Long-Term Variable Milfoil & Brittle Naiad Management Plan

Big Island Pond
Derry, New Hampshire

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Prepared by New Hampshire Department of Environmental Services

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Purpose

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

1. To identify and describe the historic and current exotic aquatic infestation(s) in the waterbody.
2. To identify short-term and long-term exotic aquatic plant control goals.
3. To minimize any adverse effects of exotic aquatic plant management strategies on non-target species.
4. To recommend exotic plant control actions that meet the goals outlined in this plan.
5. To evaluate control practices used in this waterbody over time to determine if they are meeting the goals outlined in this plan.

This plan also summarizes the current physical, biological, ecological and chemical components of the subject waterbody as they may relate to both the exotic plant infestation and recommended control actions, and the potential social, recreational and ecological impacts of the exotic plant infestation.

The intent of this plan is to establish an adaptive management strategy for the long-term control of the target species (in this case variable milfoil) in the subject waterbody, using an integrated plant management approach.

Appendix A and Appendix B detail the general best management practices and strategies available for waterbodies with exotic species, and provide more information on each of the activities that are recommended within this plan.

Invasive Aquatic Plant Overview

Exotic aquatic plants pose a threat to the ecological, aesthetic, recreational, and economic values of lakes and ponds (Luken & Thieret, 1997, Halstead, 2000), primarily by forming dense growths or monocultures in critical areas of waterbodies that are important for aquatic habitat. Dense growths and near monotypic stands of invasive aquatic plants can grow under some circumstances, having the potential to reduce overall species diversity in both plant and animal species, and can alter water chemistry and aquatic habitat structure that is native to the system.

Since January 1, 1998, the sale, distribution, importation, propagation, transportation, and introduction of key exotic aquatic plants have been

prohibited (RSA 487:16-a) in New Hampshire. This law was designed as a tool for lake managers to help prevent the spread of nuisance aquatic plants.

New Hampshire lists 27 exotic aquatic plant species as prohibited in the state (per Env-Wq 1303.02) due to their documented and potential threat to surface waters of the state.

According to the federal 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 New Hampshire regulation Env-Wq 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" (NHDES, 2006). In fact, waterbodies that contain even a single exotic aquatic plant do not attain water quality standards and are listed as impaired.

Aquatic Invasive Plant Infestations in Big Island Pond

Big Island Pond has had a long history with fanwort (*Cabomba caroliniana*), an invasive aquatic plant, which dates back to the 1960s. Fanwort is widespread throughout the pond, and maintains a fairly consistent footprint from year to year, with plants reaching lengths of roughly 4-7 feet, but often not topping out and matting at the surface.

Variable milfoil (*Myriophyllum heterophyllum*) became established in Big Island Pond in 2003. In 2003, the variable milfoil was sparse and scattered as single stems or small patches in the northeastern end of the pond. In 2003 and 2004, NHDES divers conducted numerous site visits to perform hand-pulling activities in the area, but due to the density of fanwort, it was difficult to systematically remove the variable milfoil stems from the area. Since that time, variable milfoil has spread to various locations around the lake, albeit in low densities, and has been managed by contract divers.

During the summer of 2020, spiny naiad (*Najas minor*) was confirmed in Big Island Pond, first in Blueberry Cove, and then in other locations around the lake. Spiny naiad is locally abundant in some coves, and sparse in others. At this point in time, it is hard to determine what impacts three aquatic invasive species will have on this system, particularly since fanwort is so widespread in the system, and has been for decades. Figure 1 illustrates the distribution of variable milfoil in this waterbody over time, as well as

pioneering locations of spiny naiad. Fanwort is not shown on this map, and can be assumed to form a ring around much of the lake, to depths of approximately 10 feet.

Exotic Aquatic Plant Management Goals and Objectives

The goal for Big Island Pond is the reduction of overall biomass and distribution of aquatic invasive species in the system, with the goal of containing and minimizing both variable milfoil and Spiny naiad, to prevent further spread.

Eradication of any one of these species is unlikely in this system, due to its size and the three different invasive plants growing in the system. It will take consistent commitment using appropriate integrated plant management strategies to contain and reduce growth.

Local Support

Town or Municipality Support
Unknown/TBD.

Lake Resident Support
Big Island Pond has a large and very active lake association. They maintain a network of Weed Watchers to look for and mark areas of aquatic invasive plant growth, and have trained some lake residents to serve as divers to help control some of the variable milfoil growth in the pond in the past. The lake association is also committed to performing follow-up monitoring for aquatic invasive plant growth, and working with NHDES to coordinate strategic control actions for targeted species. In addition to invasive species monitoring, the lake association is active in water quality monitoring and watershed monitoring.

Waterbody Characteristics

The following table summarizes basic physical and biological characteristics of Big Island Pond, including the milfoil infestation. Note that a current review of the Natural Heritage Bureau (NHB) database was requested and the results from that search are included in the table below, as well as in other relevant sections of this plan. Note that additional species and natural communities are included from historic reviews, and they may not appear in the current NHB review.

Table 1: Waterbody Characteristics

Pond area (acres)	497.9

Shoreline Uses (residential, forested, agriculture)	Residential, forested
Max Depth (m)	24.4
Mean Depth (m)	5.4
Trophic Status	Eutrophic
Flushing Rate (yr^{-1})	8.3
Color (CPU) in Epilimnion	42
pH	7.5
Clarity (m)	5
Lake type /Raised by Damming/Other	Natural with dam
Sediment type in infested area (sand/silt/organic/rock)	Sandy, rocky, silty
Rare, Threatened, or Endangered Species in Waterbody (based on current and historic NHB reviews)	**2026 Review:** Blanding's Turtle (*Emydoidea blandingii*) Common Loon (*Gavia immer*) Spotted Turtle (*Clemmys guttata*) Black gum-red maple swamp basin **Historical Reviews:** Eastern Pond Mussel (*Ligumia nasuta*) American Eel (*Anguilla rostrata*) Eastern Box Turtle (*Terrapene carolina carolina*) Wood Turtle (*Glyptemys insculpta*) Goshawk (north of lake) Lake whitefish (in Big Island Pond)

A native aquatic vegetation map and key from the NHDES Biology Section is shown in Figure 8. A bathymetric map is shown in Figure 9.

Beneficial (Designated) Uses of Waterbody

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

Of these, Aquatic Life, Wildlife and Recreation are the ones most often affected by the presence of invasive plants, though drinking water supplies can also be affected in a number of ways.

The following is a general discussion of the most potentially impacted designated uses, including water supplies and near shore wells, as they relate to this system and the actions proposed in this long-term plan.

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.

Aquatic Life

Fisheries Information

Big Island Pond in Derry is managed as both a warmwater and coldwater fishery, including populations of eastern brook trout, rainbow trout, brown trout, smallmouth bass, largemouth bass, eastern chain pickerel, brown bullhead, white perch, black crappie and bluegill.

Wildlife Information

The Natural Heritage Bureau's (NHB) 2025 review lists the Blanding's turtle (*Emydoidea blandingii*), the common loon (*Gavia immer*), the Wood Turtle (*Glyptemys insculpta*), and the Eastern Box Turtle (*Terrapene carolina carolina*) as concerns.

Blanding's turtles are listed as state endangered. They are primarily aquatic, preferring habitats like marshes, vegetated ponds, swamps, and vernal pools. When it is particularly hot in the summer, Blanding's turtles become relatively inactive. During this time, they may be resting in the bottoms of marshes, lakes, or ponds. They nest on land, but feed underwater on insects, tadpoles, crayfish, and snails, among other small aquatic organisms.

The common loon is listed as state threatened. They nest on lakes that are larger than 16 acres and smaller than 60 acres that have clear water, small islands, and an irregular shoreline that creates coves. Common loons typically build their nest on the shorelines of small islands and floating bog mats. Shallow water coves are important for chick rearing as it provides suitable prey and protection from wind and large waves. They mate in the spring and leave their lakes in the beginning of September. The common loon is sensitive to human disturbance, and the primary threat to this species is loss of habitat.

The wood turtle (*Glyptemys insculpta*) is not federally listed, but it is listed as a species of special concern in NH. According to information provided in the Wildlife Action Plan (WAP) prepared by the Fish and Game Department, wood turtles are often associated with stream and river habitat with sandy or gravely substrates in late April and May, and then migrate to upland terrestrial habitats for the summer months, returning to hibernate in the fall in the banks of rivers again. The wood turtle's diet consists of insects, earthworms, green leaves and fungi, among other items. Main threats to this

species appear to be from habitat loss and fragmentation, along with injury and mortality due to land use practices (mowing, mortality on roadways). The Fish and Game Department should comment on specific potential impacts of the proposed milfoil control activities on this species, and ways to mitigate these impacts during their review of the permit application.

The Eastern Box Turtle (*Terrapene carolina carolina*) is listed as state endangered. According to information provided by the Fish and Game Department, eastern box turtles can be found in dry and moist woodlands, old fields, pastures, power-line corridors, as well as on the edges of marshes, bogs, and shallow streams. In hot weather, they may rest in the water or burrow underneath logs and moist vegetation. During summers, they excavate their nests in loose, loamy soil in open areas such as hayfields, pastures, or roadsides, and hibernate under soil, decaying vegetation, or in mammal burrows. The primary threats to this species are habitat loss and fragmentation, road mortality, as well as collection for pets.

Historic NHB reviews for this site showed a record of lake whitefish (*Coregonus clupeaformis*) in Big Island Pond. This fish is listed as rare or uncommon in the state, but is not otherwise listed as threatened or endangered in the state or nationally. Global distribution of the species appears to be demonstrably widespread, abundant, and secure according to NHB records. The lake whitefish is a reclusive fish that tends to spend most of its time in the deeper and colder waters of lakes. The whitefish does come into shallower waters to spawn in early winter. Spawning habitat is generally shallow rocky or sandy areas in waters that are less than 25 feet in depth. The young of the year fish spend time in shallow waters early on, then migrate deeper as they mature. Lake whitefish feed on small organisms due to a small mouth size. Prey includes small fish in the water column, and benthic organisms such as insects. Based on the habitat types and habits of this fish, there are no anticipated impacts as a result of the proposed herbicide treatment. The treatment is set to take place in the shallow, silty north end of the lake. Small fish species and benthic organisms are not expected to be impacted by the treatment, and abundant habitat is present throughout other parts of Big Island Pond so that this fish species, as well as others, can seek refuge as needed.

Other wildlife species that were historically listed as concerns by NHB include the Eastern pond mussel (*Ligumia nasuta*), American eel (*Anguilla rostrata*), spotted turtle (*Clemmys guttata*), and the Northern goshawk (*Accipiter gentiles*).

Eastern pond mussels are listed as state threatened. They inhabit the find sands and soft sediments of ponds, lakes, and low velocity streams and rivers. Eastern pond mussels feed on the phytoplankton, bacteria, fine particulate matter, and dissolved oxygen that is suspended in the waterbody. In order to reproduce, the larvae attach onto a host species (typically a fish) to complete their development.

American eels are listed as near threatened in the state. This species can be found in almost any freshwater habitat that can be accessed from the ocean, but they reach their largest sizes and abundance in lakes, ponds, and large rivers. The American eel is active at night and feeds on worms, small fish, and crustaceans. In October, they migrate to the Sargasso Sea to spawn. After the young are hatched, the current brings them back to the coast, where they swim upstream to their destinations.

Spotted turtles are listed as state threatened. They need large and diverse habitats with a range of wetland types. They are generally intolerant of disturbance; however, eggs are laid in open canopied upland areas in early spring, usually in areas of human alteration (yards, etc). Threats include human impacts (rapid development, roads, traffic) and habitat change.

Northern goshawks are listed as uncommon in the state, but it is not listed as threatened or endangered by the state or federal government. The goshawk typically nests in mature softwood and mixed forests with dense canopies and open forest floors, likely because prey is accessible. Prey includes squirrels, game birds, corvids, rabbits and hares. Threats to northern goshawks include habitat fragmentation due to human disturbance. Based on the habitat and diet of this species, it is not expected that treatment will affect the northern goshawk.

Recreational Uses and Access Points

Big Island Pond is used for numerous recreational activities, including boating, fishing, swimming, and water skiing, among others, by both pond residents and visitors from the campground on the pond.

In terms of boat access, the BIPC maintains a boat launch on the southwestern side of the pond, however access to this launch is limited by a gate. Small motor boats, as well as kayaks and canoes can use this facility. While this boat ramp is owned by the BIPC, it is used as a public access for 12 state-sponsored fishing tournaments per year. There is secure parking for up to 18 vehicles with trailers. The public can have access to a boat launch key

for a nominal fee for the purpose of fishing. There is another private boat launch area at the campground at the northern end of the lake. This launch is occasionally used for fishing tournaments, and the access is controlled by the campground and is generally restricted to campers. There are also at least three 'neighborhood' boat launches with access by 40 to 80 households each around the lake, and the recently renovated canoe launch in Atkinson now has parking for 5-6 vehicles.

There are generally 60 powerboats in use on a normal weekday, and 150-200 motorboats in use on weekend days, according to lake residents. There are also about 20-30 non-motorized watercraft on the pond at a given time.

There are seven designated beaches on the pond which are associated with the campground or towns. 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.*

Macrophyte Community Evaluation

The littoral zone is defined as the nearshore areas of a waterbody where sunlight penetrates to the bottom sediments. The littoral zone is typically the zone of rooted macrophyte growth in a waterbody.

The littoral zone of Big Island Pond is characterized by a mix of native and non-native (variable milfoil and fanwort) plant growth (Figure 8).

Native species include a mix of floating plants (white lily, yellow water-lily, watershield), emergent plants (pickerelweed, spike rush, sedges, rushes, arrowhead, cattail, grassy arrowhead,), and submergent plants (bur-reed, grassy spike rush, various pondweed species, clasping-leaf pondweed, four

bladderwort species, waterweed, quillwort, native milfoil, coontail, water marigold, water naiad). Native plant communities are mixed around the entire lake and are characterized as 'common' by the DES, though growth in some of the coves approaches an abundant rating.

In addition to variable milfoil and brittle naiad as invasive non-native plants, fanwort is also present in the pond.

There are no records of state threatened or endangered plant species within the lake basin; however, a black gum (*Nyssa sylvatica*)-red maple basin swamp is located north of the lake according to an NHB review. The trees are in the nearshore area in the back (shoreward) edge of a wetland complex which is adjacent to the north end of Big Island Pond. It is not expected that the proposed treatment in the lake will have any effect at all on these tree species.

Wells and Water Supplies

The location of wells, water supplies, well-head protection areas, and drinking water protection areas around Big Island Pond are not included here. Visit the NHDES OneStop Data Mapper to access public water supply data and download additional datasets.

In the event that an herbicide treatment is needed for this waterbody, the applicator/contractor will provide more detailed information on the wells and water supplies within proximity to the treatment areas as required in the permit application process with the Division of Pesticide Control at the Department of Agriculture. It is beyond the scope of this plan to maintain updated well and water supply information.

Historical Control Activities

Table 2: Sequence of exotic plant control actions, 2020-2025.

Management Actions	Date	Location	Acres Treated (ac)/ Gallons Removed (gal)	Contractor
DASH	6/10/2020	Various	10 gallons	AB Aquatics
DASH	6/12/2020	Various	70 gallons	AB Aquatics
DASH	6/16/2020	Various	40 gallons	AB Aquatics
DASH	6/17/2020	Various	30 gallons	AB Aquatics
DASH	6/18/2020	Various	20 gallons	AB Aquatics

Management Actions	Date	Location	Acres Treated (ac)/ Gallons Removed (gal)	Contractor
DASH	6/19/2020	Various	20 gallons	AB Aquatics
DASH	6/22/2020	Various	20 gallons	AB Aquatics
DASH	6/23/2020	Various	15 gallons	AB Aquatics
DASH	6/25/2020	Various	10 gallons	AB Aquatics
DASH	6/26/2020	Various	15 gallons	AB Aquatics
DASH	6/30/2020	Various	20 gallons	AB Aquatics
DASH	8/10/2020	Various	15 gallons	AB Aquatics
DASH	8/11/2020	Various	12 gallons	AB Aquatics
DASH	8/12/2020	Various	40 gallons	AB Aquatics
DASH	8/13/2020	Various	64 gallons	AB Aquatics
DASH	8/14/2020	Various	22 gallons	AB Aquatics
DASH	8/18/2020	Various	30 gallons	AB Aquatics
DASH	8/19/2020	Various	30 gallons	AB Aquatics
DASH	8/20/2020	Various	10 gallons	AB Aquatics
DASH	8/21/2020	Various	40 gallons	AB Aquatics
DASH	10/13/2020	Various	40 gallons	AB Aquatics
DASH	10/14/2020	Various	40 gallons	AB Aquatics
DASH	10/15/2020	Various	20 gallons	AB Aquatics
DASH	10/20/2020	Various	20 gallons	AB Aquatics
Herbicide treatment	8/9/2021	Various	45.3 acres	SOLitude Lake Management
DASH	9/28/2021	Various	1 gallons	AE Commercial Diving Services
DASH	9/29/2021	Various	1 gallons	AE Commercial Diving Services

Management Actions	Date	Location	Acres Treated (ac)/ Gallons Removed (gal)	Contractor
DASH	9/30/2021	Various	5 gallons	AE Commercial Diving Services
DASH	10/1/2021	Various	20 gallons	AE Commercial Diving Services
DASH	10/4/2021	Various	10 gallons	AE Commercial Diving Services
DASH	10/5/2021	Various	10 gallons	AE Commercial Diving Services
DASH	10/6/2021	Various	8 gallons	AE Commercial Diving Services
DASH	10/7/2021	Various	5 gallons	AE Commercial Diving Services
DASH	10/8/2021	Various	1 gallons	AE Commercial Diving Services
DASH/diving	7/12/2023	Various	90 gallons	Aqualogic
DASH/diving	7/13/2023	Various	60 gallons	Aqualogic
DASH/diving	7/14/2023	Various	90 gallons	Aqualogic
Dash/Diving	7/17/2023	Various	75 gallons	Aqualogic
DASH/diving	7/18/2023	Various	75 gallons	Aqualogic
DASH/diving	7/19/2023	Various	60 gallons	Aqualogic
DASH/diving	7/20/2023	Various	105 gallons	Aqualogic
DASH/diving	7/21/2023	Various	75 gallons	Aqualogic
DASH/diving	7/24/2023	Various	80 gallons	Aqualogic
DASH/diving	7/25/2023	Various	70 gallons	Aqualogic
DASH/diving	7/26/2023	Various	110 gallons	Aqualogic
DASH/diving	7/27/2023	Various	75 gallons	Aqualogic
DASH/diving	7/28/2023	Various	60 gallons	Aqualogic

Management Actions	Date	Location	Acres Treated (ac)/ Gallons Removed (gal)	Contractor
DASH/diving	7/31/2023	Various	40 gallons	Aqualogic
DASH/diving	8/1/2023	Various	97.5 gallons	Aqualogic
DASH/diving	8/2/2023	Various	105 gallons	Aqualogic
DASH/diving	8/3/2023	Various	60 gallons	Aqualogic
Herbicide treatment	8/4/2023	Various	31 acres	SOLitude Lake Management
DASH/diving	8/4/2023	Various	45 gallons	Aqualogic
DASH/diving	8/7/2023	Various	75 gallons	Aqualogic
DASH/diving	8/8/2023	Various	30 gallons	Aqualogic
DASH/diving	8/9/2023	Various	60 gallons	Aqualogic
DASH/diving	8/10/2023	Various	90 gallons	Aqualogic
DASH/diving	8/11/2023	Various	60 gallons	Aqualogic
DASH/diving	7/22/2024	Various	60 gallons	Aqualogic
DASH/diving	7/23/2024	Various	40 gallons	Aqualogic
DASH/diving	7/24/2024	Various	45 gallons	Aqualogic
DASH/diving	7/25/2024	Various	30 gallons	Aqualogic
DASH/diving	7/26/2024	Various	45 gallons	Aqualogic
DASH/diving	7/29/2024	Various	30 gallons	Aqualogic
DASH/diving	7/30/2024	Various	15 gallons	Aqualogic
DASH/diving	7/31/2024	Various	45 gallons	Aqualogic
DASH/diving	8/1/2024	Various	30 gallons	Aqualogic
DASH/diving	8/2/2024	Various	15 gallons	Aqualogic
Herbicide treatment	8/5/2024	Various	13.47 acres	SOLitude Lake Management
DASH/diving	8/5/2024	Various	5 gallons	Aqualogic

Management Actions	Date	Location	Acres Treated (ac)/ Gallons Removed (gal)	Contractor
DASH/diving	8/6/2024	Various	10 gallons	Aqualogic
DASH/diving	8/7/2024	Various	10 gallons	Aqualogic
DASH/diving	8/8/2024	Various	15 gallons	Aqualogic
DASH/diving	8/9/2024	Various	15 gallons	Aqualogic
DASH/diving	8/12/2024	Various	15 gallons	Aqualogic
DASH/diving	8/13/2024	Various	60 gallons	Aqualogic
DASH/diving	8/14/2024	Various	30 gallons	Aqualogic
DASH/diving	8/15/2024	Various	30 gallons	Aqualogic
DASH/diving	8/16/2024	Various	30 gallons	Aqualogic
Hand pull/diving	8/23/2024	Various	55 gallons	Diver for Hire and LTD Diving
Hand pull/diving	8/29/2024	Various	58 gallons	Diver for Hire and LTD Diving
Hand pull/diving	8/30/2024	Various	55 gallons	Diver for Hire and LTD Diving
Hand pull/diving	9/9/2024	Various	21 gallons	Diver for Hire and LTD Diving
Hand pull/diving	7/31/2025	Various	33.5 gallons	Aqualogic
Hand pull/diving	8/1/2025	Various	26 gallons	Aqualogic
Hand pull/diving	8/4/2025	Various	31 gallons	Aqualogic
Hand pull/diving	7/21/2025	Various	105 gallons	Aqualogic
Hand pull/diving	7/23/2025	Various	10 gallons	Aqualogic
Hand pull/diving	7/24/2025	Various	60 gallons	Aqualogic
Hand pull/diving	7/25/2025	Various	80 gallons	Aqualogic
Hand pull/diving	7/28/2025	Various	60 gallons	Aqualogic
Hand pull/diving	7/29/2025	Various	90 gallons	Aqualogic

Management Actions	Date	Location	Acres Treated (ac)/ Gallons Removed (gal)	Contractor
Hand pull/diving	7/30/2025	Various	60 gallons	Aqualogic
Hand pull/diving	7/31/2025	Various	10 gallons	Aqualogic
Herbicide treatment	8/11/2025	Various	25.8 acres	SOLitude Lake Management

Aquatic Invasive Plant Management Options

The control practices used should be as specific to the target species 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 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).

Criteria for the selection of control techniques are presented in Appendix A. Appendix B includes a summary of the exotic aquatic plant control practices currently used by the State of New Hampshire.

Feasibility Evaluation of Control Options in this Waterbody

NHDES has evaluated the feasibility of potential control practices on Big Island Pond.

Table 3: NHDES control strategy recommendations for Big Island Pond.

Control Method	Use on Big Island Pond
Restricted Use Areas (RUAs) and/or Fragment Barriers	Challenging due to the large amount of boating traffic and the need for ease of ingress and egress for residents within the aquatic invasive plant infested areas. Multiple areas would need to be erected and maintained.
Hand-pulling/Diver Assisted Suction Harvesting	Recommended that the individual stems or small patches of variable milfoil and brittle naiad be hand pulled when encountered, particularly following herbicide treatment. Diver Assisted Suction Harvesting is recommended for larger patches of target aquatic invasive plants, as feasible and reasonable.

Control Method	Use on Big Island Pond
Mechanical Harvesting/Removal	Not recommended due to generation of fragments and subsequent spread of variable milfoil and brittle naiad.
Benthic Barriers	Recommended where feasible in areas of re-growth if small patches of variable milfoil and fanwort re-grow and can adequately be contained by benthic barriers. We do not recommend installing benthic barriers throughout the lake.
Herbicides	An herbicide treatment is recommended to reduce the overall biomass of Spiny naiad, as this is new to the lake and containment and management is critical to reduce further spread. Variable milfoil growth could be managed chemically if densities reach levels where diver removal is impractical. Fanwort treatment would require nearly lakewide treatment, for likely long (2-3 month) exposure times. Widespread fanwort growth is not recommended at this time.
Extended Drawdown	Drawdown is not an effective control method for control of the aquatic invasive plants in Big Island Pond. Big Island Pond does annual deep drawdowns that expose large areas of shallows in the lake. These species are not controlled by drawdown/exposure.
Dredge	Cost prohibitive and not target specific.
Biological Control	There are no biological controls that are approved for these species at this time.
No Control	The future expansion of these aquatic invasive plants is likely if no management is performed. Fanwort is already widespread and covering much of the likely available habitat. Both variable milfoil and Spiny naiad have the capacity to continue to expand in coming years, if no control occurs, or if inadequate controls are implemented.

Recommended Actions, Timeframes and Responsible Parties

An evaluation of the size, location, and type of variable milfoil infestation, as well as the waterbody uses was conducted at the end of the last growing season (see attached figures for findings). Based on this survey the following recommendations are made for variable milfoil and brittle naiad control in the system:

Table 4: Summary of Control Action Plans, 2024-2029

Year	Action	Responsible Party	Schedule
2024	Weed Watching and reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Herbicide treatment as shown in Figure 5	SOLitude Lake Management	June
	Dive/DASH work as needed and recommended	Contract divers	June through September
	Survey waterbody and planning for next season's control actions	NHDES	September
2025	Weed Watching and reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Herbicide treatment as shown in Figure 6	SOLitude Lake Management	July
	Dive/DASH work as needed and recommended	Contract divers	June through September
	Survey waterbody and planning for next season's control actions	NHDES	September
2026	Weed Watching and reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Herbicide treatment as shown in Figure 7	SOLitude Lake Management	June
	Dive/DASH work as needed and recommended	Contract divers	June through September
	Survey and planning for next season's control actions	NHDES	September
2027	Weed Watching and reporting of milfoil growth	Local Weed Watchers	Once a month from May through September
	Dive/DASH work as needed and recommended	Contract divers	June through September
	Survey and planning for next season's control actions	NHDES	September
2028	Weed Watching and reporting of milfoil growth	Local Weed Watchers	Once a month from May through September

Year	Action	Responsible Party	Schedule
	Dive/DASH work as needed and recommended	Contract divers	June through September
	Survey and planning for next season's control actions	NHDES	September
2029	Update and revise Long-Term Variable Milfoil Control Plan	NHDES and interested parties	Fall/ Winter

Notes

Target Specificity

It is important to realize that aquatic herbicide applications are conducted in a specific and scientific manner. To the extent feasible, the permitting authority favors the use of selective herbicides that, where used appropriately, will control the target plant with little or no impact to non-target species, such that the ecological functions of native plants for habitat, lake ecology, and chemistry/biology will be maintained. *Not all aquatic plants will be impacted as a result of an herbicide treatment.*

Adaptive Management

Because this is a natural system that is being evaluated for management, it is impossible to accurately predict a management course over five years that could be heavily dependent on uncontrolled natural circumstances (weather patterns, temperature, adaptability of invasive species, etc).

This long-term plan is therefore based on the concept of adaptive management, where current field data drive decision making, which may result in modifications to the recommended control actions and timeframes for control. As such, this management plan should be considered a dynamic document that is geared to the actual field conditions that present themselves in this waterbody.

If circumstances arise that require the modification of part or all of the recommendations herein, interested parties will be consulted for their input on revisions that may be needed to further the goal of variable milfoil and brittle naiad management in the subject waterbody.

Maps of Variable Milfoil Infestations

Figure 1: Map of exotic aquatic plant infestations over time, 2014-2025.

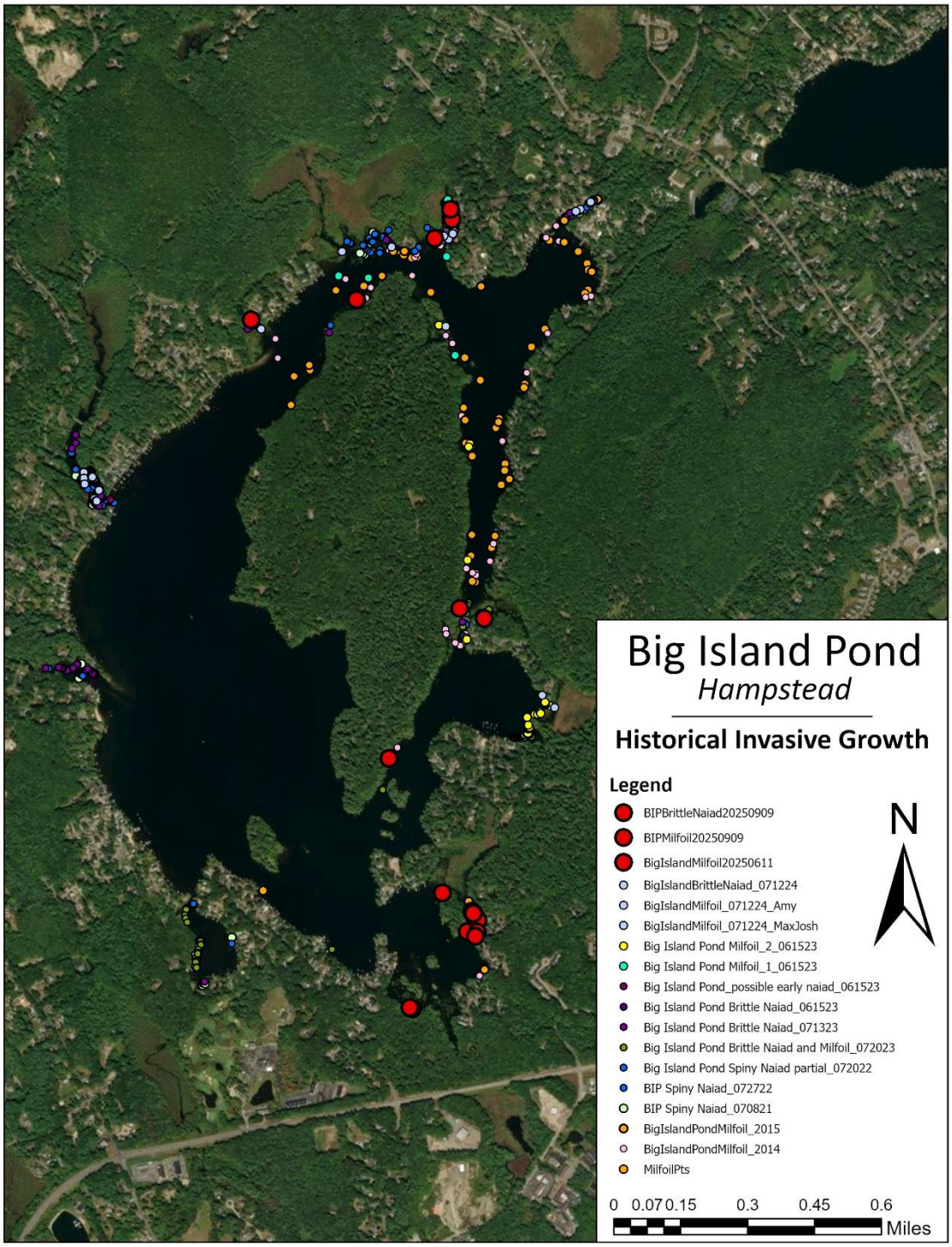


Figure 2: 2021 Treatment Areas

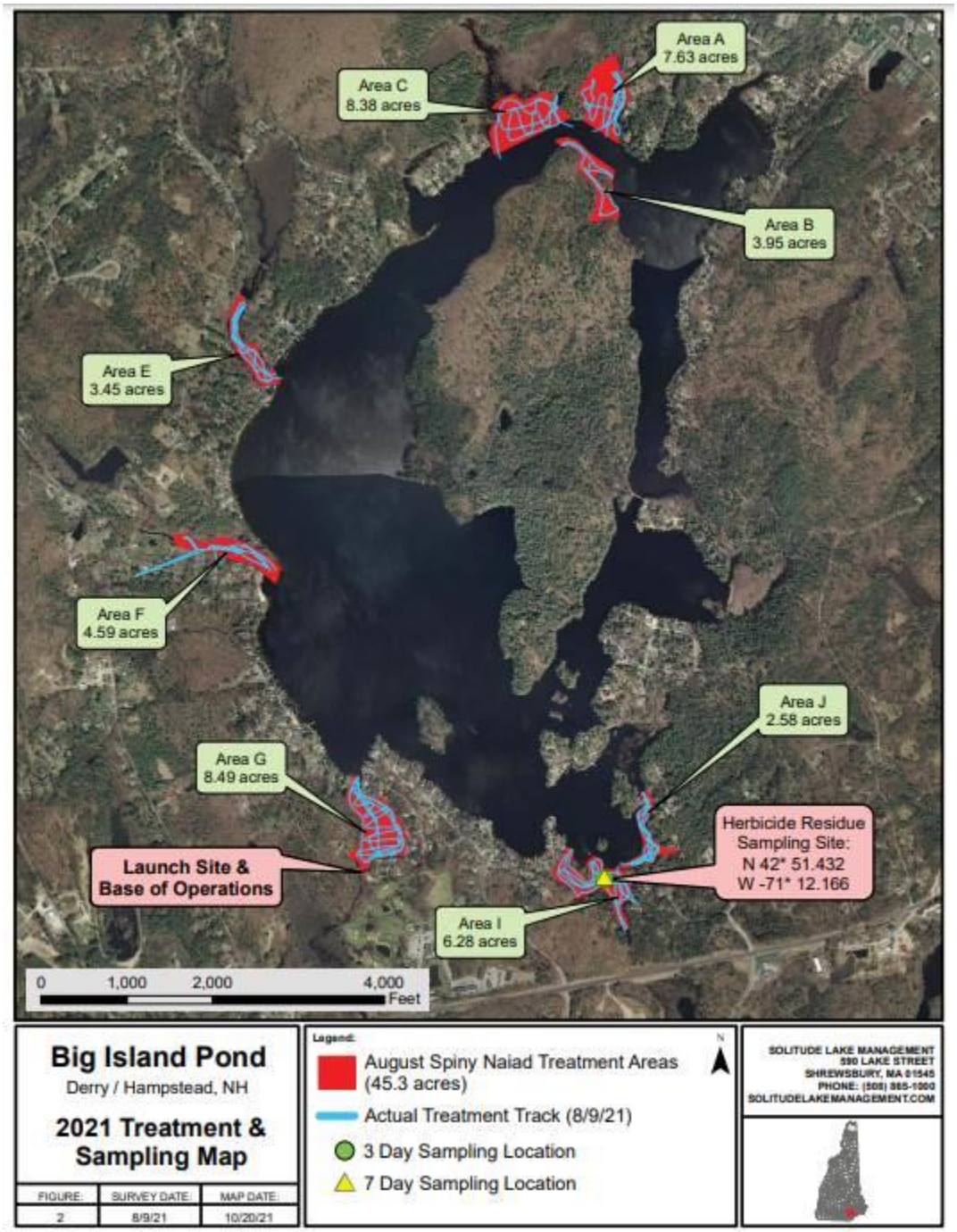


Figure 3: 2022 Diving Areas

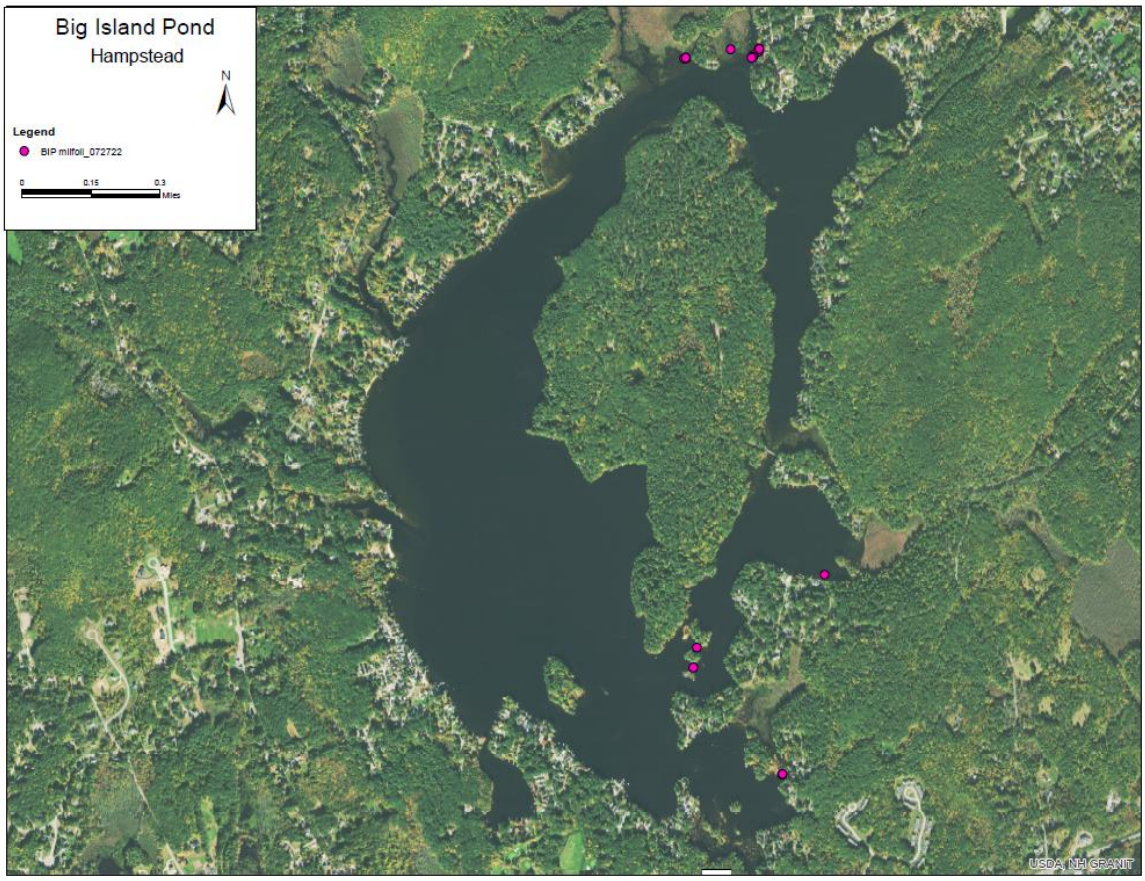


Figure 4: 2023 Treatment Areas

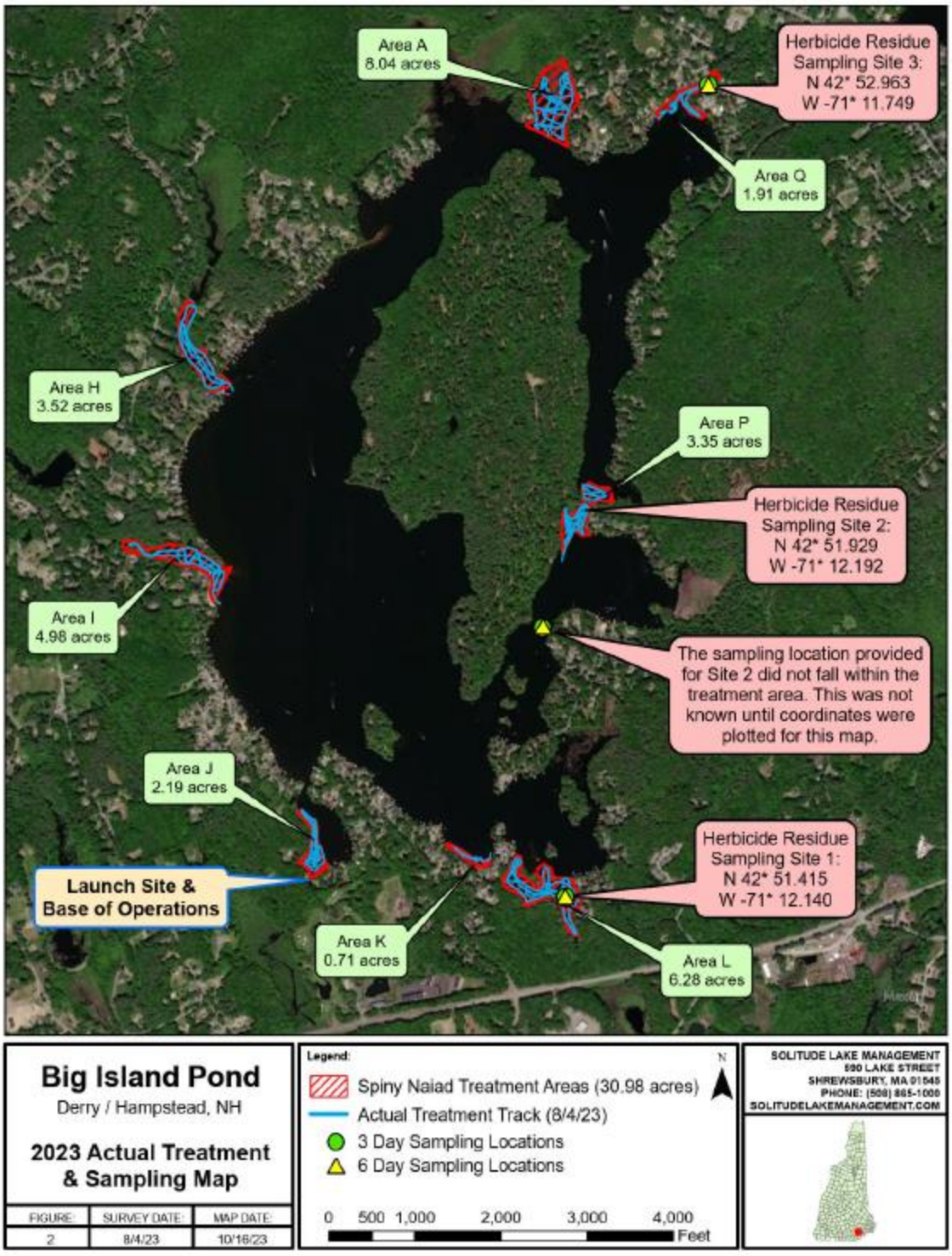


Figure 5: 2024 Treatment Areas

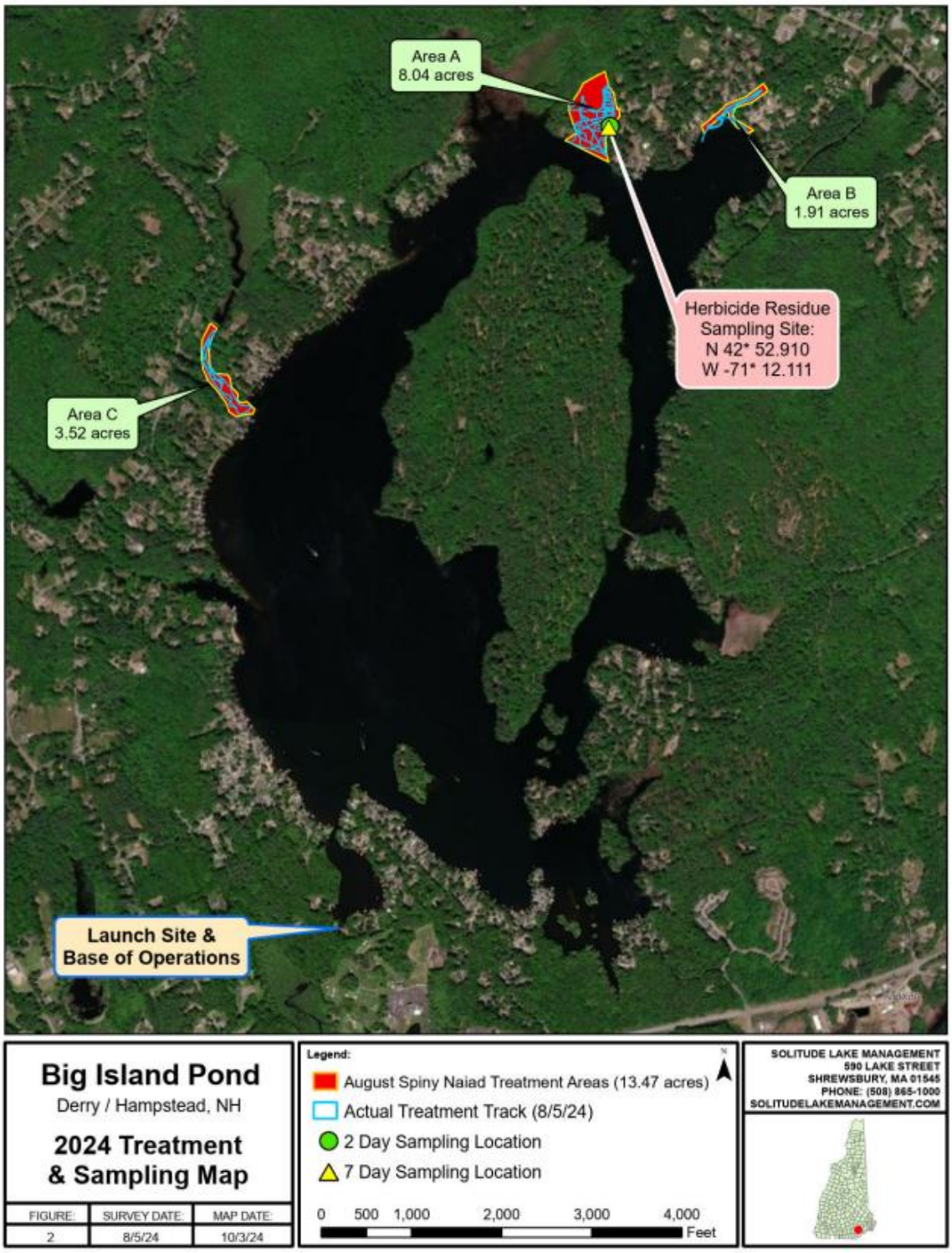


Figure 6: 2025 Treatment Areas

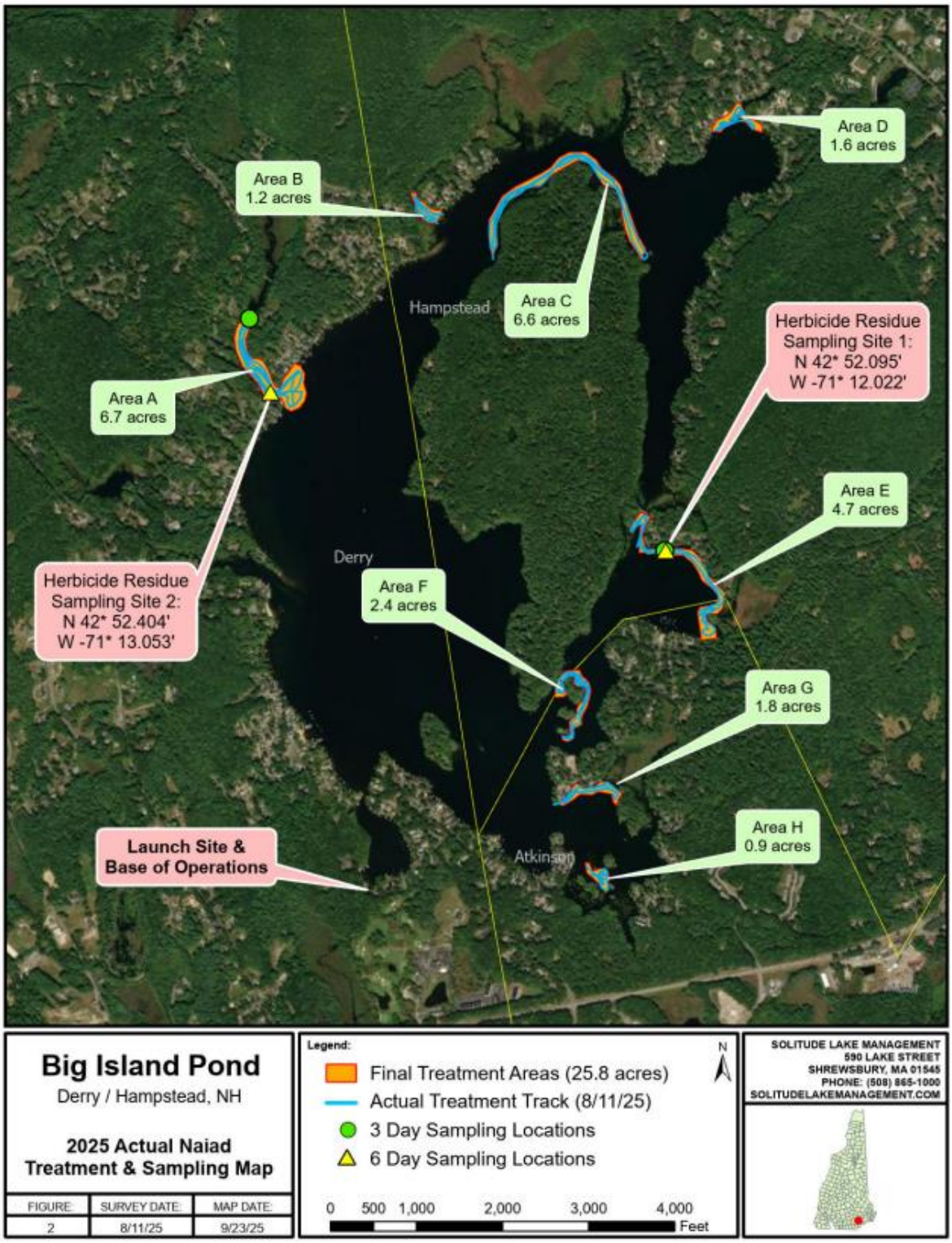
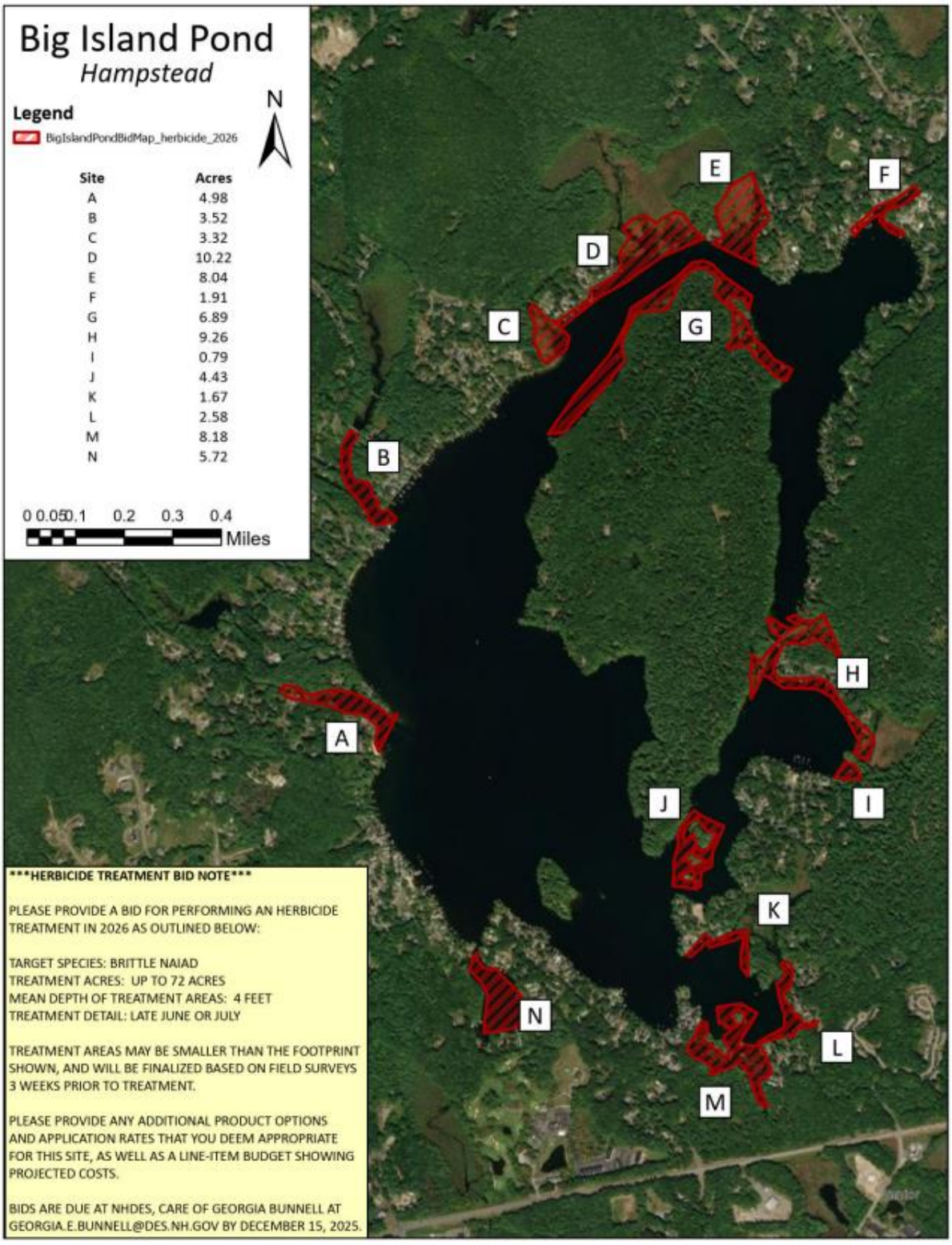


Figure 7: 2026 Proposed Treatment Areas



Map of Native Aquatic Macrophytes

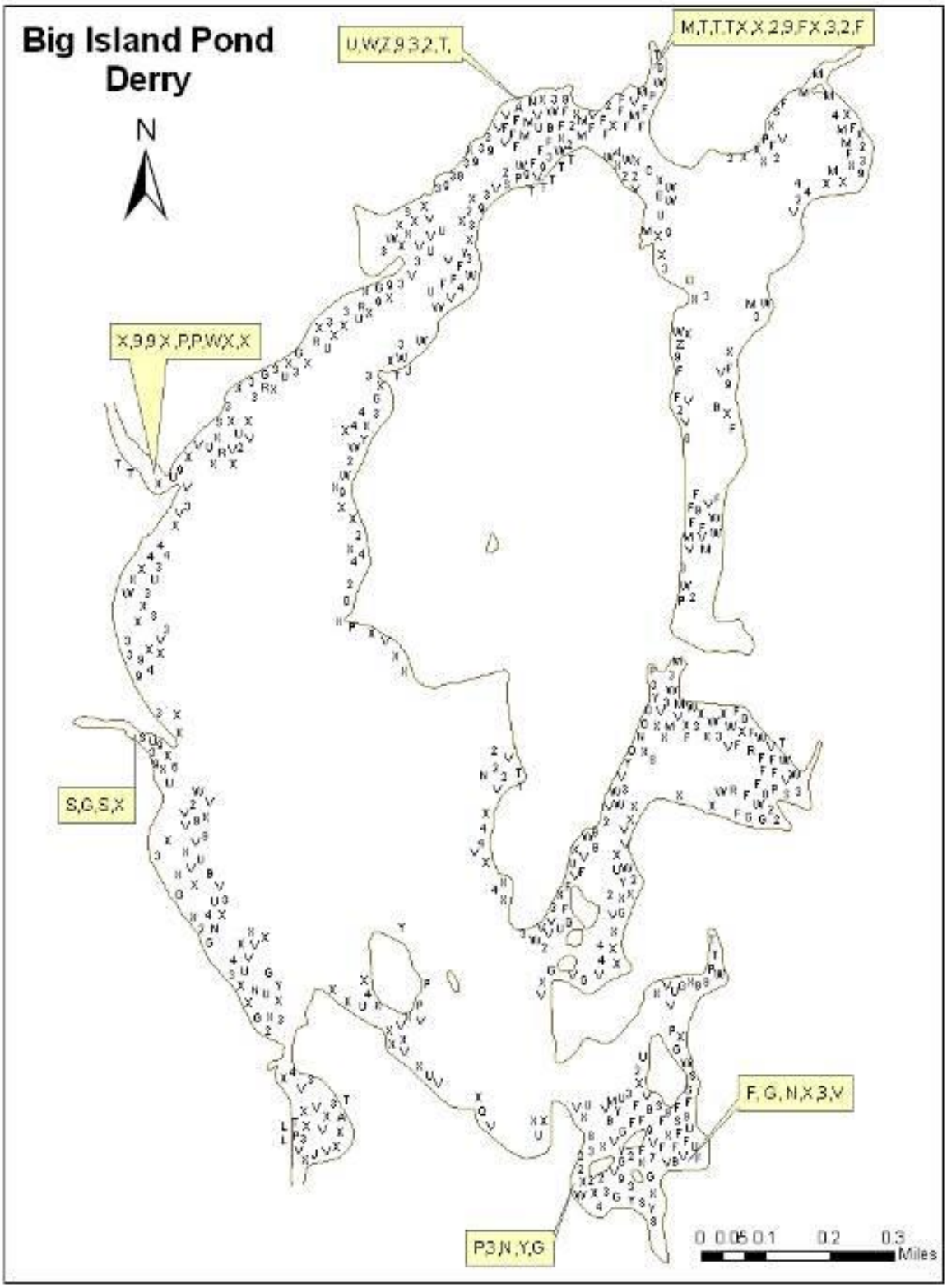
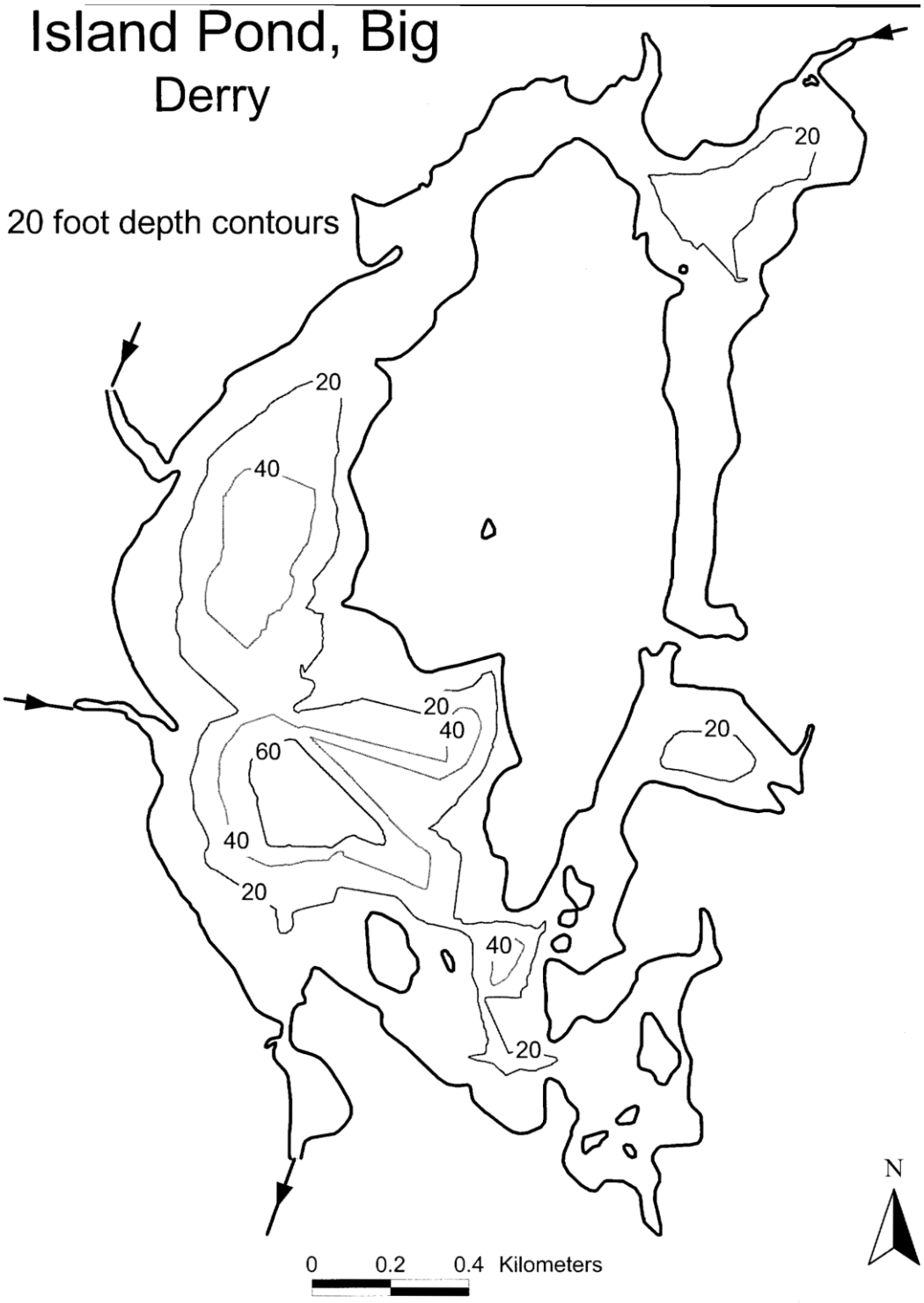


Figure 8: Map of native aquatic macrophytes.

Symbol	Common Name	Latin Name
X	Pondweed sp.	*Potamogeton sp.*
E	Waterweed	*Elodea canadensis*
V	Tapegrass	*Vallisneria americana*
e	Pipewort	*Eriocaulon*
3	Clasping-leaf pondweed	*Potamogeton perfoliatus*
L	Purple loosestrife	*Lythrum salicaria*
4	Spotted pondweed	*Potamogeton pulcher*
N	Water naiad	*Najas sp.*
I	Iris	*Iris versicolor*
C	Musk grass	*Chara*
R	Robbins pondweed	*Potamogeton robbinssi*
T	Cattail	*Typha sp.*
W	White water-lily	*Nymphaea*
Y	Yellow water-lily	*Nuphar*
P	Pickerelweed	*Pontedaria cordata*
S	Grassy arrowhead	*Sagittaria graminea*

Figure 9: Bathymetry Map



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 exotic aquatic 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 threat to downstream waterbodies from the exotic aquatic plant based on limnological characteristics (water chemistry, quantity, quality as they relate to movement or support of exotic plant growth).

Overall Control Options

For any given waterbody that has an infestation of exotic plants, one of four options will be selected, based on the status of the infestation, the available management options, and the technical knowledge of the NHDES Limnologists and other key resource managers who have conducted the field work and who are preparing or contributing to this plan. The options are as follows:

1) Eradication: The goal is to completely remove the exotic plant infestation over time. In some situations, this may be a rapid response that results in an eradication event in a single season (such as for a new infestation). In other situations, a longer-term approach may be warranted given the age and distribution of the infestation. Eradication is more feasible in smaller systems without extensive expanded growth (for example, Lake Winnipesaukee is unlikely to achieve eradication of its variable milfoil), or without upstream sources of infestation in other connected systems that continually feed the lake.
2) Maintenance: Waterbodies where maintenance is specified as a goal are generally those with expansive infestations, that are larger systems, that have complications of extensive wetland complexes on their periphery, or that have upstream sources of the invasive plant precluding the possibility for eradication. For waterbodies where maintenance is the goal, control activities will be performed on the waterbody to keep an infestation below a desirable threshold. For maintenance projects, thresholds of

percent cover or other measurable classification will be indicated, and action will occur when exotic plant growth exceeds the threshold.

3) Containment: The aim of this approach is to limit the size and extent of the existing infestation within an infested waterbody if it is localized in one portion of that waterbody (such as in a cove or embayment), or if a whole lake is infested action may be taken to prevent the downstream migration of fragments or propagules. This could be achieved through the use of fragment barriers and/or Restricted Use Areas or other such physical means of containment. Other control activities may also be used to reduce the infestation within the containment area.
4) 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. Feasibility of control or control options may be revisited if new information, technologies, etc., develop.

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

Guidelines and requirements of each control practice are suggested and detailed below each alternative, but note that site specific conditions will be factored into the evaluation and recommendation of use on each individual waterbody with an infestation.

A. Hand-Pulling and Diver-Assisted Suction Harvesting

- Hand-pulling 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'). For larger areas Diver-Assisted Suction Harvesting (DASH) may be more appropriate.
- 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 or DASH
- 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).

- If a waterbody is fully infested and no other control options are effective, mechanical harvesting can be used to open navigation channel(s) through dense plant growth.

C. Herbicide Treatment

- Can be used if application of herbicide is conducted in areas where alternative control techniques are not optimum due to depth, current, use, or density and 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
    - 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 herbicide treatment as compared with other treatments.

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

- Can be established in an area that effectively restricts use to a small cove, bay, or other such area where navigation, fishing, and other transient 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 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.
- Use must be in compliance with the Wetlands Bureau rules.

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 RSA 211:11 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 as they are illegal in New Hampshire.
- *Exotic* controls, such as insects, cannot be introduced to control a nuisance plant unless approved by Department of Agriculture.
- Research should be conducted on a potential biological control prior to use to determine the extent of target specificity.

Appendix B: Summary of Control Practices

Restricted Use Areas and Fragment Barrier:

Restricted Use Areas (RUAs) are a tool that can be used to quarantine a portion of a waterbody if an infestation of exotic aquatic plants is isolated to a small cove, embayment, or section of a waterbody. RUAs generally consist of a series of buoys and ropes or nets connecting the buoys to establish an enclosure (or exclosure) to protect an infested area from disturbance. RUAs can be used to prevent access to these infested areas while control practices are being done, and provide the benefit of restricting boating, fishing, and other recreational activities within these areas to prevent fragmentation and spread of the plants outside of the RUA.

Hand-pulling:

Hand-pulling exotic aquatic plants is a technique used on both new and existing infestations, as circumstances allow. For this technique divers carefully hand-remove the shoots and roots of plants from infested areas and place the plant material in mesh dive bags for collect and disposal. This technique is suited to small patches or areas of low-density exotic plant coverage.

For a new infestation, hand-pulling activities are typically conducted several times during the first season, with follow-up inspections for the next 1-2 years or until no re-growth is observed. For existing infestations, hand-pulling may be done to slow the expansion of plant establishment in a new area or where new stems are removed in a section that may have previously been uninfested. It is often a follow-up technique that is included in most management plans.

In 2007 a new program was created through a cooperative between a volunteer monitor that is a certified dive instructor, and the NHDES Exotic Species Program. A Weed Control Diver Course (WCD) was developed and approved through the Professional Association of Dive Instructors (PADI) to expand the number of certified divers available to assist with hand-pulling activities. NHDES only had four certified divers in the Limnology Center to handle problems with aquatic plants, and more help was needed. There is a unique skill involved with hand-removing plants from the lake bottom. If the process is not conducted correctly, fragments could spread to other waterbody locations. For this reason, training and certification are needed to help ensure success. Roughly 100 divers were certified through this program through the 2010 season. NHDES maintains a list of WCD divers and shares them with waterbody groups and municipalities that seek diver assistance for controlling exotic aquatic plants. Classes are offered two to three times per summer.

Diver Assisted Suction Harvesting

Diver Assisted Suction Harvesting (DASH) is an emerging and evolving control technique in New Hampshire. The technique employs divers that perform hand removal actions as described above, however, instead of using a dive bag a mechanical suction device is used to entrain the plants and bring them topside where a tender accumulates and bags the material for disposal. Because of this variation, divers are able to work in moderately dense stands of plants that cover more bottom area, with increased efficiency and accuracy.

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:

Benthic barriers are fiberglass coated screening material that can be applied directly to the lake bottom to cover and compress aquatic plant growth. Screening is staked or weighted to the bottom to prevent it from becoming buoyant or drifting with current. The barriers also serve to block sunlight and prevent photosynthesis by the plants, thereby killing the plants with time. While a reliable method for small areas of plants (roughly 100 sq. ft. or less), larger areas are not reasonably controlled with this method due to a variety of factors (labor intensive installation, cost, and gas accumulation and bubbling beneath the barrier).

Targeted Application of Herbicides:

Application of aquatic herbicides is another tool employed for controlling exotic aquatic plants. Generally, herbicides are used when infestations are too large to be controlled using other alternative non-chemical controls, or if other techniques have been tried and have proven unsuccessful. Each aquatic plant responds differently to different herbicides and concentrations of herbicides, but research performed by the Army Corps of Engineers has isolated target specificity of a variety of aquatic herbicides for different species.

Generally, 2,4-D (Navigate formulation) is the herbicide that is recommended for control of variable milfoil. Based on laboratory data this is the most effective herbicide in selectively controlling variable milfoil in New Hampshire's waterbodies.

A field trial was performed during the summer of 2008 using the herbicide Renovate to control variable milfoil. Renovate is a systemic aquatic herbicide

that targets both the shoots and the roots of the target plant for complete control. In this application it was dispersed as a granular formulation that sank quickly to the bottom to areas of active uptake of the milfoil plants. A small (<5 acre) area of Captains Pond in Salem was treated with this systemic herbicide. The herbicide was applied in pellet form to the infested area in May 2008 and showed good control by the end of the growing season. Renovate works a little more slowly to control aquatic plants than 2,4-D and is a little more expensive, but presents NHDES with another alternative that could be used in future treatments.

During the summer of 2010, NHDES worked with other researchers to perform field trials of three different formulations of 2,4-D in Lake Winnisquam, to determine which product was most target-specific to the variable milfoil. Navigate formulation was used, as were a 2,4-D amine formulation, and a 2,4-D amine and triclopyr formulation (MaxG). Although the final report has not been completed for this study, preliminary results suggest that all three products worked well, but that Navigate formation may be the most target specific of all three.

Another herbicide, Fluridone, is sometimes also used in New Hampshire, mainly to control growths of fanwort (*Cabomba caroliniana*). Fluridone is a systemic aquatic herbicide that inhibits the formation of carotenoids in plants. Reduced carotenoids pigment ultimately results in the breakdown of chlorophyll and subsequent loss of photosynthetic function of the plants.

Other aquatic herbicides are also used in New Hampshire when appropriate (glyphosate, copper compounds, etc). The product of choice will be recommended based on what the target species is, and other waterbody-specific characteristics that are important to consider when selecting a product.

In 2018, a new aquatic formulation of herbicide was labeled and licensed for use. ProcellaCOR is a reduced-risk liquid formulation herbicide that is a systemic. Based on New Hampshire field data, it works well on variable milfoil, is taken up very quickly following treatment (hours), and it degrades quickly in the water column, with typical non-detect readings within 24-48 hours post treatment.

Extended Drawdown

Extended drawdown serves to expose submersed aquatic plants to desiccation and scouring from ice (if in winter), physically breaking down plant tissue. Some species can respond well to drawdown and plant density can be reduced, but for invasive species drawdown tends to yield more disturbance

to bottom sediments, something to which exotic plants are most adapted. In waterbodies where drawdown is conducted exotic plants can often outcompete native plants for habitat and come to dominate the system.

Some waterbodies that are heavily infested with exotic plants do conduct drawdowns to reduce some of the invasive aquatic plant density. During this reporting period both Northwood Lake (Northwood) and Jones Pond (New Durham) coordinated deep winter drawdowns to reduce growths of variable milfoil (the drawdown on Northwood Lake is primarily for flood control purposes, but they do see some ancillary benefits from the technique for variable milfoil control).

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 alone as a means of control for aquatic vegetation.

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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