



Northeast Aquatic Research



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December 22nd, 2020

Lake Zoar 2020 Aquatic Plant Survey Results

Prepared for the Lake Zoar Authority

Survey Dates: The pre-treatment survey of Lake Zoar was conducted on June 18th. A second survey was conducted on August 17th, approximately 8 weeks after the first herbicide treatment and prior to the second treatment. The final survey was conducted on October 1st, approximately one month after the second herbicide treatment.

Herbicide Treatments:

Date: June 23rd

Target plants: Eurasian Milfoil and Curly leaf Pondweed.

Herbicide: Tribune (diquat)

Rate: 120 gallons. ~80 acres. 1.5gal/acre

Date: August 26th

Target plants: Eurasian Milfoil and Curly leaf Pondweed.

Herbicide: Tribune (diquat)

Rate: 45 gallons. ~30 acres. 1.5gal/acre

Treatment Areas Details

Lake Zoar contains ten pre-defined management areas (**Table 1, Map 1**). All management areas were surveyed before and after each herbicide treatment. Locations of the three invasive species – Eurasian milfoil (*Myriophyllum spicatum*), Curly-leaf pondweed (*Potamogeton crispus*), and Brittle naiad (*Najas minor*) – are mapped in each management area.

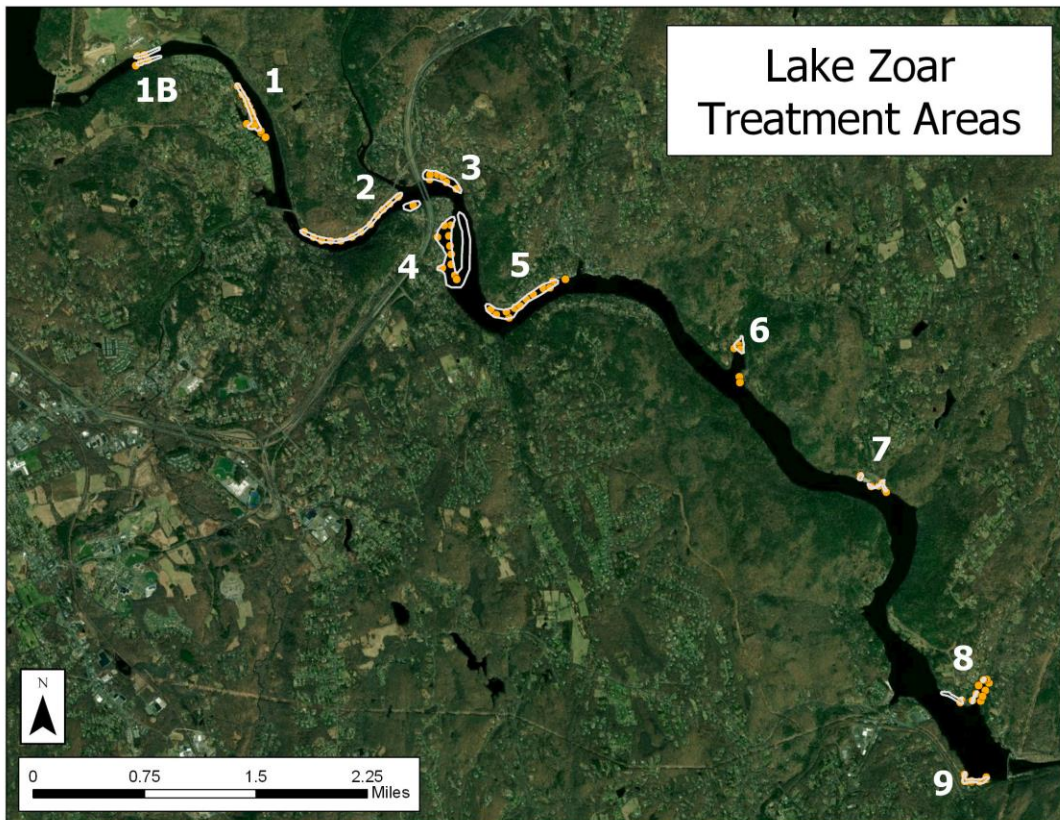
The two 2020 herbicide treatments were administered by SOLitude Lake Management. Management areas 1B and 8 were not treated in 2020. Area 1B was not included on the permit, and it is unclear why Area 8 was not treated.

At the end of this report, three zoomed maps of invasive species locations are included for each survey date.

Table 1. Descriptions of management areas.

Area	Size (acres)	Location - Description
1B	5.9	Narrow bands 100 feet wide opposite each other along the eastern and western shorelines.
1	10.0	Narrow band 100 feet wide along western side and within small cove about 1 mile below the Shepaug Dam.
2	5.7	Narrow band 70 feet wide along eastern shore about 2.5 miles below Shepaug Dam. Includes small bed on western side immediately above I84 Bridge.
3	8.2	Large bay on eastern side immediately below I84 Bridge, bounded to the west by large sandbar.
4	14.4	Large area that includes both sides of central sandbar and shallow waters on the western side.
5	11.2	Large shallow area offshore of DEEP boat launch and narrow band 75 wide along eastern shore.
6	5.0	Inner end of cove at Kettle town State Park.
7	2.4	Two small coves on eastern shore at Jackson Cove State Park.
8	8.4	Narrow band 50 feet wide and cove on eastern side about 2.5 miles above Stevenson Dam.
9	3.2	Small bay on western side about 1000 feet above Stevenson Dam.

Map 1. Locations of Lake Zoar management areas. The management areas are circled and numbered. Red points depict survey waypoints.



2020 Lake-Wide Results

For each survey in 2020, a series of GPS waypoints were used to document aquatic plant presence and coverage in the designated management areas.

Table 2 provides the percent frequency and average density (% cover) numbers lake-wide, across all management areas that were treated in 2020. **Table 3** provides the percent frequency and average density (% cover) numbers lake-wide, across the two management areas that were not treated in 2020.

Because Management Areas 1B and 8 were not treated this year, they can act as a control, allowing us to observe the pattern of growth over the course of the season in the absence of herbicides.

In **Table 2** and **Table 3**, the percent frequency number indicates the percentage of total survey waypoints at which a given species was found within a management area. The average percent cover number represents the average density over all the locations at which the plant was found within a management area during the survey. Percent cover 0-19% is sparse, 20-59% is moderate, 60-79% is dense coverage, and 80-100% is very dense plant growth. The overall percentage is a combination statistic that is calculated by multiplying the decimal percent frequency by the average percent cover to estimate the percent cover of each species over the whole survey area.

Eurasian milfoil, Brittle naiad, and Curly-leaf pondweed were the only invasive species found in Lake Zoar in 2020.

Of the three invasive species, Eurasian milfoil was the most abundant across the three aquatic plant surveys. The species was abundant in June, but the density of the plant beds was, on average, only moderate. The frequency and density of the species was reduced in August and further reduced in October.

Brittle naiad was not found in the lake in June. By August, it was present in most management areas, but it was never abundant. By October, the species had become very sparse. In Management Area 8, which was not treated this year, Brittle naiad was only found in August, suggesting the species naturally has a short growing season.

Curly-leaf pondweed was fairly abundant in June but had decreased notably by August and was very sparse in October. Curly-leaf was not found in the un-treated Areas 1B or 8 in October, suggesting the species naturally dies off by this time even without treatment impacts.

14 native aquatic plant species were found in Lake Zoar in 2020, along with filamentous algae and *Lyngbya*, which is a mat-forming cyanobacteria.

Of the native species, Coontail (*Ceratophyllum demersum*), Tape grass (*Vallisneria americana*), and Water stargrass (*Zosterella dubia*) were typically the most dominant.

Table 2. Aquatic plant presence (% occurrence) and average density across all treated management areas in June, August, and October 2020.

Scientific Name	June 18th		August 17th		October 1st	
	% Frequency	Avg. Density	% Frequency	Avg. Density	% Frequency	Avg. Density
<i>Ceratophyllum demersum</i>	9.3	17.5	50.5	29.5	34	36.8
<i>Elodea nuttallii</i>	1	10	2.1	55	0	NA
<i>Filamentous algae</i>	3.1	80	2.1	80	1	15
<i>Fontinalis</i>	2.1	25	0	NA	1	25
<i>Lyngbya</i>	1	NA	19.6	28.3	16.5	33.8
<i>Myriophyllum spicatum</i>	61.9	45.2	38.1	27	21.6	19
<i>Najas minor</i>	0	NA	19.6	38.2	2.1	22.5
<i>Nymphaea odorata</i>	0	NA	1	5	1	10
<i>Potamogeton bicupulatus</i>	2.1	100	0	NA	0	NA
<i>Potamogeton crispus</i>	60.8	50.7	19.6	18.9	4.1	7.5
<i>Potamogeton epihydrus</i>	0	NA	0	NA	1	15
<i>Potamogeton nodosus</i>	12.4	44	8.2	65.7	12.4	54.1
<i>Potamogeton perfoliatus</i>	2.1	10	5.2	41	3.1	2-
<i>Potamogeton praelongus</i>	0	NA	6.2	50	0	NA
<i>Potamogeton pusillus</i>	9.3	25.8	29.9	31.4	0	NA
<i>Potamogeton zosteriformis</i>	1	NA	0	NA	2.1	5
<i>Stuckenia pectinata</i>	1	5	0	NA	16.5	25.3
<i>Vallisneria americana</i>	13.4	32.3	56.7	62.7	47.4	68.5
<i>Zosterella dubia</i>	4.1	27.5	12.4	24.5	6.2	31.7

Table 3. Aquatic plant presence (% occurrence) and average density across all un-treated management areas in June, August, and October 2020.

Scientific Name	June 18th		August 17th		October 1st	
	% Frequency	Avg. Density	% Frequency	Avg. Density	% Frequency	Avg. Density
<i>Ceratophyllum demersum</i>	2.1	5	9.3	16.3	7.2	30.8
<i>Elodea nuttallii</i>	0	NA	0	NA	0	NA
<i>Filamentous algae</i>	0	NA	0	NA	0	NA
<i>Fontinalis</i>	3.1	43.3	0	NA	1	NA
<i>Lyngbya</i>	0	NA	0	NA	0	NA
<i>Myriophyllum spicatum</i>	7.2	46.4	2.1	10	3.1	38.3
<i>Najas minor</i>	0	NA	3.1	31.7	0	NA
<i>Nymphaea odorata</i>	0	NA	0	NA	0	NA
<i>Potamogeton bicupulatus</i>	0	NA	0	NA	0	NA

<i>Potamogeton crispus</i>	4.1	27.5	0	NA	0	NA
<i>Potamogeton epihydrus</i>	0	NA	2.1	13	0	NA
<i>Potamogeton nodosus</i>	3.1	26.7	0	NA	2.1	7.5
<i>Potamogeton perfoliatus</i>	0	NA	0	NA	0	NA
<i>Potamogeton praelongus</i>	0	NA	0	NA	0	NA
<i>Potamogeton pusillus</i>	4.1	7.5	0	NA	0	NA
<i>Potamogeton zosteriformis</i>	0	NA	0	NA	0	NA
<i>Stuckenia pectinata</i>	0	NA	0	NA	0	NA
<i>Vallisneria americana</i>	3.1	15	0	NA	0	NA
<i>Zosterella dubia</i>	5.2	26	0	NA	2.1	70

Management Area Results

Management Area 1B

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
<i>Myriophyllum spicatum</i>	80	100	75	46.25	63	38.3
<i>Najas minor</i>	0	0	0	NA	NA	NA
<i>Potamogeton crispus</i>	60	0	0	33.3	NA	NA

Because Area 1B was not treated this year, it can act as a control, allowing us to observe the pattern of growth over the course of the season in the absence of herbicides.

Eurasian milfoil was present at greater than 75% of waypoints within the management area during all three surveys. Milfoil density increased between June and August, before decreasing somewhat by October.

Curly-leaf pondweed was present at 60% of waypoints in June, with an average density of 33%. Curly-leaf was not present in this management area during the August or October surveys.

Brittle naiad was not found in Management Area 1B in 2020.

Management Area 1

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
<i>Myriophyllum spicatum</i>	100	93.3	20	63.7	45.4	5
<i>Najas minor</i>	0	40	0	NA	39.2	NA
<i>Potamogeton crispus</i>	86.7	53.3	0	64.6	16.3	NA

Eurasian milfoil was present throughout all or nearly all of Management Area 1 in June and August. The density of the plants was high in June and moderate in August. By October, the species had decreased to 20% frequency and was very sparse.

Brittle naiad was only growing in this management area in August, when it was present at 40% frequency and had an average density of 39%.

Curly-leaf pondweed was abundant in the management area in June, then decreased somewhat by August. No curly-leaf was found in Management Area 1 in October.

Management Area 2

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
Myriophyllum spicatum	92.3	84.6	75	49.6	15.9	9.4
Najas minor	0	30.8	0	NA	30	NA
Potamogeton crispus	100	38.5	0	55.8	18	NA

Eurasian milfoil was present at most waypoints within the management area in June and August, though the plants covered only about half of the lake bottom in June and had become sparser by August. In October, the species' frequency had declined somewhat, and the average density was increasingly sparse.

Brittle naiad was only found in August, with the percent frequency and average densities both at 30%.

Curly-leaf pondweed was present throughout Management Area 2 in June, though the plants were only moderately dense. By August, the species had decreased to 38% frequency and the plants had become sparser. Curly-leaf was not found in the management area in October.

Management Area 3

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
Myriophyllum spicatum	100	50	16.7	36	8.3	5
Najas minor	0	16.7	0	NA	30	NA
Potamogeton crispus	100	66.7	33.3	23.3	26.3	7.5

Eurasian milfoil was present at all waypoints in Management Area 3 in June, though the density of the plants was only moderate. By August, the species had decreased to 50% of the waypoints and had become sparse. By October, milfoil had continued to decrease in abundance.

Brittle naiad was only found in the management area in August. It was present at 16% of waypoints and the density of the plant beds was moderate.

Curly-leaf pondweed was present throughout the management area in June, before decreasing steadily across the second and third surveys. Curly-leaf was still growing in this area in June, but growth was sparse.

Management Area 4

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
Myriophyllum spicatum	90	30	0	40	26.7	NA
Najas minor	0	0	0	NA	NA	NA
Potamogeton crispus	90	0	0	41.7	NA	NA

Eurasian milfoil was found at 90% of waypoints and moderate density in June. By August, the species had decreased in both abundance and density. No milfoil was found in the management area in October.

Curly-leaf was present at most waypoints in the area in June, with an average density of 41%. The species was not found in the management area in August or October.

Brittle naiad was not found in Management Area 4 in 2020.

Management Area 5

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
Myriophyllum spicatum	66.7	18.2	8.3	32	7.5	5
Najas minor	0	0	8.3	NA	NA	10
Potamogeton crispus	88.9	0	8.3	56.4	NA	5

Eurasian milfoil was present at approximately two thirds of the waypoints in Management Area 5 in June, with an average density of 32%. Milfoil had decreased in both frequency and density by August and was very sparse by October.

Najas minor was not found in the management area in June or August but was present at one waypoint in October.

Curly-leaf pondweed was fairly abundant in June. The species was not found in August, but one very small patch was found in October.

Management Area 6

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
Myriophyllum spicatum	83.3	16.7	16.7	46	10	15
Najas minor	0	50	16.7	NA	36.7	35
Potamogeton crispus	83.3	16.7	0	44	20	NA

Eurasian milfoil was present at 83% of waypoints in June, with plants within the patches covering about half of the lake bottom. Milfoil decreased in both frequency and density by August and remained at this level of abundance into October.

Najas minor was not found in the area in June but was present at 50% frequency in August. It decreased in abundance by October, though the density within the plant beds remained about the same.

Curly-leaf pondweed was found at 83% frequency and 44% average density in June. The species had decreased in abundance by August and disappeared from the area completely by October.

Management Area 7

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
Myriophyllum spicatum	100	0	33.3	18	NA	15
Najas minor	0	16.7	0	NA	60	NA
Potamogeton crispus	60	0	0	33.3	NA	NA

Eurasian milfoil was present at all waypoints within the management area in June, though the plant beds were sparse. The species was not found in the area in August, but regrowth occurred after this survey. Milfoil was present at about a third of waypoints in October, though the growth was sparse. Najas minor was only found in Management Area 7 in August. Only one bed was found, but the bed had a relatively high density of plants.

Curly-leaf pondweed was present at 60% frequency and 33% average density in June. The species was not found in this management area in August or October.

Management Area 8

Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
Myriophyllum spicatum	27.3	18.2	0	46.7	10	NA
Najas minor	0	27.3	0	NA	31.7	NA
Potamogeton crispus	9.1	0	0	10	NA	NA

Area 8 was not treated in 2020. However, none of the invasive species were abundant in this area.

Eurasian milfoil was present at low to moderate frequency and density in June and August. The species was not found in the management area in October.

Najas minor was only present in the management area in August, at a moderate frequency and density.

Curly-leaf pondweed was very sparse in June and was not found in the area in August or October.

Management Area 9

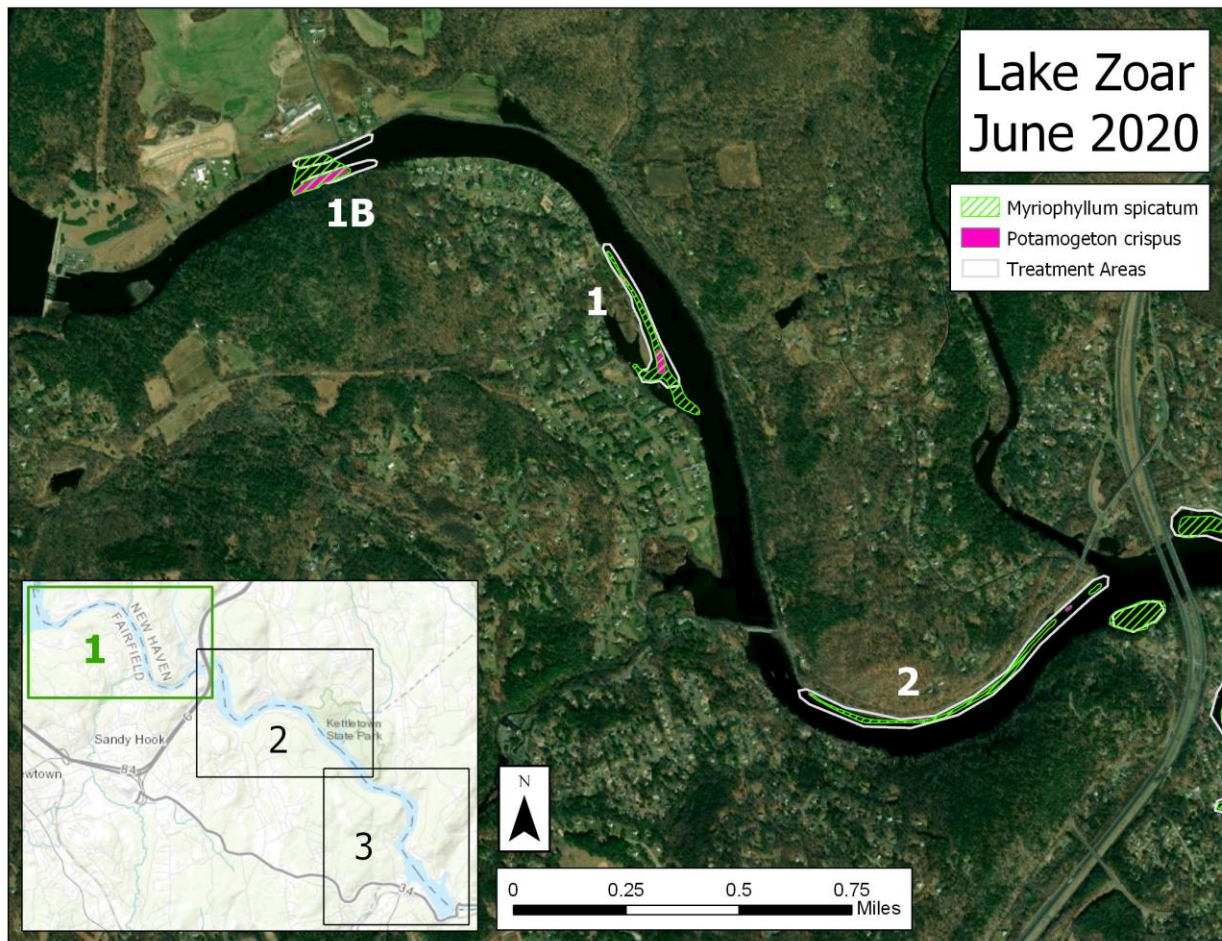
Species	% Frequency			Avg Density		
	Jun-18	Aug-17	Oct-1	Jun-18	Aug-17	Oct-1
Myriophyllum spicatum	50	37.5	62.5	31.7	20	50
Najas minor	0	50	0	NA	42.5	NA
Potamogeton crispus	50	12.5	12.5	40	15	10

Eurasian milfoil was found at 50% of waypoints within the management area in June. The species decreased in abundance slightly in August, but regrowth led to increased occurrence and density by October.

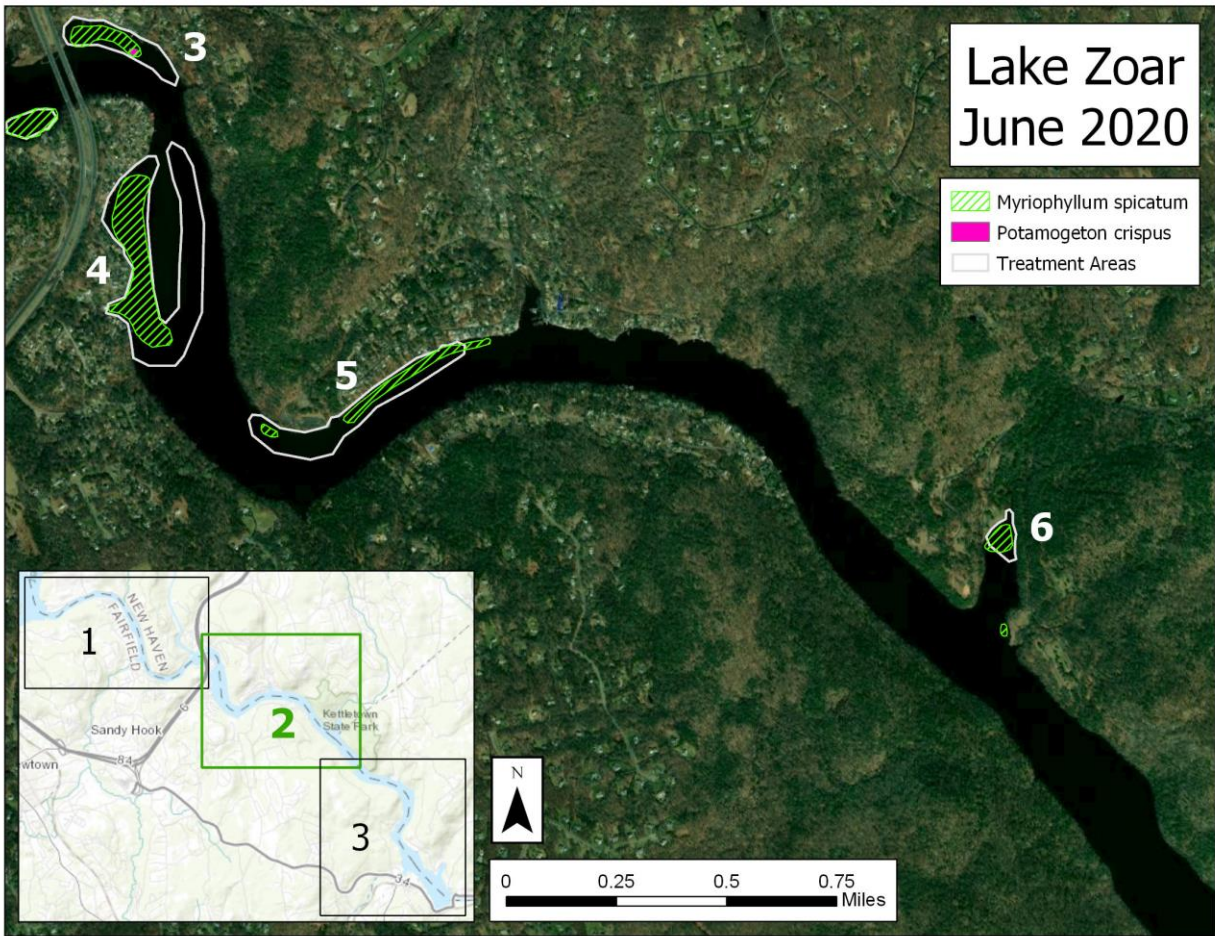
Najas minor was only found in the area in August, with moderate density.

Curly-leaf pondweed was present at 50% of waypoints in June, with a moderate density within the plant beds. The species had decreased in abundance in August and remained low into October.

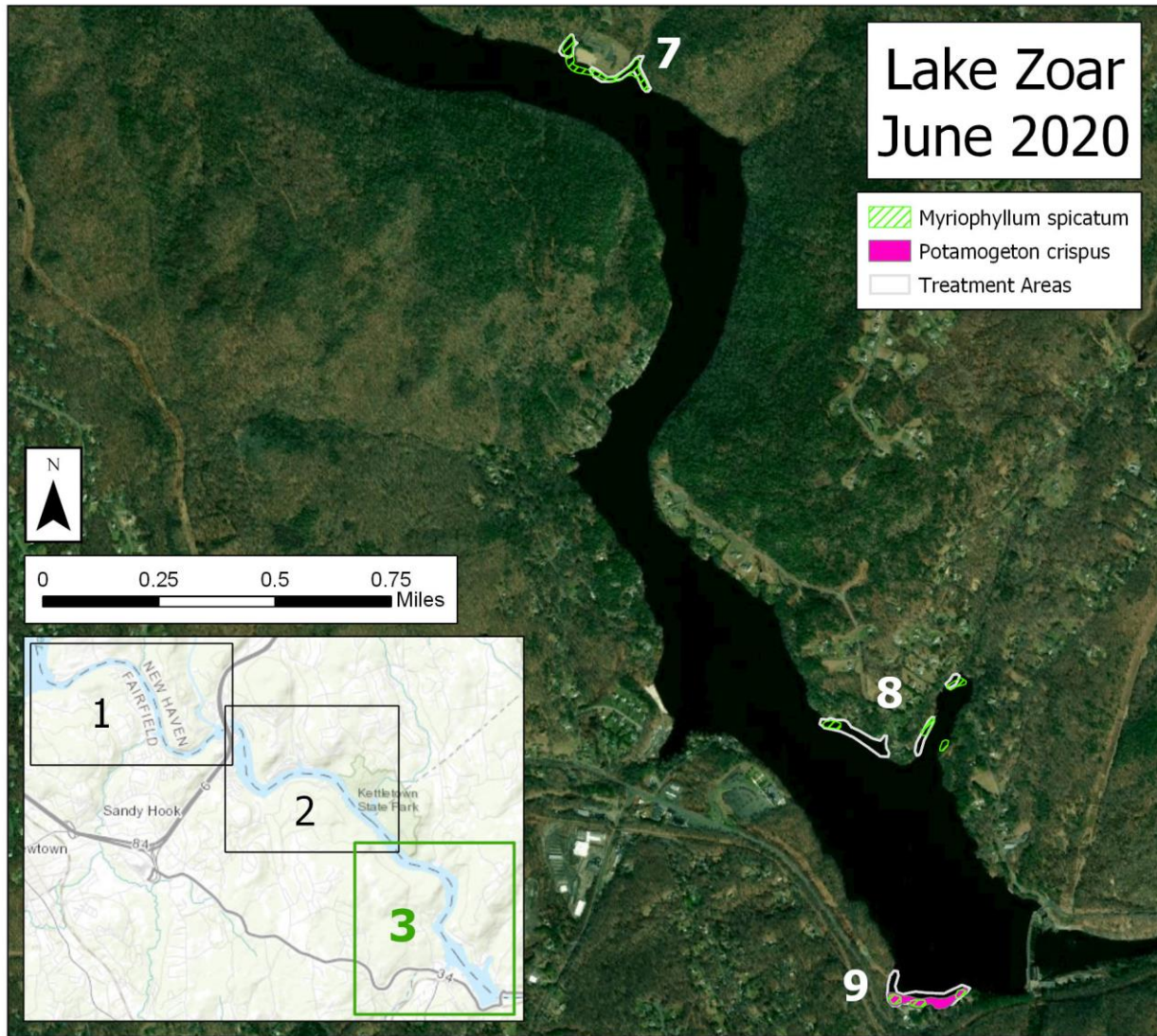
Map 2. June 18, 2020 invasive species, Zone 1.



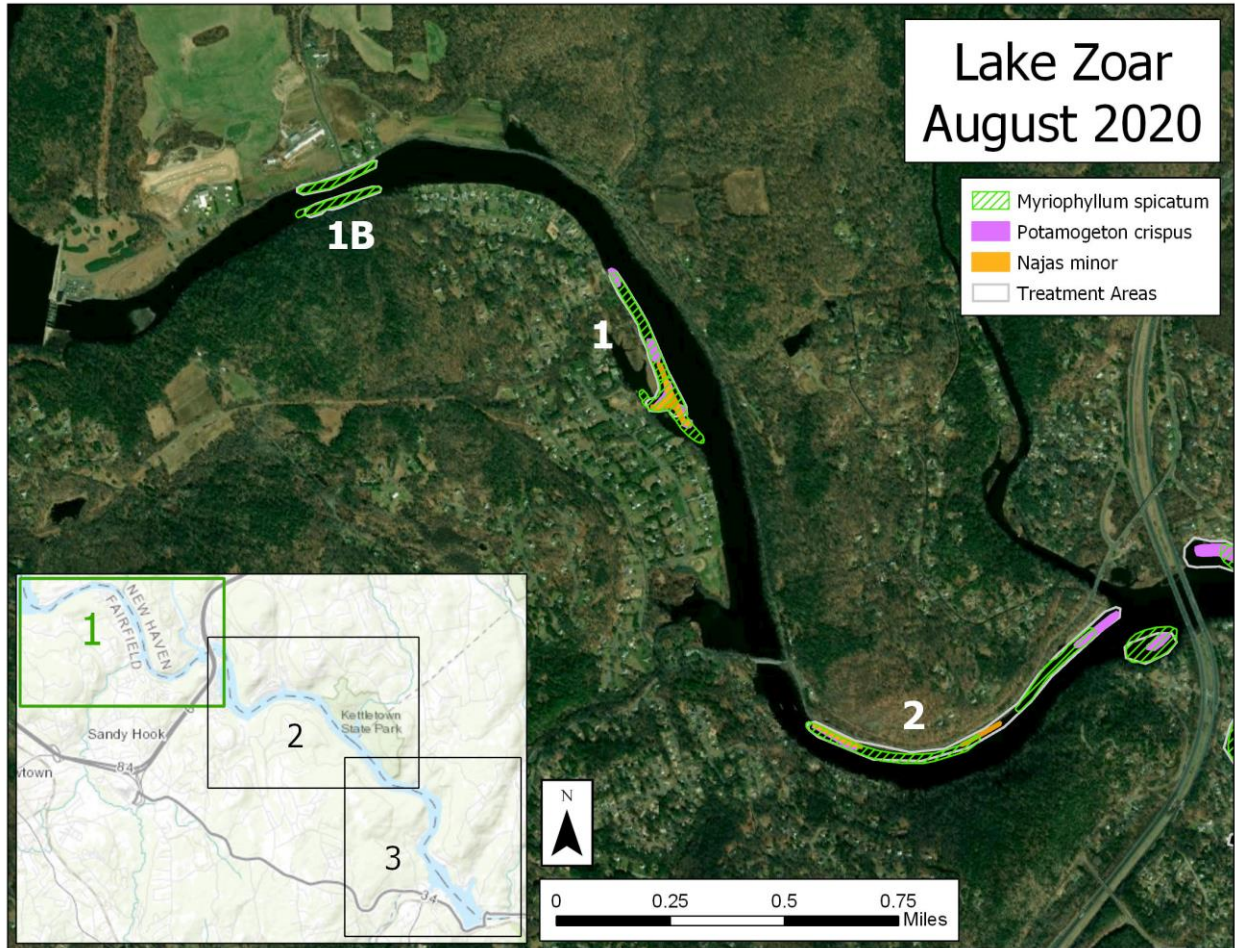
Map 3. June 18, 2020 invasive species, Zone 2.



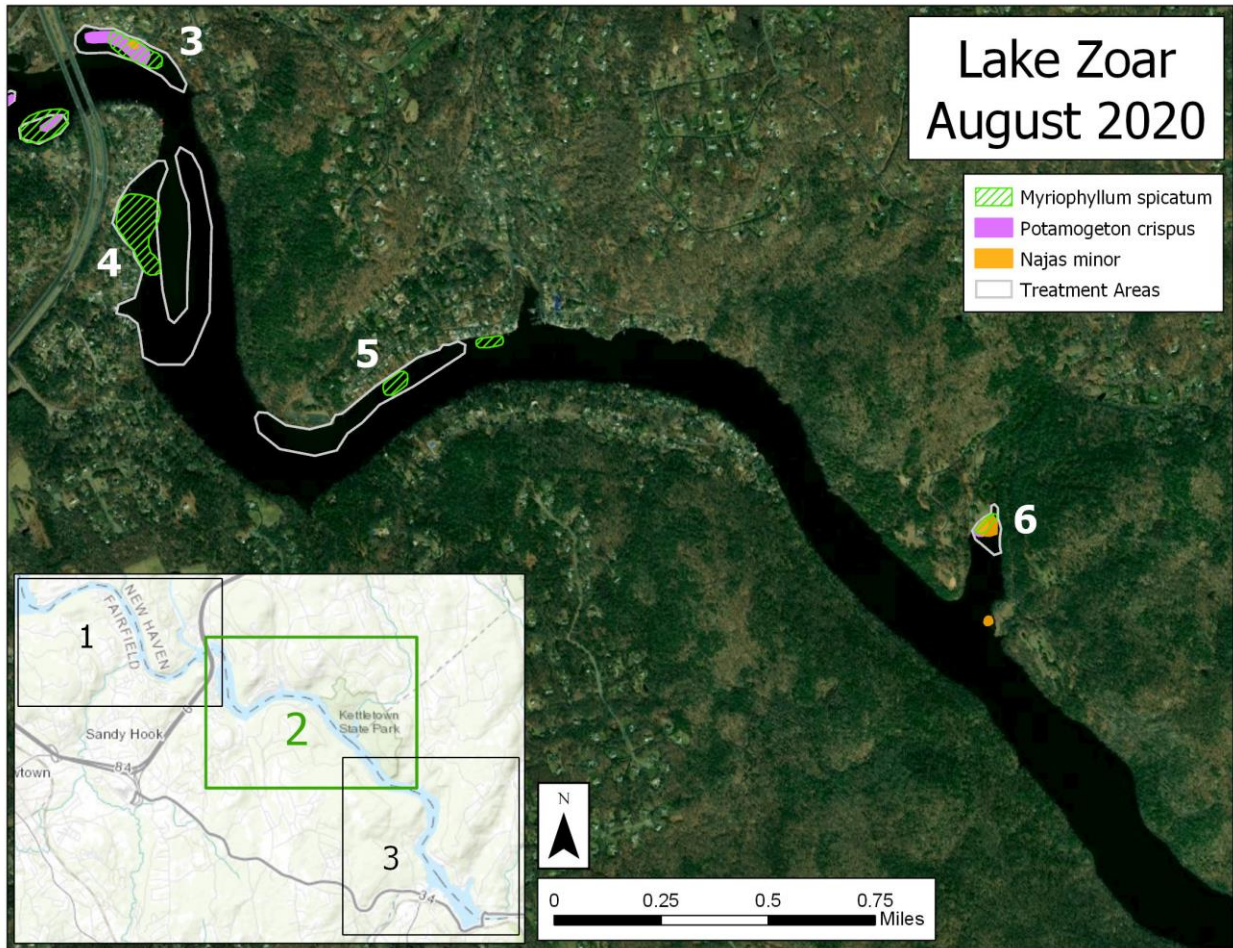
Map 4. June 18, 2020 invasive species, Zone 3.



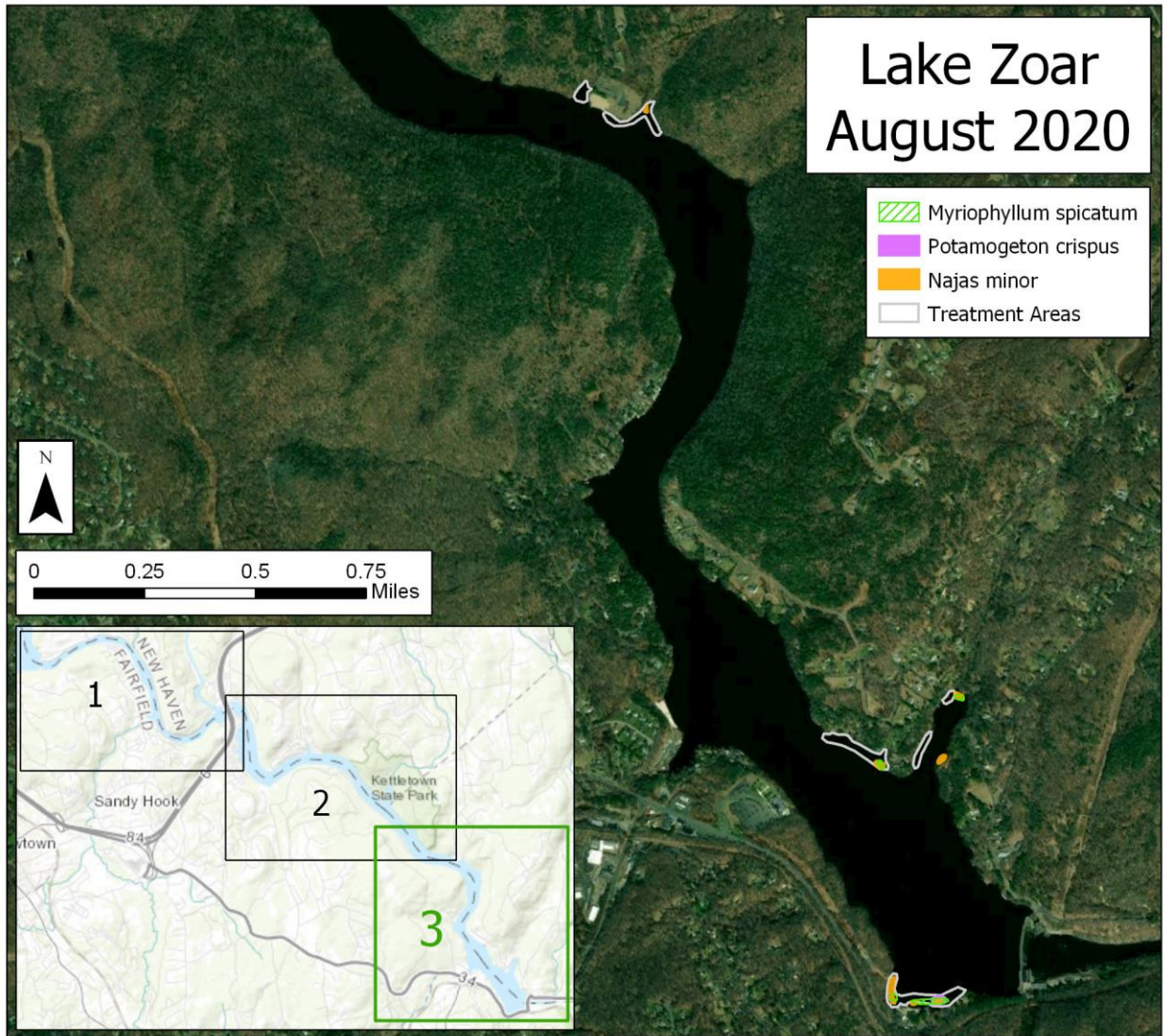
Map 5. August 17, 2020 invasive species, Zone 1.



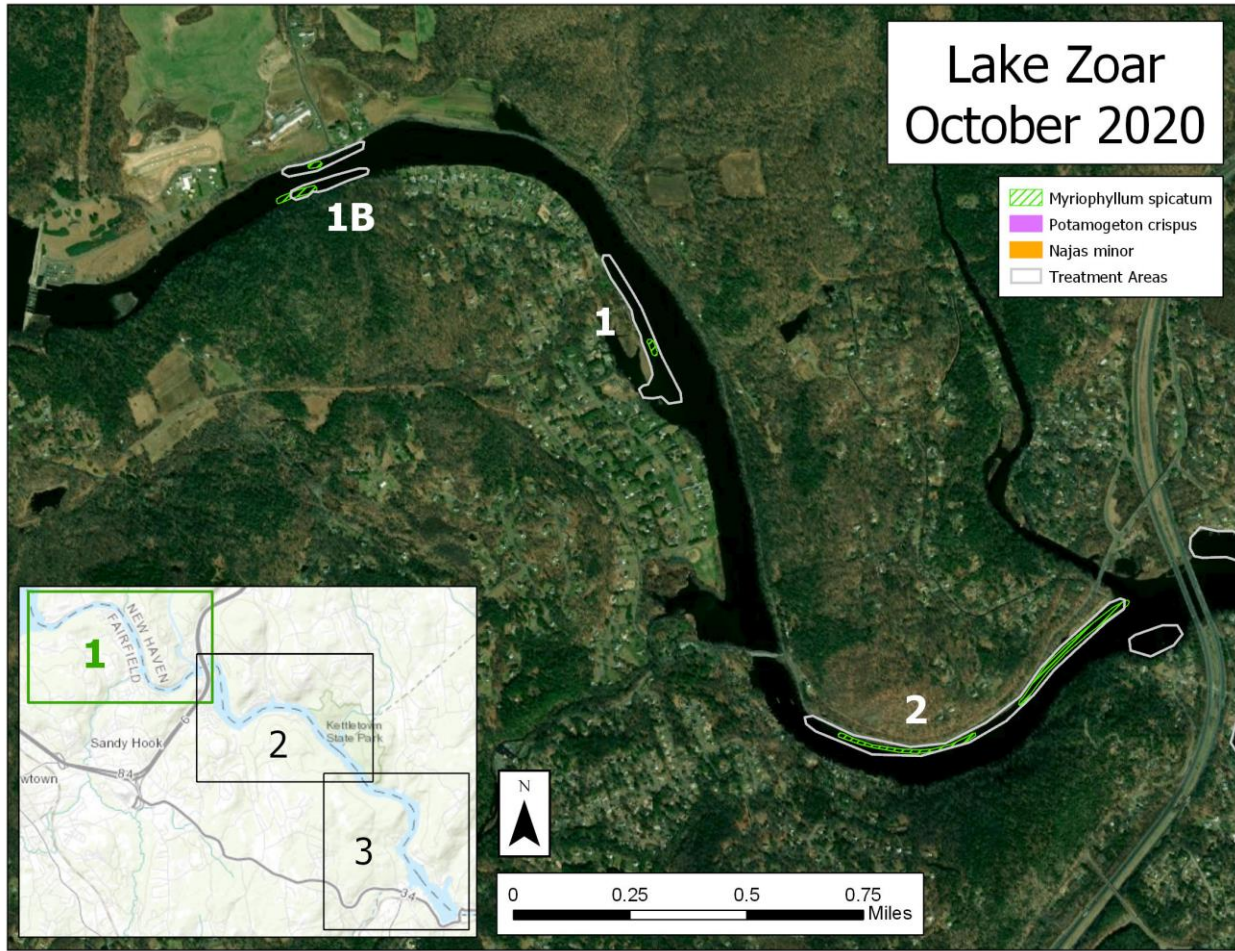
Map 6. August 17, 2020 invasive species, Zone 2.



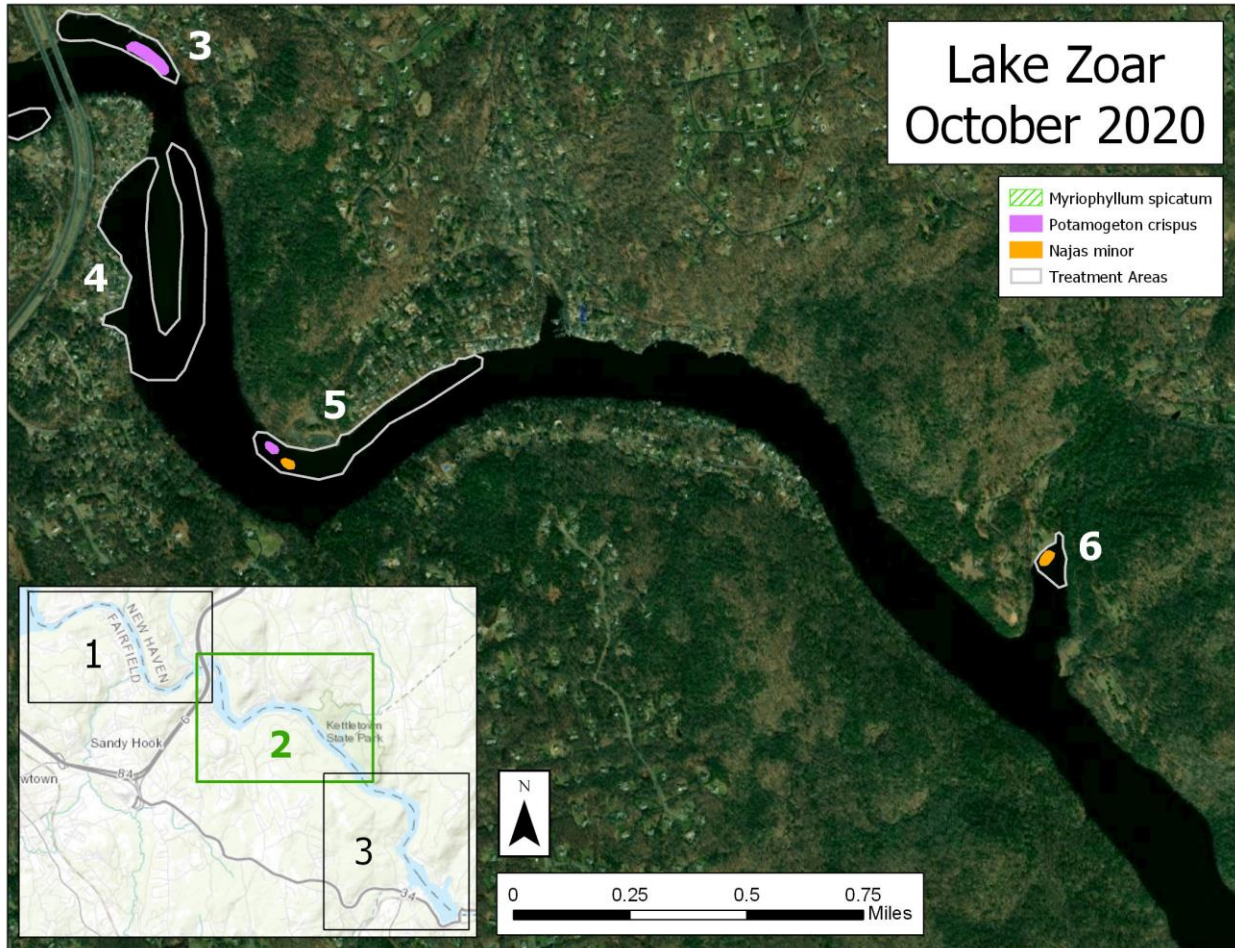
Map 7. August 17, 2020 invasive species, Zone 3.



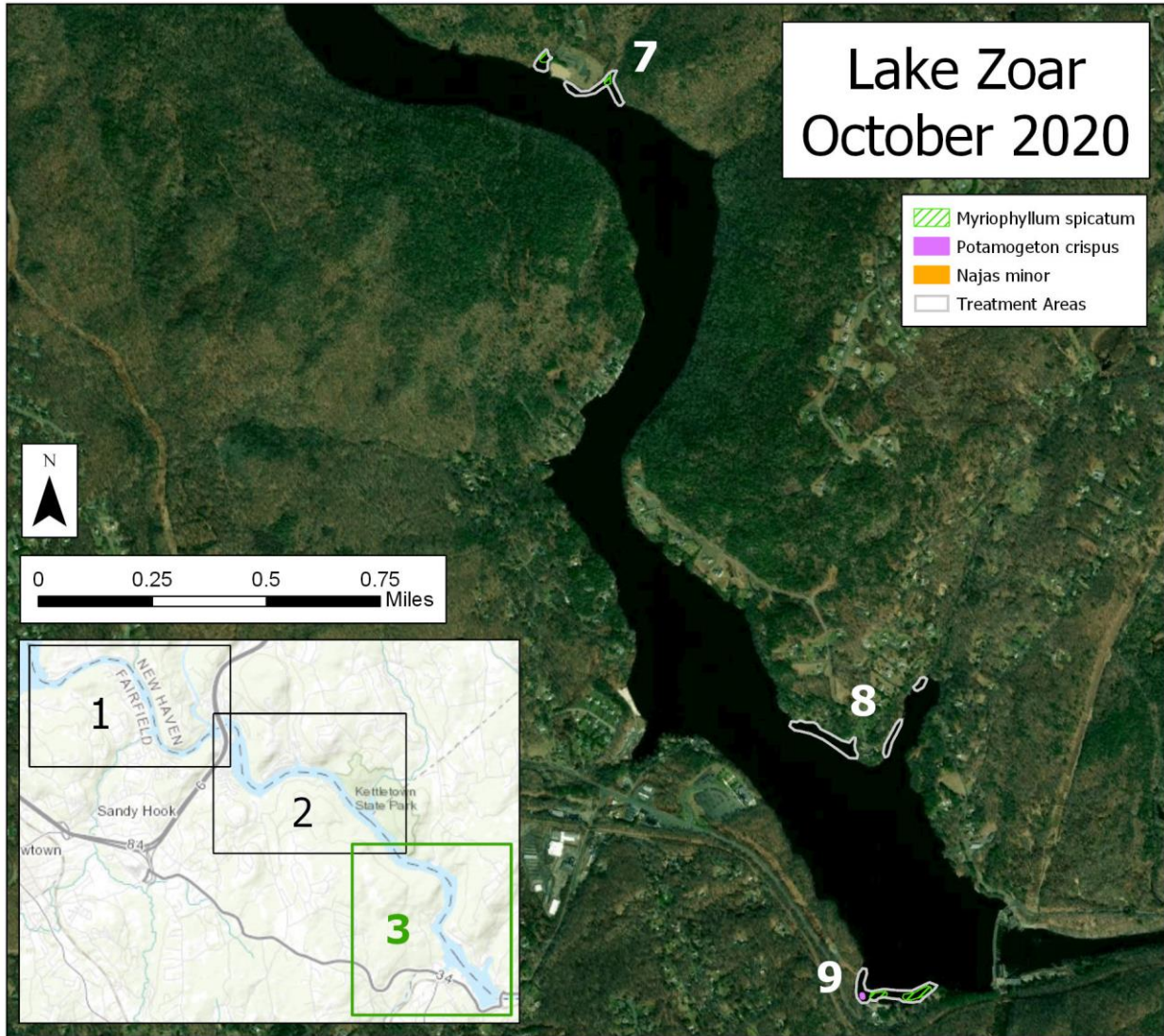
Map 8. October 1, 2020 invasive species, Zone 1.



Map 9. October 1, 2020 invasive species, Zone 2.



Map 10. October 1, 2020 invasive species, Zone 3.



Conclusions and Recommendations

The known growth pattern of Eurasian milfoil suggests that this species would have continued to expand in the lake over the course of the season if not treated. However, as a result of the two treatments, the species decreased notably in most management areas between June and August, and again between August and October.

Curly-leaf pondweed decreased considerably between June and August and was found in only three management areas in October. Without treatment, we would expect increased growth of this species between June and August.

We recommend continued treatment of the Eurasian milfoil and Curly-leaf pondweed in 2021 to continue to curb the growth of these species in the lake. Aquatic plant surveys should be conducted before and after each treatment to determine the impact of the treatments on the invasives species and the native plant community.

Area 1B was not treated in 2020 because it was not included on the permit. It is unclear why Area 8 was not treated. The herbicide applicator should ensure that all 10 management areas are included on the 2021 permit.

Though Brittle naiad was not listed as a target species in 2020, it is impacted by diquat. Brittle naiad should be included as a target species on the 2021 herbicide permit application.