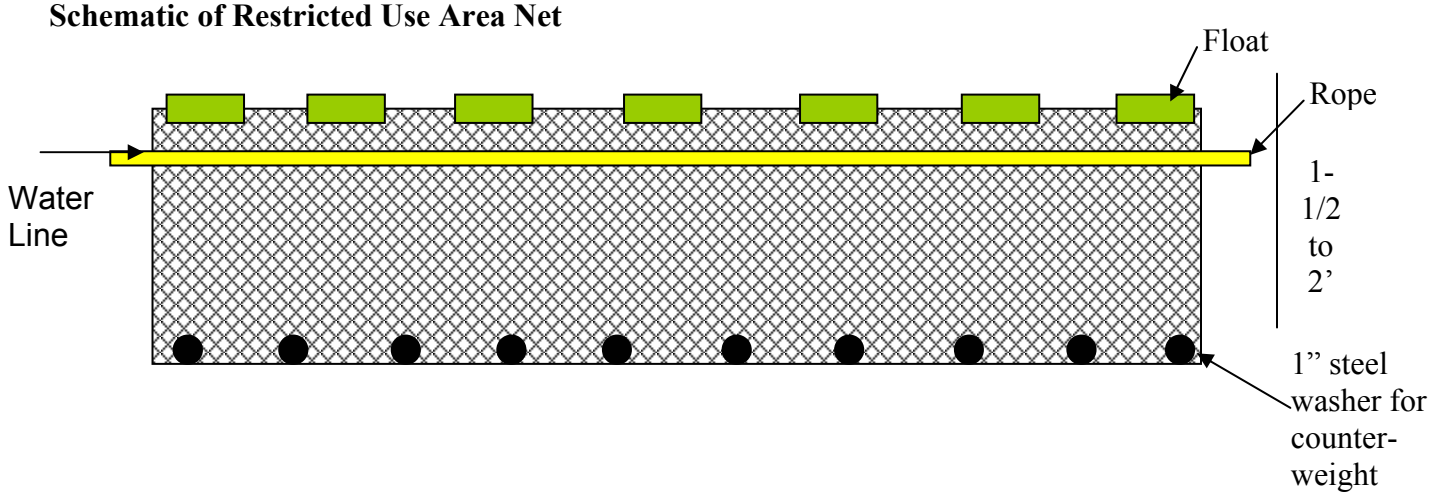
APPENDIX B

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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