Prepared by:
NH Department of
Environmental Services
March 2016

Long-Term Variable Milfoil Management Plan

Suncook River System
Barnstead, New Hampshire

Contents

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;
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 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 most used for aquatic habitat. These dense growths and near monotypic stands of invasive aquatic plants can result in reduced 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" (DES, 2006). In fact, waterbodies that contain exotic aquatic plant infestations do not attain water quality standards and are listed as impaired.

Variable Milfoil Infestation in the Suncook River System

Variable milfoil growth has been widely distributed throughout the Suncook River (Barnstead Parade Dam) system over the years. The total surface area for this river segment is approximately 107 acres. Variable milfoil growth was observed in water depths to at least 8 feet and has covered much of this river reach over the last several years, though coordinated efforts have greatly reduced the degree of the infestation, in 2015 growths had expanded once again as limited resources have led to reduced large-scale control efforts, and only smaller portions of the waterbody are managed each year.

Figure 1 illustrates the extent of variable milfoil growth over time in Barnstead Parade Dam impoundment. Figure 2 (over several maps) shows the areas of historical control actions over time.

In terms of the variable milfoil impacts to shorefront property owners, there are approximately 33 properties abutting this river segment, with an additional 10 back lots that have right-of-way access. Most of these property owners face impairments in the use of the river, particularly for swimming and ease of boating through dense milfoil beds.

Milfoil Management Goals and Objectives

The goal for the Suncook River is the reduction of overall biomass and distribution of variable milfoil in the system, using an Integrated Pest Management Approach.

Local Support

Town or Municipality Support

The town of Barnstead appreciates the importance of keeping the Suncook River system usable and controlling the variable milfoil. The town has allocated funds for milfoil hand-removal for the past several years and has had a long-standing milfoil committee that has been actively involved in control efforts.

Local Association Support

While there is no formally established association on the Suncook River system, a number of concerned riparian residents are actively working to coordinate control activities and have become active in the Weed Watcher Program and the town's milfoil committee. Some riparian residents are also active volunteers in the hand-removal and survey work taking place on the river.

Waterbody Characteristics

The following table summarizes basic physical and biological characteristics of Suncook River system, 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 pending. References in the report refer to historic NHB findings. Please refer to the 2015 NHB submitted with the permit application for current species.

Barnstead Parade Pond Dam (acres)	699.7
Watershed area (acres)	53,731.6
Shoreline Uses (residential, forested, agriculture)	Residential, commercial, forested, public access
Max Depth (ft)	15
Mean Depth (ft)	5
Epilimnetic/Hypolimnetic color (CPU)	65 CPU/60 CPU
Epilimnetic/Hypolimnetic pH	6.1 units/6.2 units
Trophic Classification (of ponded area)	Mesotrophic
Clarity (ft)	6.93
Invasive Plants (Latin name)	*Myriophyllum heterophyllum (variable milfoil)*
Infested Area (acres)	See maps for historic and

	current infestation
Distribution (ringing lake, patchy growth, etc)	See maps for historic and current distribution as they vary from year to year
Sediment type in infested area (sand/silt/organic/rock)	Silt/muck
Rare, Threatened, or Endangered Species in Waterbody (based on NH Natural Heritage Bureau database)	2016 Review: Brook floater (*Alasmidonta varicose)* Historic NHB Listed Species: Brook floater (*Alasmidonta varicose)* Blandings turtle (*Emydoidea blandingii)* Eastern box turtle (*Terrapene carolina)*

A native plant map and key from a fall 2009 survey (check annually) conducted by the DES Biology Section is shown in Figure 3. A bathymetric map of the river is shown in Figure 4.

Beneficial (Designated) Uses of Waterbody

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

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

The Suncook River (Barnstead Parade Dam) impoundment is managed primarily as a warmwater fishery, with the primary gamefish being largemouth bass, black crappie and chain pickerel.

Spring stocking of hatchery rainbow trout occurs in the impoundment and anecdotal information indicates these trout can survive into the summer months by taking refuge in the deeper riverine sections.

Other species that are present and may be of interest to anglers include bluegill sunfish, pumpkinseed sunfish, yellow perch, and common white sucker. Golden shiners are the primary forage fish, along with juveniles of the aforementioned species.

Of particular interest is the presence of swamp darters and potential presence of bridle shiners (found in the Suncook River (Barnstead Parade Dam) above and below the impoundment), both species of conservation concern. Southern New Hampshire and Maine are the northern most extent of the distribution of these species. Although the impoundment is within the distribution of banded sunfish and redfin pickerel (both at their northern most distribution in New Hampshire), these species have not been recorded in the impoundment. However, no surveys targeting them have been conducted in this impoundment. In addition, creek chubsucker is present. This species is also at its northern most distribution in New Hampshire, and is a species of conservation concern.

The abundant submergent aquatic vegetation in the Suncook River (Barnstead Parade Dam) serves as habitat for the spawning and rearing lifestages of most, if not all, of the fish species in this impoundment. In particular, bridle shiner, swamp darter, redfin pickerel and banded sunfish are all dependent on submerged aquatic vegetation for at least one lifestage.

Wildlife Information

Historic NHB reports show three wildlife species of concern in the river segment: the brook floater (*Alasmidonta varicose)*, Blandings turtle (*Emydoidea blandingii)* and eastern box turtle (*Terrapene carolina).*

To our knowledge, no mussel surveys have been conducted immediately upstream or downstream of the impoundment. If suitable habitat for the state endangered brook floater mussel exists in these reaches, it may be found there as this species is known to occur throughout much of the Suncook River (Barnstead Parade Dam) in suitable habitat.

The Blanding's turtle (2002 record) is listed as endangered in NH and the eastern box turtle (1987 record) are listed as a species of concern in New Hampshire. Turtles are mostly aquatic and are found in the shallows of lakes and ponds, in marshes, bogs, and small streams. The turtles nest on land, but feed underwater on insects, tadpoles, crayfish, and snails, among other small

aquatic organisms. It is not expected that habitat or food sources for the turtle will be affected by the recommended milfoil control practices.

The impoundment is also utilized by fish-eating birds such as great blue heron, snowy egret, and double-crested cormorant as well as several species of ducks and geese. Use of the shoreline by beaver was also observed

Recreational Uses and Access Points

The Suncook River (Barnstead Parade Dam) is used for many recreational activities including: boating, fishing, and swimming by local resident and transient boaters. There is one designated public access site for boats onto the Suncook River (Barnstead Parade Dam), which is located immediately upstream of the Barnstead Parade Dam. Figure 5 shows the location of the public access site.

Swimming occurs at the boat launch area, and immediately upstream of the dam although there are no public (also called "designated") beaches along the Suncook River (Barnstead Parade Dam). 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.*

Riparian landowners also swim in the river along the front of their property, though many have decreased their use of the river for swimming due to dense growths of the variable milfoil. There are an estimated 11 swim platforms and docks along this subject reach of the river. Figure 5 illustrates the locations of swim areas and docks.

There are a few resident-owned and transient powerboats on the river from time to time, and numerous canoes, kayaks, and row boats. Generally, non-motorized craft seem more common than motorized craft.

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 the Suncook River (Barnstead Parade Dam) extends from the shoreline area to a depth of approximately 8 feet.

The littoral zone of the Suncook River (Barnstead Parade Dam) is characterized by a mix of native and non-native (variable milfoil) plant growth. Native species include a mix of floating plants (white and yellow water-lilies, watershield, floating heart), emergent plants (three-way sedge, pickerelweed, bur-reed, cattail, buttonbush, spike rush, arrowhead, and various grasses, sedges, and rushes), and submergent plants (native waterweed, pondweeds, bladderwort, submersed bur-reed, water naiad, tapegrass).

The plants are generally mixed around the banks and shoreline, and are slightly more abundant in the backwater areas, rather than the main thread of the river, which tends to be deeper.

Pink lilies (non native) were also present in patches in the river.

Small areas of filamentous green algae are present throughout the river segment, but they were not indicative of a nutrient problem, and were generally in line with what would naturally be found in the river.

Wells and Water Supplies

Figure 7 shows the location of wells, water supplies, well-head protection areas, and drinking water protection areas around the Suncook River system, based on information in the DES geographic information system records. Note that it is likely that Figure 7 does not show the location of all private wells. *Due to DES restrictions for providing water supply data under Homeland Security restrictions, note that the map in Figure 7 cannot be provided on a finer scale than 1:48,000.*

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 other than that provided in Figure 7.

Historical Control Activities

DATE	ACTION	AREA (ac)	APPLICATOR
07-Sep-05	2,4-D	1.5	ACT
02-May-07	2,4-D, PLT&LIQ	64	ACT
17-Jul-08	2,4-D (G)	40	ACT
01-Aug-08	Diver hand removal	varied	BMCC
01-Aug-08	fragment barrier	varied	BMCC
17-Sep-08	2,4-D (G)	32.5	ACT
30-Jun-09	2,4-D	3.5	ACT
July/August 2009	Diver hand removal	varied	BMCC
16-Sep-09	2,4-D	3	ACT
June-September 2010	Diver/DASH hand removal	Throughout infested area	BMCC
05-Jul-10	2,4-D (150 lbs/acre)	3.25	ACT
27-Sep-10	2,4-D (100 lbs/acre)	3	ACT
August/September 2011	Diver/DASH hand removal	varied	BMCC
13-Sep-12	2,4-D (L)	78.2	ACT
9/6/2013	2,4-D (L)	20	ACT
8/26/2014	2,4-D (L)	25	ACT
9/24/2015	2,4-D (L)	25 ACRES	ACT

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 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 currently used by the State of New Hampshire.

Feasibility Evaluation of Control Options in this Waterbody

DES has evaluated the feasibility of potential control practices on the Suncook River system. The following table summarizes DES' control strategy recommendations:

Control Method	Use on Suncook River System
Restricted Use Areas (RUAs) and/or Fragment Barriers	RUAs are recommended where feasible. Fragment barriers have been tried in the Suncook River but provided infeasible to maintain due to flow regimes which damaged nets.
Hand-pulling and/or Diver Assisted Suction Harvesting (DASH)	Hand pulling and DASH are recommended as regular control techniques each summer as milfoil plants rebound from larger-scale control techniques.
Mechanical Harvesting/Removal	Mechanical harvesting is not recommended due to risk of fragmentation and further spread
Benthic Barriers	Benthic barriers are infeasible in this system due to flow and concerns about uplifting of barrier from bottom sediments.
Herbicides	Herbicide treatment is recommended when the variable milfoil becomes too widespread or dense for non-chemical means of control to be effective.
Extended Drawdown	Extended drawdown is cost effective but not a reasonable solution or likely long-term solution for milfoil control. This technique also yields a broader impact to non-target species.
Dredge	Cost prohibitive and not recommended as it opens further habitat for invasive species through causing disturbance.
Biological Control	Not recommended as there is no proven biological control for variable milfoil at this time.
No Control	A no control option is not reasonable as variable milfoil in this system continues to fragment and spread further downstream. Control is recommended to lesson downstream impacts and rebounding of the plant to a full infestation as was seen in 2006 and 2007.

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. Based on this survey the following recommendations are made for variable milfoil control in the system:

Year	Action	Responsible Party	Schedule
2012	Herbicide treatment	Aquatic Control Technology, Inc.	June/July and or September
	Weed Watching and Diver Hand Removal or DASH where feasible	Barnstead Milfoil Committee	May through September
	Field survey and planning for next year	DES and interested parties	September /October
2013	Herbicide treatment, if needed. Up to a maximum of 40 acres in areas showing in map.	Aquatic Control Technology, LLC	June/July and or September
	Weed Watching and Diver Hand Removal or DASH where feasible	Barnstead Milfoil Committee	May through September
	Field survey and planning for next year	DES and interested parties	September /October
2014	Weed Watching and Diver Hand Removal or DASH where feasible	Barnstead Milfoil Committee	May through September
	Herbicide treatment if needed (up to 25 acres within area shown on 2014 proposed map in Figure 2)	Aquatic Control Technology, LLC	August or September
	Field survey and planning for next year	DES and interested parties	September /October
2015	Weed Watching and Diver Hand Removal or DASH where feasible	Barnstead Milfoil Committee	May through September
	Herbicide treatment, if needed	Aquatic Control Technology, LLC	July, August or September
	Weed Watching and Diver Hand Removal if feasible	Local residents	May through September
	Field survey and planning for next year	DES and interested parties	September /October
2016	Weed Watching and Diver Hand Removal or DASH where feasible	Barnstead Milfoil Committee	May through September

Year	Action	Responsible Party	Schedule
	Herbicide treatment, if needed	SŌLitude Lake Management	July, August or September
	Field survey and planning for next year	DES and interested parties	September /October
2017	Update and revise Long-Term Variable Milfoil Control Plan	DES 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 fanwort management in the subject waterbody.

Figure 1: Map of Variable Milfoil Infestations Over Time

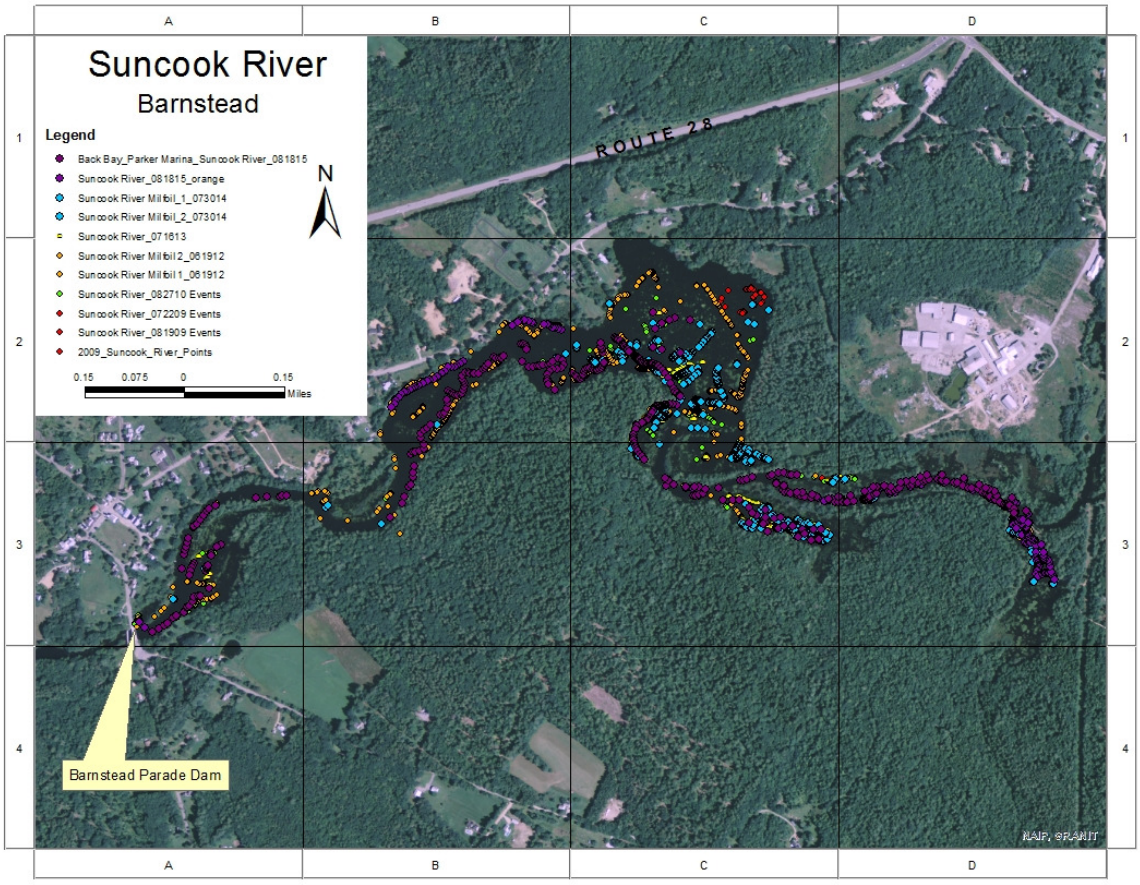
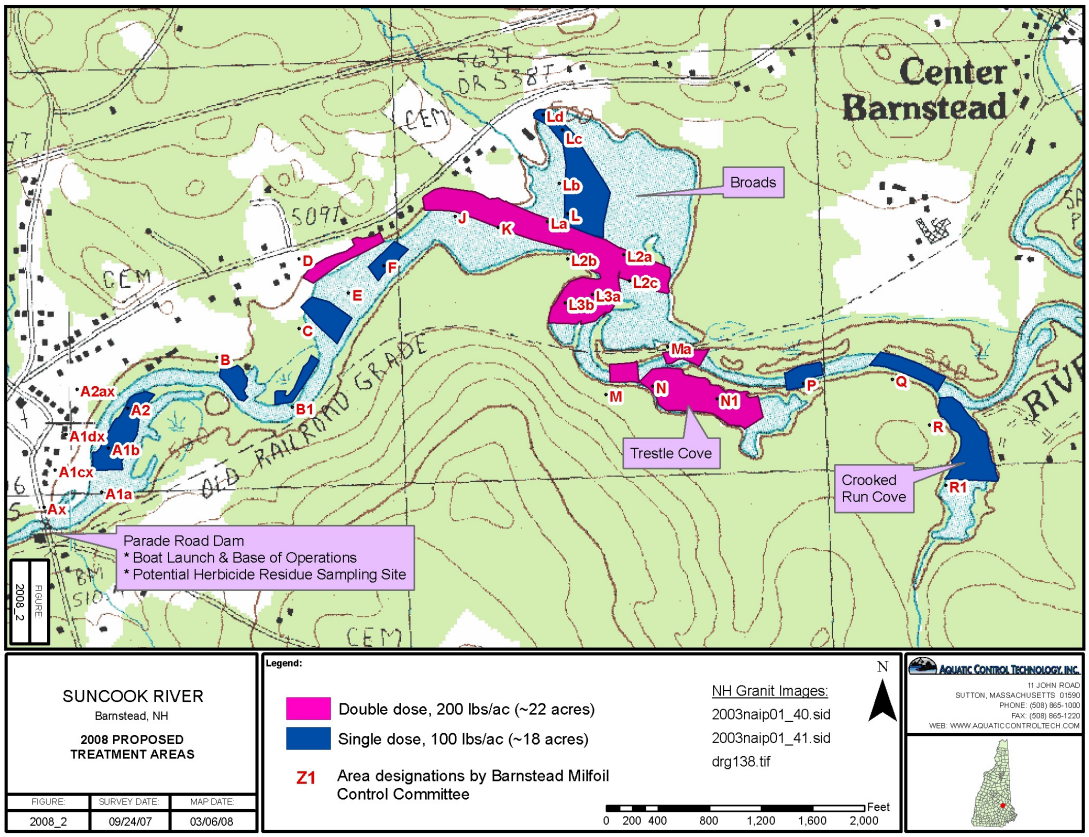
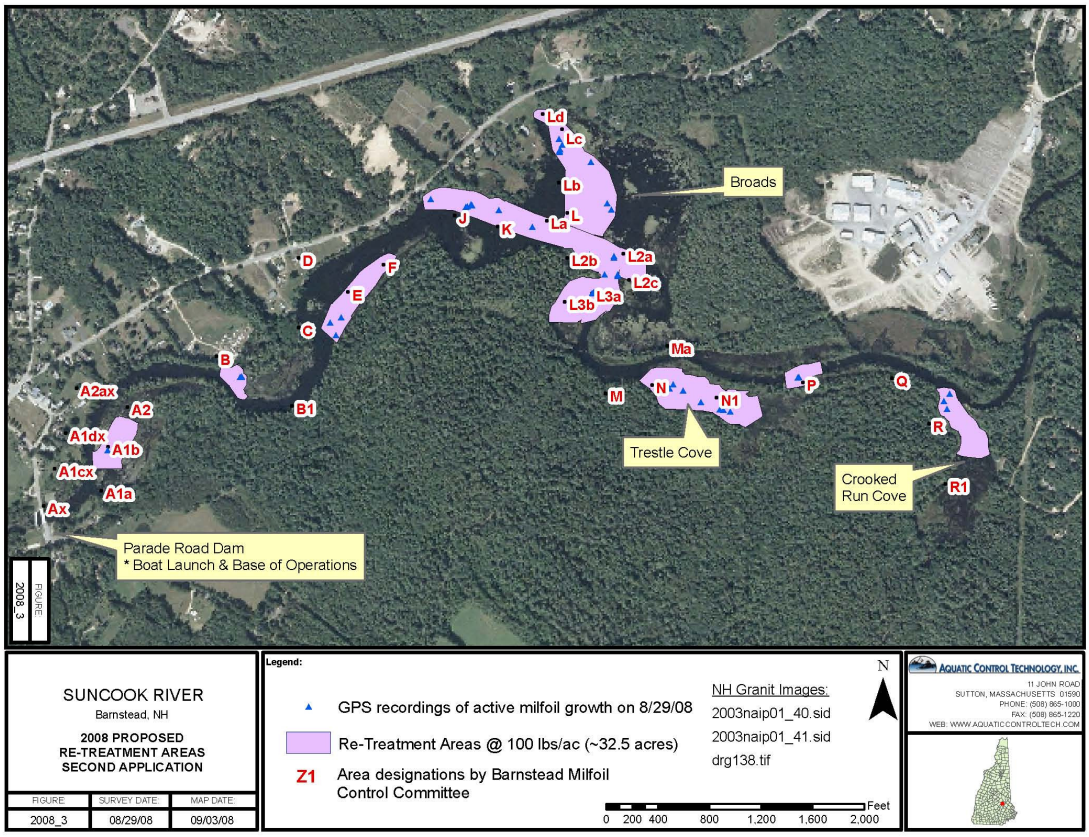


Figure 2: Map of Control Actions Over Time

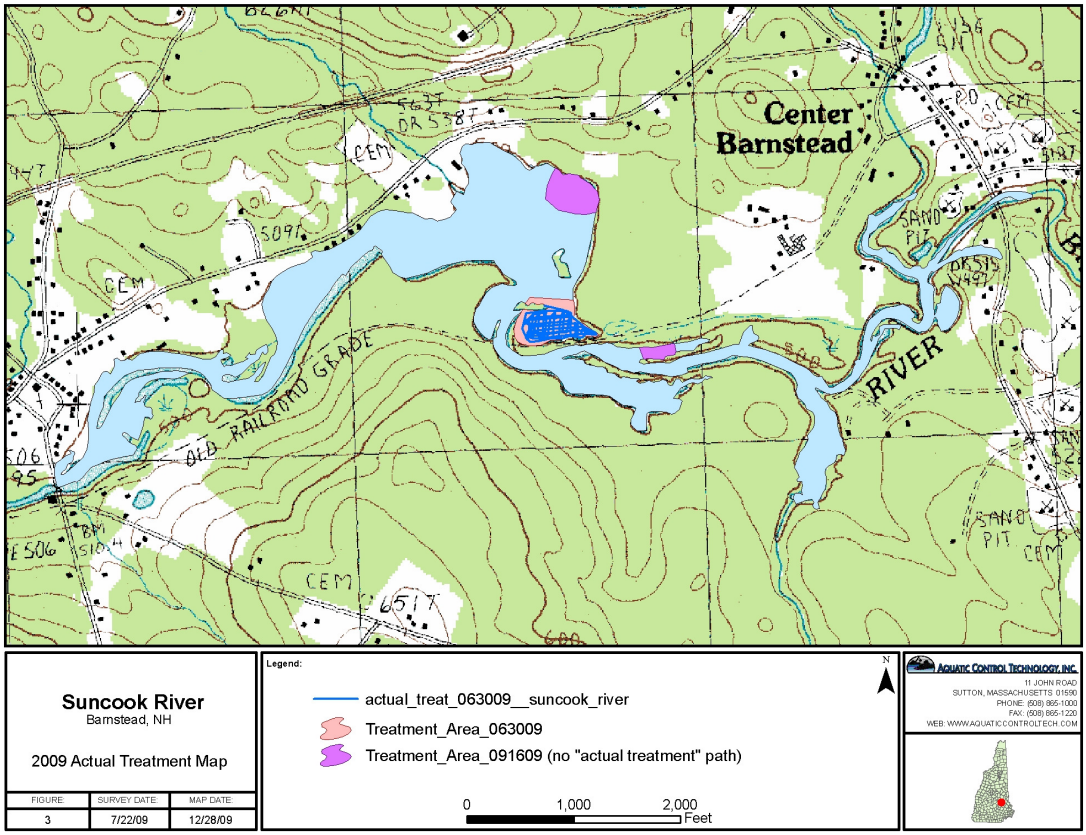
2007 (Actual)



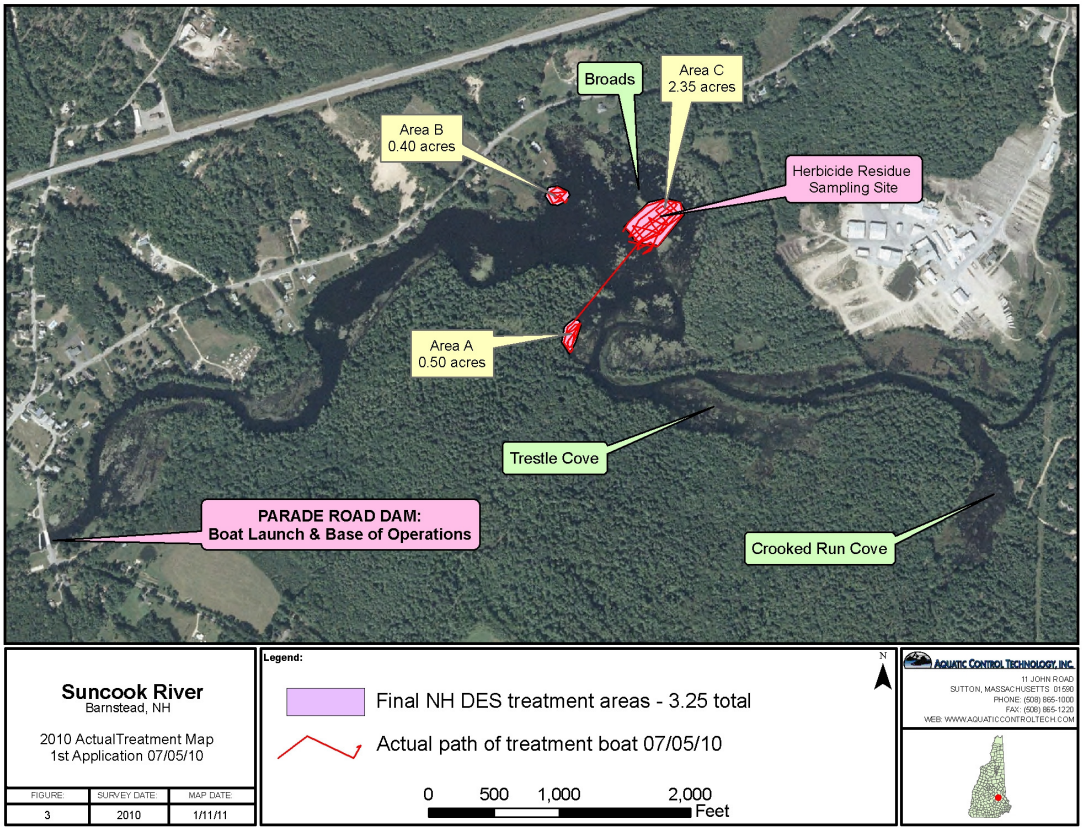
2008 (Actual)


Ld
Lc
Lb
Broads
J
K
La
L
L2b
L2a
L2c
L3b
L3a
D
F
E
C
B
Ma
M
N
N1
P
Q
R
R1
A2ax
A2
A1dx
A1b
A1cx
A1a
Ax
B1
Trestle Cove
Crooked Run Cove
Parade Road Dam
* Boat Launch & Base of Operations
FIGURE 2008_3
SUNCOOK RIVER
Barnstead, NH
2008 PROPOSED RE-TREATMENT AREAS SECOND APPLICATION
FIGURE: 2008_3
SURVEY DATE: 08/29/08
MAP DATE: 09/03/08
Legend:
GPS recordings of active milfoil growth on 8/29/08
Re-Treatment Areas @ 100 lbs/ac (~32.5 acres)
Z1 Area designations by Barnstead Milfoil Control Committee
NH Granit Images:
2003naip01_40.sid
2003naip01_41.sid
drg138.tif
N
0 200 400 800 1,200 1,600 2,000 Feet
AQUATIC CONTROL TECHNOLOGY, INC.
11 JOHN ROAD
SUTTON, MASSACHUSETTS 01590
PHONE: (508) 865-1000
FAX: (508) 865-1220
WEB: WWW.AQUATICCONTROLTECH.COM

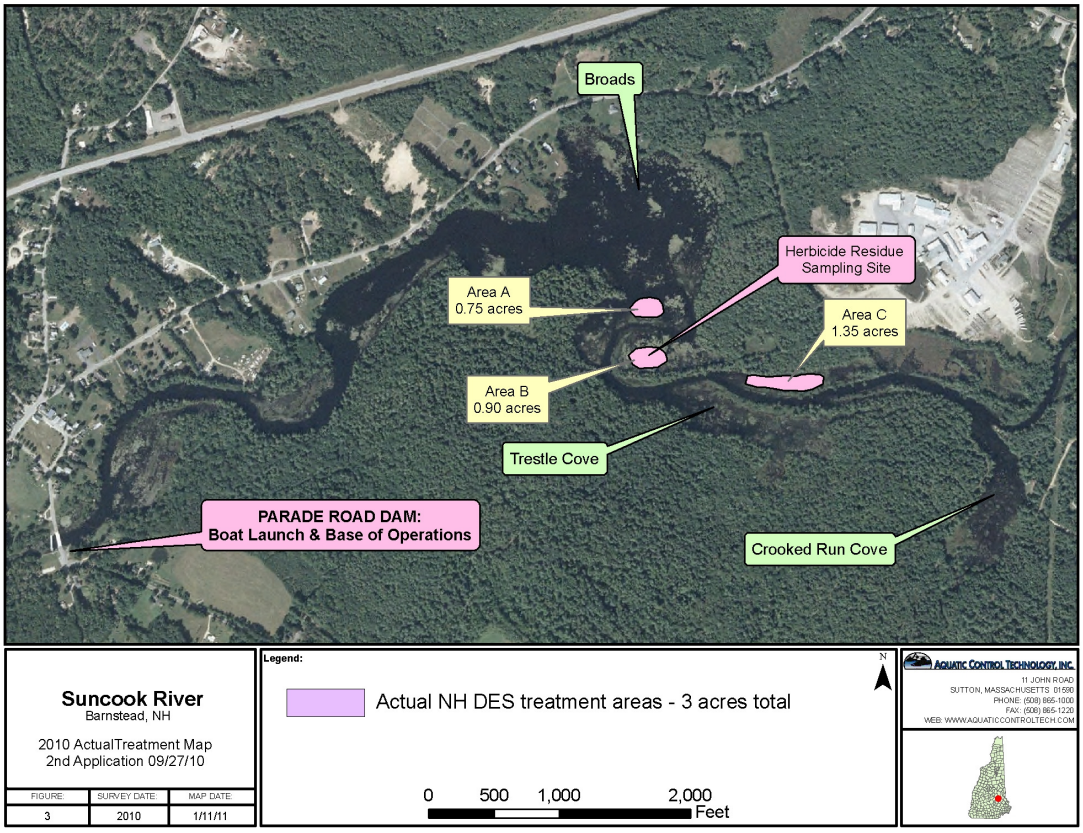
2009 (Actual)


Center
Barnstead
OLD RAILROAD GRADE
RIVER
SAND PIT
SAND PIT
CEM
CEM
CEM
Suncook River
Barnstead, NH
2009 Actual Treatment Map
FIGURE
SURVEY DATE
MAP DATE
3
7/22/09
12/28/09
Legend:
actual_treat_063009__suncook_river
Treatment_Area_063009
Treatment_Area_091609 (no "actual treatment" path)
N
0
1,000
2,000
Feet
AQUATIC CONTROL TECHNOLOGY, INC.
11 JOHN ROAD
SUTTON, MASSACHUSETTS 01590
PHONE: (508) 865-1000
FAX: (508) 865-1220
WEB: WWW.AQUATICCONTROLTECH.COM

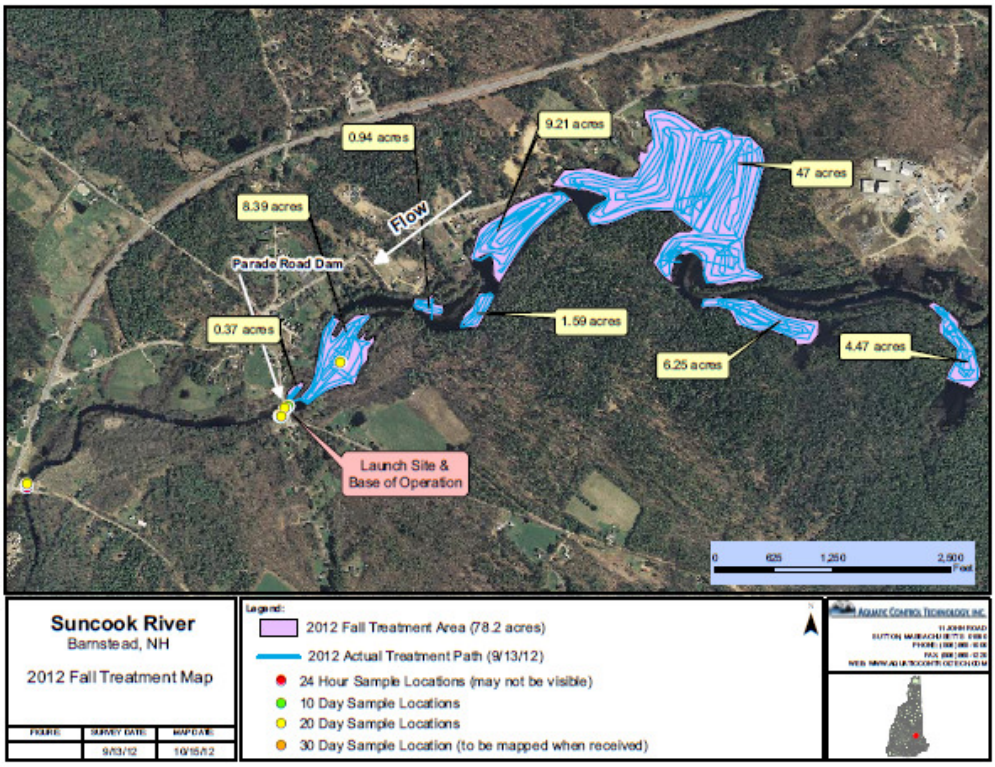
2010 (Actual 1st Treatment)



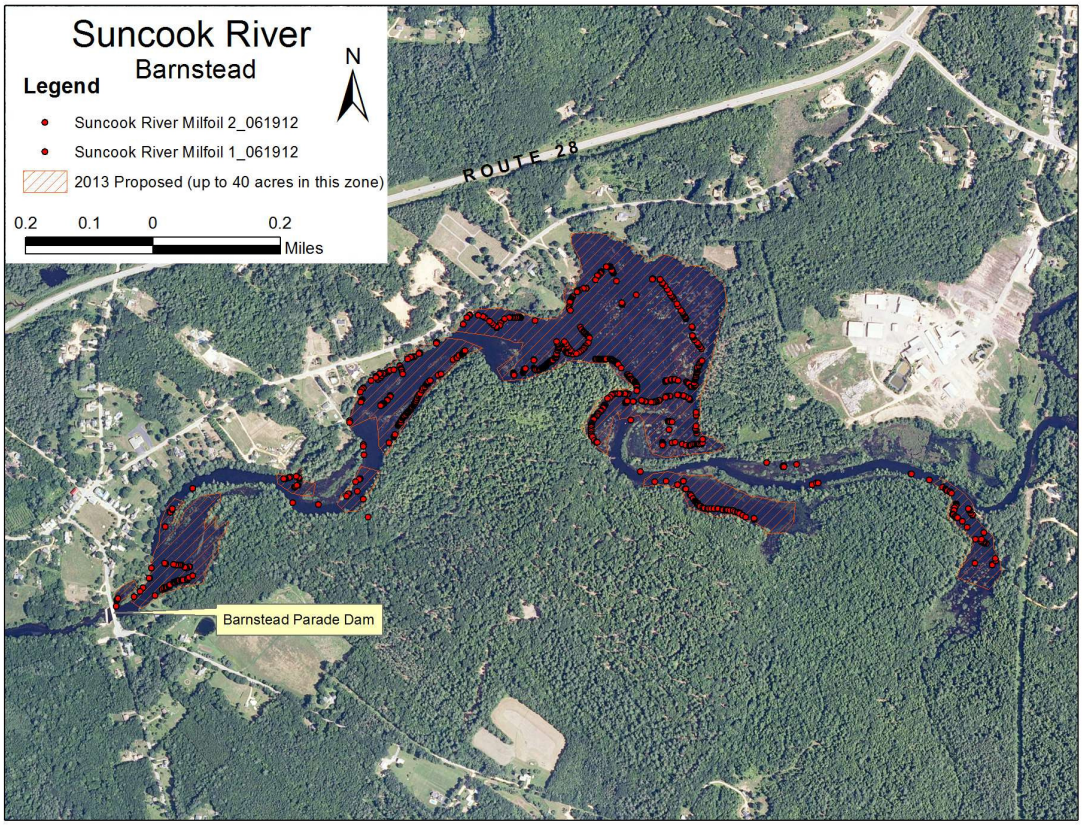
2010 (Actual 2nd Treatment)



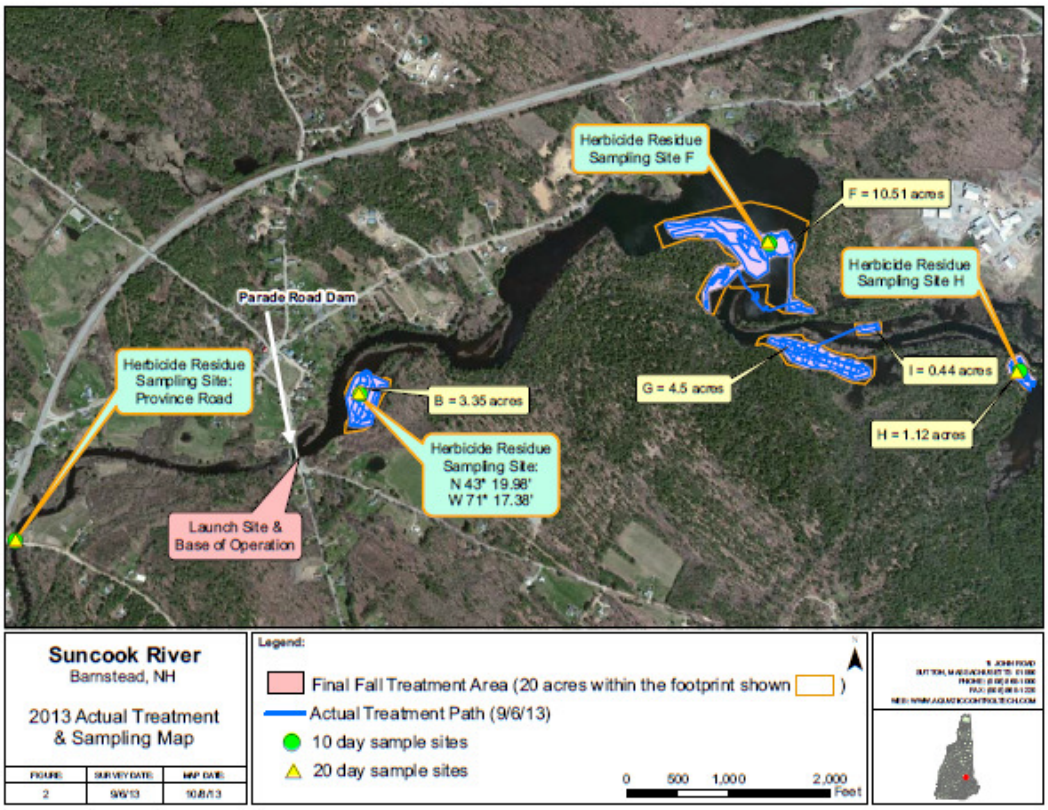
2012 (Actual)


0.94 acres
9.21 acres
47 acres
8.39 acres
Flow
Parade Road Dam
0.37 acres
1.59 acres
6.25 acres
4.47 acres
Launch Site &
Base of Operation
0
625
1,250
2,500
Feet
Suncook River
Barnstead, NH
2012 Fall Treatment Map
SURVEY DATE:
9/13/12
MAP DATE:
10/15/12
Legend:
2012 Fall Treatment Area (78.2 acres)
2012 Actual Treatment Path (9/13/12)
24 Hour Sample Locations (may not be visible)
10 Day Sample Locations
20 Day Sample Locations
30 Day Sample Location (to be mapped when received)

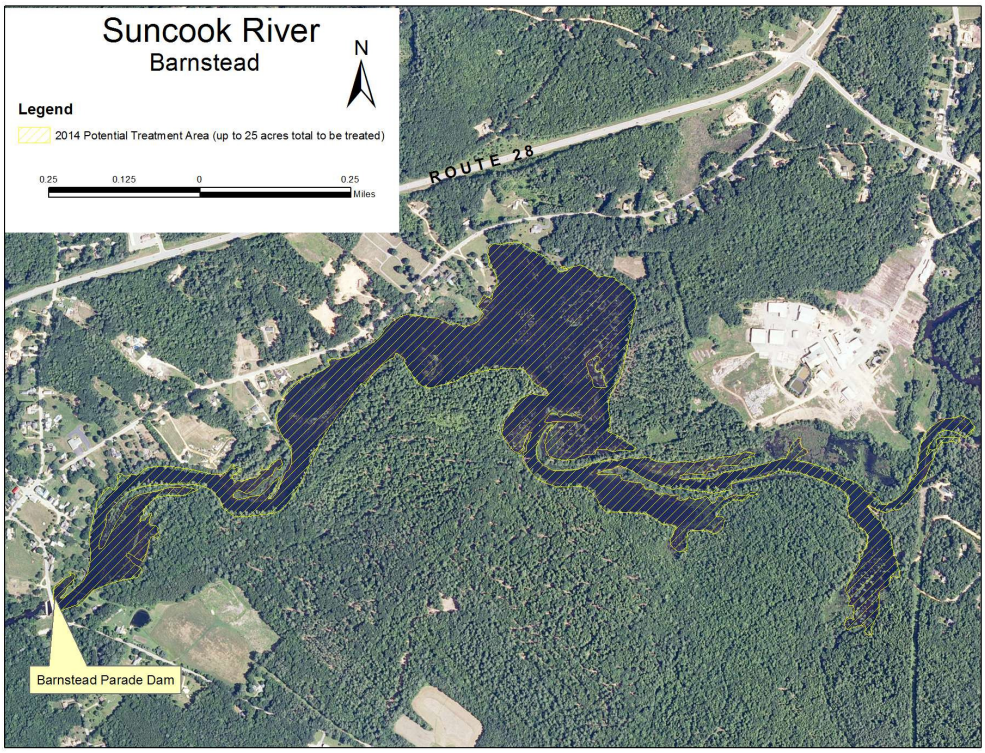
2013 (Proposed)



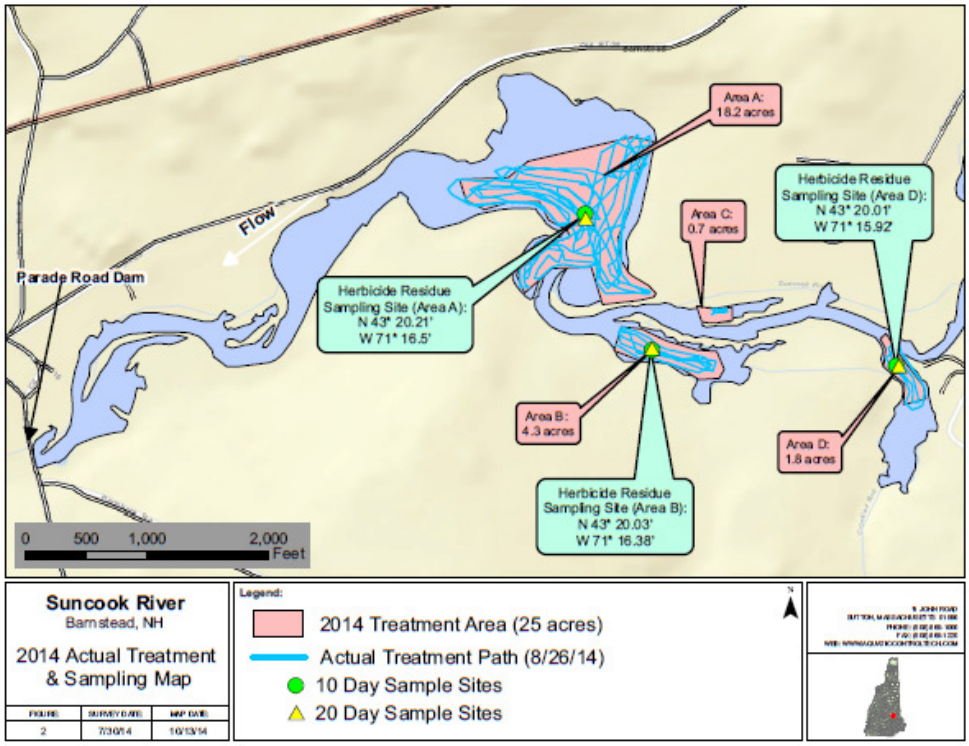
2013 (Actual)


Herbicide Residue Sampling Site F
F = 10.51 acres
Herbicide Residue Sampling Site H
Parade Road Dam
Herbicide Residue Sampling Site: Province Road
B = 3.35 acres
G = 4.5 acres
I = 0.44 acres
H = 1.12 acres
Herbicide Residue Sampling Site: N 43° 19.98' W 71° 17.38'
Launch Site & Base of Operation
Suncook River
Barnstead, NH
2013 Actual Treatment & Sampling Map
FIGURE
SURVEY DATE:
MAP DATE:
2
9/6/13
10/8/13
Legend:
Final Fall Treatment Area (20 acres within the footprint shown)
Actual Treatment Path (9/6/13)
10 day sample sites
20 day sample sites
0 500 1,000 2,000
Feet

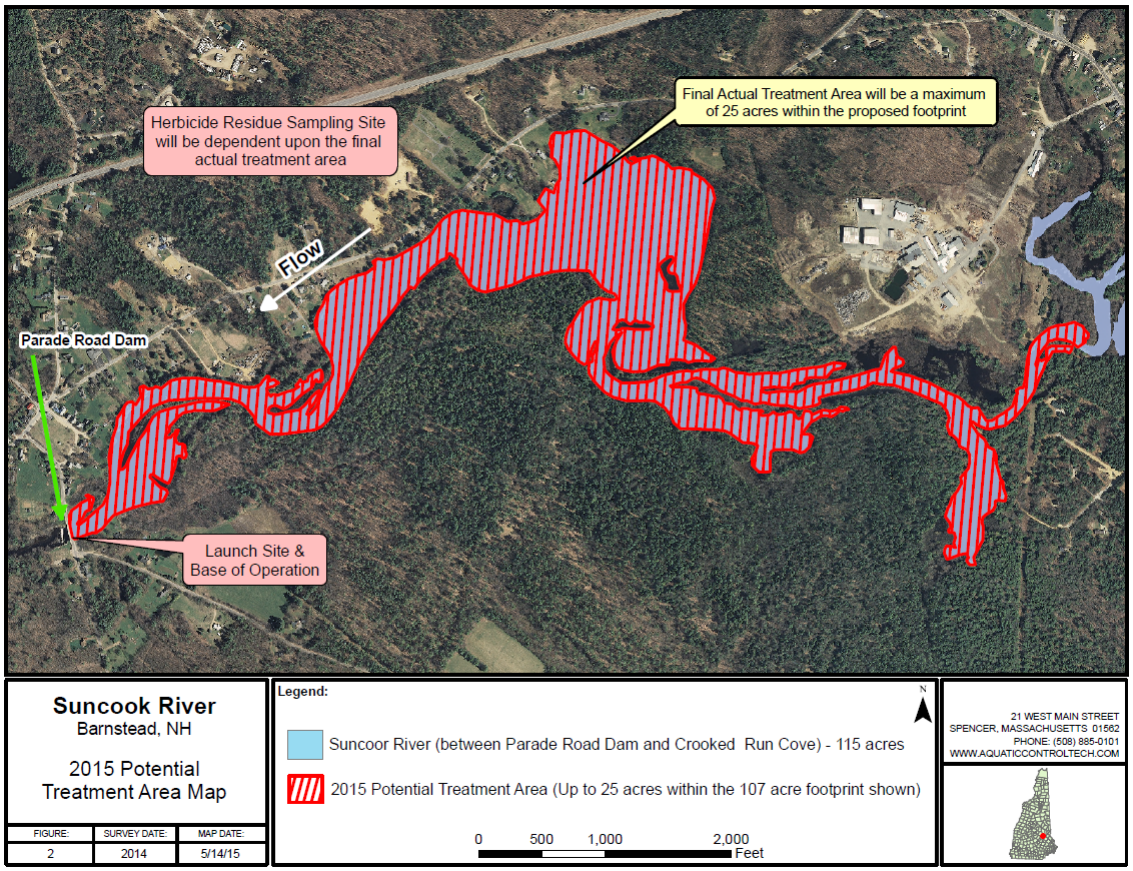
2014 (Proposed- up to 25 acres within zone shown)



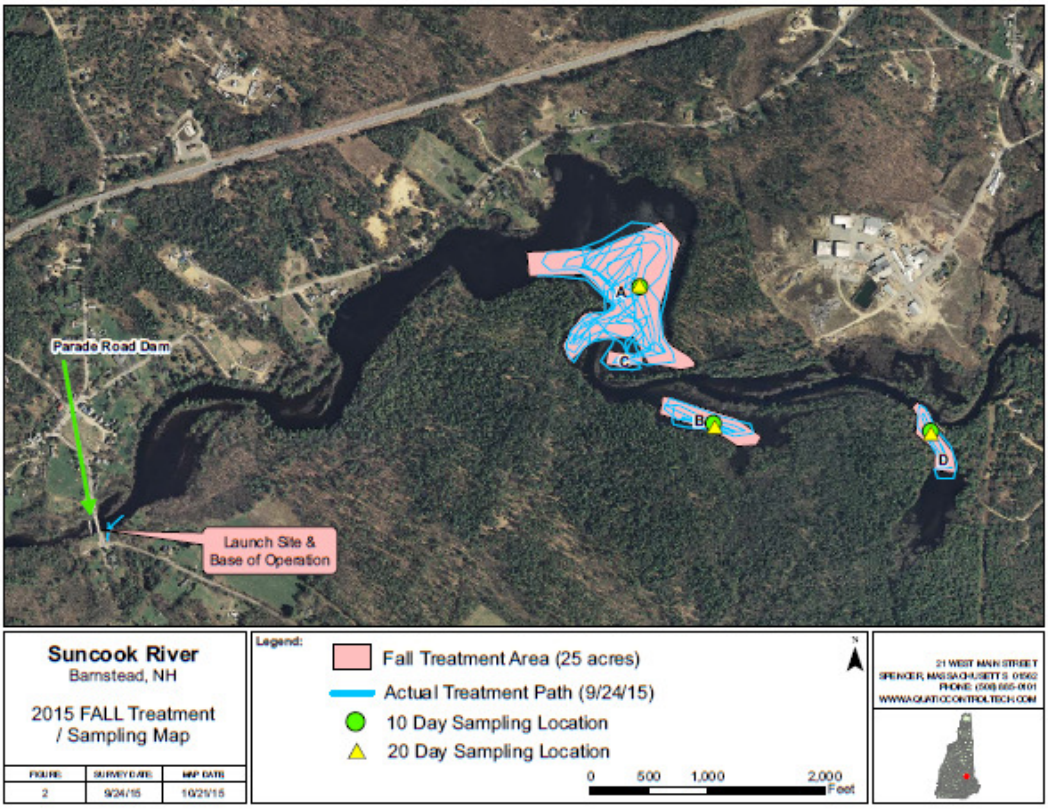
2014 (Actual)


Area A:
18.2 acres
Herbicide Residue
Sampling Site (Area D):
N 43° 20.01'
W 71° 15.92'
Area C:
0.7 acres
Flow
Parade Road Dam
Herbicide Residue
Sampling Site (Area A):
N 43° 20.21'
W 71° 16.5'
Area B:
4.3 acres
Area D:
1.8 acres
Herbicide Residue
Sampling Site (Area B):
N 43° 20.03'
W 71° 16.38'
0 500 1,000 2,000
Feet
Suncook River
Barnstead, NH
2014 Actual Treatment
& Sampling Map
FIGURE
2
SURVEY DATE
7/30/14
MAP DATE
10/13/14
Legend:
2014 Treatment Area (25 acres)
Actual Treatment Path (8/26/14)
10 Day Sample Sites
20 Day Sample Sites

2015 (Proposed)



2015 (Actual)


Parade Road Dam
Launch Site &
Base of Operation
A
B
C
D
Suncook River
Barnstead, NH
2015 FALL Treatment
/ Sampling Map
FIGURE
SURVEY DATE
MAP DATE
2
9/24/15
10/21/15
Legend:
Fall Treatment Area (25 acres)
Actual Treatment Path (9/24/15)
10 Day Sampling Location
20 Day Sampling Location
0
500
1,000
2,000
Feet
N
21 WEST MAIN STREET
SPENCER, MASSACHUSETTS 01562
PHONE: (508) 885-0101
WWW.AQUATICCONTROLTECH.COM

2016 (Proposed)

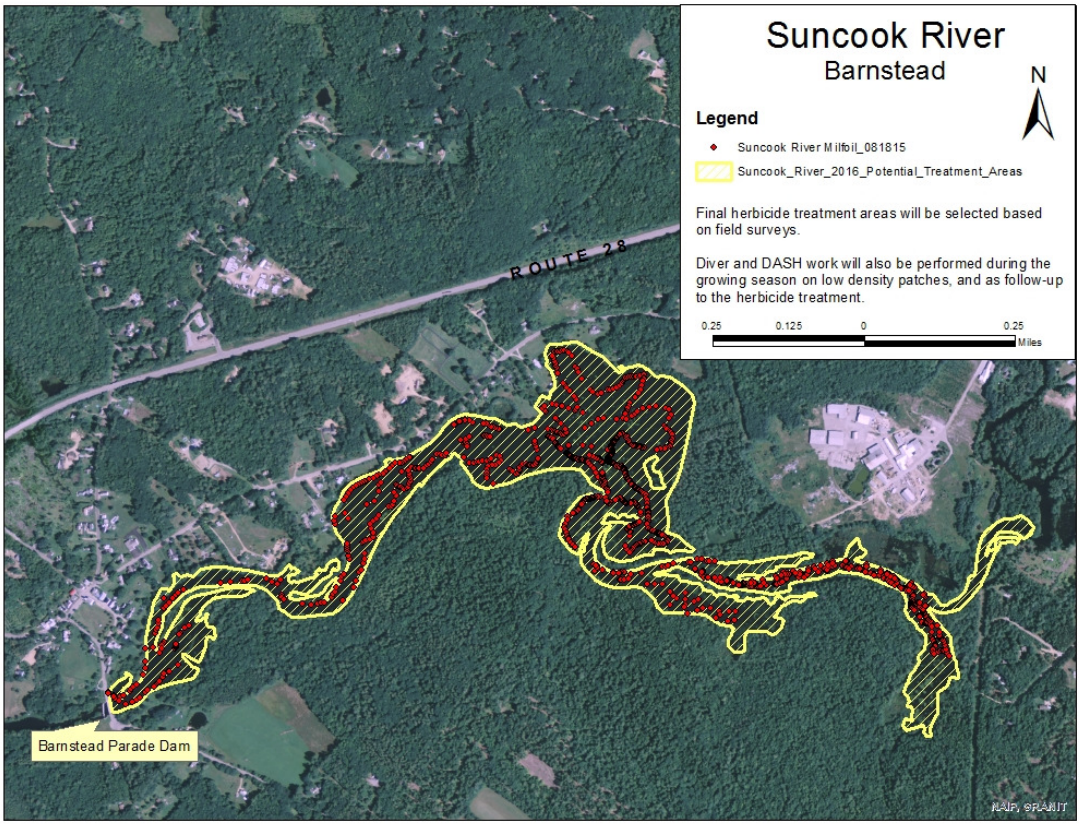
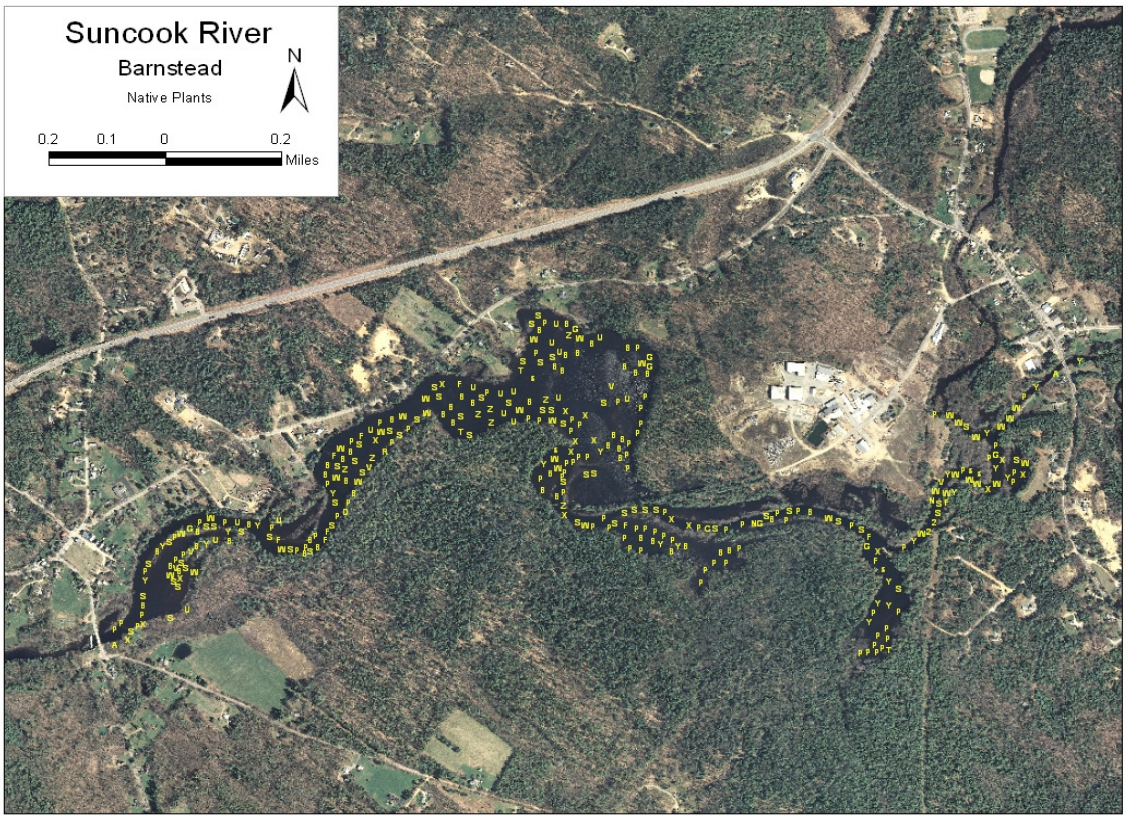


Figure 3: Map of Native Aquatic Macrophytes



Symbol	Common Name	Latin Name
B	Watershield	*Brasenia schreberi*
W	White water-lily	*Nymphaea*
U	Bladderwort	*Utricularia*
P	Pickerelweed	*Pontedaria cordata*
S	Bur-reed	*Sparganium*
X	Pondweed sp.	*Potamogeton sp.*
F	Floating heart	*Nymphoides cordatum*
N	Water naiad	*Najas sp.*
T	Cattail	*Typha*
Z	Pink water-lily	*unknown genus/species*
V	Tapegrass	*Vallisneria*
Y	Yellow water-lily	*Nuphar*
C	Buttonbush	*Cephalanthus occidentalis*
S	Grassy spike rush	*Eleocharis sp.*
A	Arrowhead	*Sagittaria sp.*
G	Grassy arrowhead	*Sagittaria graminea*

Figure 4: Bathymetric Map

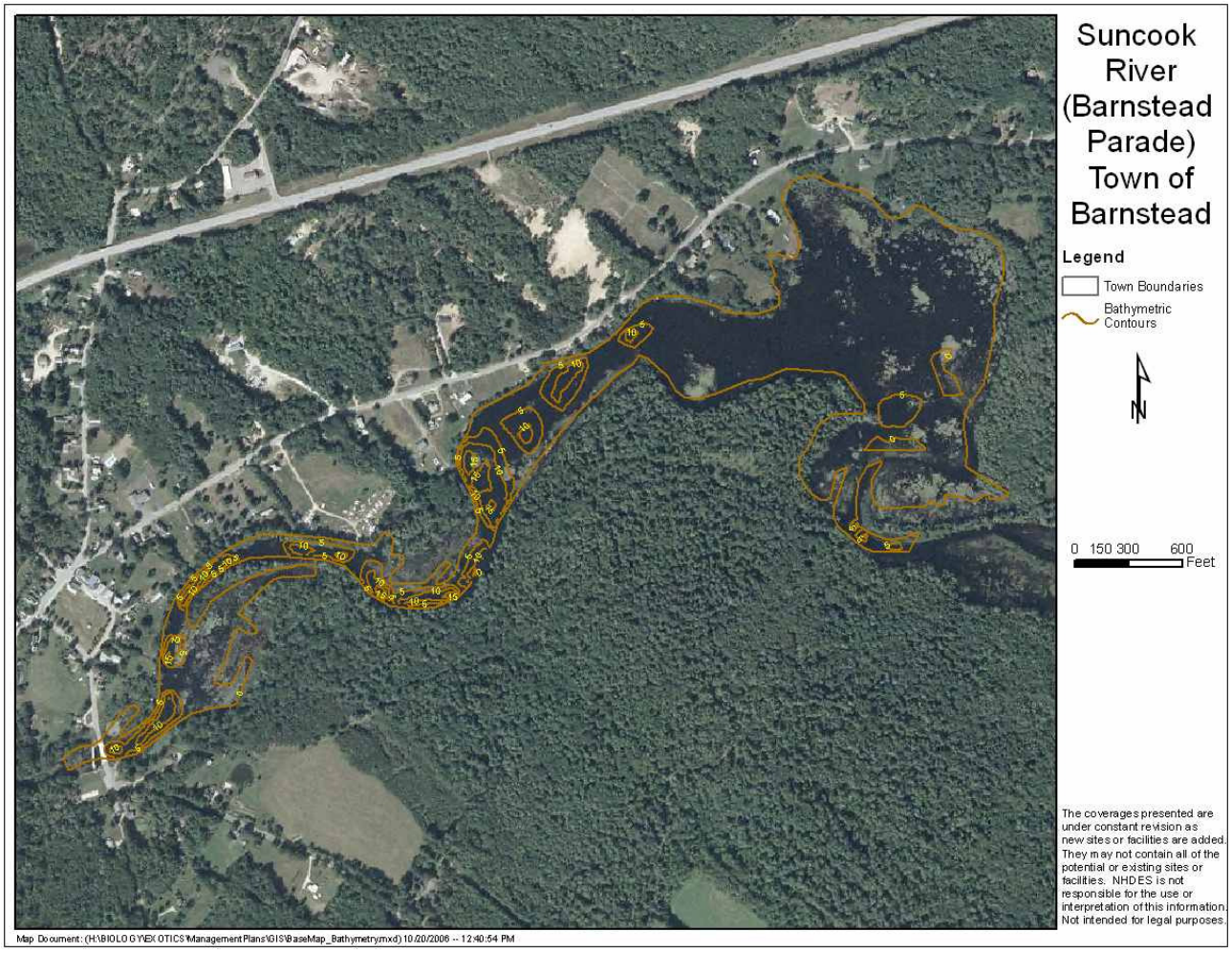
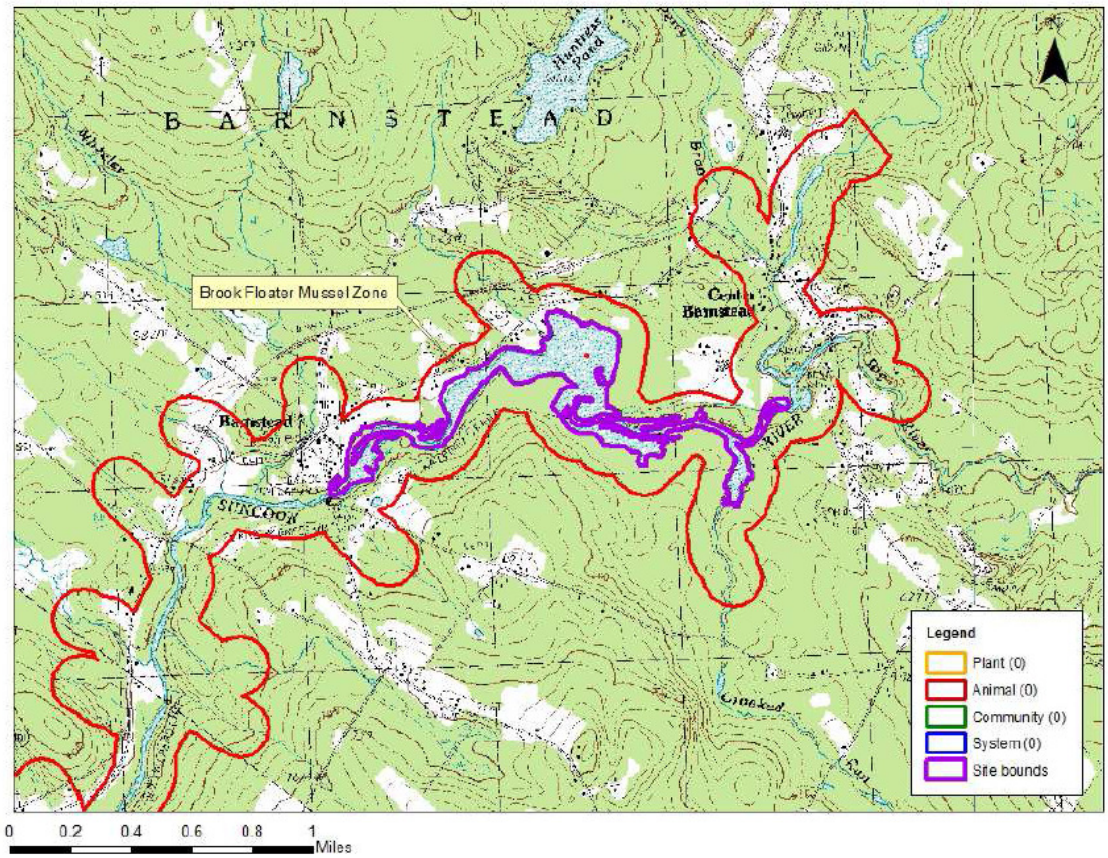


Figure 5: Critical Habitats or Conservation Areas

2016 Review

NHB15-4005

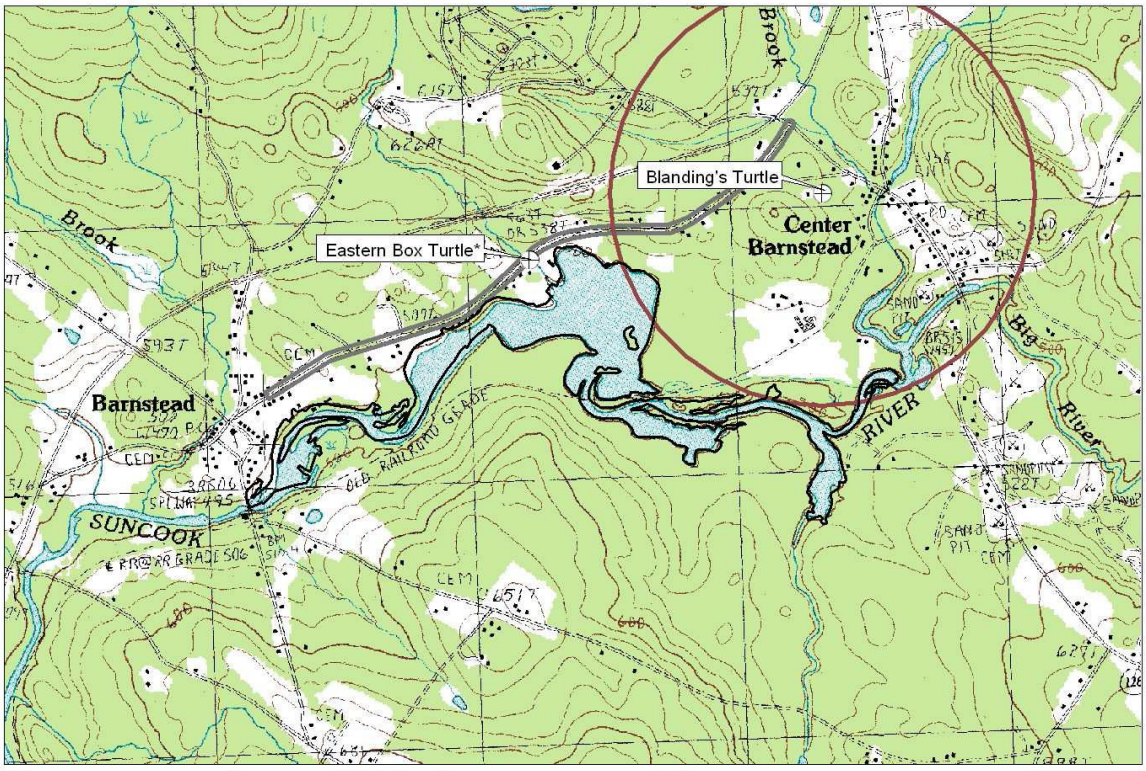


2015 Review

NH Natural Heritage Bureau

Known locations of rare species and exemplary natural communities

Note: Mapped locations are not always exact. Occurrences that are not in the vicinity of the project are not shown.



0.5 0 0.5 1 Miles

*Historical record

1:18000

Valid for one year from this date: 17 Apr 2014

Figure 6: Public Access, Swim Areas, Docks

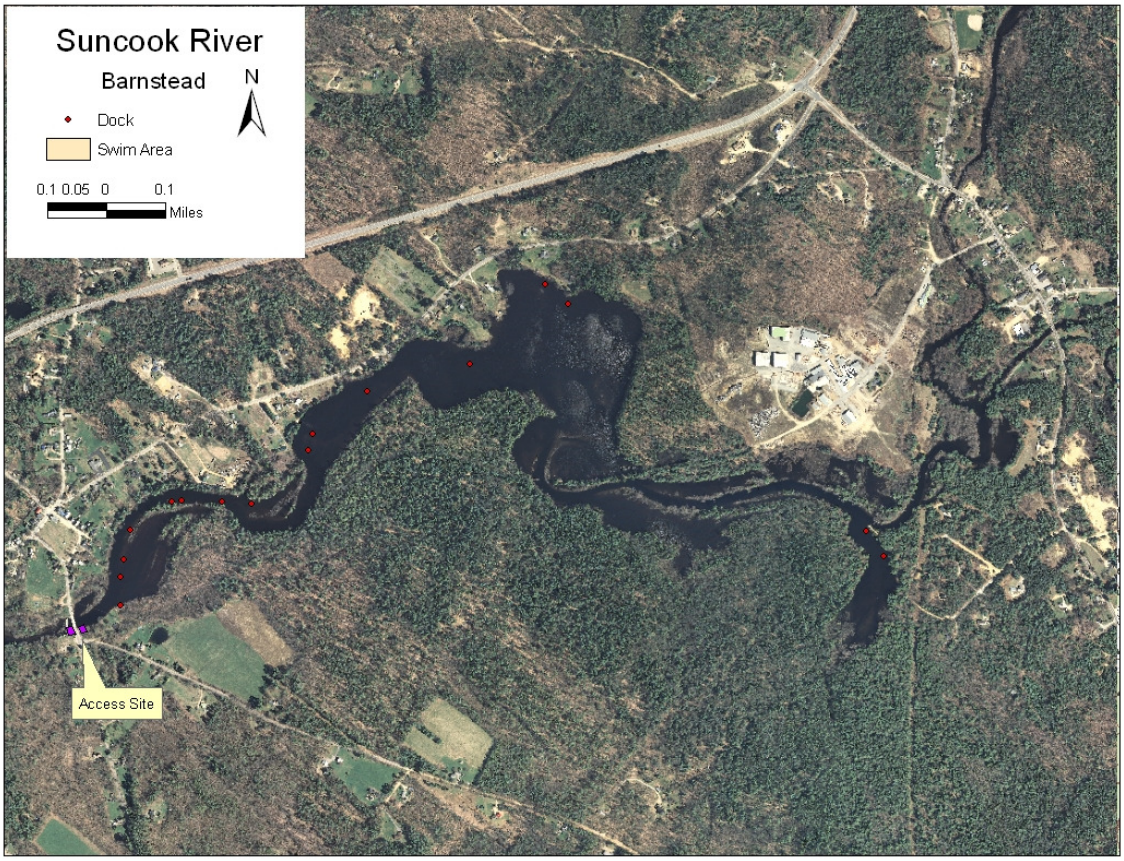
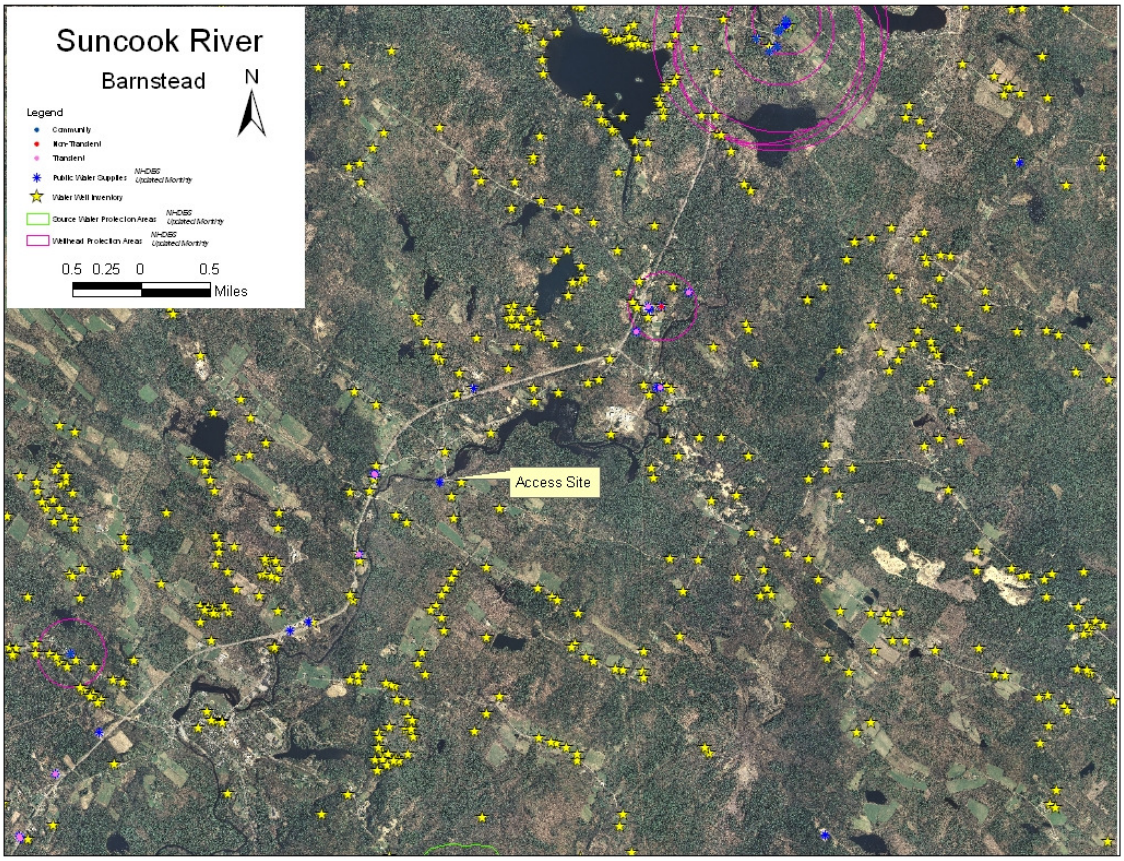


Figure 7: Wells and Water Supplies, 1:48,000 scale



Appendix A 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 four 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: 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

- 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).
- 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 Control Practices Used in New Hampshire

Restricted Use Areas and Fragment Barrier:

Restricted Use Areas (RUAs) are a tool that can be use 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, so as 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 DES 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. DES has only 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. DES 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 2008 summer 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 it is a little more expensive, but presents DES with another alternative that could be used in future treatments.

During the summer of 2010, DES 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).

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.

Extended Drawdown

Extended drawdown serves to expose submersed aquatic plants to dessication 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 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

Department of Environmental Services. 2006: 2006 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology. November 2005. New Hampshire Department of Environmental Services. NHDES-R-WD-05-29. Available at http://des.nh.gov/WMB/swqa/calm.html

Halstead, J.M., J. Michaud, S. Hallas-Burt, and J.P. Gibbs. 2003. "An Hedonic Analysis of Effects of a Nonative Invader (*Myriophyllum heterophyllum)* on New Hampshire (USA) Lakefront Properties." Environmental Management. 32 (3): 391 – 398

Luken, J.O. and J.W. Thieret. 1997. Assessment and Management of Plant Invasions. Springer-Verlag, New York. 324 pages.