Northeast Aquatic Research

2019 Monitoring Report

Article 409 Nuisance Plant Monitoring of Lakes;
Candlewood, Lillinonah, and Zoar

Prepared for FirstLight Power Resources
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Executive Summary

Northeast Aquatic Research LLC (NEAR) conducted the 409 Nuisance Plant Monitoring Surveys of Candlewood Lake, Squantz Pond, and Lake Lillinonah in 2019. In 2018, NEAR surveyed Lakes Candlewood, Squantz Pond, and Zoar.

The 2019 survey of Candlewood Lake revealed 477 acres of Eurasian Milfoil. The previous three years showed very similar coverage at: 511 acres in 2018, 498 acres in 2017 and 506 acres in 2016.

Three invasive aquatic plant species were found during the Candlewood/Squantz Pond survey: Eurasian milfoil (*Myriophyllum spicatum*), Brittle Waternymph (*Najas minor*), and Mudmat (*Glossostigma cleistanthum*). The following invasive plants specified in the 409 Survey Plan were not found in Candlewood Lake in 2019:

- *Butomus umbellatus* (Flowering rush)
- *Cabomba caroliniana* (Fanwort)
- *Egeria densa* (Brazilian water-weed)
- *Marsilea quadrifolia* (European waterclover)
- *Myriophyllum heterophyllum* (Variable-leaf watermilfoil)
- *Potamogeton crispus* (Curly-leaved pondweed) –**Found in Lake Lillinonah**
- *Rorippa nasturtium-aquaticum* (Watercress)
- *Trapa natans*-(*Water chestnut*) –**Found in Lake Lillinonah**

Eurasian milfoil formed a dense band between approximately 6-7ft and 15ft of water depth. Milfoil growth was relatively consistent along shoreline areas that can support plant growth. Variations in bed width frequently followed the lake depth contours. Some milfoil was found growing to a maximum of 20ft of water depth.

No milfoil was found in Squantz Pond during the 2019 survey.

Invasive *Najas minor* (Brittle waternymph/Spiny naiad) and *Glossostigma cleistanthum* (Mudmat) were scarce in both lakes (**Map 13**). In Candlewood Lake, *Glossostigma* was found mainly in Echo Bay and along the eastern shoreline of New Milford Bay, as well as one or two plants in several small coves. In Squantz Pond, *Glossostigma* was found along the northeastern shoreline. *Najas minor* was found at 10 waypoints scattered throughout Candlewood lake and at one location in Squantz pond.

The winter water level drawdowns in 2016 – 2018 were all shallower than 8 feet. In 2019, the lake reached a maximum drawdown depth of 8.7 feet:

2015-16 = max depth of -4.18ft
2016-17 = max depth of -5.6ft
2017-18 = max depth of -7.68ft
2018-19 = max depth of -8.7ft

Native aquatic plant species were very scarce in both Candlewood and Squantz Pond.

8 native plants were found in Candlewood:

Ceratophyllum demersum
Elatine minima
Eleocharis acicularis
Najas flexilis
Nymphaea odorata
Potamogeton pusillus
Vallisneria americana
Wolffia sp

4 native plant species were found in Squantz Pond:

Ceratophyllum demersum
Elatine minima
Eleocharis acicularis
Potamogeton amplifolius

The 2019 Survey of Lake Lillinonah found 134 acres of Eurasian milfoil, 15 acres of Brittle waternymph, and 2.7 acres of Curly-leaf pondweed. Water chestnut was found at 23 waypoints in the lake.

- 9 native plants were found in Lake Lillinonah

Ceratophyllum demersum
Elodea canadensis
Lemna
Potamogeton nodosus
Potamogeton perfoliatus
Stuckenia pectinata
Potamogeton pusillus
Vallisneria americana
Zosterella dubia

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Article 409 Survey Background

On February 3, 2006, the Federal Energy Regulatory Commission (FERC) approved methodology for the licensee to conduct Article 409-Nuisance Plant Monitoring at Candlewood Lake, Lake Lillinonah and Lake Zoar (Rocky River, Shepaug, and Stevenson Developments)[1]. The licensee at the time of this report is FirstLight CT Housatonic LLC. (FirstLight). Nuisance plant monitoring involves conducting annual or biannual surveys at Candlewood Lake, Lake Lillinonah, and Lake Zoar, to determine presence and extent of invasive aquatic plant species.

The Connecticut Agricultural Experiment Station (CAES) conducted the Article 409 Survey under contract with the licensee for 12 years (2007-2017) The number of days and months of the surveys are recorded in **Table 1**. NEAR first performed the Article 409 Survey in 2018.

Table 1 *Dates of prior Nuisance Aquatic Plant Surveys of Candlewood Lake 2007 to 2018*

Year	Acres of Milfoil	Days of survey time each month					Total
		June	July	August	Sept.	Oct	days
2019	477			4	5		9
2018	511			7	2		9
2017	498	3	2	12			17
2016	506	4		12	2		17
2015	441	1	1	10	1		13
2014	447	4	1	11	4		20
2013	259	3		14	2	1	20
2012	505	5		16			21
2011	331			17	4	2	23
2010	461		1	14	1		15
2009	373			13	2		15
2008	451	1	5	9	3		18
2007 (all 3 lakes)	221	2	7	8			17

Yellow shading is Lake Lillinonah survey years
Blue shading is Lake Zoar survey years
Green shading are Curly-leaf pondweed surveys in Candlewood

2019 Article 409 Survey Methods

Northeast Aquatic Research (NEAR) conducted the Article 409 Nuisance Plant Monitoring Plan Survey (Article 409 survey) in 2019. Candlewood Lake was surveyed over nine days between August 19th and September 10th, 2019. Squantz Pond was surveyed on August 16th, 2019. Lake Lillinonah was surveyed over six days between July 30th and August 15th. The Lake Zoar herbicide treatment areas were surveyed under a separate contract with Lake Zoar Authority on July 16th for pre herbicide treatment conditions and September 23rd for post herbicide treatment conditions. The dates of the Candlewood Lake and Squantz Pond survey are presented in **Table 3**, along with the

[1] FERC. Feb. 2006 Order Modifying and Approving Nuisance Plant Monitoring Plan Pursuant to Article 409

number of miles searched per day. The number of miles surveyed per day varied due to differences in the area of littoral zone in each location.

Table 2 *Dates of NEAR 2019 aquatic plant surveys in Candlewood Lake and Squantz Pond*

Date	Location	Miles of shoreline surveyed	Number of Waypoints
August 19	Western Sherman Arm	6.64	192
August 20	Northern Sherman Arm	6.66	159
August 22	Eastern Sherman Arm	8.09	210
August 30*	Western New Milford Arm, Western Central Basin, Southern Echo Bay	13.53	466
September 3	Northern New Milford Bay	3.25	97
September 5	Eastern New Milford Arm	6.96	172
September 6*	Eastern Danbury Bay & Northern Echo Bay	4.47	169
September 9	Western Danbury Bay	10.01	414
September 10	Southeastern New Milford Arm	4.89	109
	Sub-Total =	**64.48**	**1988**
August 16	Squantz Pond	5.4	203
	Candlewood + Squantz Total =	**69.88**	**2,191**

* Two teams surveyed on these days

Northeast Aquatic Research Survey Methods

General Methodology

Surveys were conducted using high resolution down-imaging SONAR devices (Humminbird 688ciHD and/or Garmin Echo Map 74cv) transfixed to a survey boat. Both SONAR devices have imaging power of 455 and 800 kHz and scrolling images of resolved features in the water column, with water depth contours at 5 feet intervals. Scroll speed was set to 0.5 feet/sec.

A Garmin GPSMap78 (GPS) was used to record waypoints and tracks during the survey. GPS waypoints were made when the boat was stopped to improve location accuracy. Waypoints provide geographical sampling units to estimate community species richness, diversity, abundance, and density. Waypoints were typically made at intervals of 200 feet throughout the littoral zone. Additional waypoints were made when water depth changed rapidly, species composition/density changed, or when new species were found. Extra waypoints were taken when necessary to improve mapping accuracy. Regular 200ft spaced waypoints were made at inner and outer edges of Eurasian milfoil beds. Detailed field notes documented the depth of the inner and outer edge of Eurasian milfoil stands, as shown by the depth soundings in **Photo 1**, as well as between waypoints to document the continuous nature of the milfoil bands. Samples of plants were collected with a pole rake and throw rake at each waypoint where aquatic plants were not entirely visible from the surface. Aquatic plants were identified according to Crow and Hellquist 2000[2]. In addition to waypoints, the GPS continuous survey track from each day recorded the continuous position of the boat.

NEAR Survey Methods Details

The central purpose of the Article 409 Survey is to census the population of Eurasian milfoil and to search for new invasive species in the three lakes. The plant surveys aim to report the surface coverage, location, and qualitative density of each invasive and native species found. Annual locations and acreages are to be compared against data from previous years. This type of census survey requires a diligent search for target plants in the littoral zone. New

[2] Crow and Hellquist 2000. Aquatic and Wetland Plants of Northeast North America.

or rarely present species are more likely found with this "meander" survey technique than with transect-based surveys.

Eurasian milfoil in Candlewood Lake frequently inhabits the steep sided narrow littoral zone, meaning that plant beds are typically very narrow, sometimes just two boat lengths from shore. A "meander" survey is performed through surveying along shore in one direction, following the edges of the plant beds. The outer edge of plant growth is not visible from the boat[3] (Kalff 2002[4]). The outer edge of plant growth was found using SONAR images, which showed a flat featureless line when plants stopped growing at certain depths (**Photo 1**). The lack of plant cover was verified with at least two throws of the rake. The edge was marked with a waypoint and water depth was recorded. The outer edge of plant growth can be considered the boundary between the littoral zone and water too deep to support rooted aquatic plants. SONAR imaging was used continuously throughout the survey and noted for mapping purposes between waypoints.

Survey Track and Waypoints

Survey boat speed was maintained between 0.1 and 0.4 miles/hour. Surveyors continuously observed plants, primarily at the front of the boat, but also on either side of the boat. Maintained visual assessment allows for detection of rare and potentially new invasive species. Waypoints were made along the inner and outer edges of plant growth, which consisted primarily of invasive Eurasian milfoil. As previously described, waypoints were spaced roughly 200ft apart. Where the milfoil beds were consistent, waypoints could be made in a zig-zag pattern moving from inner and outer edges in one direction along the shore. In areas where Eurasian milfoil beds were not constant, the inner and outer edges were found using a survey pattern perpendicular to shore to document the outer limits of plant growth. Outer limits of plant growth were often governed by changes in landscape and slope. Consistency of milfoil beds was visually assessed between waypoints and indicated on data sheets as notes to improve GIS mapping accuracy. Field notes such as, "*Milfoil continuous band approximately 5ft wide from waypoints 50-70*," or "*Milfoil band wider (~15ft) between waypoints 70-78*," add more data to the survey and diminish the amount of interpolation between waypoints. Infrequent invasive species were also marked with GPS waypoints when identified, which is one reason why some waypoints occur closer together than the typical 200ft. Waypoints were also made to indicate the beginning and end of milfoil beds, when they occurred. The continuous GPS track, waypoints, and additional field notes were used for post-survey polygon creation in ArcGIS.

Waypoint Data: Density & Plant Height

Plant density was determined using a combination of three methods. The first method, visual density determination, is based solely on what is seen from the surface within 10ft of the boat. This method involves a scaled-up version of quadrat vegetation percent cover assessments. In this method, one visually assesses an estimate of how much area is covered by the plant in question. **Image 1** below demonstrates approximate ranges in visual percent cover of aquatic plants as seen from the surface. Yet, using an actual quadrat in the field is not appropriate for the large scale of aquatic plant surveys. For that reason, surveyors visualize a hypothetical quadrat, approximately 5-10ft in length, and then estimate coverage accordingly.

[3] This phenomenon is true because the minimum light requirement of SAV is much less than the transparency of the water.

[4] Kalff J. 2002. Limnology. Prentice Hall.

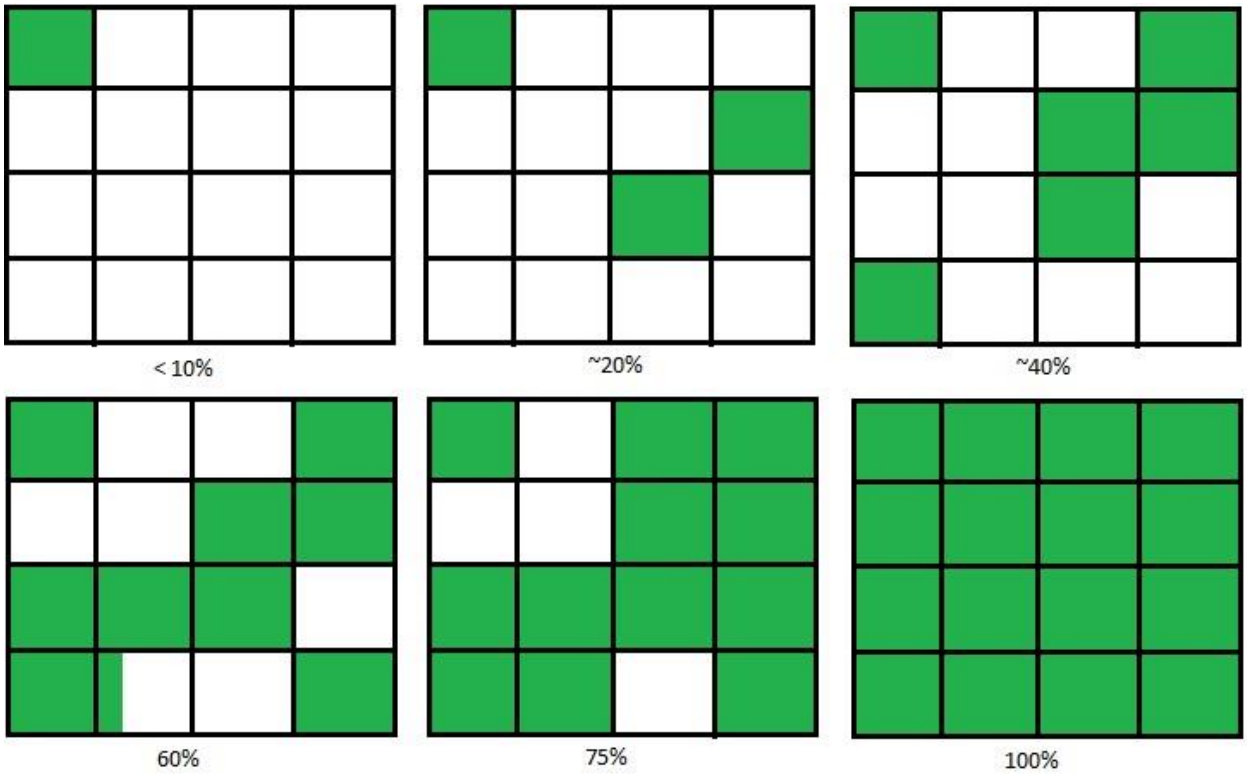


Image 1 *Visual Percent Cover Estimate Guides - Hypothetical Field Quadrats ~10ft across*.

Visual estimates are made by a single person throughout the survey, but survey team members do input their perceived percent coverage estimates if the primary surveyor's estimate seems too low or too high. Team collaboration encourages objectivity and more accurate estimates.

The second way to estimate percent cover of vegetation is to use down-imaging SONAR, which shows a detailed image of the plants as the boat passes above (**Photo 1**). SONAR imaging is used to corroborate visual percent cover estimates in areas where plants can be seen from the surface. In areas where plants cannot be seen from the surface, the SONAR image becomes the primary way to 'see' coverage. SONAR and visual estimates are then corroborated by weed-rake tosses. Rake tosses involve stopping the boat and throwing a 30ft line to tow through plant beds. Plants retrieved by the rake are estimated semi quantitatively as a percent cover:

Sparse (1-19%, handful of plants)
Moderate (20-59%, plants covering about half of the rake tines)
Dense (60-100%, plants covering all rake tines)

When possible, all three methods of estimating percent cover are used at each waypoint, and the resulting estimate is recorded on the datasheet. Raking in shallow water, however, yields limited results due to sandy and rocky substrates, so visual assessment was the primary density determination method for waters shallower than 3ft.

Coverage percentages are used to distinguish between Sparse, Moderate, and Dense plant beds for the purposes of GIS mapping.

The down-imaging SONAR device is also used to estimate plant height in the water column, as well as the water depth (**Photo 1**). In almost all cases in Candlewood Lake, Eurasian milfoil reached to only 1-2ft from the surface. Survey methods involve a number scale of 1 to 5 in estimating plant height in the water column.

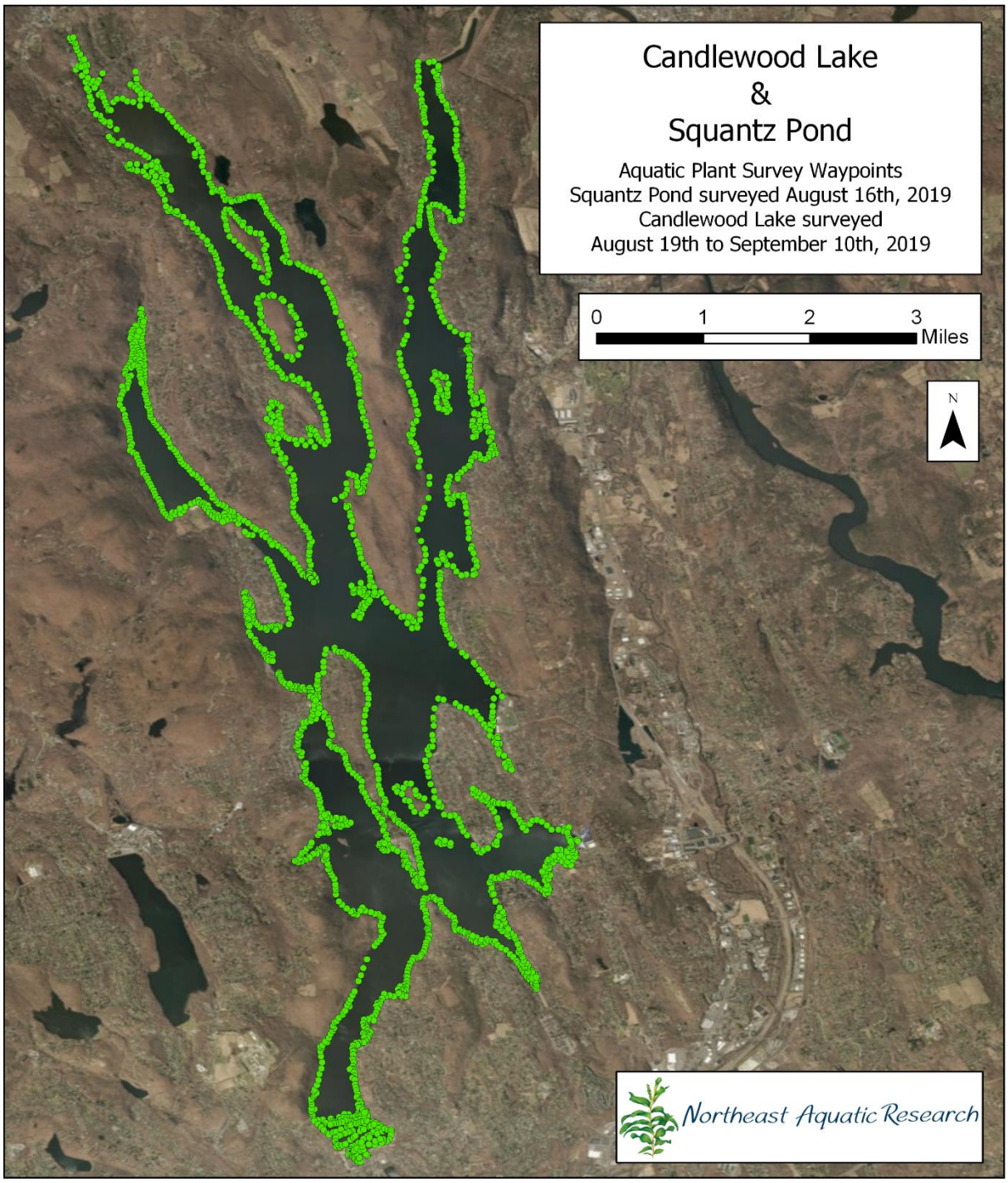
1 = Plants low to the lake bottom, not more than a few inches tall.
2 = Plants reach about 1/3 of water depth tall.
3 = Plants reach about 2/3 of water depth tall, typically 1-2ft below the surface in milfoil depth-ranges.
4 = Plants just beneath the surface, < 1ft from surface.
5 = Plants "topped out" and breaking the surface, likely flowering.

Photo 1 *Down-imaging SONAR images showing edge of milfoil coverage and the height of milfoil plants. Milfoil is shown reaching to about 3 feet from the surface in both images. Plants in the first image begin growing at 7.5ft deep, while milfoil plants in the second image are very sparse in shallow water and dense starting at 8ft. The boat is at far right at time of depth readout in both images.*

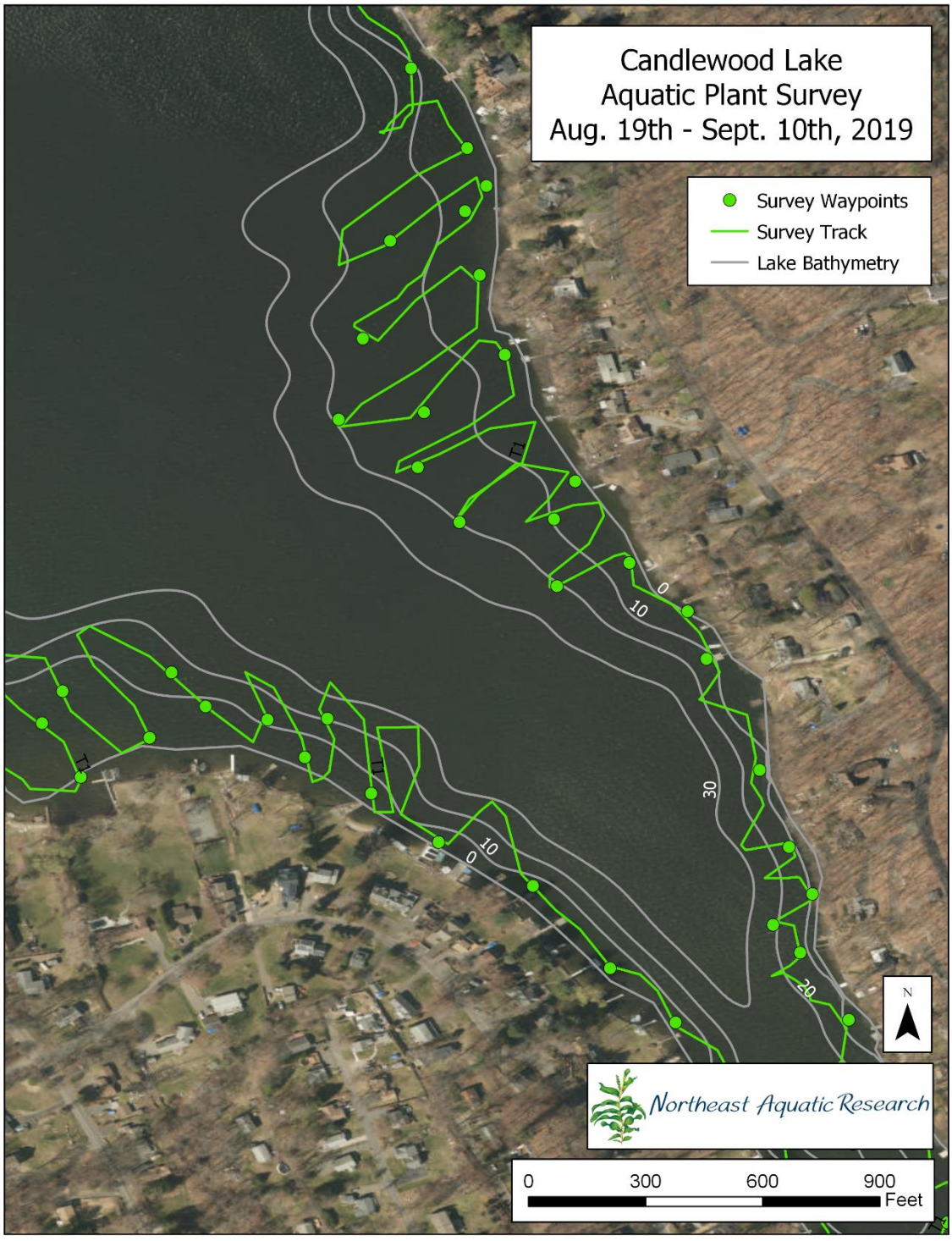
GIS Mapping

A total array of 1,988 waypoints were created in Candlewood Lake and 203 waypoints were created in Squantz Pond (**Map 1**)**.** A zoomed area of a section of waypoints and survey track are shown in **Map 2**. All waypoints were used in ArcGIS to create the milfoil maps. In ArcGIS, the project's coordinate system was set to *CT State Plane NAD83*. The GPS tracks and waypoints were uploaded as .gbd files and converted to .gpx files using GPSBabel, and then ESRI 2D shapefiles (.shp), using DNRGarmin. Both are simple file formatting computer programs designed to transfer GPS data between various types of mapping programs. The three density categories for milfoil – Sparse, Moderate and Dense – taken from waypoint percent cover data, were mapped by using the GPS track, waypoints, and survey notes as guides to accurately draw polygons. Bathymetric data was also used to determine the edges of polygons between waypoints in areas where the GPS track did not directly follow the outer or inner edges of milfoil bands. Bathymetric data was verified using depths recorded on survey notes as well as additional field notes between waypoints that indicated the depth range of the milfoil beds. Total acreage of polygons within each density category was calculated in the layer's attribute table.

Map 1 *All waypoints made in Candlewood Lake and Squantz Pond during NEAR 2019 survey*



Map 2 *Zoomed section of survey track and waypoints*



Candlewood Lake Results

INVASIVE AQUATIC PLANTS

Three invasive aquatic plant species were found in Candlewood Lake during the 2019 survey: Eurasian milfoil *(Myriophyllum spicatum*), Brittle waternymph (*Najas minor*), and Mudmat (*Glossostigma cleistanthum*). These are the same three invasive species that were found in Candlewood during the 2018 survey (**Table 3**).

Eurasian milfoil was the most frequent invasive species, with coverage spanning 477.0 acres. Of this total, there were approximately 262.2 acres of high-density beds (**Table 4**). Locations of Eurasian milfoil beds in Candlewood Lake are shown on **Maps 3-12.**

Brittle waternymph was very scarce in Candlewood Lake, found at only 10 waypoints. All plants were less than 12 inches tall. For comparison, Brittle waternymph was found at 27 waypoints in 2018. The 2019 locations are shown for both Candlewood Lake and Squantz Pond in **Map 13**.

Mudmat is a minute plant with quarter-inch long leaf blades. This plant grows in shallow sandy sediments in water depths of just several inches. Mudmat was found at 22 waypoints in Candlewood Lake in 2019, compared to 17 waypoints in 2018. Locations of Mudmat are also are shown in **Map 13**.

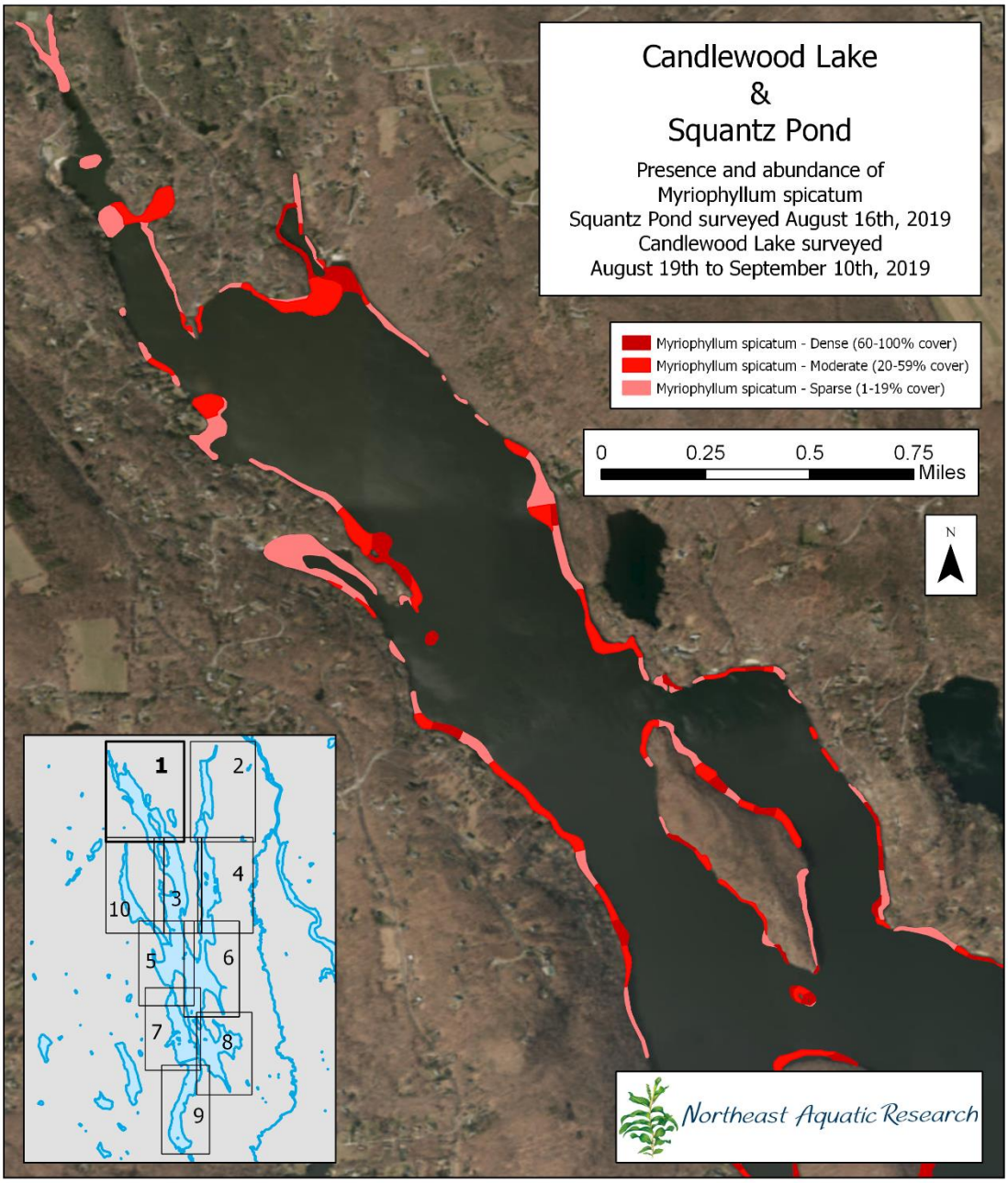
Table 3 *Invasive aquatic plant species found in Candlewood Lake by NEAR during 2018 & 2019 surveys*

Invasive Species	% Frequency 2019	% Frequency 2018
Eurasian Milfoil	74.5%	83.10%
Brittle Waternymph	0.5% / 10 points	1.6% / 27 points
Mudmat	1.1% / 22 points	1% / 17 points

Table 4 *Acreages of milfoil density categories in 2018 and 2019*

Density Category	2019		2018	
	Acres	% of Total Acres	Acres	% of Total Acres
Dense	262.2	55.0	418.1	81.7
Moderate	112.8	23.6	61.7	12.1
Sparse	102.1	21.4	31.8	6.2
Total	477.0		511.7	

Map 3 *Zone 1*


Candlewood Lake
&
Squantz Pond
Presence and abundance of
Myriophyllum spicatum
Squantz Pond surveyed August 16th, 2019
Candlewood Lake surveyed
August 19th to September 10th, 2019
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Myriophyllum spicatum - Moderate (20-59% cover)
Myriophyllum spicatum - Sparse (1-19% cover)
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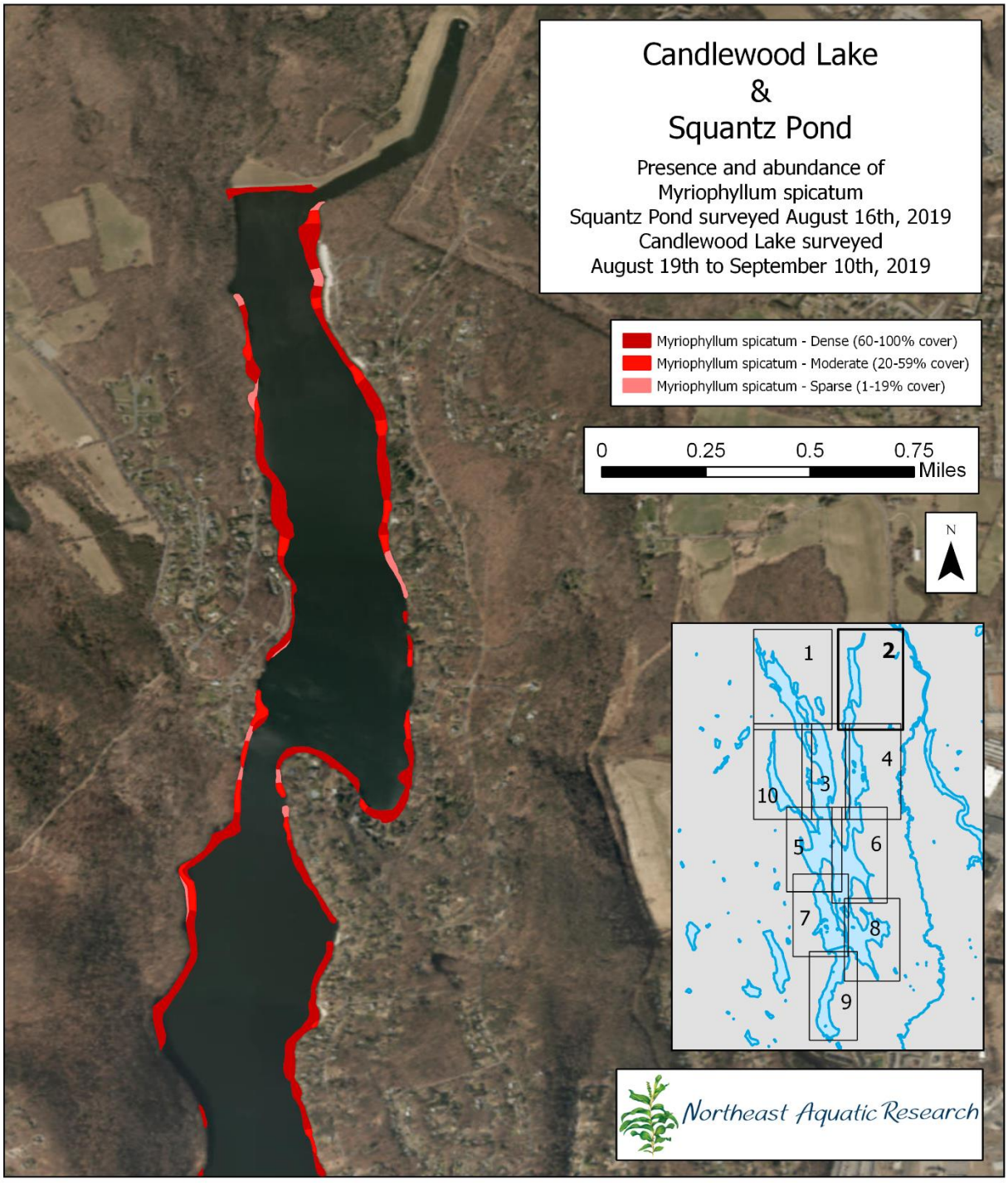
Map 4 *Zone 2*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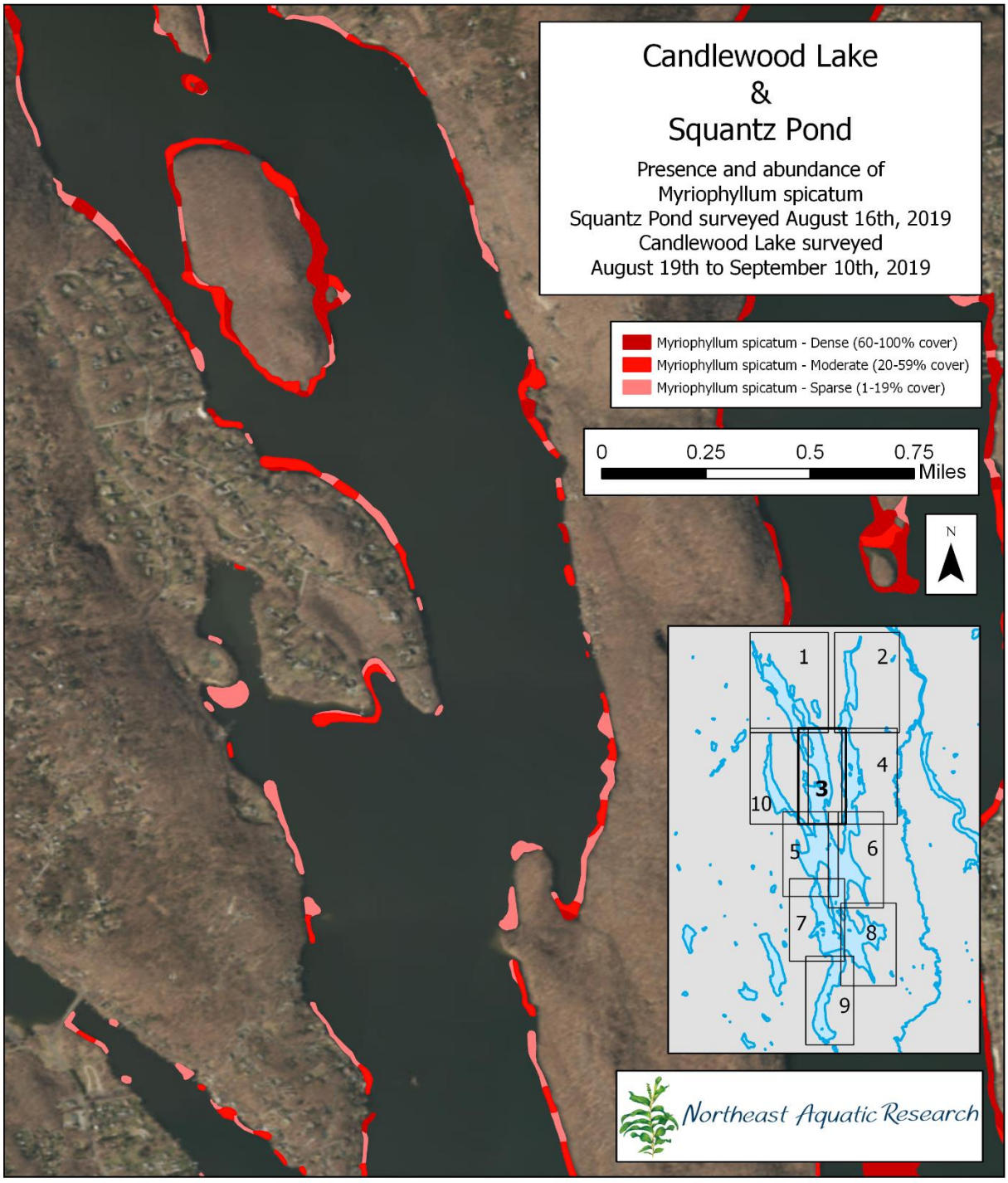
Northeast Aquatic Research

Map 5 *Zone 3*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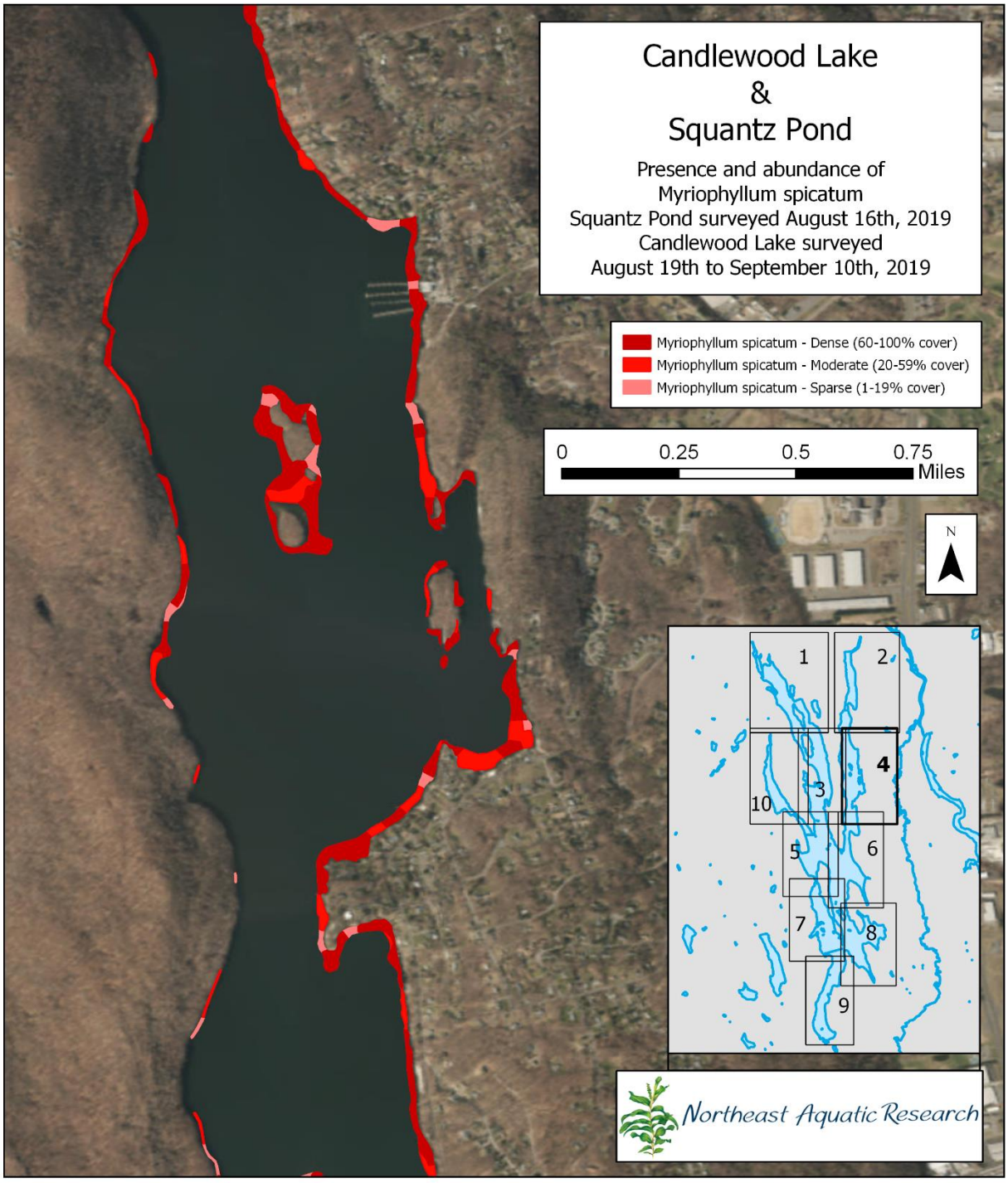
Northeast Aquatic Research

Map 6 *Zone 4*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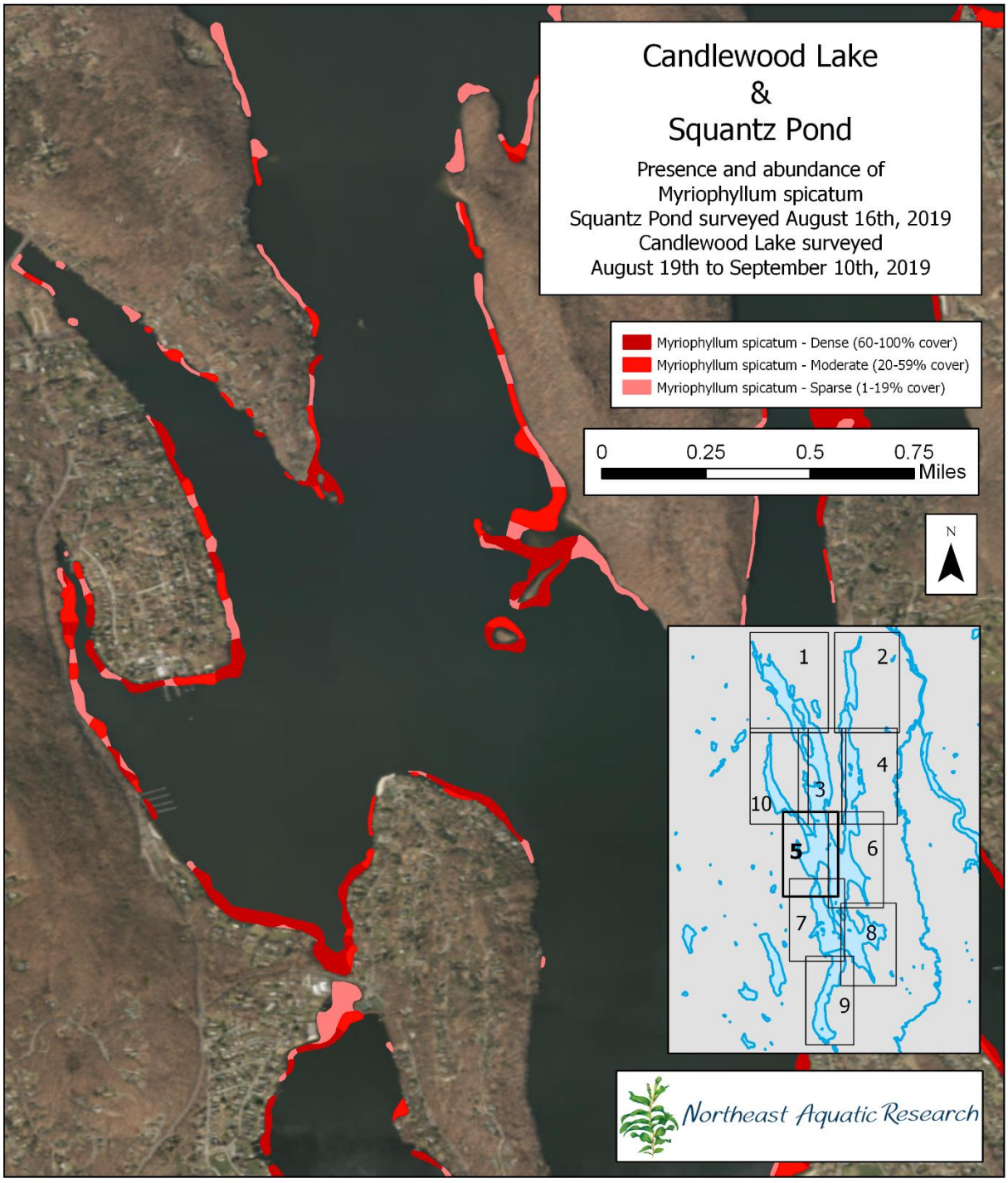
Northeast Aquatic Research

Map 7 *Zone 5*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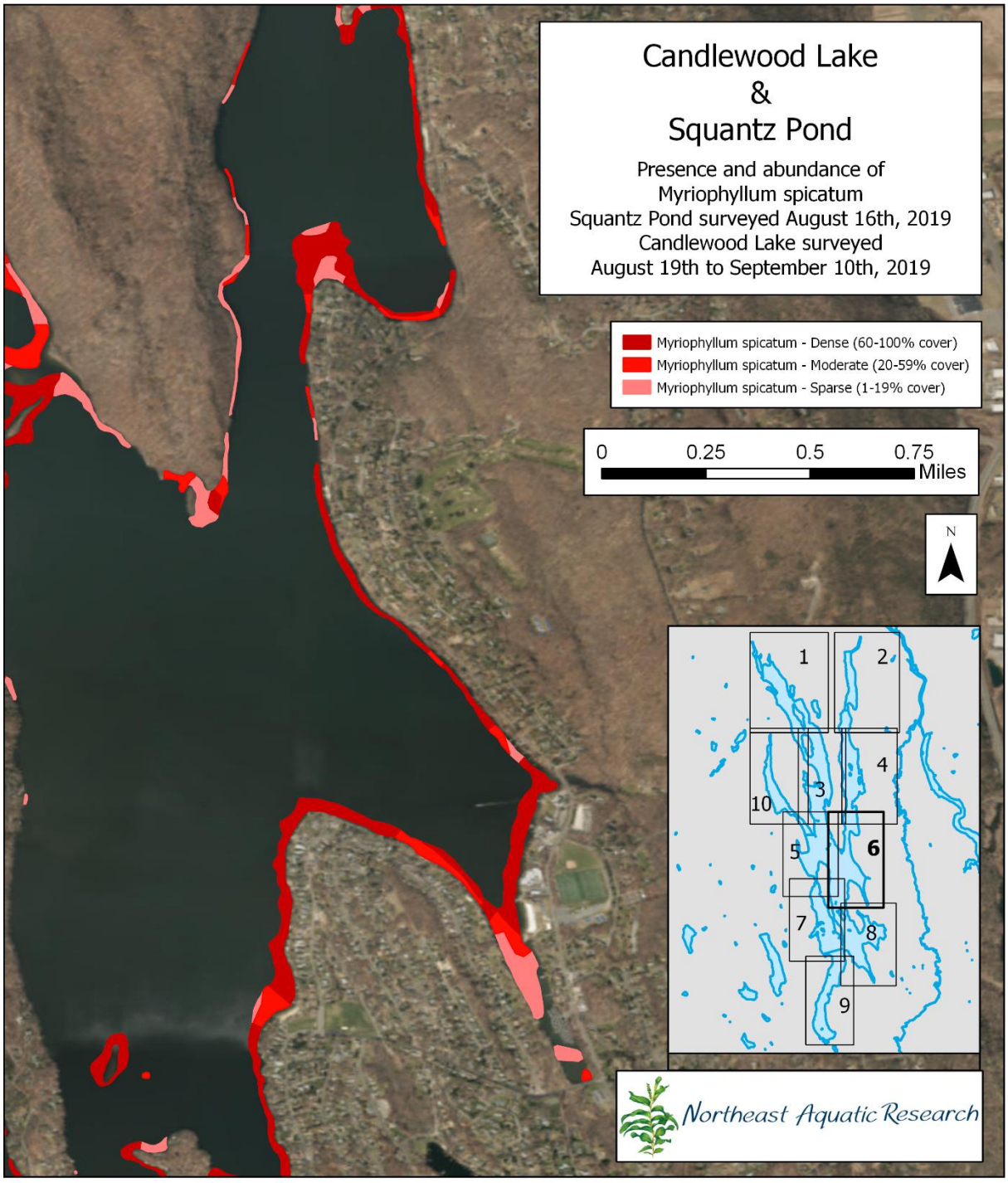
Northeast Aquatic Research

Map 8 *Zone 6*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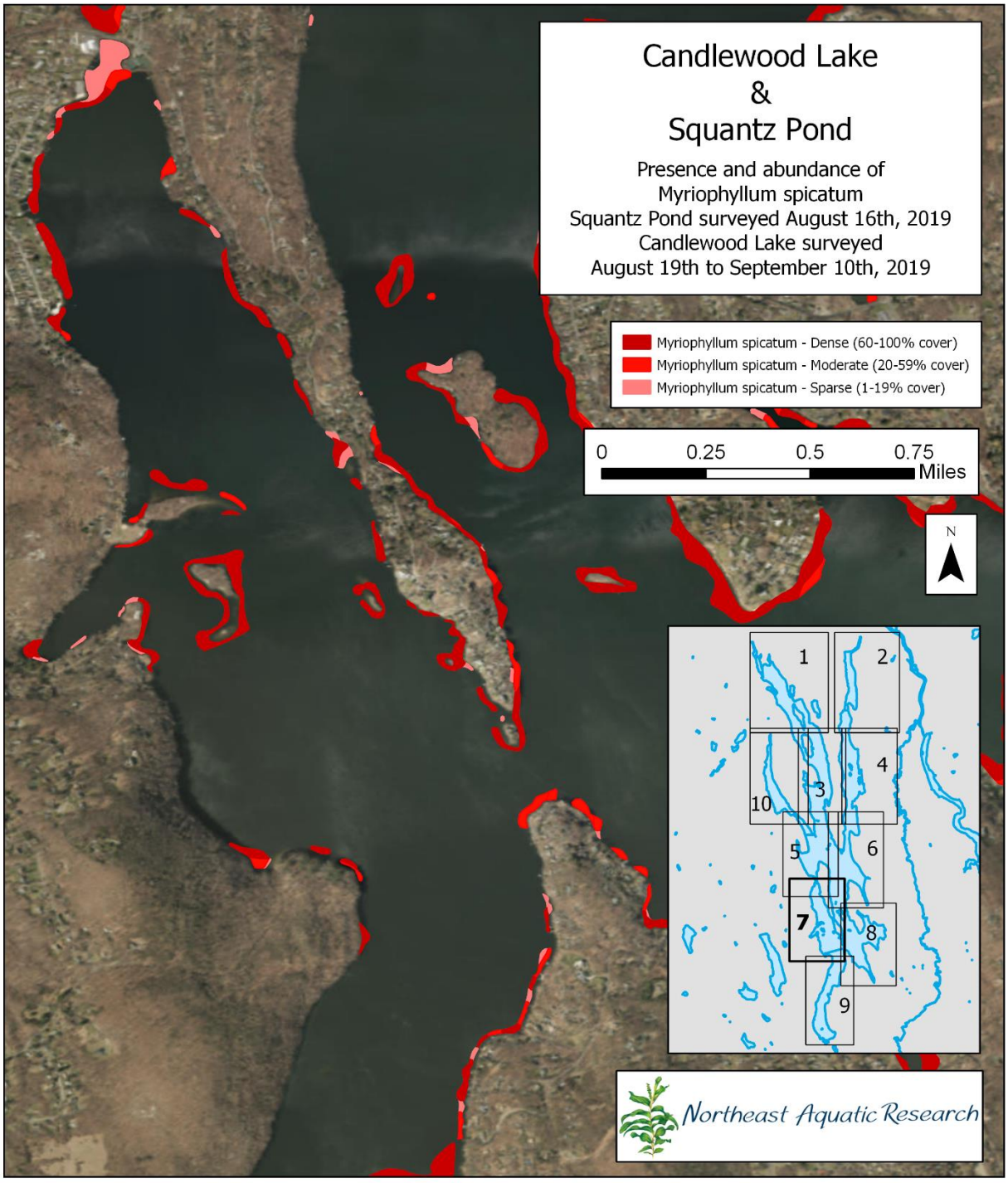
Northeast Aquatic Research

Map 9 *Zone 7*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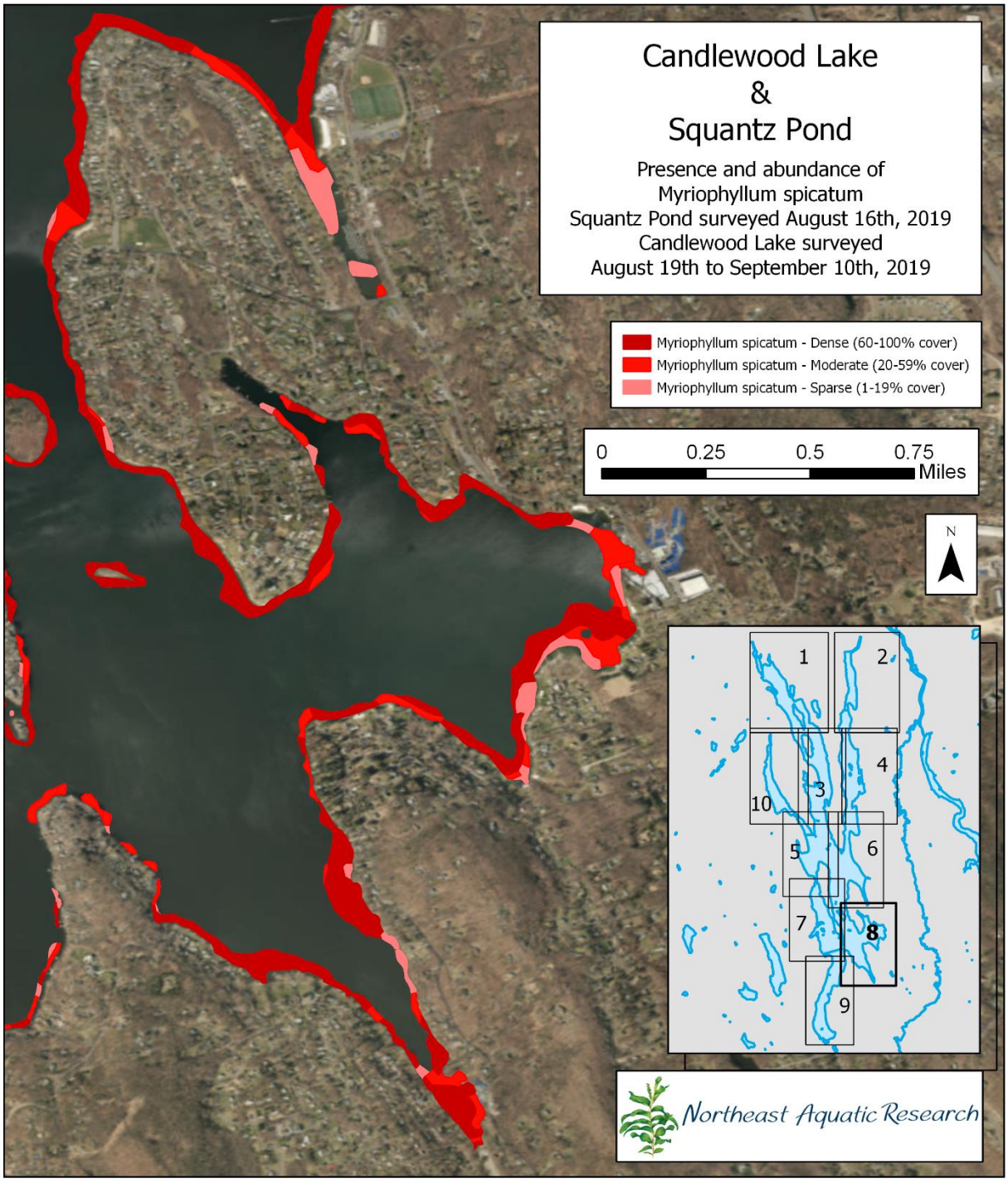
Northeast Aquatic Research

Map 10 *Zone 8*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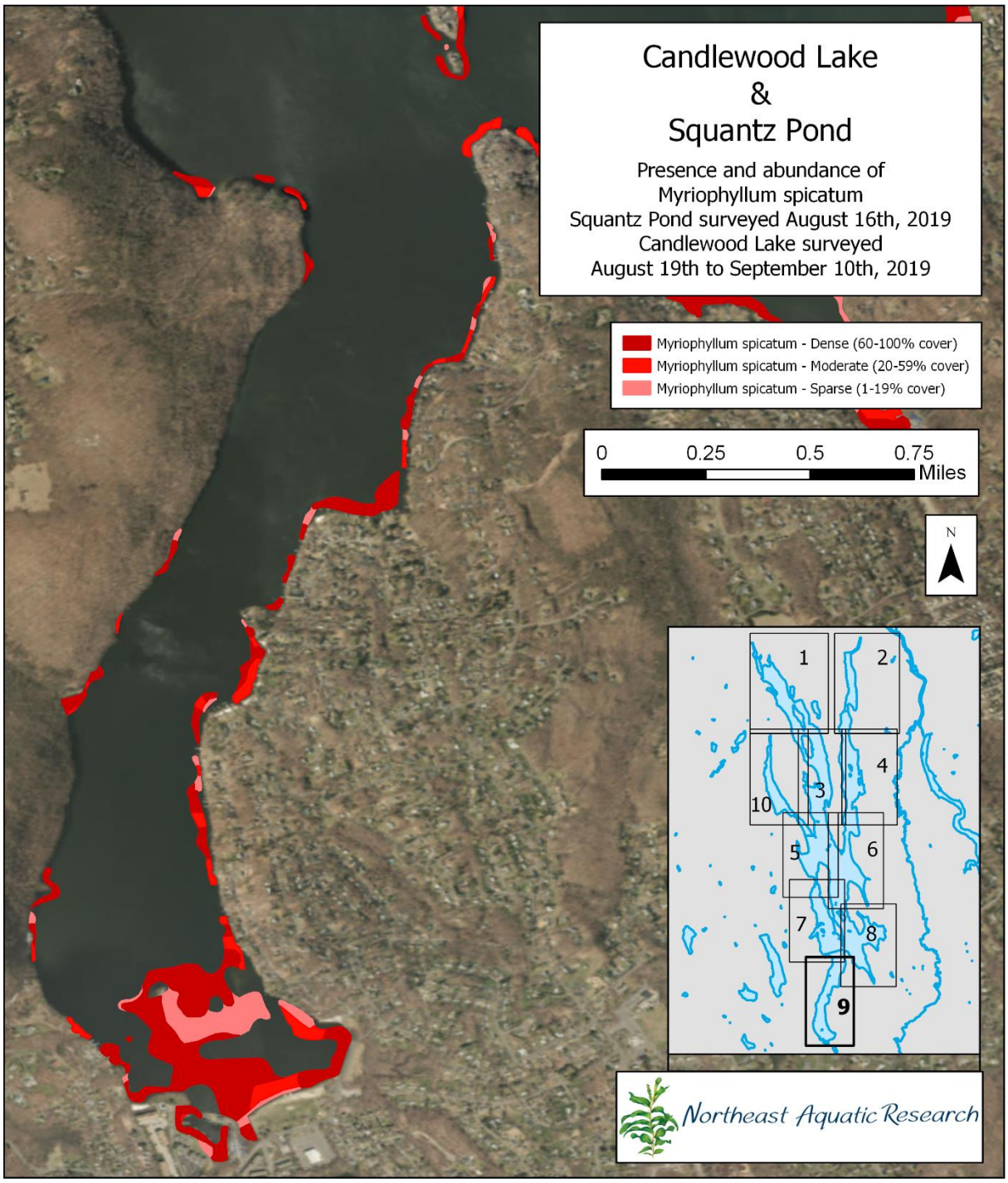
Northeast Aquatic Research

Map 11 *Zone 9*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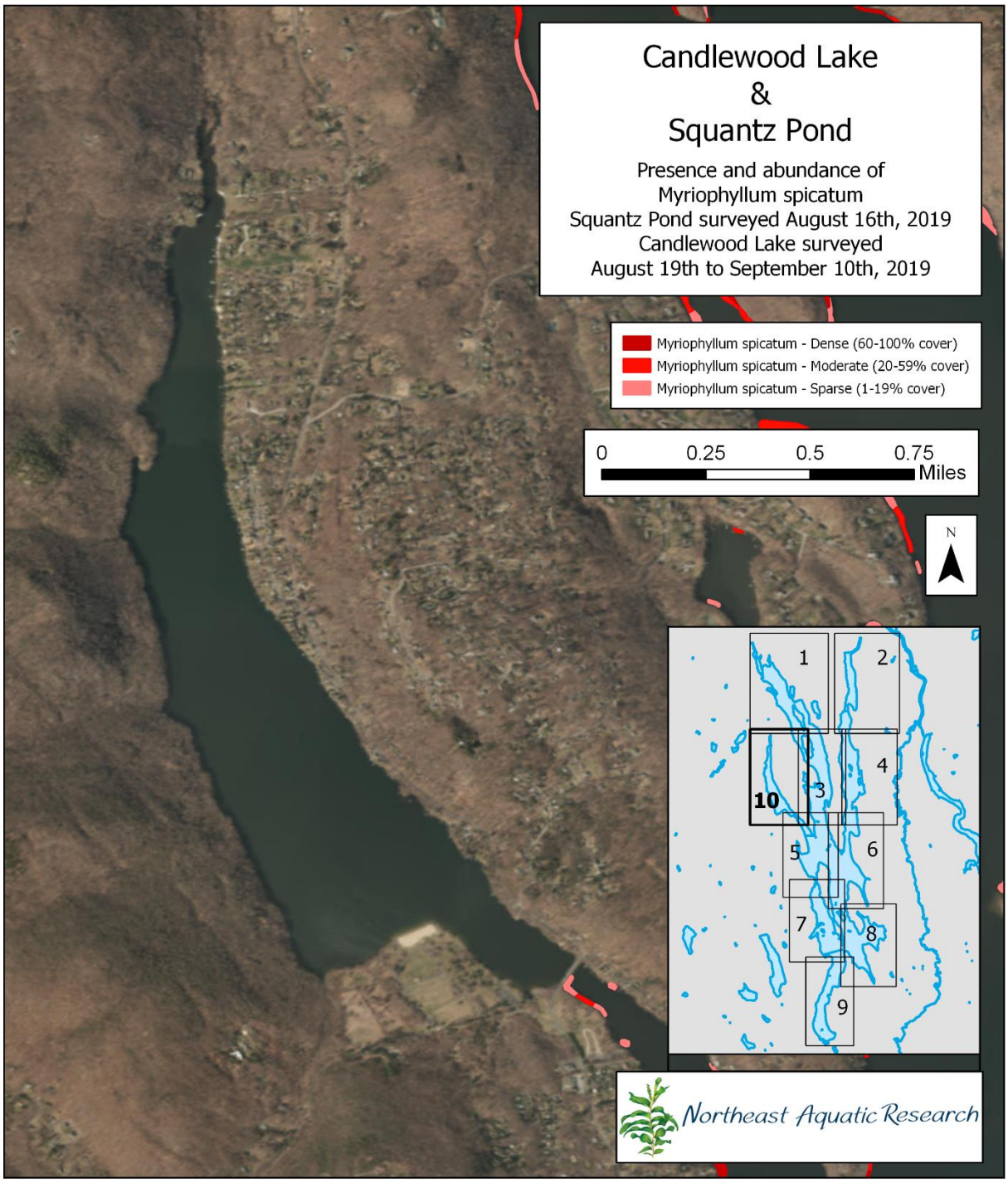
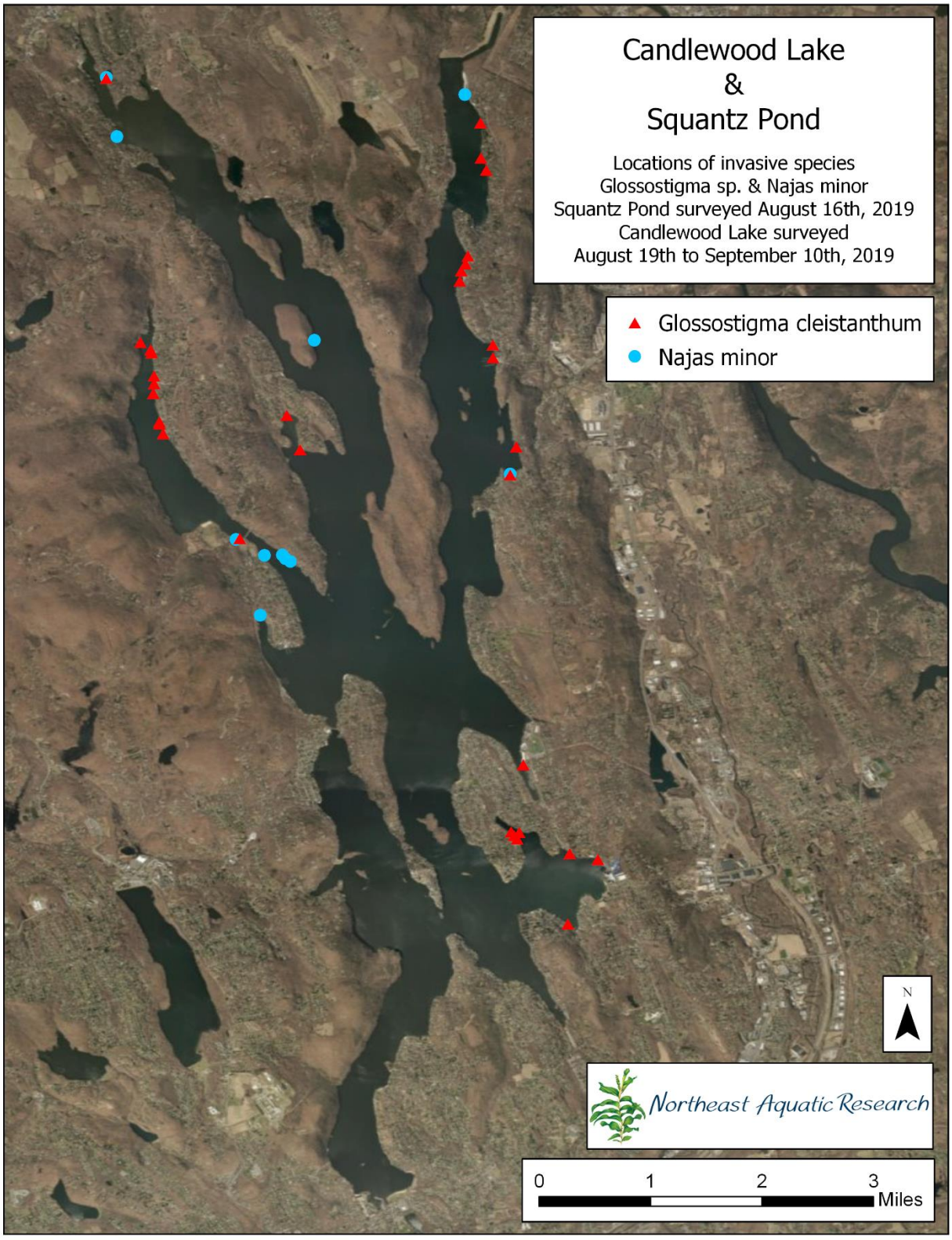
Northeast Aquatic Research

Map 12 *Zone 10*



Map 13 *Najas minor and Glossostigma cleistanthum waypoint locations.*

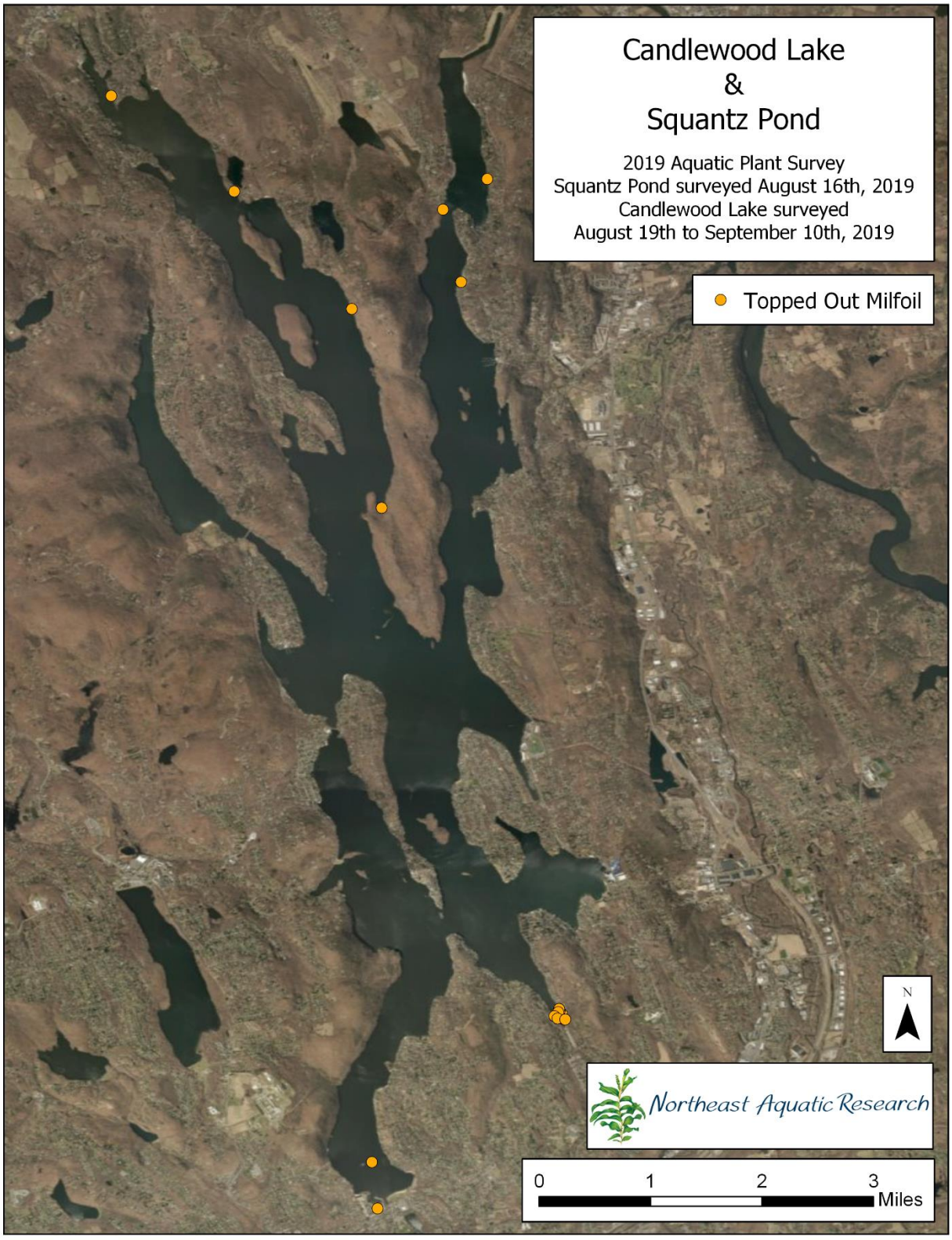


The amount of high-density milfoil in 2019 was much lower than that found in 2018. Instead, the 2019 amount of low- and moderately dense milfoil increased. The data demonstrates that some dense beds of milfoil in 2018 had become reduced in density in 2019. The overall acreage of Eurasian milfoil in Candlewood Lake was also lower in 2019.

The Eurasian milfoil plants in 2019 were rarely "topped-out," a term used to describe growth conditions where plant shoots break the water surface and produce aerial flowers. At Candlewood Lake, milfoil was rarely found growing to the water surface at most waypoints. This is unusual for Eurasian milfoil, as the species typically forms a surface canopy and "tops out" in most other lakes that we surveyed in 2019. It is possible that the grass carp in Candlewood Lake browse the shoot tips, thereby limiting Eurasian milfoil from breaking the surface waters in many areas. Locations of topped-out milfoil are shown in **Map 14.**

Some shoreline areas had very steep slopes where water quickly became >20ft deep very close to shore. These areas had exposed bedrock and large boulders, which are a hindrance to plant growth and account for the gaps in shoreline milfoil bands**.** The inner edge of the milfoil band around the shoreline appears somewhat regulated by exposure during winter drawdown, but it also seems to be related to the amount of wind and wave action which limits plant colonization. The outer edge is restricted by loss of available light in deeper water. The outer edge of milfoil was typically between 10 and 15ft but was occasionally found out to 19 feet. Similar to 2018 findings, the inner edge of milfoil in 2019 had more variation. The inner edge of milfoil was most commonly around 7.5ft. Areas where milfoil was found growing right up to the shoreline in very shallow water may indicate specific areas that are not susceptible to drawdown.

Map 14 *Locations of "Topped Out" Eurasian Milfoil*



NATIVE PLANTS IN CANDLEWOOD LAKE

Six native vascular aquatic plant species were found during the survey (**Table 5).**

1. Coontail (*Ceratophyllum demersum*) was the most abundant native plant found in Candlewood Lake during the 2019 survey but was found at fewer waypoints than in 2018. Similar to the 2018 findings, Coontail was frequently found in 2019 at the outer edge of milfoil growth, in water between 16-20 feet deep. Yet there appears to be less Coontail in 2019 than there was in 2018.
2. Spike rush (*Eleocharis acicularis*)
3. Waterwort (*Elatine minima*)
4. Tape-grass (*Vallisneria americana*)
5. Slender naiad
6. Pondweed
7. White water lily (*Nymphaea odorata)*

Table 5 *Native aquatic plant species, Spirogyra, and Lyngbya found in Candlewood Lake by NEAR during the 2018 and 2019 surveys.*

Scientific Name	*Common Name*	Number of sites* 2019	Number of sites** 2018
Ceratophyllum demersum	Coontail	53	110
Elatine minima	Waterwort	23	0
Eleocharis acicularis	Spike rush - submersed	27	19
Najas flexilis	Slender naiad	1	0
Nymphaea odorata	White water-lily	1	4
Potamogeton amplifolius	Large-leaf pondweed	0	1
Potamogeton pusillus	Pondweed	3	0
Vallisneria americana	Tape-grass	12	5
Wolffia	Watermeal/Duckweed	5	1
Spirogyra typical - green	Filamentous algae	3	6
Lyngbya blue-green algae	Cyanomat	0	4

* Out of a total of 1,988 sites

** Out of a total of 1,686 sites

Squantz Pond Results

INVASIVE AQUATIC PLANTS

The aquatic invasive species Mudmat (*Glossostigma cleistanthum*) and Brittle waternymph (*Najas minor*) were found in Squantz Pond during the 2019 survey (**Map 13**). Eurasian milfoil (*Myriophyllum spicatum*) was not found in Squantz Pond in 2019. In 2018, Eurasian milfoil covered a total of 22.55 acres in the pond, with 13.48 acres of high-density beds (**Table 6**).

Table 6 *Invasive aquatic plant species found in Squantz Pond by NEAR during 2019 survey*

Invasive Species	Number of Sites 2019	Number of Sites 2018
Eurasian Milfoil	0	99
Brittle Waternymph	10	24
Mudmat	1	3

NATIVE PLANTS

Very few aquatic plants were present in Squantz pond during the 2019 survey. Ninety four percent of the recorded waypoints had no plant presence. Only 4 native vascular aquatic plant species were found in Squantz Pond during this 2019 survey, compared to 6 in 2018 (**Table 7).**

Table 7 *Native aquatic plant species found by NEAR in Squantz Pond in the 2018 & 2019 surveys. The table also shows frequency of green filamentous algae (Spirogyra).*

Scientific Name	Common Name	Number of sites* 2019	Number of sites** 2018
Ceratophyllum_demersum	Coontail	2	15
Elatine minima	Waterwort	1	0
Eleocharis acicularis	Spike rush - submersed	3	0
Najas flexlilis	Bushy Pondweed	0	3
Fontinalis	Aquatic moss	0	1
Elodea canadensis	Water weed	0	2
Potamogeton amplifolius	Large-leaf pondweed	1	0
Potamogeton pusillus	Narrow-leaf pondweed	0	1
Lemna	Duckweed/Giant Duckweed	0	1
Filamentous_algae	Green –Spyrogira typical	2	4

* Out of a total of 203 sites

** Out of a total of 182 sites

Comparison with Prior Surveys

CT AGRICULTURAL EXPERIMENT STATION SURVEYS

Table 8 *Surface area coverage of two invasive species in Candlewood Lake. As mapped by CAES (2007-2017) and NEAR (2018-2019).*

Year	2005/2006	07	08	09	10	11	12	13	14	15	16	17	18	19
Eurasian milfoil	275	221	451	373	461	331	505	259	447	441	506	498	511	477
Spiny naiad	ND	12	11	26	21	19	32	24	19	72	54	5	0	NA

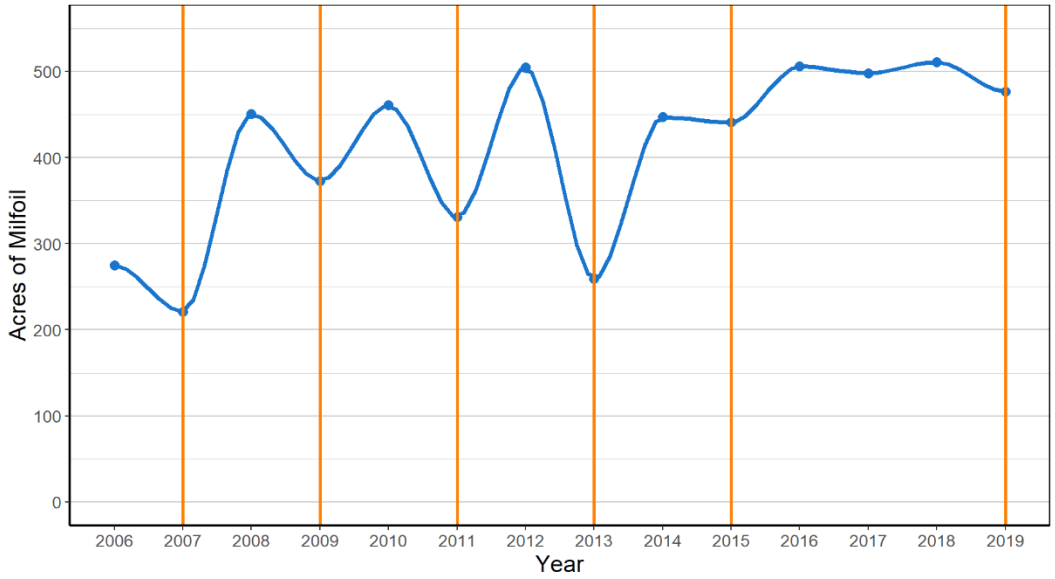


Figure 1 *Acres of Eurasian Milfoil in Candlewood Lake 2006 – 2019, deep drawdowns indicated with orange vertical lines*

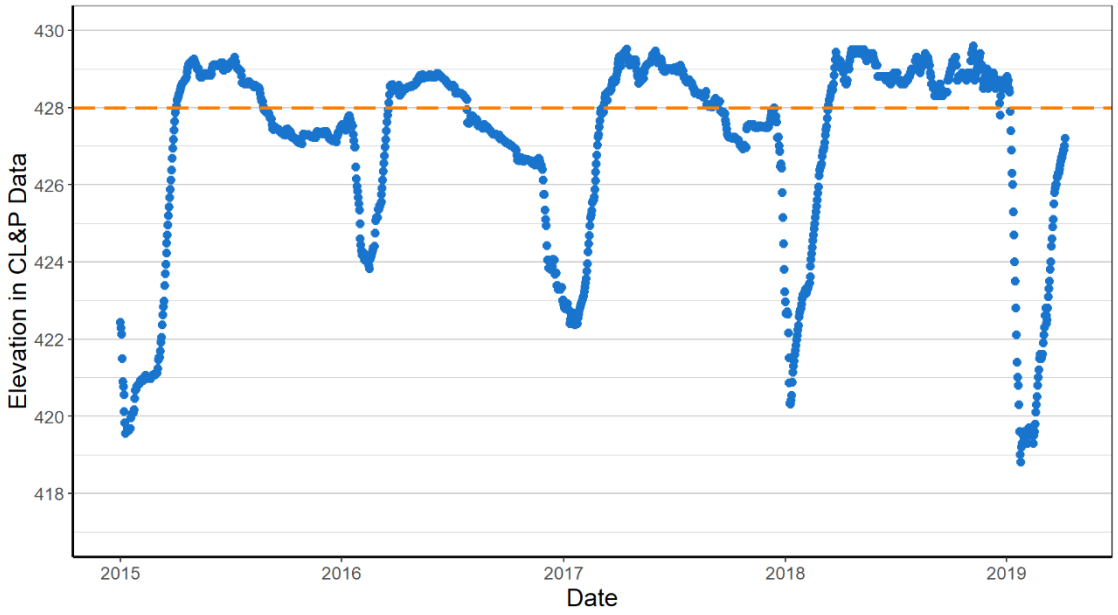


Figure 2 *Water levels at Candlewood Lake between Jan. 1, 2015 and April 7, 2019. Average summer elevation indicated with orange vertical dashed line. (DATA Provisional)*

Native species

Frequency data for each species observed by CAES and NEAR is given in (**Table 10).** The rooted aquatic plant community in Candlewood Lake typically consists of only 8 species: Eurasian milfoil, Spiny naiad, Coontail, Tape-grass, Waterwort, White waterlily, Spikerush, and Mudmat. Other species have been reported in the past but have not been observed in many years.

Table 9 *Percent frequency of aquatic plant species observed in Candlewood Lake by CAES and NEAR*

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018^	2018*	**2019****
Eurasian Milfoil	*Myriophyllum spicatum*	51	79	65	71	78.4	29.4	42.3	76	68	77	57	84	77.8	**76.8**
Spiny Naiad	*Najas minor*	12.5	6.3	8.2	11.5	15.5	12.4	19.6	24	16	10	10	1	1.6	**0.5**
Coontail	*Cerat. demersum*	31	33	11.3	22.7	29.9	27.7	21.7	27	27	39	39	24	6.6	**2.8**
Tape-grass	*Vallisneria americana*	2.1	2.1	4.1	4.1	3	4	4.1	6	4	3	5	1	0.3	**0.5**
Mudmat	*Glossostigma cleistanthum*	0	0	0	0	0	0	0	0	0	0	0	1	1	**1.2**
Waterwort	*Elatine minima*	0	1	3	2	0	4	0	1	2	1	0	0	0	**1.2**
Pondweed	*Potamogeton gramineus*	2.1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Pondweed	*P. bicupulatus*	0	1	0	0	0	0	0	0	0	0	0	0	0	**0**
Pondweed	*P. crispus*	13.5	1	0	0	0	0	0	0	0	0	0	0	0	**0**
Pondweed	*P. perfolatus*	1	2.1	1	0	0	2.1	0	1	1	0	0	0	0	**0**
Pondweed	*P. foliosus*	3.1	0	0	0	2.1	1	5.2	1	0	0	0	0	0	**0**
Pondweed	*P. pusillus*	3.1	1	0	0	0	0	0	0	0	0	0	0	0	**<0.01**

Pondweed	*P. amplifolius*	0	0	0	0	0	0	0	0	0	0	0	0	0.1	**0**
Spikerush	*Eleocharis accicularis*	0	0	0	0	0	0	0	0	0	0	0	2	1.1	**1.5**
H. Pondweed	*Zannichellis palustris*	11.5	3.1	0	0	0	0	0	0	0	0	0	0	0	**0**
Water weed	*Elodea nuttallii*	4	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Bushy Pondweed	*Najas flexilis*	7.3	1	1	0	2	0	0	0	0	0	0	0	0	**0.1**
Water Starwort	*Callitriche sp.*	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
White Water lily	*Nymphaea odorata*	1	1	1	1	1	1	1	2	1	1	1	0	0.2	**0.1**
Sago Pondweed	*Stuckenia pectinata*	6.3	1	0	4.1	0	3.1	2.1	2	1	11	0	0	0	**0**
Watermeal	*Wolffia sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.3**
Duckweed	*Lemna minor*		2.1	6.3	1	4.2	7.2	4.1	0	3	0	0	0	0	**0**
Giant duckweed	*Spirodela polyrhiza*		1	0	0	1	5.2	0	0	0	1	0	0	0.1	**0**

2007-2017 = Frequency based on 96 points

^ 2018 = Frequency based on 96 points on CAES transects

* 2018 = Frequency based on 1669 points

** 2019 = Frequency based on 1988 points

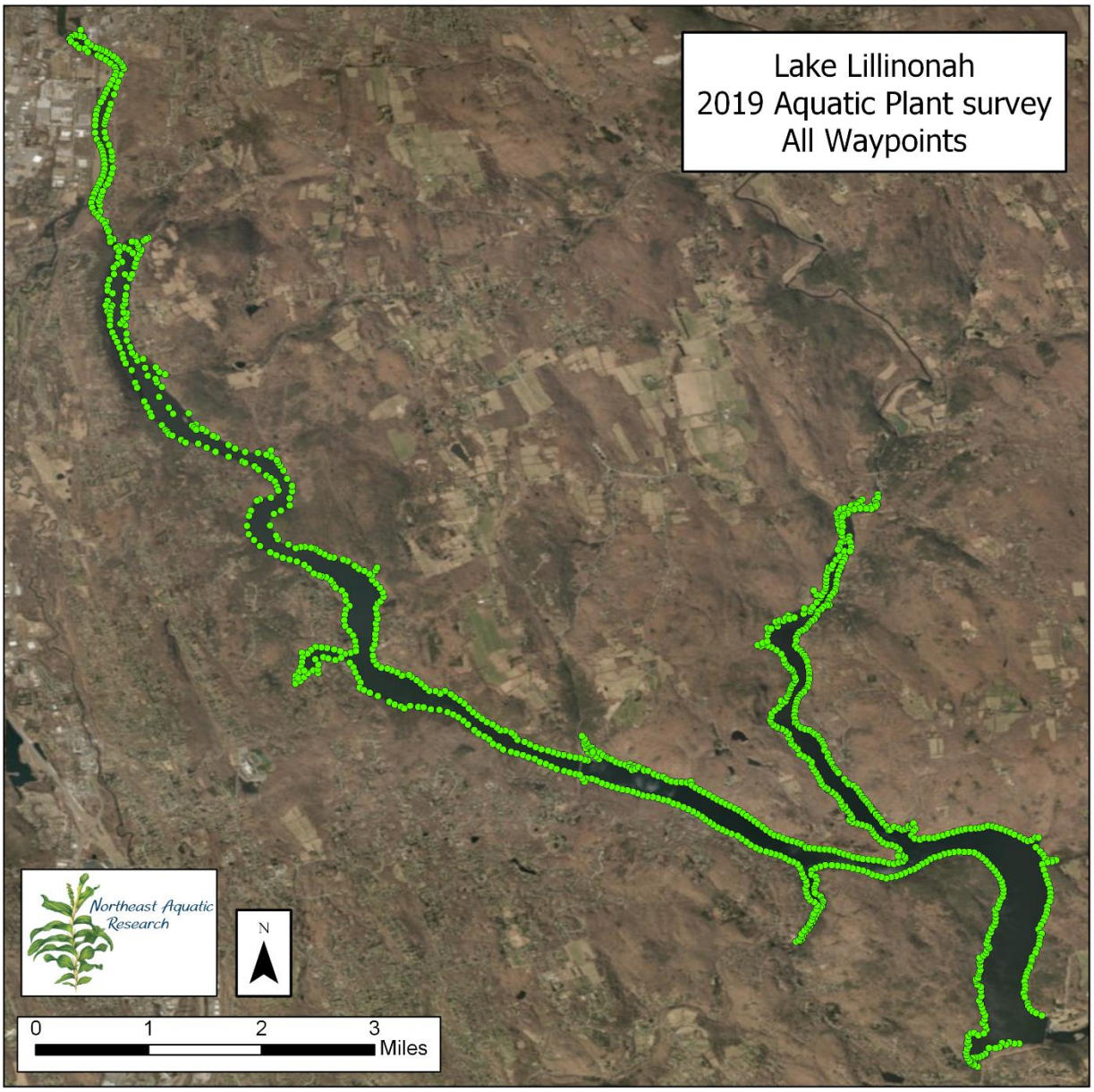
Lake Lillinonah Results

Lake Lillinonah was surveyed over six days between July 30th and August 15th. In total, approximately 134 acres of milfoil was found in the lake. The invasive species Water chestnut, which is not present in Candlewood Lake or Squantz Pond, was found at 34 waypoints in Lake Lillinonah (**Maps 16-19**). Three other invasive species were found in Lillinonah: *Najas minor*, *Potamogeton crispus* and *Trapa natans*. Respective total acreages or number of sites are listed in the table below.

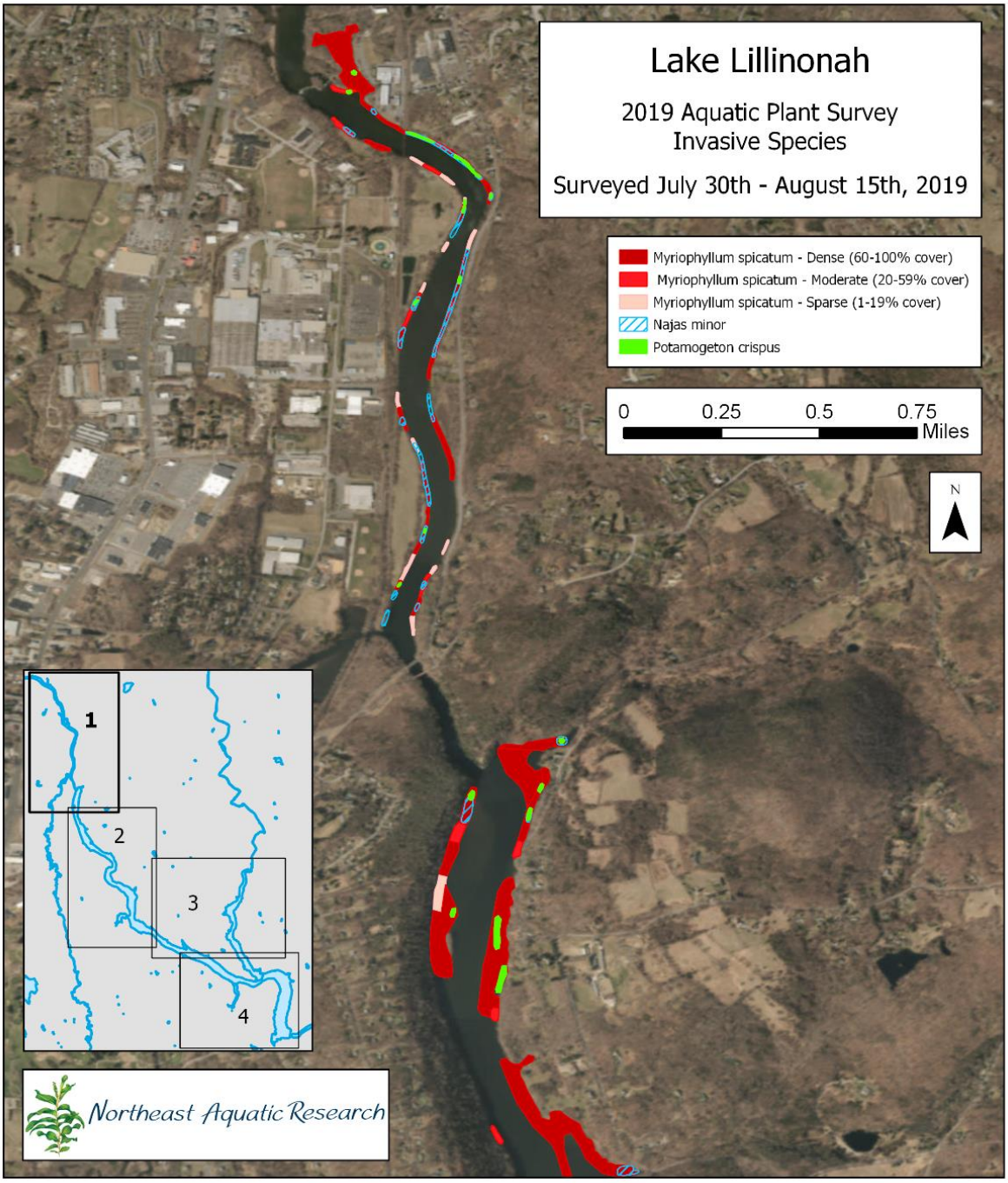
Table 10 *Acres of invasive plants found in Lake Lillinonah in 2019*

Species	Acres			
	Sparse	Moderate	Dense	Total
Myriophyllum spicatum	18.35	26.43	89.39	134.17
Najas minor	NA	NA	NA	15.46
Potamogeton crispus	NA	NA	NA	2.73
Water chestnut				23 sites

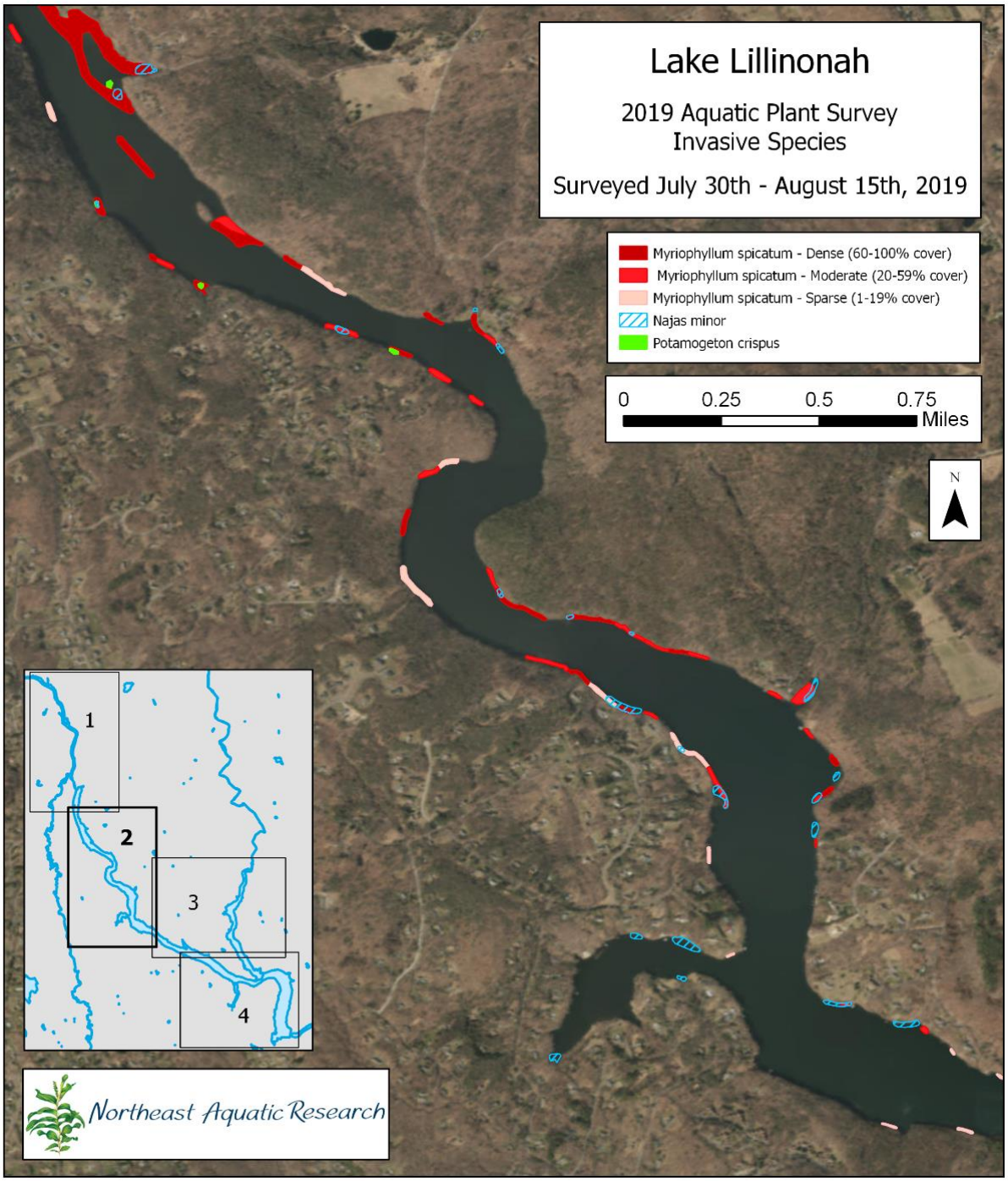
Map 15 *Waypoints (green dots) made in Lake Lillinonah during NEAR 2019 survey*



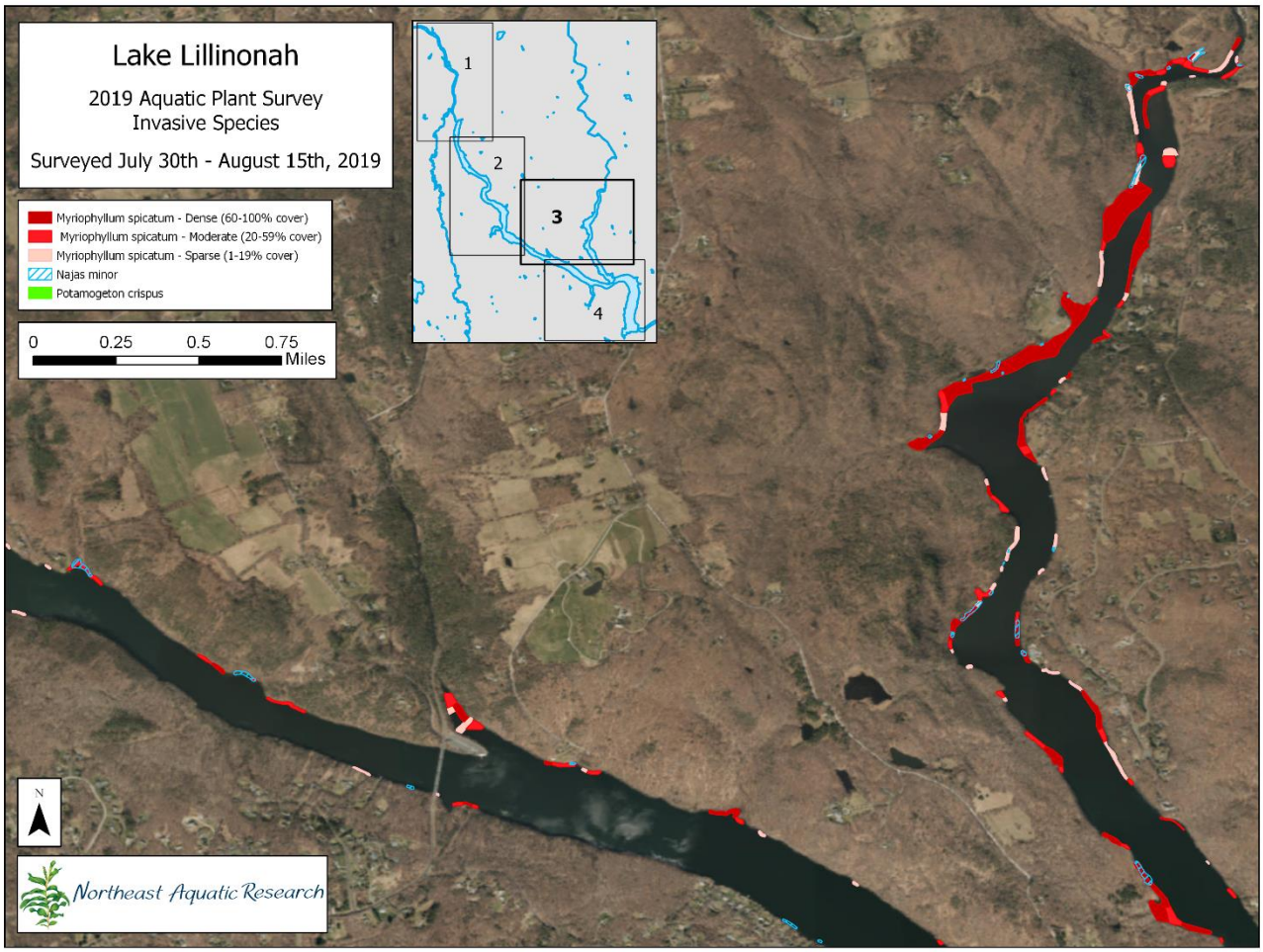
Map 16 *Lake Lillinonah Zone 1*



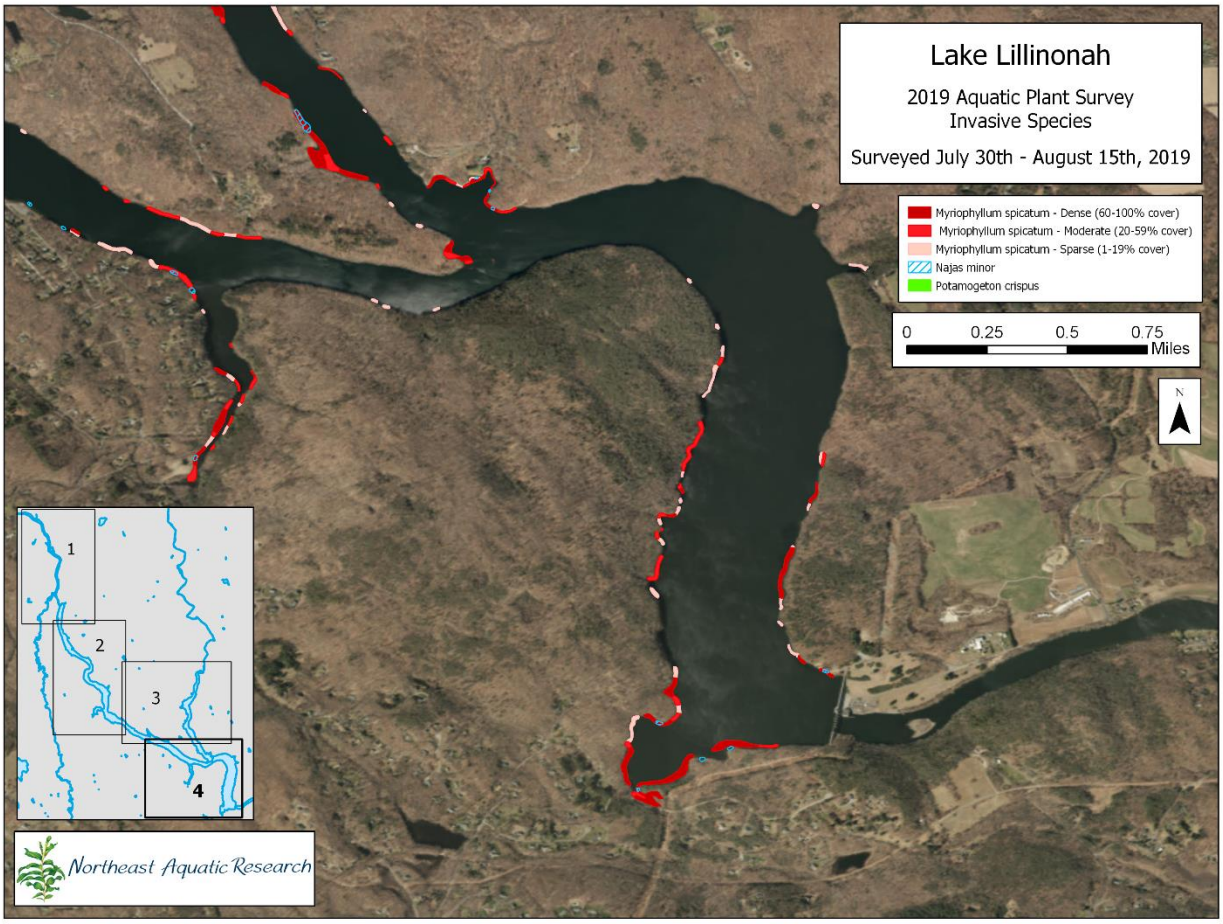
Map 17 *Lake Lillinonah Zone 2*



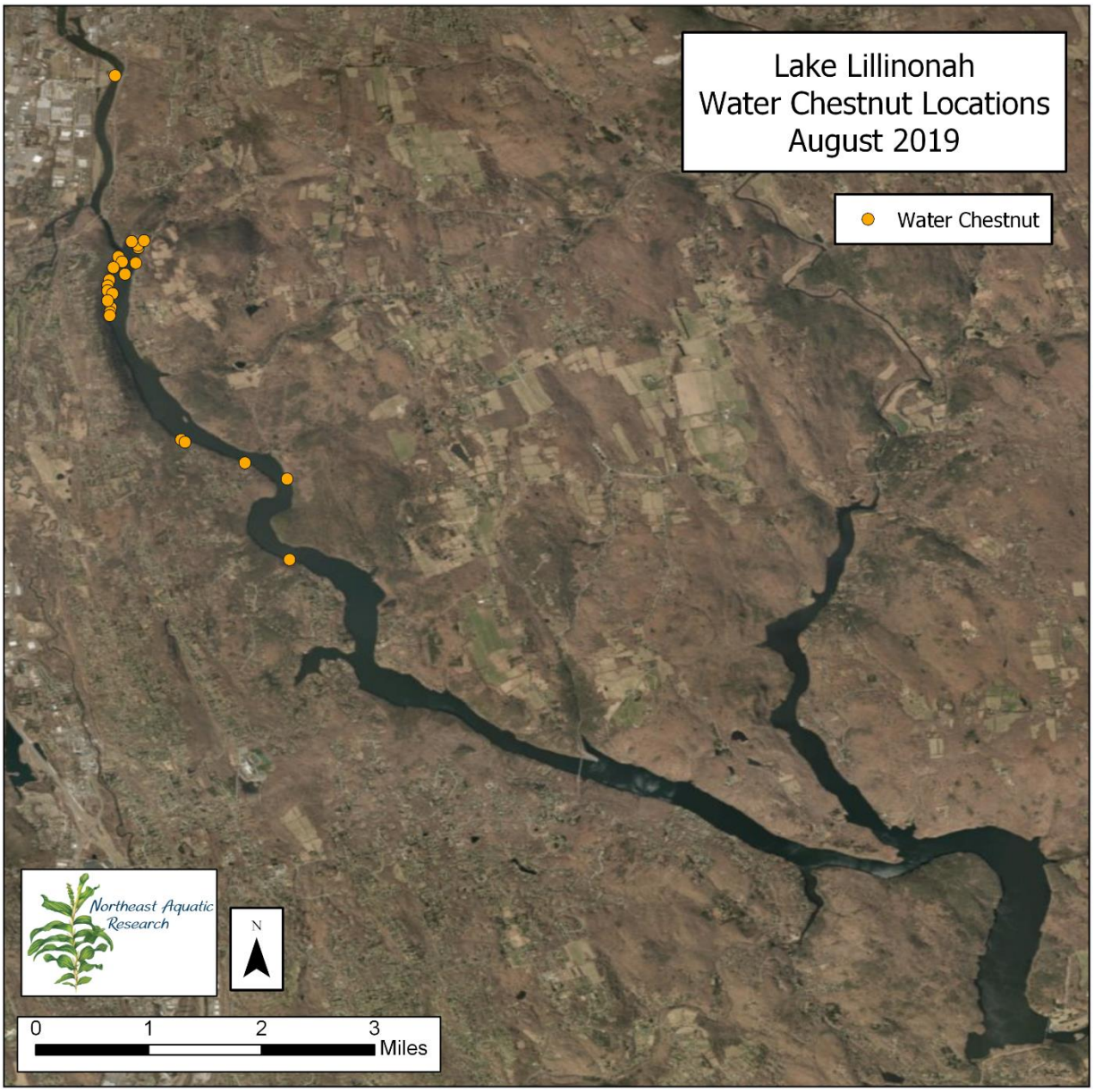
Map 18 *Lake Lillinonah Zone 3*



Map 19 *Lake Lillinonah Zone 4.*



Map 20 *Lake Lillinonah water chestnut locations.*



Appendix 1: Raw Lake Survey Data

Raw waypoint data is included as a separate pdf document.