# Long-Term Variable Milfoil Management and Control Plan for Lake Wentworth Wolfeboro, New Hampshire Carroll 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.

Lake Wentworth is an oligotrophic lake, 3,017 acres in size, upstream of and connected to Crescent Lake, a 148-acre waterbody, which drains into the so-called Back Bay area of the Smith River, which flows into Back Bay and then Wolfeboro Bay, Lake Winnipesaukee.

Variable milfoil infests approximately 27 acres of Lake Wentworth. The infestation is scattered around the lake, and locally abundant in some of the coves and inlet channels on the lake. Most of the main body of the lake is free from variable milfoil at this time. Figure 1 illustrates the extent of the variable milfoil infestation in Lake Wentworth, and following is a summary of each area indicated in Figure 1:

**Heath Cove-** Heath Cove is located in the southwestern corner of Lake Wentworth (Figures 1 and 1-a). The variable milfoil infestation here is extensive, and topping out on the surface of the water by mid-summer. Overall, variable milfoil covers nearly 19 acres in this cove, with 85% cover. There are generally many fragments drifting through this area, which receives high fishing and boating traffic. The substrate in this area is organic/silty. There are approximately 22 properties that abut this cove/channel. There is a very diverse assemblage of native plant species within this cove as well.

**Willey Cove-** This stream inlet is located in the middle of the northern shoreline of Lake Wentworth (Figure 1-a). Variable milfoil is at 45% cover throughout this 6.4 acre cove area. Milfoil is present in many large patches throughout the shallows, including in and around boat docking facilities around the eastern edge. There is frequent boat traffic up through the channel. The substrate in this area is silty/rocky/sandy. There are two lots plus a large campground along this inlet channel and cove. The campground has numerous docking facilities and transient boats which fragment the variable milfoil in the shallow waters of this area. There is a mix of native aquatic plants along the margins of this stream.

**Clay Brook-** This is the mouth of a smaller stream that enters on the eastern end of the northern shoreline of Lake Wentworth (Figure 1-a). The stream is narrow and quickly becomes shallow. Variable milfoil covers roughly 0.4 acres in this area, at roughly 45% cover. The substrate in this area is silty/organic. There are three properties located along this brook, which use the stream channel for lake access. The variable milfoil is in shallow water in this area, and easily fragmented.

**Individual Points-** Points 1 and 2 (Figure 1) located in the northeastern cove of Lake Wentworth signify areas where individual stems of milfoil are becoming established, and are still suitable for control with hand-removal. There are no dense patches in this cove at present. The substrate in this area is silty/sandy. A mix of native plants abounds in this area.

In terms of the milfoil impacts to shorefront property owners, there are approximately 369 houses surrounding the Lake Wentworth shoreline, with an additional 110 back lots that have lake access. Most of these properties are not directly impacted by variable milfoil growth at this time, but cove residents in areas of infestations are more heavily impacted, and other shorefront property owners are at risk of facing impairments from exotic aquatic plant growth.

Currently there are no data and no observable problems with the biological integrity of the aquatic community as a result of the variable milfoil infestation. The variable milfoil infestation is still somewhat localized to cove areas, and it is not commonly found within the main body of the lake at this time. No biological integrity surveys have been conducted, however, as part of this plan preparation.

## PURPOSE

In September 2006, the Lake Wentworth Association expressed an interest in conducting 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 Lake Wentworth, and the social and ecological impacts of the milfoil infestation.

The intent of this strategic plan is to eradicate variable milfoil from Lake Wentworth over time through the use of Integrated Pest Management Strategies (IPM), and then to move down through this chain of lakes and basins to eradicate variable milfoil from them, as well (including Crescent Lake and Back Bay). Appendix A details the strategies available for waterbodies with exotic species, and provides more information on each of the activities that are recommended within this plan.

## GOALS/OBJECTIVES OF MILFOIL CONTROL ACTIONS

The aquatic plant management plan for Lake Wentworth 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 Lake Wentworth is the eventual eradication of milfoil from the system using an Integrated Pest Management Approach. To achieve this goal, we recommend the following:

1) To reduce the size (acreage) of the milfoil infestation in Heath Brook from 18.69 acres to less than one acre, and the overall percent cover from 85% to less than 5% with the use of 2,4-D in 2007 and 2008 treatments.

2) To reduce the size (acreage) of the milfoil infestation in Willey Brook (cove) from 6.88 acres to less than one acre, and the overall percent cover from 45% to less than 5% cover with the use of hand-pulling, benthic barriers, and/or suction harvesting in 2007. A possible herbicide application may be recommended here in 2008 if the non-chemical strategies are not effectively reducing variable milfoil growths after the summer of 2007. If physical removal of the plants is successful, they will be continued until the variable milfoil is eradicated at this site.

3) To reduce the size (acreage) of the milfoil infestation in Clay Brook from 1.37 acres to less than ½ acre, and the overall percent cover from 45% to less than 5% cover with the use of hand-pulling, benthic barriers, and/or suction harvesting in 2007. An herbicide application may be recommended here in 2008 if the non-chemical strategies are not effectively reducing variable milfoil growths. If physical removal of the plants is successful, they will be continued until the variable milfoil is eradicated at this site.

4) To eradicate variable milfoil infestations located at Points 1 and 2 by hand-removal and benthic barrier placement.

5) To eradicate variable milfoil infestations throughout Lake Wentworth by 2012 by 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 and Lake Host Program for the lake.

**Town Support**

The Town of Wolfeboro is fortunate to have a strong team of local residents that are active in controlling variable milfoil on a number of fronts in the waterbodies of Wolfeboro. The control of variable milfoil has been, and will continue to be, a cooperative project with these individuals and groups.

The Milfoil Control Committee has set forth a Plan of Action for dealing with exotic aquatic plant species based on a series of goals and outcomes. Following is a summary of the elements of that plan:

I. Vision Statement

Mitigate and prevent the presence of exotic aquatic plant species in the lakes, ponds and streams within the boundaries of the Town of Wolfeboro.

II. Guiding Principles

A. Strive to keep area lakes, ponds, and streams protected for future generations from invasive aquatic plant species.

B. Ensure that the residents who live in the area will want to stay because of the quality of the natural resources.

C. Promote Wolfeboro as a place where the importance of the environment and the quality of recreational activities reflect the reasons why people want to come and visit.

D. Work diligently with the Selectmen and others to ensure that property values in Wolfeboro will not depreciate due to the presence of exotic aquatic plant species.

E. Seek the public's help to prevent the Town of Wolfeboro from being continually burdened by the long-term cost and control of exotic weeds, considering these invasive plants are capable of being regenerated each year if appropriate management techniques are not followed.

F. Minimize the environmental impacts in managing exotic aquatic weeds by the various techniques and processes available in removing the exotic weeds.

III. Goals

A. Limit the spread and reduce the harmful effects resulting from infestations of invasive aquatic plant species by managing and controlling those exotic plants that cannot be completely eradicated.

B. Educate Wolfeboro residents and visitors about the threat of invasive aquatic plants to the degree that they do not facilitate the continued multiplication of these plants through activities over which they have control.

C. Prevent introduction of new invasive aquatic species into Wolfeboro's waterways that currently do not have the presence of those plants.

D. Pursue sustainable funding to develop long-term programs for preventing the spread of existing invasive aquatic plant species and the potential introduction of new exotic aquatic plants.

IV. Projected Outcomes of Wolfeboro's Milfoil Control Committee Activities

A. Native plant species will be regenerated, increased biodiversity and increased water quality for recreational uses will occur in Wolfeboro's lakes and ponds.

B. The number of visitors attracted to the area will increase to enjoy the aesthetic qualities of weed free waterways.

C. Property values on the waterfront will continue to appreciate, businesses thrive, and employment increases.

D. Sustainable funding sources will be found to continue the control of exotic plant species.

E. A proactive model for exotic aquatic plant species control will be developed by other associations and groups within the Lakes Region that can be easily duplicated from Wolfeboro's Milfoil Control Committee work.

## Lake Wentworth Association Support

The Lake Wentworth Association (LWA) has been implementing programs of water quality assurance and weed control in Lake Wentworth for a number of years. In addition to numerous volunteer programs, LWA has and will continue to allocate funding for the implementation of various management programs, including:

- Financial support for state approved weed control programs
- New Hampshire Lake Host (monitoring at boat launch area)

- Lay Lake Monitoring (team of volunteers supervised by LWA limnologist and in cooperation with UNH to evaluate water samples from both lakes and give annual report)
- Weed Patrol Program (volunteer weed watchers assigned to various shoreline areas report findings to group leader)
- Volunteer dive teams used to locate and assess size and density of milfoil areas; to hand pull small areas of milfoil (surface team secures any weed fragments which may migrate using nets and twenty foot pool skimmers; surface boats are in position down wind or as needed); to record GPS readings at milfoil sites for re-examination at later site visit
- Educational programs (e.g., weed identification, shoreline protection with appropriate plantings and fertilizer use and non-use
- Annual loon census and fishing derby
- Work in cooperation and communication with state agencies and local government.
- Volunteer services to support The Lake Wentworth Foundation in its efforts to manage over 200 acres of sensitive land parcels within the lakes' watershed
- Support efforts of Stamp Act Island Conservancy to maintain the largest lake island as a nature preserve

## WATERBODY CHARACTERISTICS

Table 1 summarizes basic physical and biological characteristics of Lake Wentworth, based on a summer 2006 DES Lake Assessment:

| **General Lake Information** (based on 2006 lake assessment) | |
|---|---|
| Lake area (acres) | 3,017.5 |
| Watershed area (acres) | 22,591.9 |
| Shoreline Uses (residential, forested, agriculture) | Residential, children's camps, beaches, forested, commercial, seasonal cottages |
| Max Depth (ft) | 80.85 |
| Mean Depth (ft) | 21.12 |
| Trophic Status | Oligotrophic |
| Flushing Rate ($yr^{-1}$) | 0.5 |
| Color (CPU) in Epilimnion | 11 |
| pH (Epilimnion/Metalimnion/Hypolimnion) | 6.3 units/6.2 units/5.8 units |
| Clarity (ft) | 21.45 |
| Natural waterbody/Raised by Damming/Other | Natural waterbody raised by damming |
| Invasive Plants (Latin name) | *Myriophyllum heterophyllum* |
| Infested Area (acres) | 27 |
| Distribution (ringing lake, patchy growth, etc) | More abundant in cove areas, patchy in some shoreline segments |
| Sediment type in infested area (sand/silt/organic/rock) | Organic in the tributary coves, sandy/silty elsewhere |
| Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory) | Common Loon (*Gavia immer*) Threatened in NH<br>Great Blue Heron (Rookery) (*Ardea herodias*)<br>Lake Whitefish (*Coregonus clupeaformis*) |
| Natural Community of Concern | Sandy pond shore system (These natural |

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|---|---|
| | communities are extremely vulnerable to trampling, and tend to disappear from areas that experience even moderate recreational use. They are vulnerable to changes to the hydrology of the pond or lake). |
| Area of Littoral Zone (acres) | 1,224.7 |
| Area of Profundal Zone (acres) | 1,853.4 |
| Area of Macrophyte Coverage (native or otherwise) of Plants in Littoral Zone | 140.9 |
| % of Littoral Zone with Macrophyte Cover | 11.5 |
| % of Macrophyte cover comprised of invasives | 19.1 |
| % of Littoral Zone with Variable Milfoil Cover | 26.9 |

An aquatic vegetation map and key from a summer 2006 survey by the DES Biology Section is shown in Figure 2. A bathymetric map of the lake is shown in Figure 3.

## BENEFICIAL (DESIGNATED) USES

In New Hampshire, beneficial (designated) uses of our waterbodies are categorized into five general categories: Aquatic Life, Fish Consumption, Recreation, Drinking Water Supply, and Wildlife (CALM).

Of these, Aquatic Life and Recreation are the ones affected by the presence of variable milfoil.

## AQUATIC LIFE

The goal for aquatic life support is to provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of the region.

## FISHERIES AND WILDLIFE

The principal fisheries of Lake Wentworth include both warm and coldwater species. Coldwater species of primary interest are rainbow trout, lake whitefish, and rainbow smelt.

Warmwater species of primary interest are; largemouth bass, smallmouth bass, white perch, yellow perch, chain pickerel, black crappie, brown bullhead, and bluegill.

Numerous warmwater species are present in littoral areas of the lake and constitute the prey fish sought by larger game fish (warmwater). These species include; common shiner, common white sucker, creek chubsucker, fallfish, golden shiner, pumpkinseed, redbreast sunfish, and slimy sculpin.

The American eel, a catadromous species, resides up to 4-9 years in our inland lakes, such as Lake Wentworth, where they reach sexual maturity and migrate down the rivers and outlets of our large lakes to the Atlantic Ocean.

Figure 4 illustrates the common fishing areas on Lake Wentworth, 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, particularly Heath Brook. Lake residents and DES biologists have observed high levels of variable milfoil fragmentation following boating traffic through the Heath Brook area. There is also a lot of fishing activity taking place amongst the smaller islands to the west of Stamp Act Island.

## RECREATIONAL USES AND ACCESS POINTS

Lake Wentworth is used for recreational activities including boating, fishing, swimming, and water skiing (among others) by both lake and town residents.

There are generally numerous lake-resident owned and transient powerboats on the lake each year, and numerous canoes, kayaks, and row boats. Lake residents estimate that there are 5-10 off-lake motorboats visiting Lake Wentworth each day, with many more on the weekends. Lake residents also estimate that there are 5-10 kayakers and canoeists that visit the lake each day, not including those that live on the lake that partake in this activity. Figure 5 indicates the areas and boat paths common on the lake.

There is no designated public access for boats directly on Lake Wentworth, but access can be achieved at the Mast Landing access site on Crescent Lake, and boaters can navigate the channel that connects the two lakes. Figure 6 shows the location of the public access site on Crescent Lake, known as Mast Landing. The map also shows lake and land use patterns around Lake Wentworth.

One public (also called "designated") beach exists on Lake Wentworth (the Lake Wentworth State Park Beach). There are also 5-6 private beaches owned by the town of Wolfeboro, condominium associations, or campgrounds around the lake. 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 7 shows the locations of designated beaches and other areas commonly used for swimming. At this point only Robie's Campground in Willey Cove/Brook is impaired by growths of exotic aquatic plants. Points 1 and 2 are nearby the State Park, and if left unmanaged, could impair swimming and other recreational activities at this beach.

## MACROPHYTE EVALUATION

The littoral zone of the lake is characterized by a mix of native and non-native (variable milfoil) plant growth (Figure 3).

Native species include a mix of floating plants (yellow water-lily, watershield, and pondweed) emergent plants (bur-reed, pickerelweed, pipewort, water lobelia, three-way sedge, buttonbush, swamp candle, cattail, and arrowhead), and submergent plants (tapegrass, waterwort, quillwort, variable milfoil, pondweed, and bladderwort).

Native plant communities are mixed around the entire lake, but are characterized as sparse/scattered by the DES. The bottom composition of much of Lake Wentworth is comprised of sandy and cobbly substrates, which are not conducive to excessive plant growth.

The native plant communities are more abundant on the northern shoreline near the state park, but they do not exceed a 'common' rating in terms of abundance.

Native aquatic plants in the bay and coves are generally more abundant than exposed shorelines of the lake.

Variable milfoil is common in the tributary coves, particularly in Heath Brook, Clay Brook, and Willey Brook.

Northern and western shorelines of the lake are slightly more turbid due to growths of filamentous green algae in the water column.

## HISTORICAL CONTROL ACTIVITIES:

| Contractor | Management Type: | Chemical Application/Treatment Date | Treatment Area (acres) | Effectiveness |
|---|---|---|---|---|
| Aquatic Control Technology | Diquat | June 9th 1999 (Heath Brook Cove) | 9.3 acres | Contained infestation for the short term by reducing footprint and density of patch, but it did not eradicate the variable milfoil. |
| Lycott Environmental | Diquat | June 11th 2003 | 10 acres | Contained infestation for the short term by reducing footprint and density of patch, but it did not eradicate the variable milfoil. |

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| Lake Residents | Diver Hand Removal | 2001 to present | Varies | Very effective in small new areas |
| Aquatic Control Technology, Inc. | 2,4-D | June 5, 2007 | 19 acres | Variable milfoil growth in Heath Brook was reduced to less than 5% cover. |

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

| **Control Method** | |
|---|---|
| Restricted Use Areas | DES recommends that Restricted Use Area, or that the very least, a fragment barrier be installed at the mouth of the Heath Brook where it enters Lake Wentworth. There are high numbers of fragments generated and drifting within this cove and out into Lake Wentworth. A Restricted Use Area would limit boat traffic in the area, thereby preventing some of the fragmentation from occurring. A fragment barrier, which could be part of an RUA, would help contain fragments and could be cleaned regularly by local residents. |
| Hand-pulling | DES recommends hand removing the milfoil stems at the areas indicated by Point 1 and Point 2 in Figure 2. Hand removal practices are also recommended in Willey Brook and Clay Brook in 2007 to try to minimize the size and percent cover of the variable milfoil infestations. Also, hand-removal should be conducted on small patches or areas of re-growth following herbicide application in Heath Brook. |
| Mechanical Harvesting/Removal | Not recommended due to fragment generation and spread. |
| Benthic Barriers | Recommended for all intermediate sized patches where feasible. |
| Herbicides | Recommended 2007 2,4-D treatment for Heath Brook with the provision for a repeat treatment in this area for 2008 if needed for an |

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| | intensive aim to reduce biomass of variable milfoil in those areas. Also, if hand-removal and other techniques at milfoil eradication in Willey and Clay Brooks is not effective in 2007, a possible herbicide treatment at these two additional sites in 2008 will be considered, based on September 2007 DES field data. |
| Extended Drawdown | Not feasible or recommended for control of variable milfoil. |
| Dredge | Not recommended based on locations of milfoil in the lake. |
| Biological Control | There are no biological controls for variable milfoil at this time. |
| No Control | We recommend against a 'no control' regime in Lake Wentworth. The variable milfoil infestations are still small and localized, but as the lake ages and the bottom composition changes due to sedimentation from watershed activities, more milfoil habitat will be created. Also, there are additional organic substrates in the lake that have yet to be infested. It is critical to act now and to act effectively while variable milfoil populations are small and manageable, with still the possibility for eradication. Lake Wentworth is the first in a chain of waterbodies in Wolfeboro that has variable milfoil. Lack of action to control variable milfoil will result in further infestation of downstream waterbodies as a result of downstream migration of viable fragments of this plant. |

## EXOTIC AQUATIC PLANT CONTROL PLAN

An evaluation of the size, location, and type of variable milfoil infestation, as well as the waterbody uses was conducted by DES during September 21, 2006, and again on September 13, 2007. Based on the evaluation, the following control actions are recommended:

| Year | Treatment Type | Responsible Party | Schedule |
|---|---|---|---|
| 2007 | 1. 2,4-D treatment of Heath Brook | Aquatic Control Technology, Inc. | May/June |
| | 2. Install fragment barrier or Restricted Use Area (as determined by DES, F&G, DOS) at mouth of Heath Brook | NH DES and LWA | June |
| | 3. Work with local divers on hand-removal of variable milfoil at Points 1 and 2 and in Willey and Clay Brooks, and for follow-up after 2,4-D treatments in Heath Brook | NH DES and LWA | June/July |
| | 4. Installation of benthic barriers where small and suitable patches exist | NH DES and LWA | June/July |
| | 5. End of season monitoring and re-mapping of infestation, including estimate of variable milfoil percent cover | NH DES | September |

| Year | Treatment Type | Responsible Party | Schedule |
|---|---|---|---|
| | 6. Perform Weed Watcher activities | LWA | Monthly during summer months |
| | 7. Removal of fragment barrier/RUA from Heath Brook | LWA | October 15 |
| 2008 | 1. 2,4-D treatment of Heath Brook, Willey Brook, and Clay Brook variable milfoil infestations (determined based on September 2007 field data, shown in Figure 1-a as prepared by Aquatic Control Technology, Inc.) | Aquatic Control Technology, Inc. | May/June |
| | 2. Install fragment barrier or Restricted Use Area (as determined by DES, F&G, DOS) at mouth of Heath Brook | LWA | June |
| | 3. Continued hand-removal of variable milfoil in areas where feasible and practical | LWA | June/July |
| | 4. Installation of benthic barriers where small and suitable patches exist | LWA | June/July |
| | 5. End of season monitoring and re-mapping of infestation, including estimate of variable milfoil percent cover | NH DES | September |
| | 6. Perform Weed Watcher activities | LWA | Monthly during summer months |
| | 7. Removal of fragment barrier/RUA from Heath Brook | LWA | October 15 |
| 2009 | 1. Install fragment barrier or Restricted Use Area (as determined by DES, F&G, DOS) at mouth of Heath Brook | LWA | June |
| | 2. Continued hand-removal of variable milfoil in areas where feasible and practical | LWA | June/July |
| | 3. Installation of benthic barriers where small and suitable patches exist | LWA | June/July |
| | 4. Perform Weed Watcher activities | LWA | Monthly during summer months |
| | 5. Removal of fragment barrier/RUA from Heath Brook | LWA | October 15 |
| 2010 | 1. Install fragment barrier or Restricted Use Area (as determined by DES, F&G, DOS) at mouth of Heath Brook | LWA | June |
| | 2. Continued hand-removal of variable milfoil in areas where feasible and practical | LWA | June/July |

| Year | Treatment Type | Responsible Party | Schedule |
|---|---|---|---|
| | 3. Installation of benthic barriers where small and suitable patches exist | LWA | June/July |
| | 4. Perform Weed Watcher activities | LWA | Monthly during summer months |
| | 5. Removal of fragment barrier/RUA from Heath Brook | LWA | October 15 |
| 2011 | 1. Install fragment barrier or Restricted Use Area (as determined by DES, F&G, DOS) at mouth of Heath Brook | LWA | June |
| | 2. Continued hand-removal of variable milfoil in areas where feasible and practical | LWA | June/July |
| | 3. Installation of benthic barriers where small and suitable patches exist post treatment | LWA | June/July |
| | 4. End of season monitoring and re-mapping of infestation, including estimate of variable milfoil percent cover | NH DES | September |
| | 5. Perform Weed Watcher activities | LWA | Monthly during summer months |
| | 6. Removal of fragment barrier/RUA from Heath Brook | LWA | October 15 |
| 2012 | Update and revise Long-Term Variable Milfoil Control Plan | NH DES, F&G, and interested parties | Spring 2012 |

The herbicide application in 2007 will be targeted in Heath Brook in 2007. In 2008, if needed, Heath Brook, Clay Brook, and Willey Brook may be treated with aquatic herbicide. 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. Less than 1% 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

- Activities that take place in Lake Wentworth will be conducted in concert with other management strategies in downstream waterbodies. We propose to target Lake Wentworth first as it is the first lake in a chain of lakes feeding into Lake Winnipesaukee. Activities for Crescent Lake, followed by Back Bay, and Wolfeboro Bay will hinge on the success of management strategies in Lake Wentworth.

- The 2007 proposed herbicide treatment will affect roughly 19 acres of lake area, specifically in Heath Brook. This is less than 1% of the overall surface area of Lake Wentworth. Plant assemblages that are strictly comprised of native plant species will not be subject to control practices. Only areas with variable milfoil growth will be targeted for control activities.

- The 2008 proposed herbicide applications will affect a total of 24.9 acres of the lake, mostly in the mouths of the tributaries feeding the lake. This is less than 1% of the overall surface area of Lake Wentworth.

- 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 hand-pulling re-growth and the installation of benthic barriers, variable milfoil re-growth or population expansion can be reduced.

- Based on the types of native plants found with the stands of variable milfoil (Figure 3) where herbicide application is recommended, there will be no significant impacts to native plant communities. It is expected that a well distributed stand of native aquatic plants will remain following herbicide application.

- Local divers have agreed to continue to work with follow-up inspections and hand removal of the variable milfoil if any stems are missed or if there is re-growth in the lake. Benthic barriers may also be placed to control larger patches of infestation.

- The LWA already has an established group of Weed Watchers and Lake Hosts that are active. They will continue with their activities throughout the course of this project.

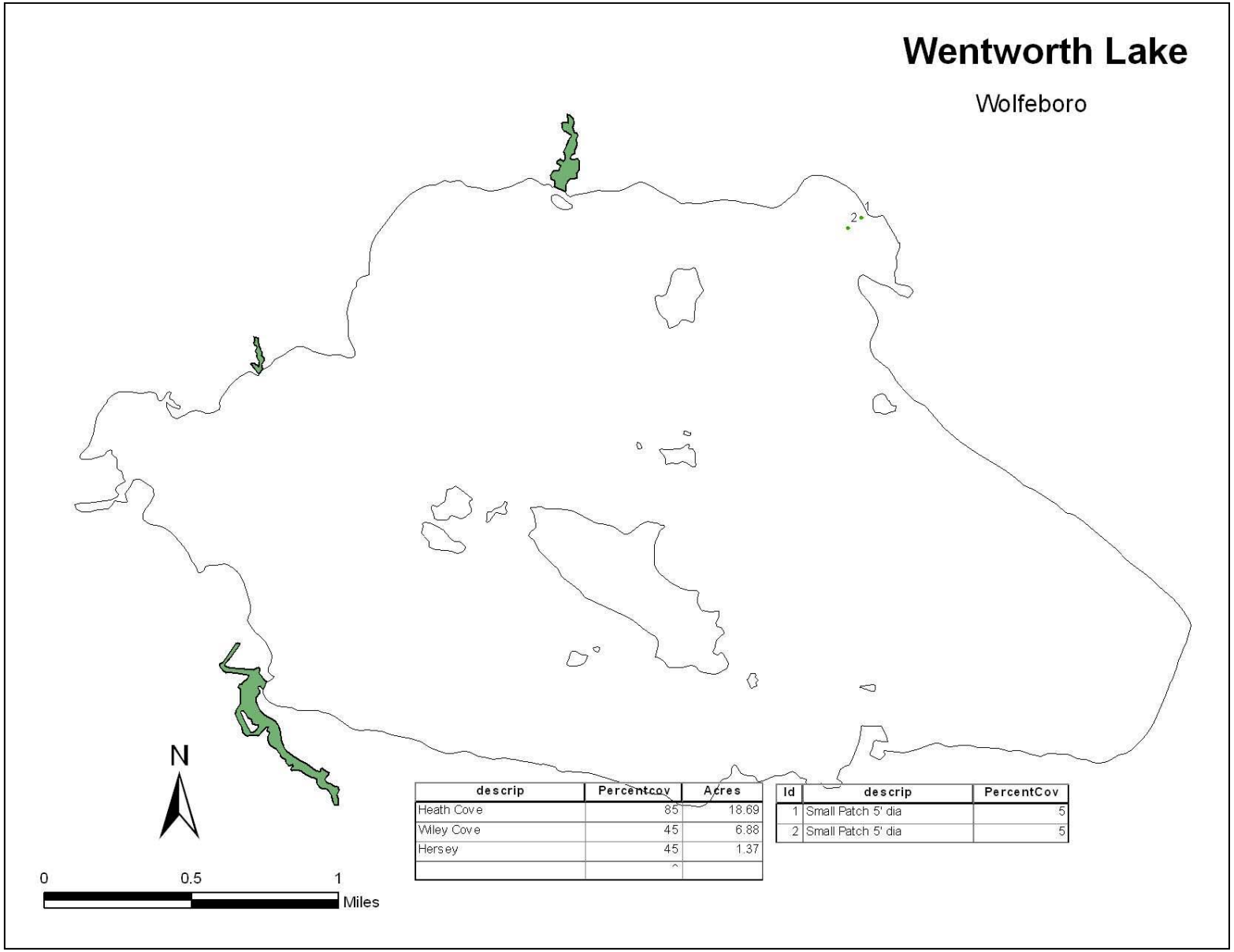
## RESULTS FROM 2007 TREATMENT

The 2007 herbicide treatment of Heath Brook resulted in a dramatic decrease of variable milfoil, from 85% cover to less than 10% cover. The original footprint of the milfoil was approximately 19 acres, and by the end of the 2007 growing season, the size of the infestation was less than half of that. A re-treatment is recommend in Heath Brook to ensure continued control of the milfoil. This was an established infestation in a highly silted area, which may result in more mature root crowns that need a second year of treatment to effectively control the plants. It is unlikely that the whole 19 acres of Heath Brook will require treatment in 2008, but in the event that there is substantial spring re-growth, we would like to be prepared with a permit to treat the whole area, if needed.

In terms of non-chemical control, DES biologists dove on Points 1 and 2 (Figure 1) and removed those in September 2007. In September and October 2007, DES divers and local divers controlled variable milfoil growths with hand-removal and benthic barrier placement in Hersey Brook, Willey Brook, and Clay Brook. The infestations in Willey Brook and Clay Brook are

more expansive at this point than divers can manage, and thus herbicides are recommended in 2008 to reduce the footprint of milfoil growth in these two areas (per the original recommendations of this plan in 2007).

**Figure 1- 2007 Map of Variable Milfoil Infestation**




| descrip | Percentcov | Acres |
|---|---|---|
| Heath Cove | 85 | 18.69 |
| Wiley Cove | 45 | 6.88 |
| Hersey | 45 | 1.37 |
| | | |

| Id | descrip | PercentCov |
|---|---|---|
| 1 | Small Patch 5' dia | 5 |
| 2 | Small Patch 5' dia | 5 |

**Figure 1-a- Map of Variable Milfoil Infestation (courtesy of Aquatic Control Technology, Inc., in cooperation with DES and the LWA).**

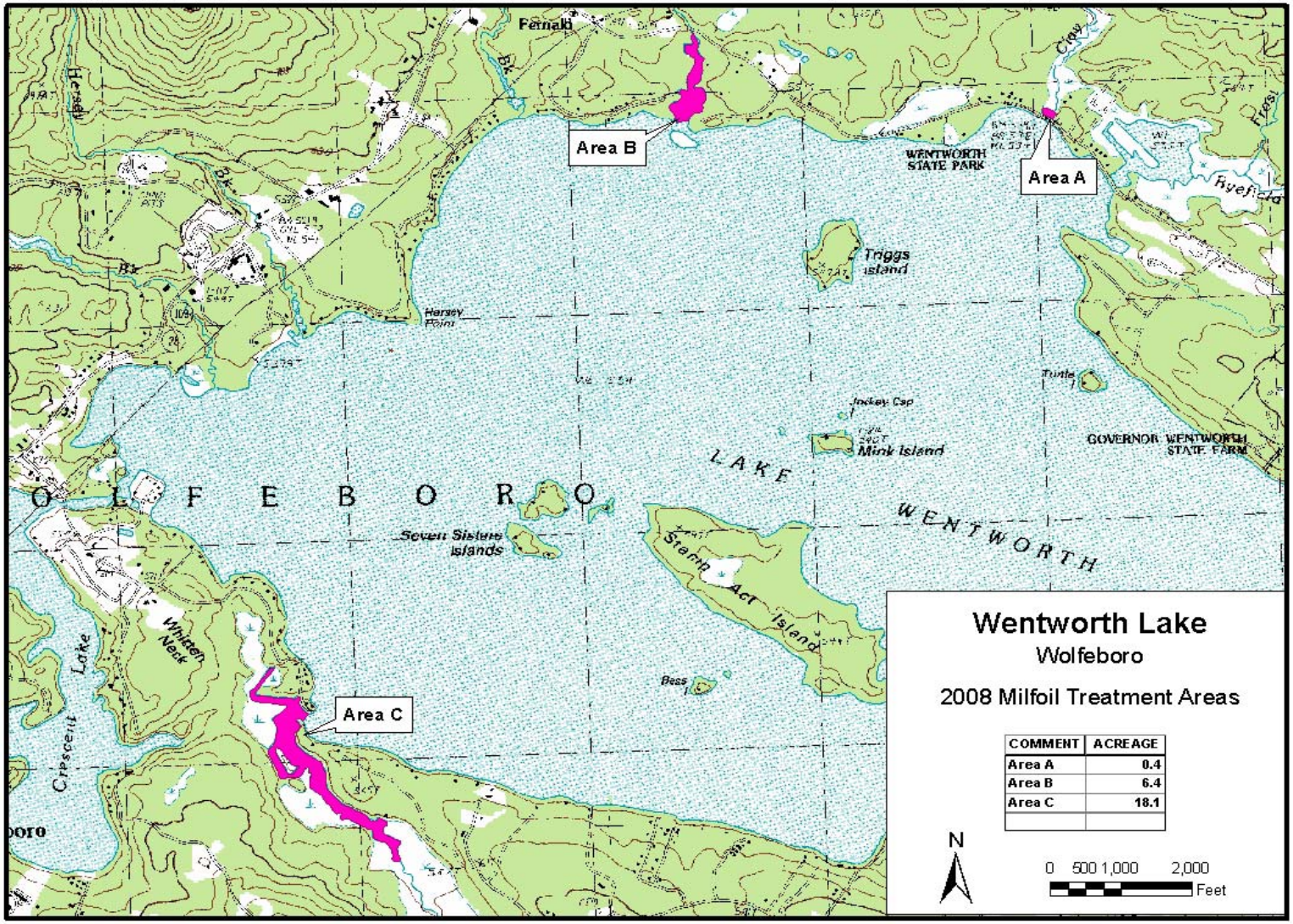
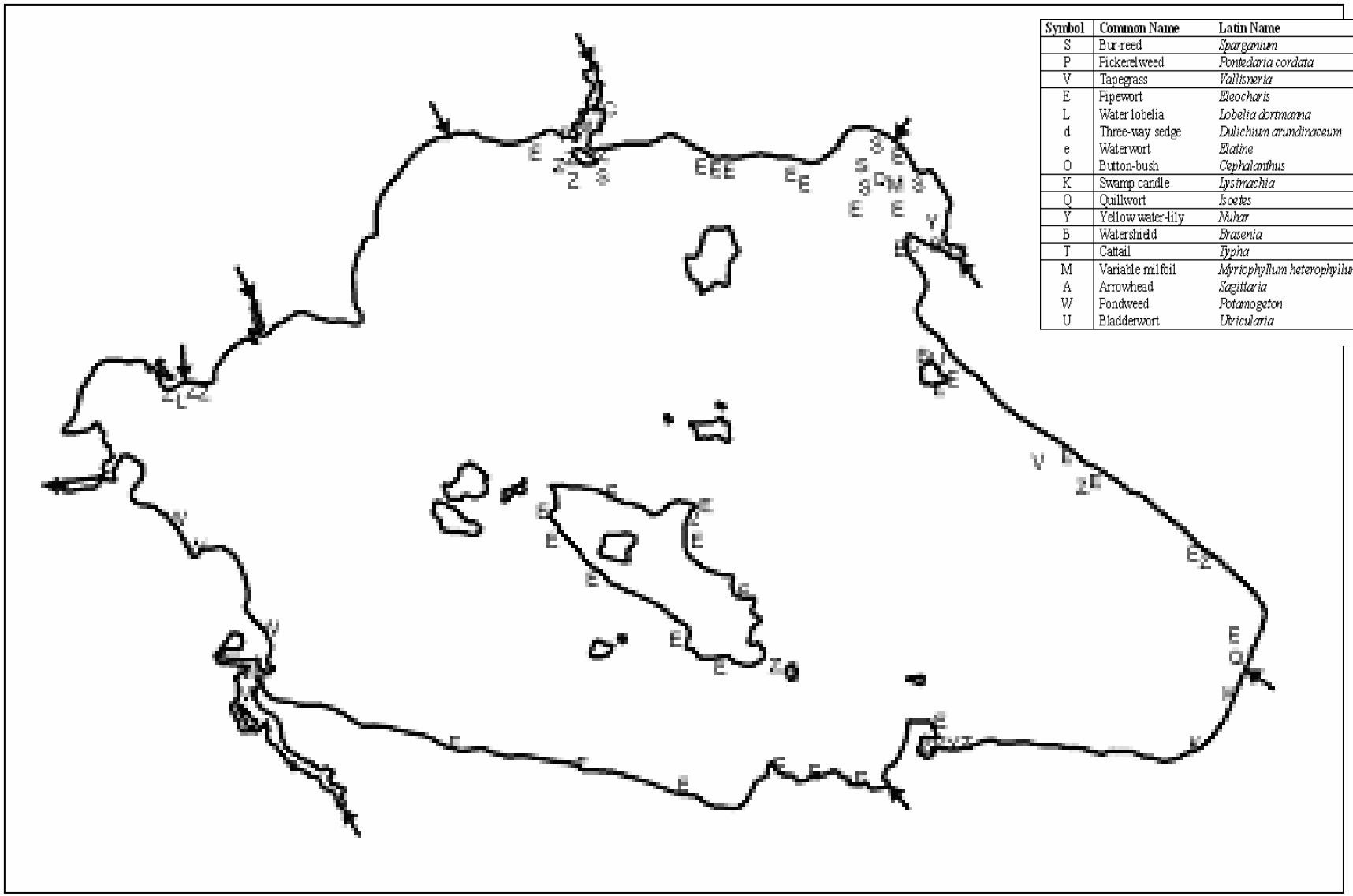


**Figure 2- Aquatic Vegetation Map and Key**



| Symbol | Common Name | Latin Name |
|---|---|---|
| S | Bur-reed | *Sparganium* |
| P | Pickerelweed | *Pontederia cordata* |
| V | Tapegrass | *Vallisneria* |
| E | Pipewort | *Eleocharis* |
| L | Water lobelia | *Lobelia dortmanna* |
| d | Three-way sedge | *Dulichium arundinaceum* |
| e | Waterwort | *Elatine* |
| O | Button-bush | *Cephalanthus* |
| K | Swamp candle | *Lysimachia* |
| Q | Quillwort | *Isoetes* |
| Y | Yellow water-lily | *Nuhar* |
| B | Watershield | *Brasenia* |
| T | Cattail | *Typha* |
| M | Variable milfoil | *Myriophyllum heterophyllum* |
| A | Arrowhead | *Sagittaria* |
| W | Pondweed | *Potamogeton* |
| U | Bladderwort | *Utricularia* |

**Figure 3- Bathymetric Map**

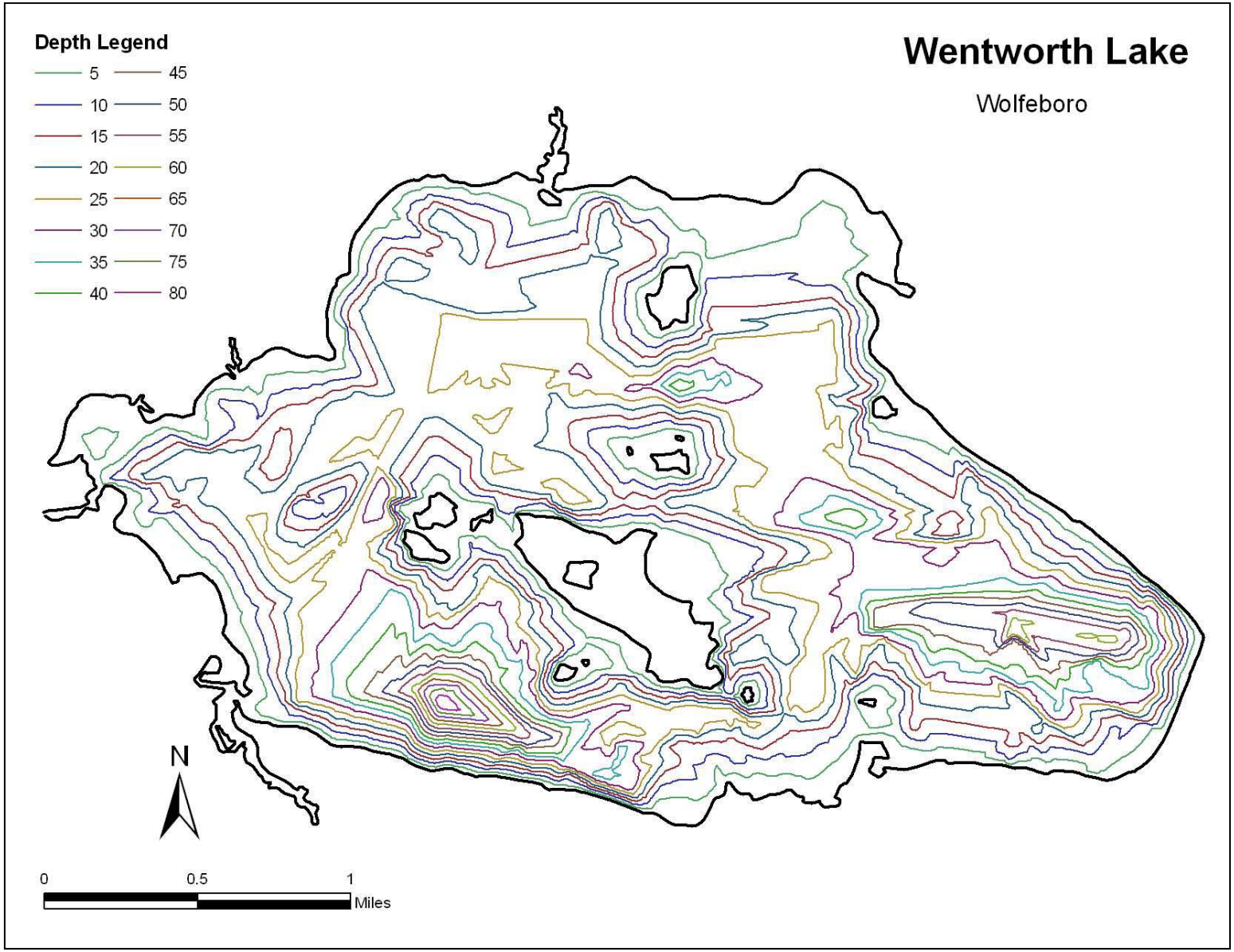


**Figure 4- Common Fishing Locations (based on knowledge of lake residents)**

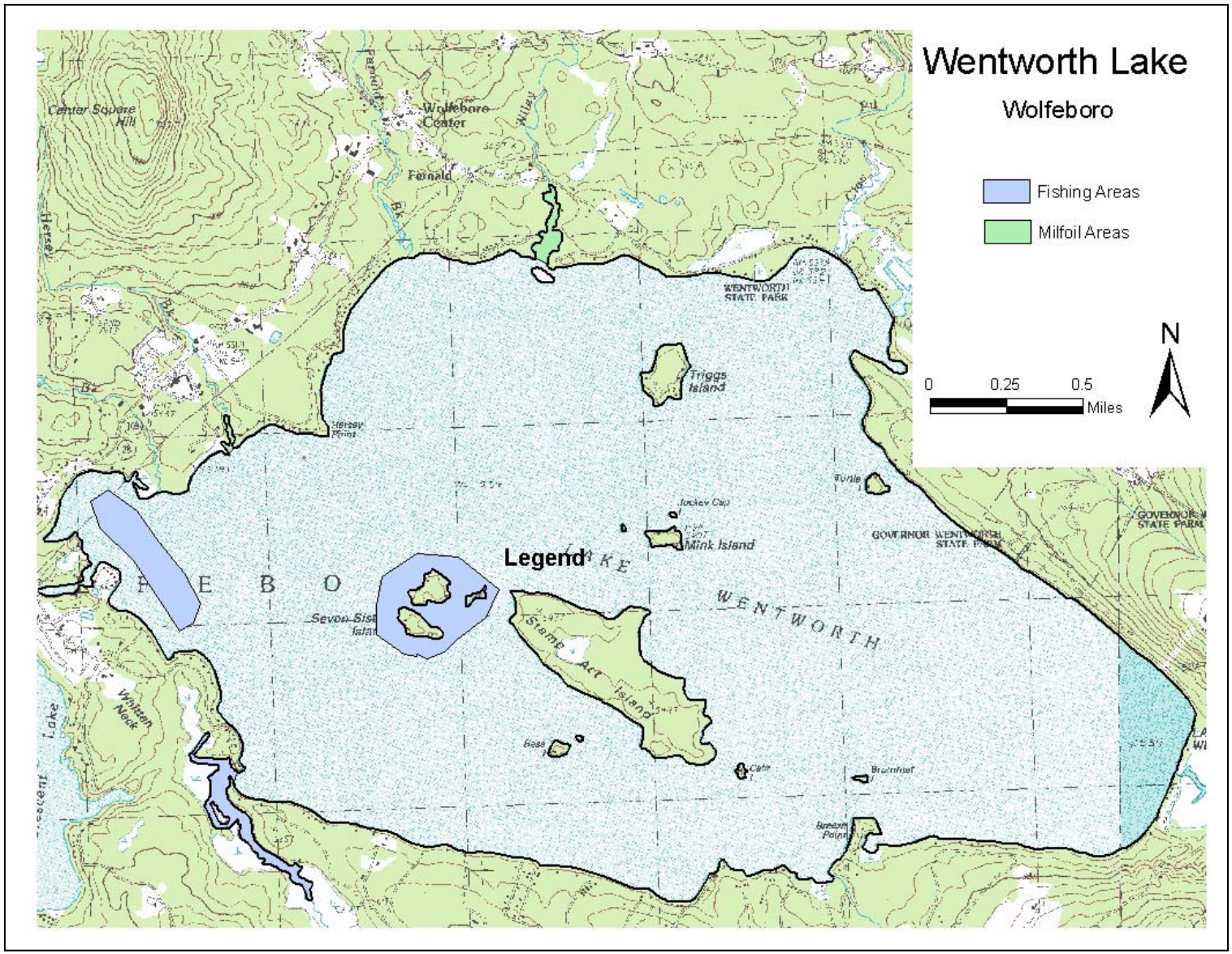


**Figure 5- Common Boating Lanes**

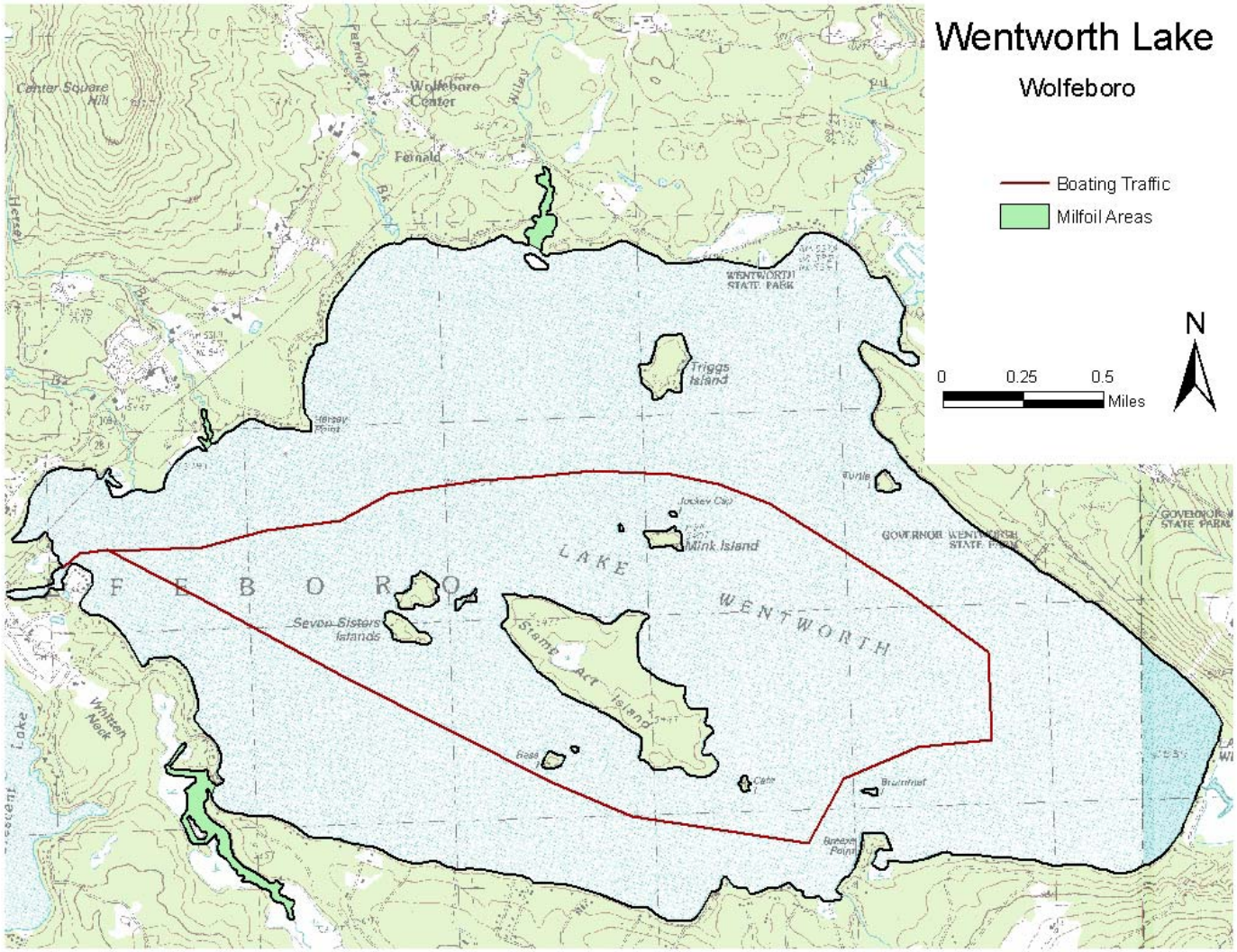


**Figure 6- Public Uses and Access Points**

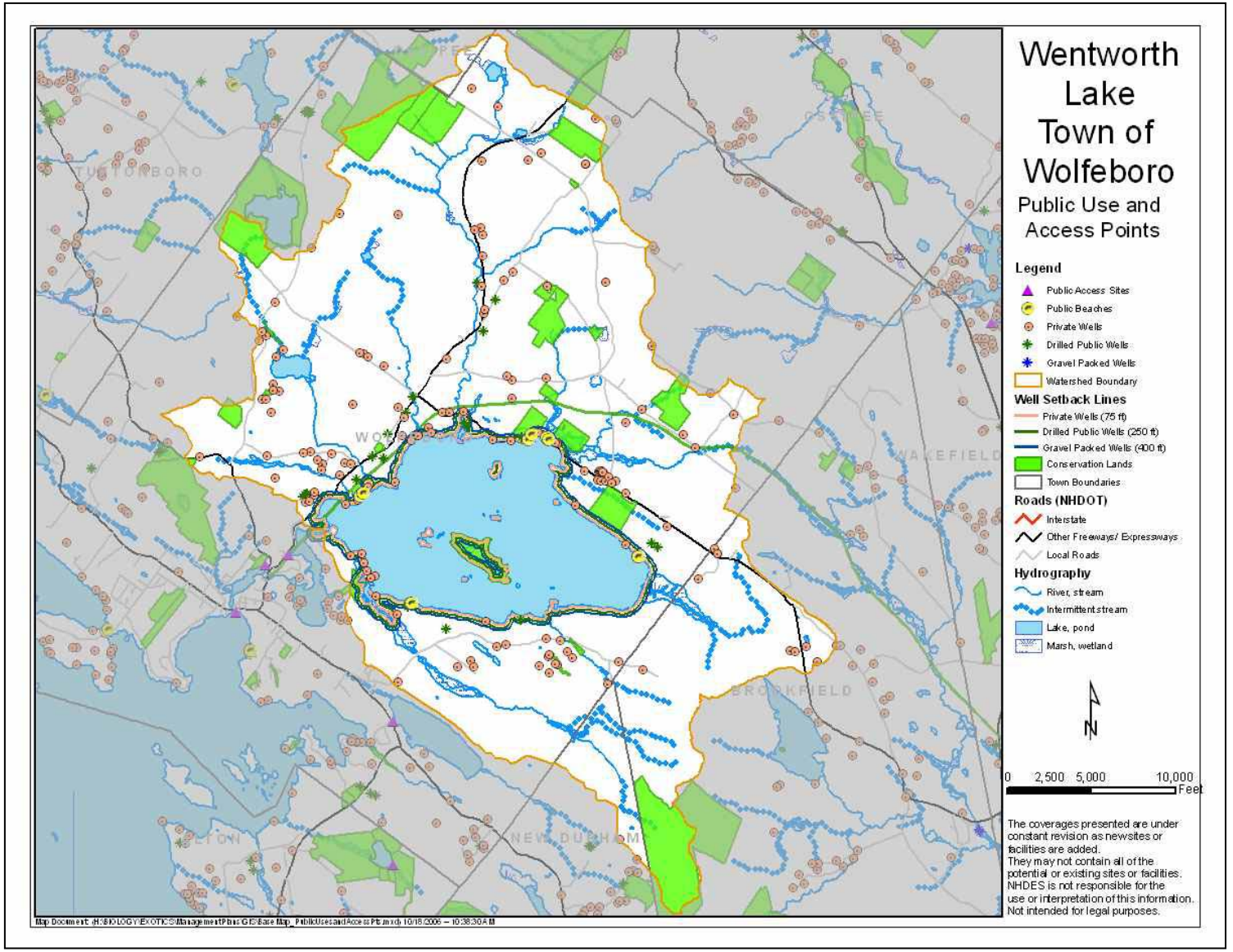
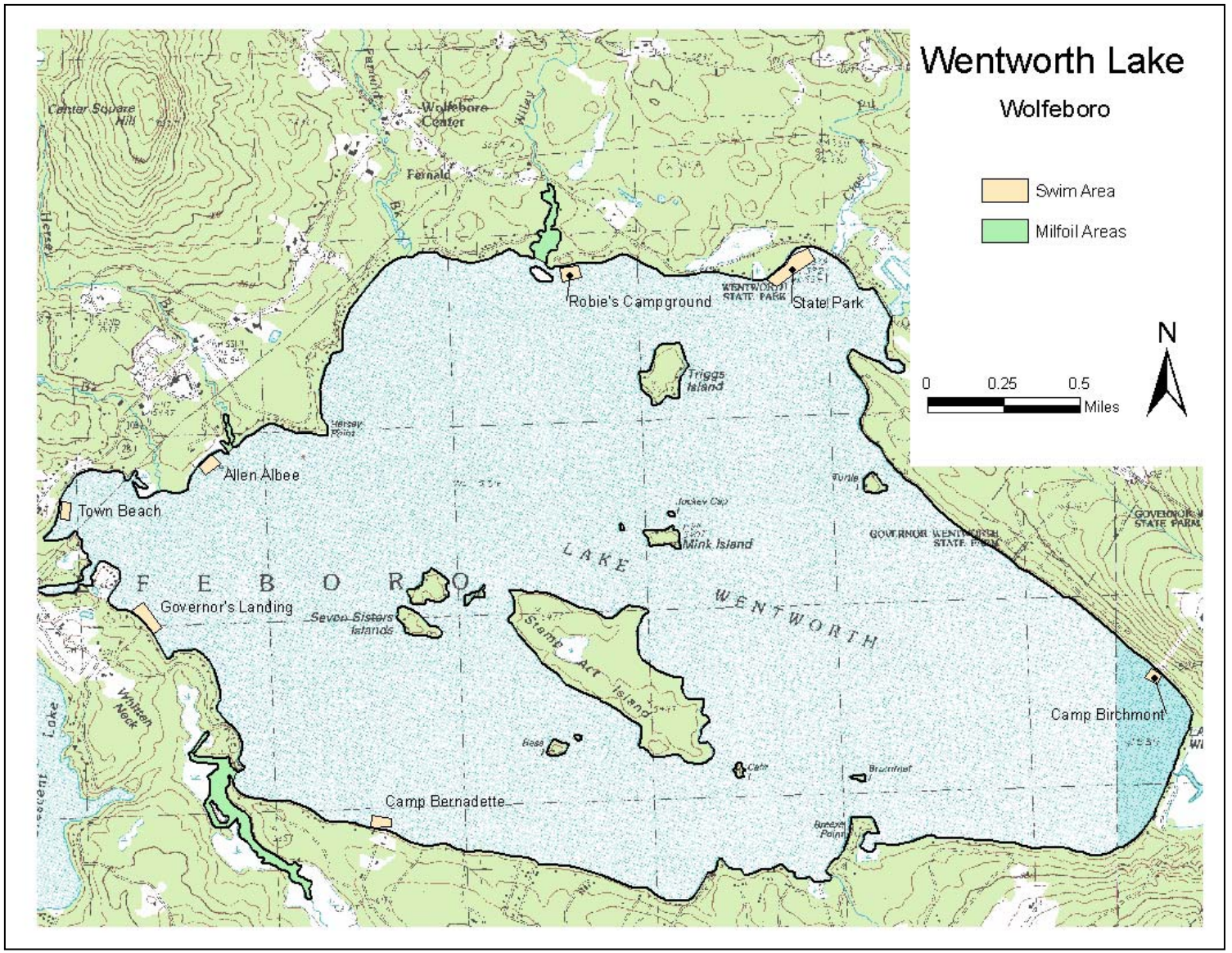


**Figure 7- Swim Areas**



**APPENDIX A**

**CRITERIA TO EVALUATE THE SELECTION OF AQUATIC PLANT CONTROL TECHNIQUES**

Preliminary Investigations

## I. Field Site Inspection

- Verify genus and species of the plant.
- Determine if the plant is a native or exotic species per RSA 487:16, II.
- Map extent of the plant infestation (area, water depth, height of the plant, density of the population).
- Document any native plant abundances and community structure around and dispersed within the exotic/nuisance plant population.

## II. Office/Laboratory Research of Waterbody Characteristics

- Contact the appropriate agencies to determine the presence of rare or endangered species in the waterbody or its prime wetlands.
- Determine the basic relevant limnological characteristics of the waterbody (size, bathymetry, flushing rate, nutrient levels, trophic status, and type and extent of adjacent wetlands).
- Determine the potential impacts to downstream waterbodies based on limnological characteristics (water chemistry, quantity, quality).

## Overall Control Options

For any given waterbody that has an infestation of exotic plants, one of three options will be selected, based on the status of the infestation, the available management options, and the technical knowledge of the DES Limnologists who have conducted the field work and who are preparing this plan. The options are as follows:

1) Eradication: Herbicide application targeted at exotic aquatic plant to be eradicated, to either eradicate the plant or to reduce overall biomass to a point where alternative non-chemical strategies may be used. This action will be followed by thorough annual monitoring for regrowth and the use of non-chemical actions to achieve the eradication.

2) Containment: The aim of this approach is to limit the size and extent of the existing infestation. An herbicide application may be used to reduce specified areas down to a percent cover of the exotic species so that it can be maintain or contained with alternative management strategies, including Restricted Use Areas, benthic barriers, and others. Subsequent herbicide applications may be necessary if the target species shows exponential growth and further spread.

3) No action. If the infestation is too large, spreading too quickly, and past management strategies have proven ineffective at controlling the target exotic aquatic plant, DES, in consultation with others, may elect to recommend 'no action' at a particular site. All efforts will instead be made towards containment of the target species to that specific waterbody, so that downstream migration of the plant can be prevented.

If eradication or control is the recommended option to pursue, the following series of control techniques may be employed. The most appropriate technique based on the determinations of the preliminary investigation will be selected.

Guidelines and requirements of each control practice are detailed below each alternative.

**A. Hand-Pulling**

- Can be used for exotic or native species.
- Can be used if infestation is in a small localized area (sparsely populated patch of up to 5' X 5', single stems, or dense small patch up to 2' X 2').
- Can be used if plant density is low, or if target plant is scattered and not dense.
- Can be used if the plant could effectively be managed or eradicated by hand-pulling a few scattered plants.
- Use must be in compliance with the Wetlands Bureau rules.

**B. Mechanically Harvest or Hydro-Rake**

- Can not be used on plants which reproduce vegetatively by fragmentation (e.g., milfoil, fanwort, etc.) unless containment can be ensured.
- Can be used only if the waterbody is accessible to machinery.
- Can be used if there is a disposal location available for harvested plant materials.
- Can be used if plant depth is conducive to harvesting capabilities (~ <7 ft. for mower, ~ <12 ft. for hydro-rake).
- Funds are available for repeated harvesting activities in that season.
- A navigation channel is required through dense plant growth.

**C. Chemical Treatment**

- Can be used if application of chemical is conducted in areas where alternative control techniques are not optimum due to depth, current, use, or type of plant.
- Can be used for treatment of exotic plants where fragmentation is a high concern.
- Can be used where species specific treatment is necessary due to the need to manage other plants (rare or endangered that will not be impacted by chemical treatment).
- Can be used if other methods used as first choices in the past have not been effective.
- A licensed applicator should be contacted to inspect the site and make recommendations about the effectiveness of chemical treatment as compared with

other treatments.

**D. Restricted Use Areas (per RSA 487:17, II (d))**

- Can be used for exotic species only.
- Can be established in an area that effectively restricts use to a small cove, bay, or other such area where navigation, fishing, and other activities may cause fragmentation to occur.
- Can not be used when there are several "patches" of an infestation of exotic aquatic plants throughout a waterbody.
- Can be used as a temporary means of control.

**E. Bottom Barrier**

- Can be used for exotic or native species.
- Can be used in small areas, preferably less than 10,000 sq. ft.
- Can be used in an area where the current is not likely to cause the displacement of the barrier.
- Can be used early in the season before the plant reaches the surface of the water.
- Can be used in an area to compress plants to allow for clear passage of boat traffic.
- Can be used in an area to compress plants to allow for a clear swimming area.

**F. Drawdown**

- Can be used if the target plant(s) are susceptible to drawdown control.
- Can be used in an area where bathymetry of the waterbody would be conducive to an adequate level of drawdown to control plant growth, but where extensive deep habits exist for the maintenance of aquatic life such as fish and amphibians.
- Can be used where plants are growing exclusively in shallow waters where a drawdown would leave this area "in the dry" for a suitable period of time (over winter months) to control plant growth.
- Can be used in winter months to avoid encroachment of terrestrial plants into the aquatic system.
- Can be used if it will not significantly impact adjacent or downstream wetland habitats.
- Can be used if spring recharge is sufficient to refill the lake in the spring.
- Can be used in an area where shallow wells would not be significantly impacted.
- Reference RSA211:11 with regards to drawdown statutes.

**G. Dredge**

- Can be used in conjunction with a scheduled drawdown.
- Can be used if a drawdown is not scheduled, though a hydraulic pumping dredge should be used.

- Can only be used as a last alternative due to the detrimental impacts to environmental and aesthetic values of the waterbody.

## H. Biological Control

- Grass carp cannot be used.
- Exotic controls, such as insects, cannot be introduced to control a nuisance plant.
- Research should be conducted on a potential biological control prior to use to determine the extent of host specificity.

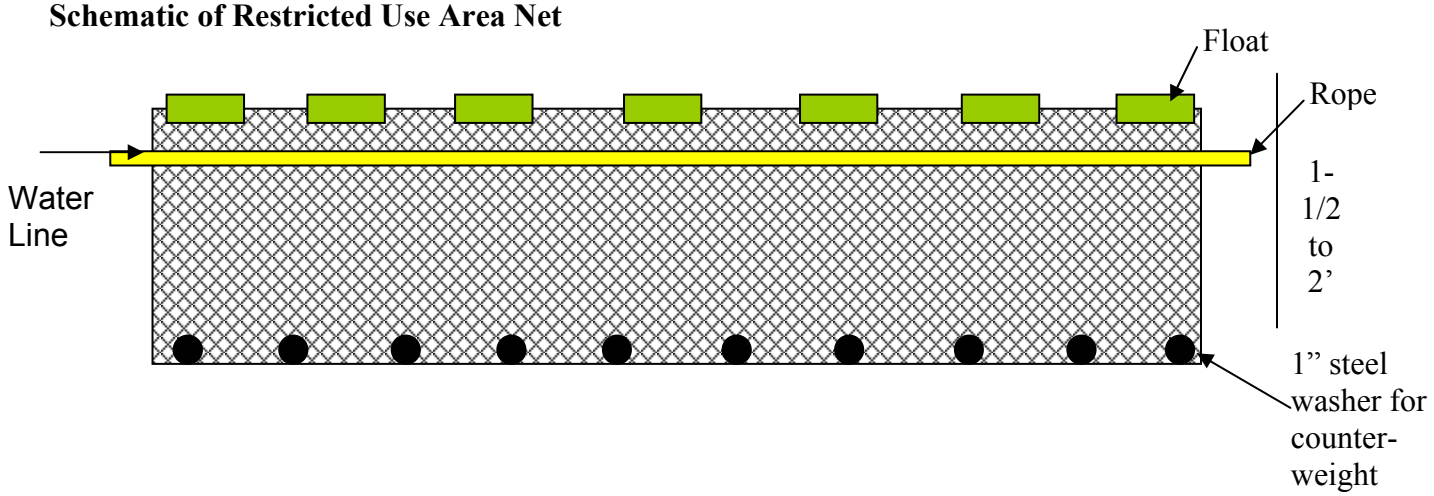
**APPENDIX B**

**SUMMARY OF CONTROL PRACTICES USED IN THE STATE OF NEW HAMPSHIRE FOR EXOTIC AQUATIC PLANTS**

**Restricted Use Areas:**

Restricted Use Areas (RUAs) are a regular control option for lakes with small, contained infestations of exotic plants, limited to small patches or embayments. This is often the case in waterbodies with newly-discovered infestations. RUAs restrict access to all recreational activities in a delineated area to minimize plant fragmentation and thereby reduce the spread of milfoil. As an additional method of protection from fragment migration, RUAs are encircled with a shallow net that is suspended vertically in the water column. The net is approximately 1.5-2.0 feet in height. The top of the net is set to extend four inches above the surface of the water, while the remainder is positioned below the surface of the water (see figure below). This configuration prevents the movement of fragments from infested areas to uninfested areas. Due to the size and nature of net construction, there is no impediment to fish migratory patterns or spawning activities.

**Schematic of Restricted Use Area Net**




**Hand-pulling:**

When infestations of exotic aquatic plants begin as single scattered stems or small patches, DES biologists SCUBA dive to hand-pull the plants (and DES can train other certified divers to also perform this management practice). Guidelines for determining feasibility and effective for hand-removal are site specific, but generally sparsely populated patches of up to 5' X 5', single stems, or dense small patch up to 2' X 2' are reasonable.

The whole plant including the roots should be removed in this process, while leaving the beneficial native species intact. This technique works best in softer sediments, with shallow rooted species and for smaller, scattered infestation areas. When hand pulling nuisance species, the entire root system and all fragments of the plants must be collected since small root or stem fragments could result in additional growth of the species. The process must be repeated often to control re-growth of the exotic plants. For a new infestation, hand-pulling activities are typically

conducted several times during the first season, with follow-up inspections for the next 2-5 years or until no re-growth is observed. This control practice has proven successful in many waterbodies.

**Mechanical Harvesting**

The process of mechanical harvesting is conducted by using machines which cut and collect aquatic plants. These machines can cut the plants up to twelve feet below the water surface. The weeds are cut and then collected by the harvester or other separate conveyer-belt driven device where they are stored in the harvester or barge, and then transferred to an upland site.

The advantages of this type of weed control are that cutting and harvesting immediately opens an area such as boat lanes, and it removes the upper portion of the plants. Due to the size of the equipment, mechanical harvesting is limited to water areas of sufficient size and depth. It is important to remember that mechanical harvesting can leave plant fragments in the water, which if not collected, may spread the plant to new areas. Additionally harvesters may impact fish and insect populations in the area by removing them in harvested material. Cutting plant stems too close to the bottom can result in re-suspension of bottom sediments and nutrients. This management option is only recommended when nearly the entire waterbody is infested, and harvesting is needed to open navigation channels through the infested areas.

**Benthic Barriers:**

When a small infestation of exotic aquatic plants occurs in clusters of growth (generally areas >5 $ft^2$), as opposed to scattered stems, a permeable fiberglass screen can be placed over the area of infested lake sediments. The permeable fabric screening allows for gas release from the sediments while effectively blocking sunlight and compressing the plants into the sediment, inhibiting photosynthesis and eventually killing the plant. Occasionally, in some lakes, gas release from the sediments or boating activity cause the uplifting of screening. Benthic barriers can effectively control small infestations of less than approximately 10,000 square feet.

Benthic barriers have two basic applications. These practices are used to cover pioneering infestations and prevent the spread of the plant. Bottom barriers are installed across small portions of lake bottoms infested with invasive aquatic plants. The disadvantage of benthic barriers is their non-selectivity and limitation of cover to less than 10,000 square feet. Additionally, these physical barriers prevent the growth of all vegetation, which is a necessary component of fish and wildlife habitat.

Bottom barriers are attached to the bottom of a water body by re-bar attached to the edges and across the middle of the material. Bottom barriers are transported to the shoreline adjacent to where installation is to occur. They are then cut to fit the treatment site and rolled onto a length of pipe. Divers carry the roll into the water at the start of the treatment site and secure one edge of the material to the lake bottom. The divers then roll out the remainder of the material and continue to secure it to the bottom sediments. This process is repeated until the plants in the treatment are covered.

Bottom barriers are generally considered for small localized areas rather than lakewide application. Bottom barriers provide 100% control of this weed in areas where they are installed. They also provide long-term control. An ongoing maintenance operation is required to inspect the bottom barrier and clear the mats of sediment buildup.

Benthic barriers are not recommended for application in river systems, as flow can easily uplift the barrier.

**Targeted Application of Herbicides:**

The use of chemicals, such as herbicides, for the control of noxious and nuisance plant species represents one of the most widely known and effective management options available. Herbicide control of invasive aquatic plants is often the first step in a long-term integrated control program. In the last 15 to 20 years the use and review of herbicides has changed significantly in order to accommodate safety, health, and environmental concerns. Currently no herbicide product can be labeled for aquatic use if it has more than a one in a million chance of causing significant harmful effects to human health, wildlife, or the environment. Because of this, the number of effective and U.S. Environmental Protection Agency (EPA) approved herbicides for aquatic weeds are limited. In most cases the cost and time of testing and registration, rather than environmental issues, limits the number of potentially effective compounds.

All herbicide applications in New Hampshire are performed under permits issued by the New Hampshire Department of Agriculture, Division of Markets and Food, Bureau of Pesticide Control.

Two herbicides have been used in New Hampshire for the control of milfoil. Diquat (trade name Reward), the most often-used herbicide, is a contact herbicide that can generally provide one season of control for milfoil. Because this herbicide does not target the root systems, the plants eventually re-grow from established roots.

The second herbicide, 2, 4-D (trade name Navigate or Aqua Kleen), is a systemic herbicide. It is absorbed into the sediments and taken up through the root system, killing both the roots and the plant biomass above the sediments. Label restrictions for aquatic application currently limit its use in New Hampshire to waterbodies with no water intakes, and with no wells adjacent to the shoreline.

The aquatic herbicide SONAR has been used in New Hampshire to control growths of fanwort. The chemical acts by limiting photosynthesis when chlorophyll-a is affected by the active ingredient of the herbicide.

**Extended Drawdown**

Water drawdown is used for control of some species of aquatic macrophytes. Drawdown requires some type of mechanism to lower water levels, such as dams or water control structures and use is thus limited. It is most effective when the drawdown depth exceeds the depth or invasion level of the target plant species.

In northern areas, drawdown will result in plant and root freezing during the winter for an added degree of control. Drawdown is typically inexpensive and has intermediate effects (2 or more years). However, drawdown can have other environmental effects and interfere with other functions of the water body (e.g. drinking water, recreation, or aesthetics). Drawdown can result in the rapid spread of highly opportunistic annual weed species, which in most cases is the plant that is targeted for control.

Drawdowns have been used in the past for plant control. In theory, the drying of the plants in the summer, or the freezing of the plants in the winter, will eliminate or limit plant growth. However, milfoil often forms a more succulent terrestrial form during drawdown conditions and the succulent form of the plant can remain viable for long periods of time without submergence, making the practice ineffective. This strategy can be used for control of some native plant species.

**Dredging**

Dredging is a means of physical removal of aquatic plants from the bottom sediments using a floating or land-based dredge. Dredging can create a variety of depth gradients creating multiple plant environments allowing for greater diversity in lakes plant, fish, and wildlife communities. However due to the cost, potential environmental effects, and the problem of sediment disposal, dredging is rarely used for control of aquatic vegetation alone.

Dredging can take place in to fashion, including drawdown followed by mechanical dredging using an excavator, or using a diver-operated suction dredge while the water level remains up.

**Biological Control**

There are no approved biological controls for submersed exotic aquatic plant at this time in New Hampshire.

## REFERENCES

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