Northeast Aquatic Research

Twin Lakes
2023 Aquatic Plant Monitoring Report

Prepared for the Twin Lakes Association

January 2024

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Executive Summary

Twin Lakes, in Salisbury CT, is a lake system of three connected water bodies: 569-acre East Twin Lake, 177-acre Middle Twin Lake, and 100-acre West Twin Lake. East Twin Lake has the deepest water at 78 feet, and a littoral zone (area where aquatic plants can grow) of 220 acres, Middle Twin Lake is much shallower, with a maximum depth of 25 feet and a littoral zone of 147 acres. West Twin Lake is the shallowest, with a maximum depth of 10 feet and a littoral zone of 100 acres, giving a total area of 467 acres where aquatic plants can grow within the lake system.

The Twin Lakes are known to contain two invasive aquatic plant species, Eurasian Milfoil (*Myriophyllum spicatum)* and Curly-leaf Pondweed (*Potamogeton crispus),* and five protected aquatic plant species; Straight-leaved Pondweed (*Potamogeton strictifolius*, Endangered), Small Bur-reed (*Sparganium natans*, Endangered), Hard-stemmed Bulrush (*Schoenoplectus acutus* Threatened), Northern Milfoil (*Myriophyllum sibiricum*, Threatened), and Water Marigold (*Bidens beckii*, Special Concern).

Northeast Aquatic Research (NEAR) conducted several surveys of the aquatic plants in the Twin Lakes system during 2023. Initially, NEAR was tasked with conducting pre- and post- treatment surveys of the lakes to map the distribution of the invasive plants before and after herbicide application and identify locations of the protected species. However, on June 21st, NEAR found Hydrilla (*Hydrilla verticillata*) at the private boat ramp of O'Hara's Landing Marina. With this discovery, NEAR was additionally tasked with searching for Hydrilla.

NEAR conducted a pre-treatment survey of all three lakes between May 31st and June 2nd. A ProcellaCOR treatment to control Eurasian Milfoil was made on August 14th. During the survey, the protected species Hard-stemmed Bulrush and Water Marigold were located. An additional 36 species of aquatic plants were identified in the lake. NEAR visited the treated areas on September 27th. No Eurasian milfoil was found in the treated area. No treatment was made to control Curly-leaf Pondweed in 2023.

NEAR conducted extensive surveys searching for Hydrilla in the area around the O'Hara's Landing boat ramp during late July and early August, marking the locations where Hydrilla plants were found, then pulling the plants. Early in the survey process, a large bed was found directly north of the marina that was too large to be hand removed. This bed was later covered with a bottom barrier. After looking closely at the threatened shoreline, Hydrilla was only found in one location outside of the marina, in the northern waters of East Twin Lake, some 2000 feet north of the marina boat launch. During these surveys, NEAR identified an additional 12 species of aquatic plants in the lakes, bringing the total number of identified species to 50.

The Hydrilla in the marina was treated with the maximum dose of ProcellaCOR on September 19th. The Eurasian Milfoil was eliminated overnight as NEAR visited the marina treatment area on September 20th and could not find Eurasian Milfoil in the treatment area. Hydrilla took much longer die, with plants still present on our last visit of the year on October 26th.

Actions for 2024

A. Use Diquat to treat Curly-leaf Pondweed in early spring. Target Curly-leaf Pondweed plants outside of the non-treatment area, as mapped in 2023 (See **Map 22** on pg. 34). A significant amount of mapped Curly-leaf is within non-treatment areas. The area that can be treated needs to be expanded to include most, if not all, of the Curly leaf Pondweed in West Twin. This can be done by both refining the necessary setback from Water Marigold, and treating very early in the season when Curly-leaf Pondweed is actively growing but prior to germination of Water Marigold. Several steps can be taken to increase the amount of Curly-leaf that can be treated without threatening the Water Marigold:
    1. Measure the Diquat concentration outside of the treatment area to determine if the chemical spreads away from where it is applied.
    2. Treat Curly-leaf in proximity to mapped locations of minor amounts of Water Marigold in early spring to determine whether Diquat affects Water Marigold while the plants are mostly undeveloped.
    3. Conduct a census survey of both West Twin and Middle Twin Lakes to find all the Water Marigold in both water bodies.

B. Consider hand harvesting Curly-leaf Pondweed. This method can be effective if the plants are repeatedly removed prior to maturity.
    1. Curly-leaf Pondweed's only mode of reproduction is through the formation of a winter bud at the end of the shoot. Removing this winter bud, or turion, eliminates one year's recruitment of new plants. New plants will come from the turion bank in the sediments. If new plants are removed each year prior to maturity, eventually the turion bank in the sediments will be depleted.

C. Use ProcellaCOR to treat Eurasian Milfoil in areas where it is necessary.
    1. Evaluate the Eurasian Milfoil treated in 2023 for regrowth.
    2. Continue to search for Northern Milfoil, with the goal of establishing the presence of this species in Twin Lakes and the specific locations where non treatment areas need to be established.

D. Evaluate the Hydrilla in the marina area for regrowth. This is best done in late June / early July, but the marina area should be searched in April and May to confirm this.
    1. Reoccurring Hydrilla should be treated with a systemic herbicide, preferably Fluridone.
    2. The Hydrilla beds in the northern portion of East Twin should be fully delineated.
    3. These beds will have to be surrounded with a curtain of some type prior to treatment.
    4. Herbicide can be applied inside the curtain to control the corralled Hydrilla plants. If Fluridone is used, a FastTest should be performed both inside and outside the curtain to determine whether the chemical diffused out of the corralled area.

E. The whole lake needs to be re-surveyed for the presence of Hydrilla, preferably in July/August.
    1. During this survey, all areas of prior reported presence of protected species need to be rigorously searched.

F. Ensure that Fluridone is added to the permit as an additional approved herbicide in Twin Lakes.

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INTRODUCTION

Summary of 2023 Monitoring and Management Events

The Twin Lakes is a large lake system in Salisbury, CT, consisting of three connected bodies of water; East Twin Lake, the largest at 569 acres and deepest at 78 feet, Middle Twin is much smaller at 177 acres and has a maximum depth of only 25 feet, and West Twin Lake is approximately 100 acres and is less than 10 feet deep throughout. Water leaves the Twin Lakes system through a narrow channel at the extreme northwest corner of West Twin Lake. The outflow from Twin Lakes flows north into Schenob Brook which meanders north into Massachusetts for several miles, eventually joining the Housatonic River in Sheffield Massachusetts.

Northeast Aquatic Research (NEAR) conducted several surveys of the aquatic plant community of the Twin Lakes during 2023. Our first survey was a comprehensive littoral zone characterization designed to evenly sample the aquatic plants in all three lakes. This survey was conducted over three days: May 31st, June 1st, and June 2nd, 2023. During this survey, the whole littoral zone was traversed to determine the outer edge of plant growth, that is, the water depth that prevents plant growth, the dominant aquatic plant species in the lakes, a list of all the species in the lake, scan for invasive and protected species, and evaluate the species/water depth relationship.

A total of 38 aquatic plant species were found during this survey, including the invasive species Eurasian Milfoil (*Myriophyllum spicatum*) and Curly-leaf Pondweed (*Potamogeton crispus*), as well as the State of Connecticut threatened species Hard-stemmed Bulrush (*Schoenoplectus acutus*) and special concern species Water Marigold (*Bidens beckii*). The Water Marigold plants that were found were small, new growth, with shoots no taller than about 6 inches.

The next survey consisted of 6 days of searching for Hydrilla (*Hydrilla verticillata*) between July 24th and August 3rd. NEAR found Hydrilla in East Twin, adjacent to the boat launch at O'Hara's Landing, during our routine water quality monitoring visit on June 21st. At that time, Hydrilla plants were small, only a few to several inches long and just breaking through the background plant growths of Milfoil, Pondweeds, Elodea, Bladderworts and Naiad in the Marina area. NEAR conducted an intensive Hydrilla search and removal operation in and around the Marina area over 6 days between July 24th and August 3rd. A full search of each square meter of the Marina area, about 4 acres, was conducted on July 24th, removing most Hydrilla that was found. During the search on July 25th, two dense patches of Hydrilla were found somewhat distant from the boat ramp. One patch was south of the boat ramp, where Hydrilla was growing densely inside Pickerelweed beds. The second patch was close to shore at the northern perimeter of the marina, under a large Weeping Willow tree so this patch was named the Willow Bed. The southern bed was harvested on July 28th and the Willow Bed was partially harvested on July 29th. Returning to finish harvesting on August 8th, Hydrilla had completely regrown in all the harvested areas, including the 1/3 of the Willow Bed that had been removed. This bed was later covered with bottom barrier in October. A full meander survey of the shoreline north and west of the marina was conducted over three days, on August 1st, 2nd, and 3rd. This survey inspected the shallow littoral zone along the shoreline.

We found Hydrilla in water only a few inches deep, out to about 4 feet of water depth, or where the bottom was no longer visible from the boat. During this survey, a second large bed of Hydrilla was found ~2000 feet north of O'Hara's Marina, and 1000 feet northwest from the State of CT cartop boat ramp, growing under a dense covering of waterlily pads. This bed was approximately 10 feet around with individual clumps of plants scattered around it. This bed was labeled the Waterlily Bed to differentiate it from the Willow Bed.

The Pond and Lake Connection treated Eurasian Milfoil, as per requirements of CT NDDB, on August 14th. A total of 50 acres were treated with ProcellaCOR, at a rate of 3 PDU/ac ft (**Map 1**). The treatment map was approved by CT NDDP as following setbacks from locations of protected species.

On September 19th, The Pond and Lake Connection applied ProcellaCOR, at a rate of 20 PDU/ac ft, in an area of 4.1 acres around O'Hara's Marina, to kill Hydrilla infesting that area (**Map 2**). This area had been approved by CT NDDP following their review of potential impacts to protected species. The concentration of ProcellaCOR was monitored during the treatment.

Our last survey was conducted on September 27th, when NEAR returned to our waypoints that were within the August 14th Eurasian Milfoil treatment areas. We examined all the sites where Eurasian Milfoil had been documented during the pre-treatment survey to assess the impact of the herbicide treatment on both the Eurasian Milfoil and the native plant population within the treatment areas.

Map 1. August 2023 Milfoil treatment areas, marked as areas in red.

Map 2. September 2023 Hydrilla treatment area, red polygon, and dispersion area, blue polygon. Yellow lines show 500 and 900 meters from the treatment area.

SURVEY METHODS (for whole-lake survey, May 31 – June 2, 2023)

The pre-treatment survey, conducted in late May and early June, circumnavigated the entire littoral zone of the lake by either zigzagging between the shore and deep water, or running transects across the lake from one side to the other when the entire section was shallow enough to sustain plant growth. The boat was stopped at specific and regular intervals to sample the aquatic plant community at that location. When the boat was stopped, a waypoint was made using Garmin GPS. These 'waypoints' or 'points' provide quantitative examination of the findings. Because the surveys covered the full depth range of the aquatic plant community, from shore to maximum depth, the GPS waypoints are a representative sampling of the aquatic plants in the lake. At all times during the survey, a high-resolution down-imaging SONAR device provided a constant image of the water column beneath the boat. The image was of high enough resolution to differentiate plants from other objects such as rocks and stumps, as well as to show when nothing was present. The depth sounder showed the presence of plants that were growing near the bottom that were not visible from the surface (**Figure 1**).

At each waypoint, either a long-handled (12ft) rake, or a 14-tine double-sided gravel rake attached to a 10m rope, was used to collect specimens of plant species at that point. Each species was examined visually to estimate density, or percent cover. Plant density was determined using a combination of three methods. The visual density determination method is based solely on what is visible from the surface. This method involves using a hypothetical quadrat. In this method, one visually assesses an estimate of how much area is covered by the plant species in question. The use of actual survey quadrats in the field is not appropriate for the large

scale of most aquatic plant surveys. Surveyors visualized a hypothetical quadrat approximately 10-15ft in length, then estimated coverage accordingly. The second way to estimate the percent coverage of vegetation is to use the down-imaging SONAR images of the plants as the boat passes above. In areas where plants cannot be seen from the surface, the SONAR image becomes extremely useful for percent coverage estimations, along with weed-rake tosses. Rake tosses involve stopping the boat and throwing a 30ft tow line and rake head through the plant bed. Plants retrieved by the rake are estimated semi-quantitatively as a percent cover. When possible, both methods of estimating the percent cover are used at each waypoint, and the resulting estimate is recorded on the datasheet. For purposes of mapping, the percentage density values assigned in the field are grouped into five classes: Very Sparse = 1-5%, Sparse = 6-19%, Medium = 20-59%, Dense = 60-79%, and Very Dense = 80-100.

Each species is also given a Growth Form rating from 1 to 5 to record the approximate height plants reach in the water column. A growth form of 1 means the plant was on the bottom without any vertical shoots. The growth forms 2 and 3 means the plant is either ¼ or ½ of the depth of the water column. A growth form of 4 indicates the plant is close to the surface, while a growth form of 5 indicates the plant has reached the surface and has either floating or aerial portions of the plant. The water depth at each waypoint is also recorded.

Figure 1: SONAR imagery showing Eurasian Milfoil in Candlewood Lake. The image shows plant growth starts at 7.5 feet of water depth and continues past 10 feet, while plants only grew 3 feet tall.

A total of 433 waypoints were made during the entire three-day survey (**Map 3**). Of the 433 waypoints, 237, or 55% of the waypoints, were made in East Twin Lake, 2 waypoints were made in the channel connecting East Twin to Middle Twin, 108 waypoints, or 25%, were made in Middle Twin, and 88 waypoints, or 20%, were made in West Twin Lake. There is no clear division between West and Middle Twin, just a gradual shallowing of the water depth. Prior studies have included Middle and West together as one lake. For purposes, we consider

them to be separate waterbodies. West Twin Lake is all shallow littoral zone of between 0 and 7 feet, with a very small, ¼ acre, area that has water depths between 7 and 10 feet.

Middle Twin Lake has a gently sloping deep littoral zone of 3 to 15 feet that slowly increases to 20 feet, allowing development of moderate and deeper water littoral plant communities than can't occur in West Twin or East Twin. Plants were typically not found in water deeper than about 15 feet. Middle Twin Lake has a littoral area of roughly 110 acres, and 67 acres of surface area too deep for plant growth, but only barely so.

East Twin has a shallow shelf that stretches uniformly out to about 400 feet from shore and spans the entire western and northern shores. The shelf is characterized by very gradual deepening of water depth from 3 feet to 7 feet, over the roughly 400-foot distance. Water depth drops off quickly after 7 feet; typically, within 30 to 50 feet, the water depth was greater than 20 feet. The shelf is roughly 140 acres, or about 66% of the total littoral zone of 220 acres. The remaining 80 acres consists of a steep slope that rapidly becomes too deep for plant growth.

Map 3. Pre-treatment survey waypoints, May/June 2023.

Results From Spring Survey

General Findings

During this survey, 38 aquatic plant species were documented in the lake system, including non-vascular macroalga; Muskgrass (*Chara sp.*) and Stonewort (*Nitella sp.*), and microscopic filamentous alga; the Chlorophyte *Spirogyra* and the Benthic Cyanobacteria *Lyngbya* (**Table 1**). West Twin Lake had the highest species count at 32, East Twin Lake had 25 species, and Middle Twin Lake the lowest count at 23 species. There were only 15 species that were common to all three lakes; these are given the symbol ₸, in **Table 1**. There were three species that were endemic to only East Twin Lake (labeled **E** in **Table 1**): Stonewort (*Nitella sp.*), Swamp Loosestrife (*Decodon verticillatus*), and Floating Pondweed (*Potamogeton natans*). There were 7 species that were endemic to only West Twin Lake (labeled **W** in **Table 1**). There were no endemic species in Middle Twin Lake, but there were several species that were in either West and Middle Twin but not in East Twin, or in Middle and East Twin but not in West Twin.

Table 1 ranks each species by how often they were found throughout the entire survey. The percent frequency value is the number waypoints at which the species was found, divided by the total number of waypoints made during the survey (433). The percent frequency value estimates the distributional abundance of the species throughout the lake, i.e. Muskgrass (*Chara sp.*) was found at nearly half the waypoints, 45%. The percent frequency also estimates the likelihood of finding a species at any given waypoint. **Table 1** shows that 4 species were found at greater than 20% of the points, 6 species were found at between 10 and 19% of the points, and the remaining 26 species were found at less than 10% of the points, with 20 of those species found 2% or less of the time. This indicates that, most of time, the plants that are observed in the Twin Lakes system are going to be one or more of the top 10 species (first 10 species listed in **Table 1**). The remainder of the species in **Table 1** are relatively hard to find.

The four dominant aquatic plants were Muskgrass (*Chara sp.*), Large-leaf Pondweed (*Potamogeton amplifolius*), Tape Grass (*Vallisneria americana*), and Eurasian Milfoil (*Myriophyllum spicatum*), meaning they were present at greater than 20% of survey waypoints (**Map 4 – Map 7**). Chara dominated the entire shelf of the eastern shore of East Twin Lake, where there was a continuous bottom blanket of 100% Chara from near shore to about 400± feet from shore. There were also several places along the eastern shore where Chara formed a 100% bottom covering. The north shore of the north bay of East Twin was dominated by floating leaved species.

The invasive species Eurasian Milfoil was present at 21% of waypoints throughout East, Middle, and West Twin. Most Milfoil beds were sparse to moderate abundance, though a handful were very dense.

The invasive species Curly-leaf Pondweed was abundant in the northern end of West Twin and along the southern and western shorelines of Middle Twin (**Map 8**). The majority of Curly-leaf beds were low to moderate density.

Two Connecticut state-listed species, Water Marigold (*Bidens beckii*, Special Concern) and Hard-stem Bullrush (*Schoenoplectus acutus,* Threatened), were documented during the spring survey (**Map 9, Photo 1, Map 10, Photo 2**). Water Marigold was only found in Middle Twin, mainly along the northern shoreline. Hard-stem Bullrush was found at one waypoint on the northern shoreline of East Twin, and at one waypoint at the southern end of West Twin.

Filamentous algae was prolific in East Twin, particularly along the southeast shoreline and around the peninsula (**Map 11**). It was also present in Middle Twin and the in northern portion of West Twin.

The plants that occurred at the highest density are listed in **Table 2**. Density values give an estimate of the amount of plant material present. An area where a species was considered to be at 100% means that all the observation area adjacent to the boat was full of this species and often no other species would be present. Typically, anything over 60% indicates that a species was prolific at that point. Averages are made from all density data at each waypoint so don't reflect the maximum condition that we found a species. The percentage of time that the species had over density of 50% or more and 80% or more are also given. The table shows that most plants don't attain high degrees of standing crop; only Chara and Filamentous Algae were present at greater than 50% cover most of the time. All other species reached 50%+ density at less than 20% of the locations and rarely, if ever, had stands of 80-100% cover.

Table 1. Aquatic plants found in Twin Lakes during the May 31 - June 2, 2023 survey, listed in order of abundance, with associated percent frequency and average density. *

Scientific Name	Common Name	% Frequency	Avg. Density
Nothing present		18	~
Chara vulgaris Ŧ	Muskgrass	45	72
Potamogeton amplifolius Ŧ	Large-leaf Pondweed	36	25
Vallisneria americana Ŧ	Tape Grass	21	14
Myriophyllum spicatum Ŧ	Eurasian Milfoil	21	25
Filamentous algae Ŧ	Filamentous Algae	19	50
Potamogeton illinoensis Ŧ	Illinois Pondweed	17	10
Nymphaea odorata Ŧ	White Water Lily	13	18
Potamogeton zosteriformis Ŧ	Flat-stem Pondweed	12	19
Nuphar variegata Ŧ	Yellow Water Lily	11	24
Potamogeton crispus Ŧ	Curly-leaf Pondweed	11	14
Potamogeton robbinsii	Robbins' Pondweed	6	19
Brasenia schreberi W	Watershield	6	19
Ceratophyllum demersum	Coontail	4	15
Eleocharis robbinsii W	Robbin's Spikerush	3	35
Elodea canadensis Ŧ	Canadian Waterweed	3	12
Najas flexilis W	Slender Naiad	3	19
Sagittaria graminea Ŧ	Narrow-leaved Arrowhead	2	7
Pontederia cordata Ŧ	Pickerelweed	2	18

Bidens beckii	Water Marigold	2	8
Utricularia intermedia	Flat-leaved Bladderwort	2	17
Ranunculus longirostris	Longbeak Buttercup	2	14
Najas guadalupensis	Southern Naiad	2	41
Utricularia macrorhiza W	Common Bladderwort	1.4	9
Potamogeton praelongus	White-stem Pondweed	1.4	14
Scirpus spp. ₮	Bulrush	1.2	20
Potamogeton pusillus ₮	Lesser Pondweed	1.2	12
Potamogeton natans E	Floating Pondweed	1.2	12
Lyngbya spp.	Benthic Cyanobacteria	0.9	33
Schoenoplectus acutus	Hard-stemmed Bullrush	0.7	10
Utricularia geminiscapa W	Hidden-fruit Bladderwort	0.5	5
*Zosterella dubia***	Water Stargrass	0.5	18
Ludwigia sp W	Water Purslane	0.2	5
Potamogeton obtusifolius W	Blunt-leafed Pondweed	0.2	10
Elodea nuttallii	Western Waterweed	0.2	5
Decodon verticillatus E	Swamp Loosestrife	0.2	15
Nitella sp. E	Stonewort	0.2	5

** Red lettering indicates invasive species. Green lettering indicates CT State-listed species.*
₮ = species common to all three water bodies. Species endemic to a single basin are marked with either E for East Twin Lake, or W for West Twin Lake.
*** Also known as Heteranthera dubia.*

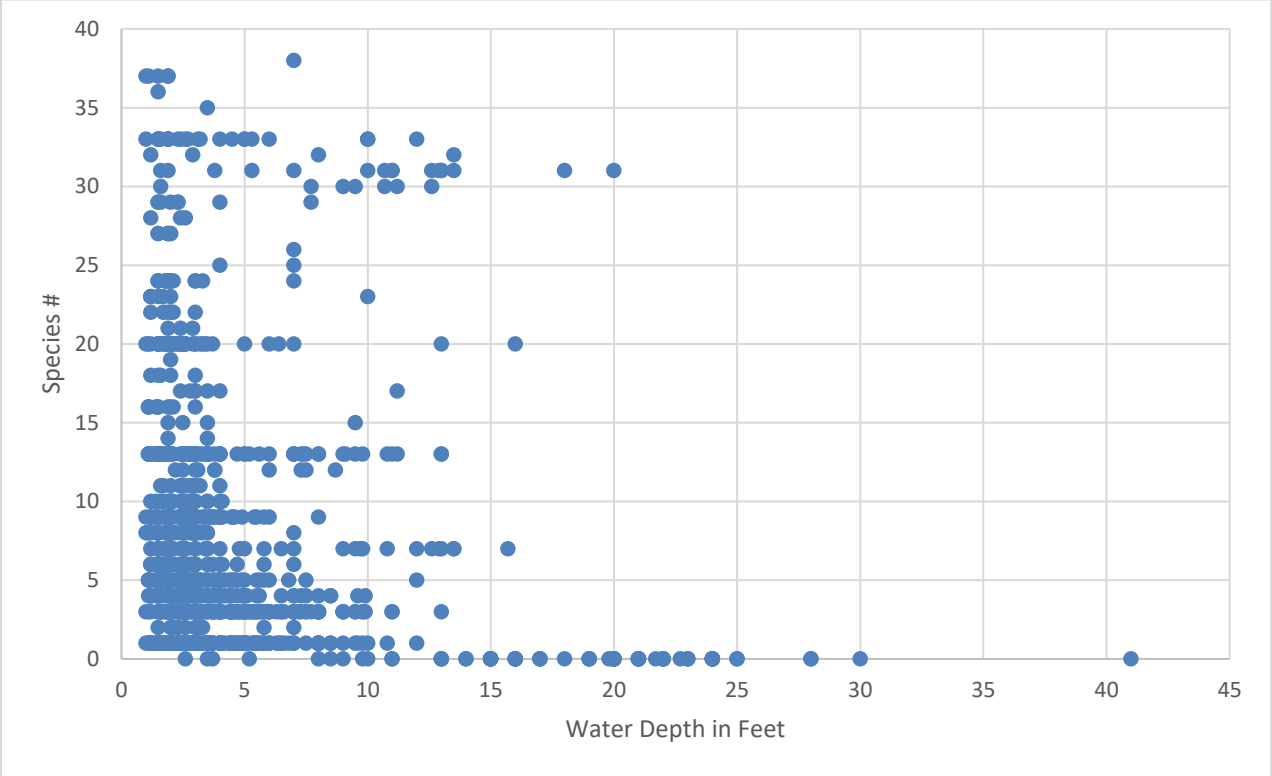
Table 2. Average density of the most prolific species, with associated percent of species waypoints with 50%+ and 80%+ density.

Top 10 species	Average Density	% of Species Waypoints with 50% or Greater Density	% of Species Waypoints with 80% or Greater Density
Chara vulgaris ₮	72	41	32
Potamogeton amplifolius ₮	25	11	3
Vallisneria americana ₮	15	4	1
Myriophyllum spicatum ₮	25	40	11
Filamentous algae ₮	50	72	33
P. illinoensis ₮	10	0	0
Nymphaea odorata ₮	17	5	0
P. zosteriformis ₮	19	16	4
Nuphar variegata ₮	15	31	13
Potamogeton crispus ₮	13	4	0
Uncommon species that had high density in localized sites			
Najas guadalupensis	41	43	0
Eleocharis robbinsii	35	33	13
Lyngbya	33	25	0

Species / Water Depth Relationship

Of the 38 species of aquatic plants found during the May 31st to June 2nd survey, 14 species were only found in water depths of less than 5 feet, eleven species reached 10 feet of water depth, and only three species*, Najas guadalupensis, Potamogeton zosteriformis,* and *Potamogeton crispus*, were found in water deeper than 15 feet, and only on four occasions (**Figure 2**). No plants were found in water deeper than 20 feet. The lack of a clear demarcation for the end of plant growth suggests that water clarity is good enough for plants to grow to 20 feet of water depth if other conditions, specifically substrate type, allow.

Figure 2. Species and water depth, species number is from Table 1. The zero species is nothing present.



Species List Comparison to Prior Surveys

The aquatic plant species and measured abundance from three comprehensive surveys of the Twin Lakes system are compared in **Table 3**. Our May31/June2 survey and Aquatic Ecosystem Research's (AER) two whole lake comprehensive surveys, that is, had waypoints spaced out equally over the whole of the three bodies of water, first in 2017, and again in 2021. Each survey was said to consist of 400 waypoints in East Twin and 180 waypoints in West Twin (their report grouped Middle and West together), with the 2021 survey revisited the same sites used in 2017. **Table 3** includes the 11 species NEAR found during the Hydrilla surveys in late July and early August. The two AER surveys were very similar with totals of 32 species in 2017 and 36 species in

2021. The two lists shared all but 11 species, these were species found either in 2017 or 2021. The two lists were combined into one AER list and compared with NEAR 2023 list. **Table 3** lists 16 species found by NEAR and not by AER, however the Table lists 8 species reported by AER, but not as yet found by NEAR. This brings the possible number of species in the Twin Lakes system to 58. Generally, both surveys found the same dominant species. Aside from AER finding ~20% Najas flexilis, vs. NEAR's 3% frequency of occurrences were within range of error with these types of surveys.

Table 3. Comparison of Species lists from comprehensive surveys by NEAR and AER. Blank cells denote species not found. "p" indicates NEAR observed the species during Hydrilla searches, but it was not recorded at any waypoints during the June survey.

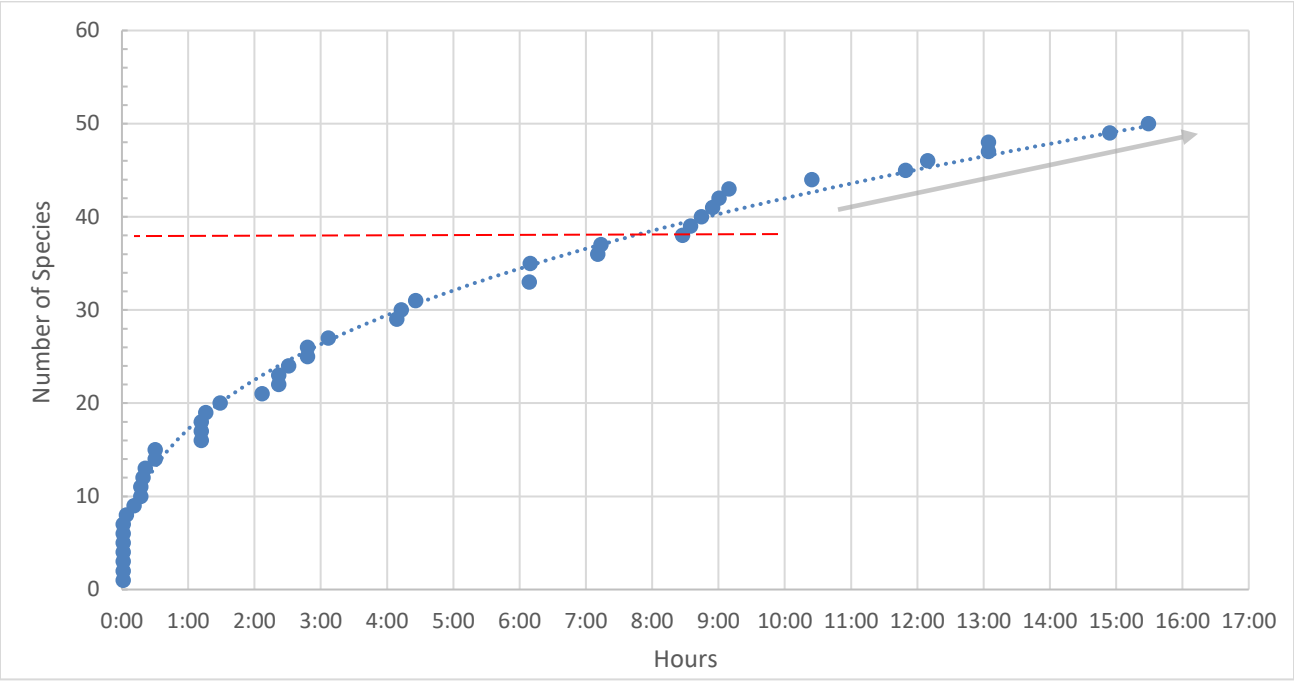
#	Species Name	NEAR June 2023 Species Frequency	AER July 2021 Species Frequency	AER Summer 2017 Species Frequency
1	*Chara sp.*	45	54	51
2	*Najas flexilis*	3	20	18
3	*Potamogeton amplifolius*	36	34	29
4	*Vallisneria americana*	21	45	29
5	*Filamentous algae*	19		
6	*Nymphaea odorata*	13	17	8
7	*Potamogeton crispus*	11	0.3	
8	*Nuphar variegata*	11	10	7
9	*Potamogeton illinoensis*	17	38	29
10	*Brasenia schreberi*	6	7	3
11	*Eleocharis robbinsii*	3		
12	*Sagittaria graminea*	2		1
13	*Myriophyllum spicatum*	21	28	5
14	*Utricularia geminiscapa*	0.5		
15	*Lyngbya sp.*	1		
16	*Pontederia cordata*	2	6	2
17	*Utricularia intermedia*	2	3	3
18	*Scirpus spp.*	1		
19	*Ludwigia sp.*	0.2	0.3	
20	*Potamogeton zosteriformis*	12	9	6
21	*Schoenoplectus acutus*	1		
22	*Utricularia macrorhiza*	1	11	3
23	*Potamogeton praelongus*	1		
24	*Elodea canadensis*	3	0.3	
25	*Zosterella dubia*	0.5		
26	*Potamogeton obtusifolius*	0.2		
27	*Ranunculus trichophyllus*	2	3	1
29	*Bidens beckii*	2	0.3	1
30	*Najas guadalupensis*	2		2
31	*Ceratophyllum demersum*	4	6	8
32	*Potamogeton pusillus*	1		0.2

33	*Potamogeton robbinsii*	6	3	4
35	*Elodea nuttallii*	0.2	3	1
36	*Decodon verticillata*	0.2		
37	*Potamogeton natans*	1	1	1
38	*Nitella sp.*	0.2	1	
39	*Hydrilla verticillata*	p		
40	*Potamogeton oakesianus*	p		
41	*Nasturtium officinale*	p		
42	*Najas minor*	p	0.3	0.2
43	*Utricularia purpurea*	p	1	2
44	*Lemna trisulca*	p	2	1
45	*Schoenoplectus subterminalis*	p		
46	*Lemna minor*	p	2	
47	*Stuckenia pectinata*	p		
48	*Wolffia sp.*	p	0.2	1
49	*Spirodela polyrhiza*	p	1	1
50	*Eleocharis acicularis?* (Spikerush)		0.2	
51	*Myriophyllum sibiricum*		0.2	1
52	*Ceratophyllum echinatum*		0.2	
53	*Potamogeton foliosus*		1	
54	*Potamogeton strictifolius*		4	2
55	*Utricularia gibba*		6	5
56	*Utricularia radiata*		2	1
	Totals	**47**	**36**	**31**

Species Effort Curve

The amount of time it took to find new species in Twin Lakes is shown by the species/effort curve (**Figure 3**). This chart shows how long it takes to add another species to the list. The first hour of surveying revealed 15 species and the second hour an additional 5. After that, species were added at a rate of 1.4 species per hour. The first 38 species were found during the May/June survey. The curve is extended past this point (red dashed line) by the additional 12 species found during the Hydrilla surveys of late July and early August. The curve has not flattened yet, as shown by the gray arrow with a slope of about 1 species / hour, indicating that there are more species to find. The AER surveys found 7 species not yet recorded by NEAR, suggesting the total number of species in the Twin Lakes system is closer to 60. Once all or nearly all of the species in the lake are found, the species/effort curve will asymptote with continual time spent, eventually becoming days or years as opposed to hours to add new species. Also shown in the graph is that the May/June survey involved 8+ hours of searching, while the Hydrilla surveying included an additional 7+ hours of searching.

Figure 3. Species effort curve for species found by NEAR in 2023.



The post-treatment investigation on September 27th involved returning to the areas where Eurasian Milfoil was found pre-treatment. No Milfoil was found in the treatment areas during this survey, meaning the ProcellaCOR effectively killed all the Milfoil growing in the treatment areas. Other areas of the lake were not searched. ProcellaCOR is a systemic herbicide that is likely to provide multiple years of control. Growth of Milfoil in treatment areas should be assessed before applying more herbicides.

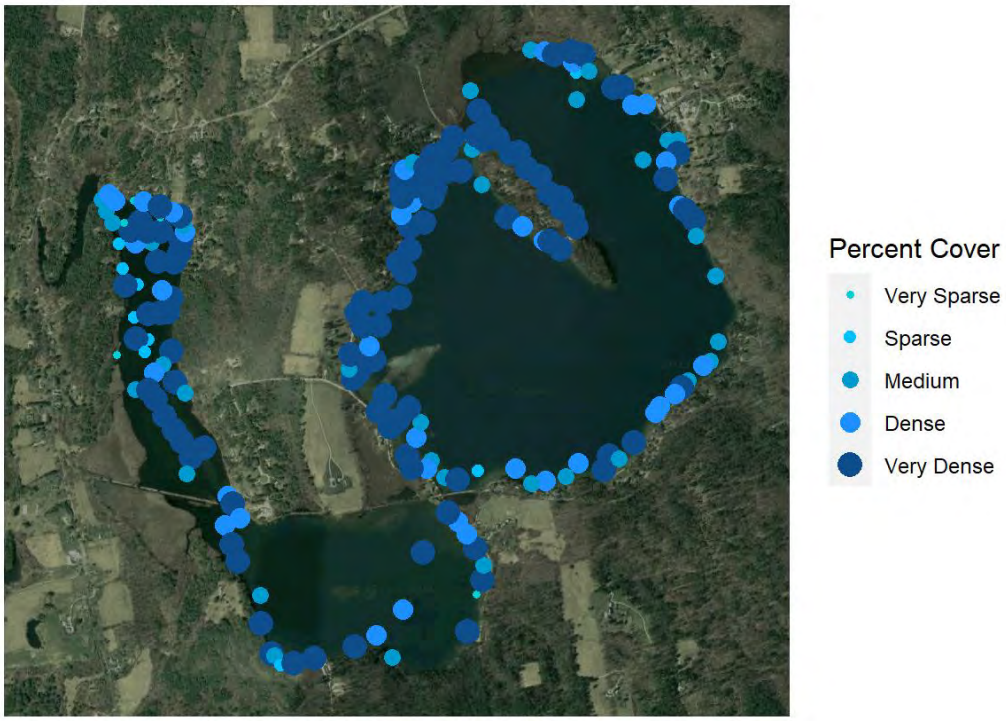
During the post-treatment investigation, Hydrilla was found in deeper water outside O'Hara's Landing Marina. Additionally, the invasive species Brittle Naiad (*Najas minor*) was found at the northern end of West Twin (**Map 12**). This species was not found during the pre-treatment survey in May because Brittle Naiad typically starts growing later in the season. Water Marigold was found in one location, in the channel between Middle Twin and West Twin.

Survey Maps

A series of maps follow that show the distributional abundance of the three native species with the highest frequency of occurrence, the three invasive species, and the two protected species, as well as Filamentous Algae and Waterweed (*Elodea spp.*).

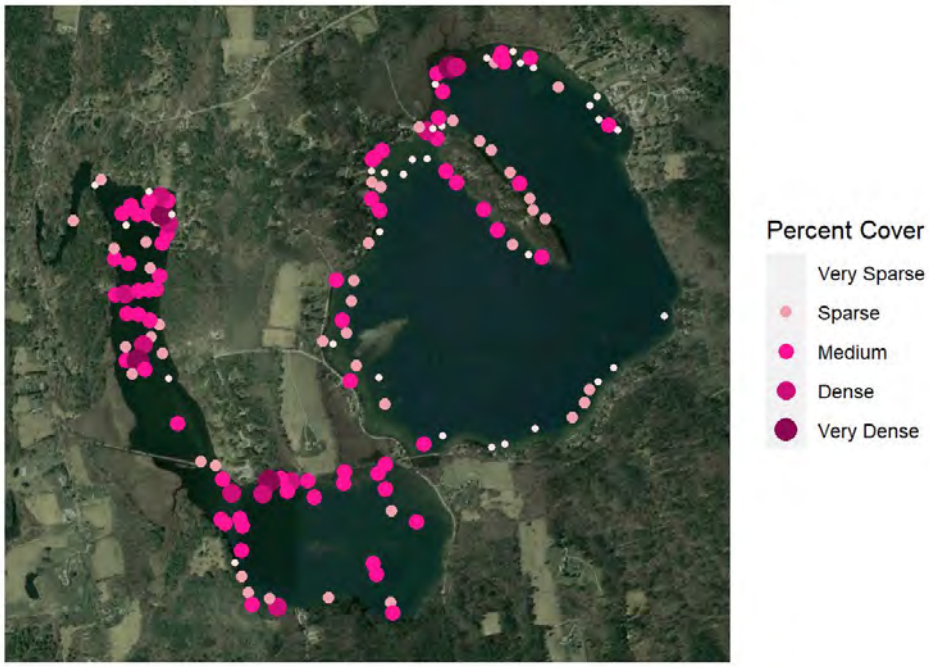
Map 4. Locations of Muskgrass (*Chara sp.*) in Twin Lakes, June 2023.

Northeast Aquatic Research, LLC

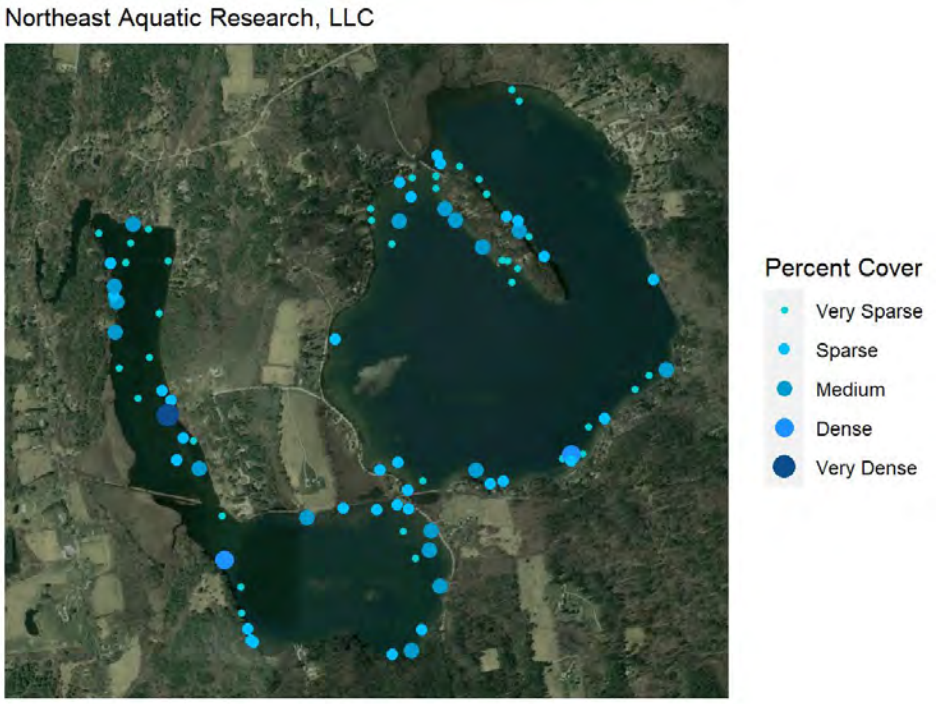


Map 5. Locations of Large-leaf Pondweed (*Potamogeton amplifolius*) in Twin Lakes, June 2023.

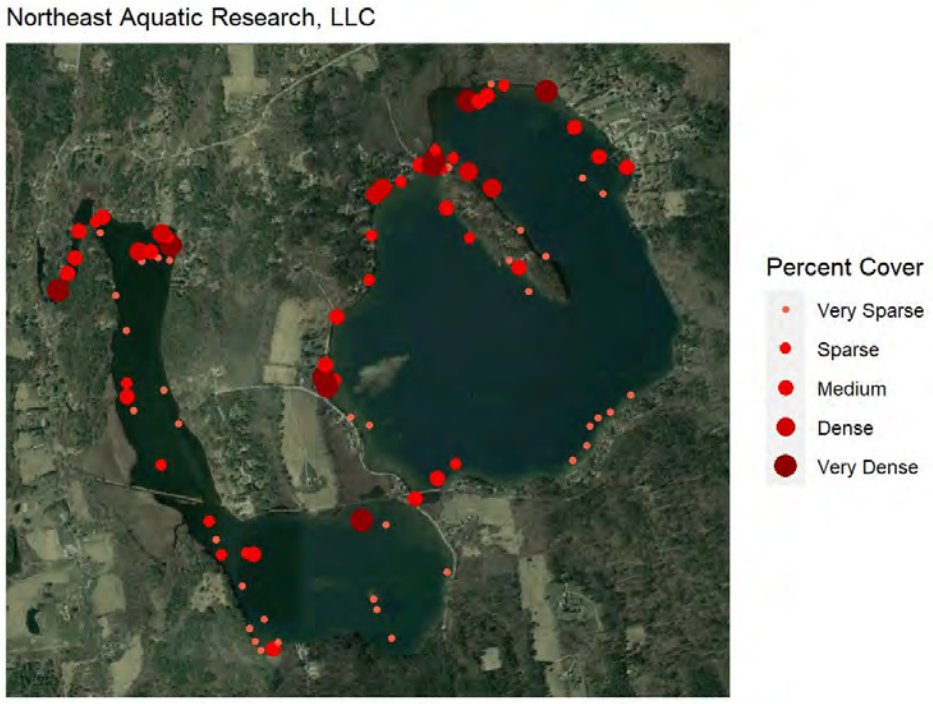
Northeast Aquatic Research, LLC



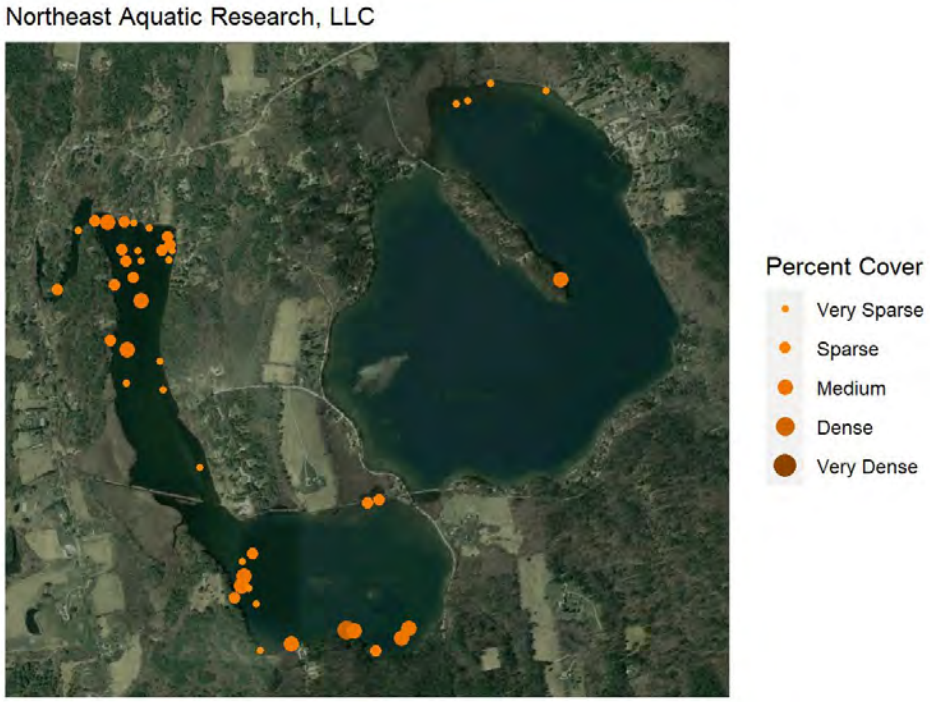
Map 6. Locations of Tape Grass (*Vallisneria americana*) in Twin Lakes, June 2023.



Map 7. Locations of Eurasian Milfoil (*Myriophyllum spicatum*) in Twin Lakes, June 2023.



Map 8. Locations of Curly-Leaf Pondweed (*Potamogeton crispus*) in Twin Lakes, June 2023.



Map 9. Locations of Hard-stem Bulrush (*Schoenoplectus acutus*) in Twin Lakes, June 2023.

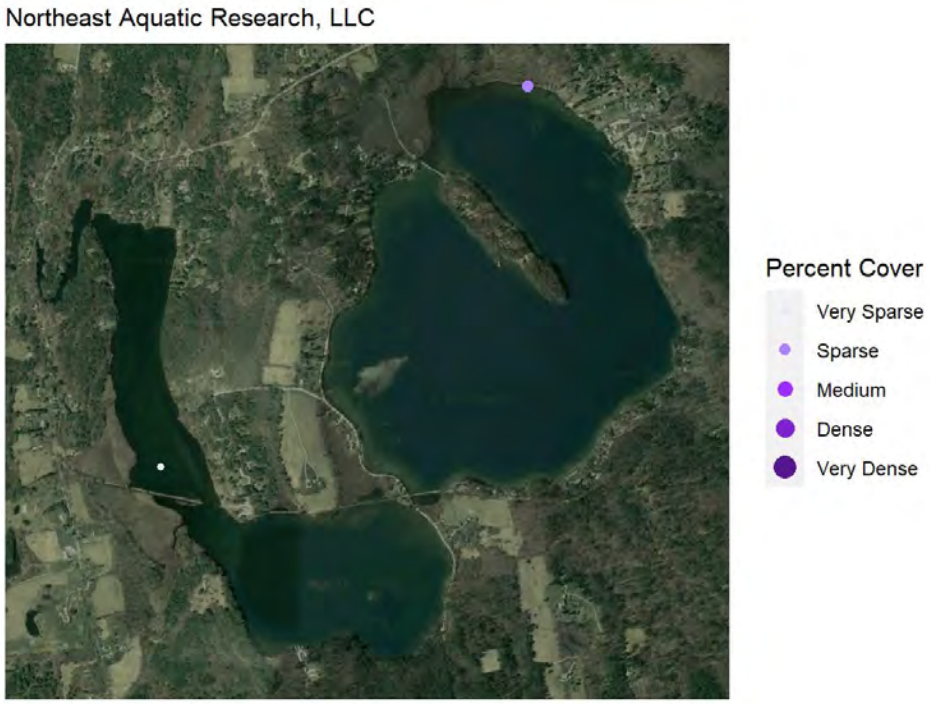


Photo 1. Hard-stem Bulrush (*Schoenoplectus acutus*) in West Twin Lake on May 31st, 2023.

Map 10. Locations of Water Marigold (*Bidens beckii*) in Twin Lakes, June 2023.

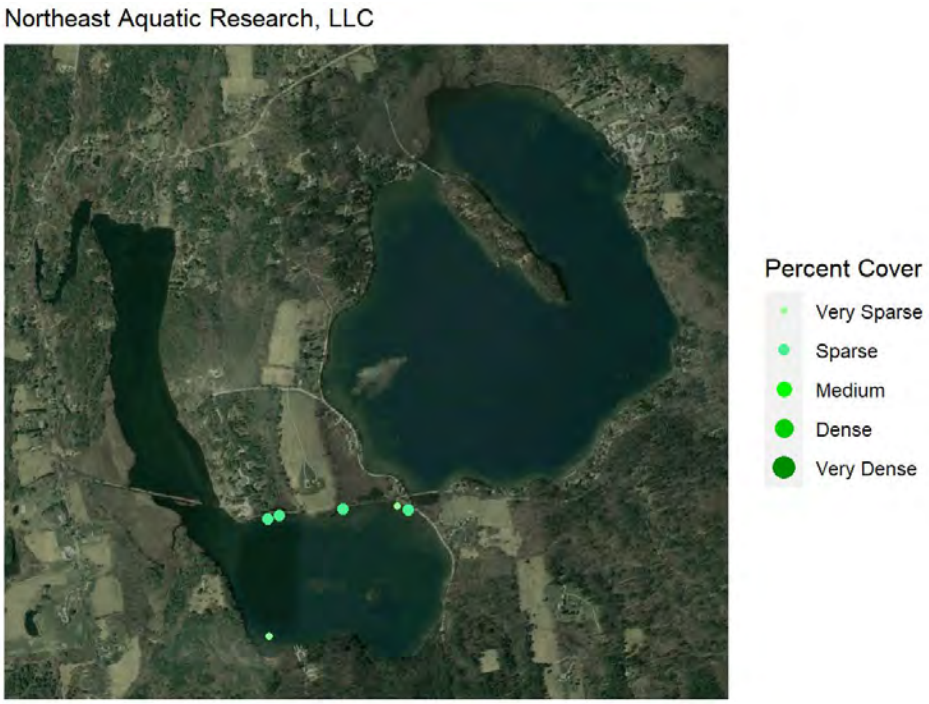
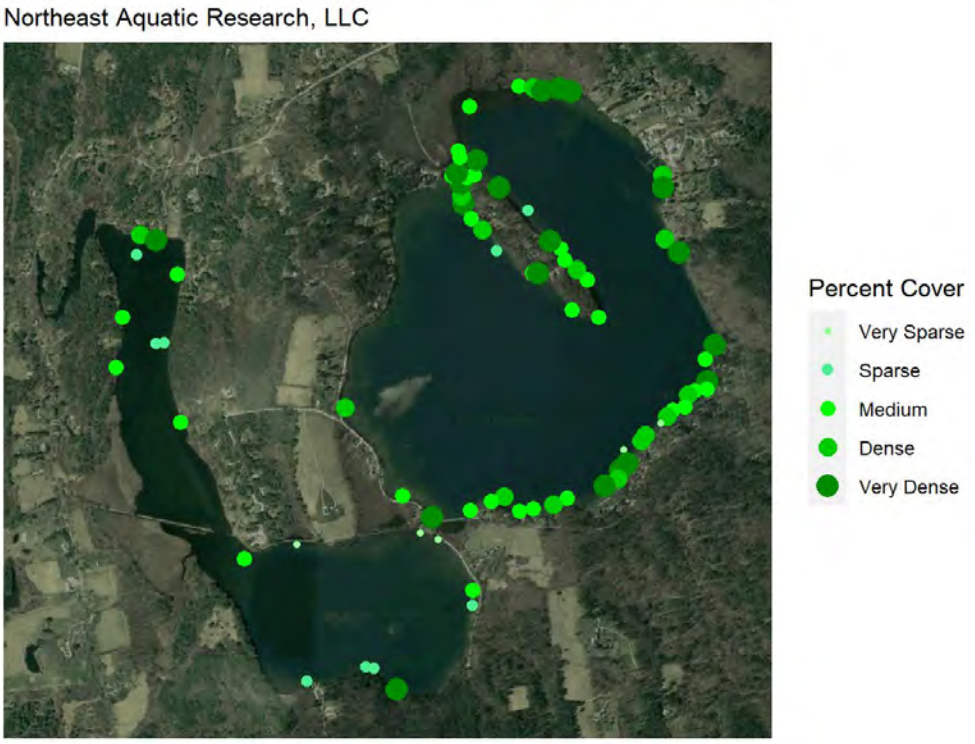
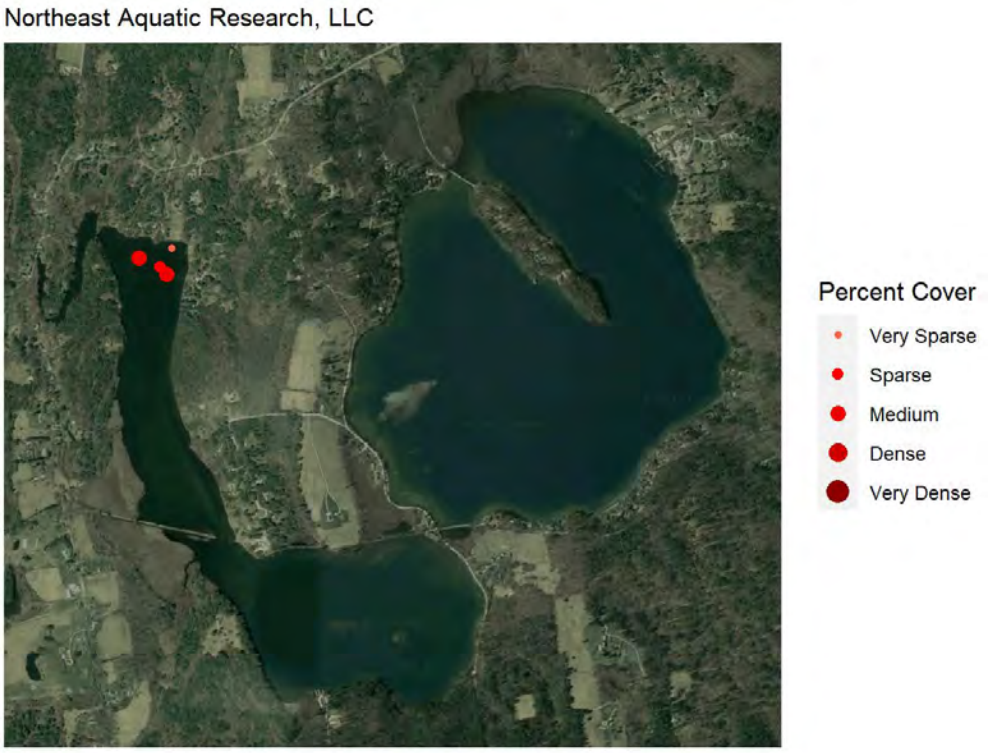


Photo 2. Photograph of *Bidens beckii* in Middle Twin Lake on May 31st, 2023.

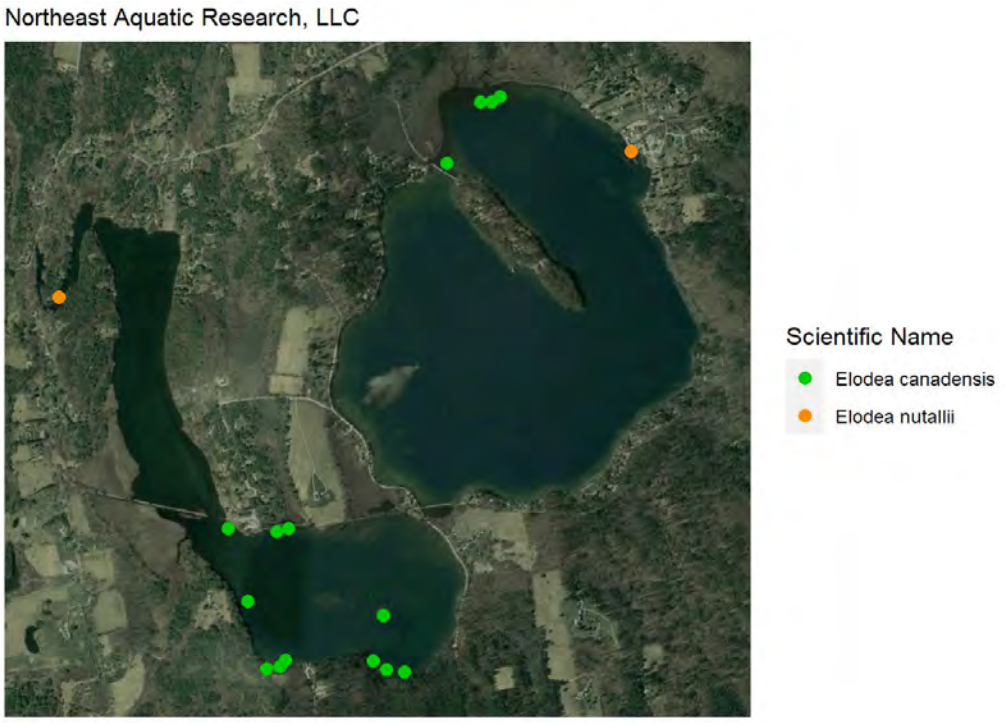
Map 11. Locations of Filamentous Algae (*Spirogyra*/*Mougeotia*) in Twin Lakes, June 2023.



Map 12. Locations of Brittle Naiad (*Najas minor*) in Twin Lakes, September 2023.



Map 13. Locations of Waterweeds (*Elodea sp.*) in Twin Lakes, June 2023.



HYDRILLA SEARCH AND 2023 MANAGEMENT

NEAR found Hydrilla next to the O'Hara's Landing Marina boat launch during a routine water quality monitoring visit on June 21st (**Map 14**). NEAR immediately reported the finding to Connecticut DEEP. Personnel from the Connecticut Agricultural Experiment Station's Office of Aquatic Invasive Species visited the lake and collected specimens to send to the University of Wisconsin – Whitewater, where the plants were genetically identified as the strain of Hydrilla present in the Connecticut River.

On July 24th and 28th, NEAR searched the marina area, as well as north of the marina to the State of CT boat access, and south past the small point (**Map 15**). Patches of Hydrilla were found throughout the area of O'Hara's Landing Marina. Hydrilla plants found in the marina during this survey were immediately pulled by NEAR staff and removed from the lake. The Hydrilla was growing amongst Western Waterweed (*Elodea nuttallii*), which has a similar appearance to Hydrilla. Eurasian Milfoil was also growing in the marina, sometimes in dense patches. The Hydrilla patches ranged in size from single plants to the 30'x30' Willow Bed. Additional aquatic plants growing in the marina area include Coontail (*Ceratophyllum demersum*), Water Buttercup (*Ranunculus sp.*), Bladderworts (*Utricularia purpurea, radiata, geminiscapa*), Tape Grass (*Vallisneria americana*) Pondweeds (*Potamogeton zosteriformis, oakesianus*, *illinoensis, robbinsii*), and Water Stargrass (*Zosterella dubia*). Approximately 30% of the Hydrilla plants in the Willow Bed were pulled. Plants in the Waterlily Bed were in water too deep to remove, making them inaccessible. In total, including July and August harvesting, and an additional day on October 12th, approximately 250 pounds of Hydrilla were pulled and removed (**Photo 3**).

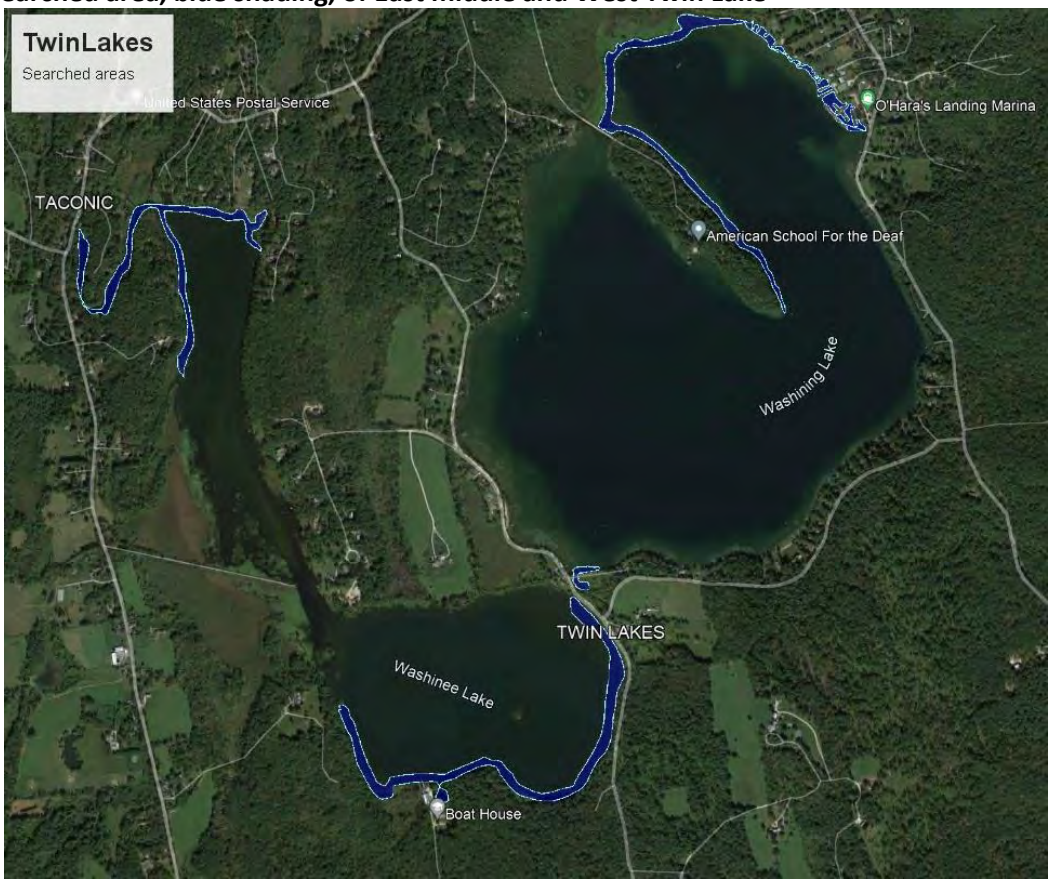
Map 14. Locations of Hydrilla (*Hydrilla verticillata*) found in Twin Lakes in2023.

Map 15. Searched area (blue shading) and locations where Hydrilla was found (red circles) July 24th & 28th. The larger red circle represents the Willow Bed.

Photo 3. A fraction of the Hydrilla harvested from the marina area in July 2023.

On August 2nd, NEAR conducted a survey of shores where Hydrilla was likely to have either drifted to or been transported to. The blue shaded area in **Map 16** shows the searched areas. We found a dense patch of Hydrilla approximately 2,000 feet north of the marina boat ramp. The patch was approximately 15 feet in diameter. The plants were at 100% density and rose up to roughly ¾ of the water column. The Hydrilla was growing under/within a dense water lily bed in about 4-5 feet of water depth. During this survey, significantly more Water Marigold was found in both East and Middle Twin Lakes. Water Marigold was found in a roughly continuous band along the northern shore of East Twin, outside of the Water Lily beds, and along the north and south shores of Middle Twin Lake (**Map 17**). Upon examination of the northern bed in early October, a second larger patch, approximately 20 feet in diameter, was found ~100 feet closer to shore, again under water-lily beds, and again with 100% cover.

Map 16. Searched area, blue shading, of East middle and West Twin Lake

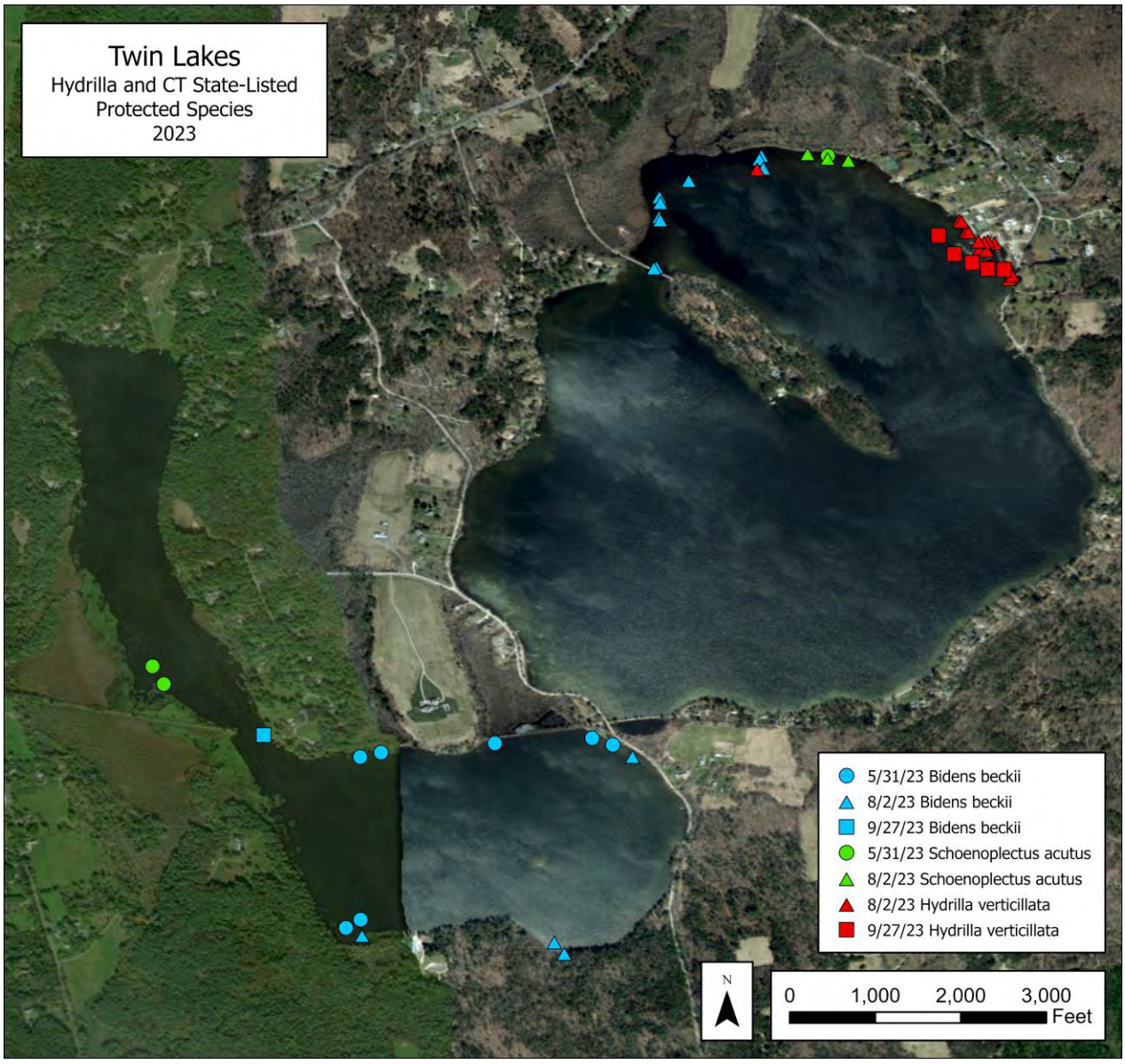


Despite very thorough searching, NEAR did not find the State-listed species Hard-stem Bullrush and Water Marigold in the area of O'Hara's Landing Marina, meaning that a ProcellaCOR treatment in this area posed little risk to these species. Additionally, the State-listed species Straight-leaved Pondweed (*Potamogeton strictifolius*, Endangered), Small Bur-reed (*Sparganium natans*, Endangered), and Northern Milfoil

(*Myriophyllum sibiricum*, Threatened) were not located in Twin Lakes during NEAR surveys in 2023. Water Marigold was not found in West Twin Lake during 2023.

Water Marigold was growing in close proximity to the Waterlily Bed of Hydrilla along the water lily beds that flank the northern shore of East Twin. This bed of Hydrilla was not treated in 2023 (**Map 17**).

Map 17. Locations of *Hydrilla verticillata* and CT State-listed aquatic plant species in Twin Lakes in 2023.



The cluster of Hydrilla locations around the marina in **Map 17** were treated with ProcellaCOR at maximum dose on September 18th. NEAR visited the marina on September 19th and found all the Eurasian Milfoil in the treatment area was gone, but Hydrilla remained, as did other native species. On this visit and the subsequent visit on October 26th, Hydrilla appeared to be dying slowly but had formed turions on most plants. The plants in the northern bed appeared greener and healthier.

For each of the three Water Marigold beds along the northern shore of East Twin, the concentration of ProcellaCOR was monitored at each bed, halfway between the treatment area and each bed, and at two locations within the treatment area (**Map 18**). ProcellaCOR was detected only twice, each time at the closest monitoring station to the ramp (**Table 4**). This indicates that ProcellaCOR does not spread past the initial area that received the dose. The chemical appeared to be completely gone by four days post treatment.

Map 18. Locations of ProcellaCOR concentration monitoring.

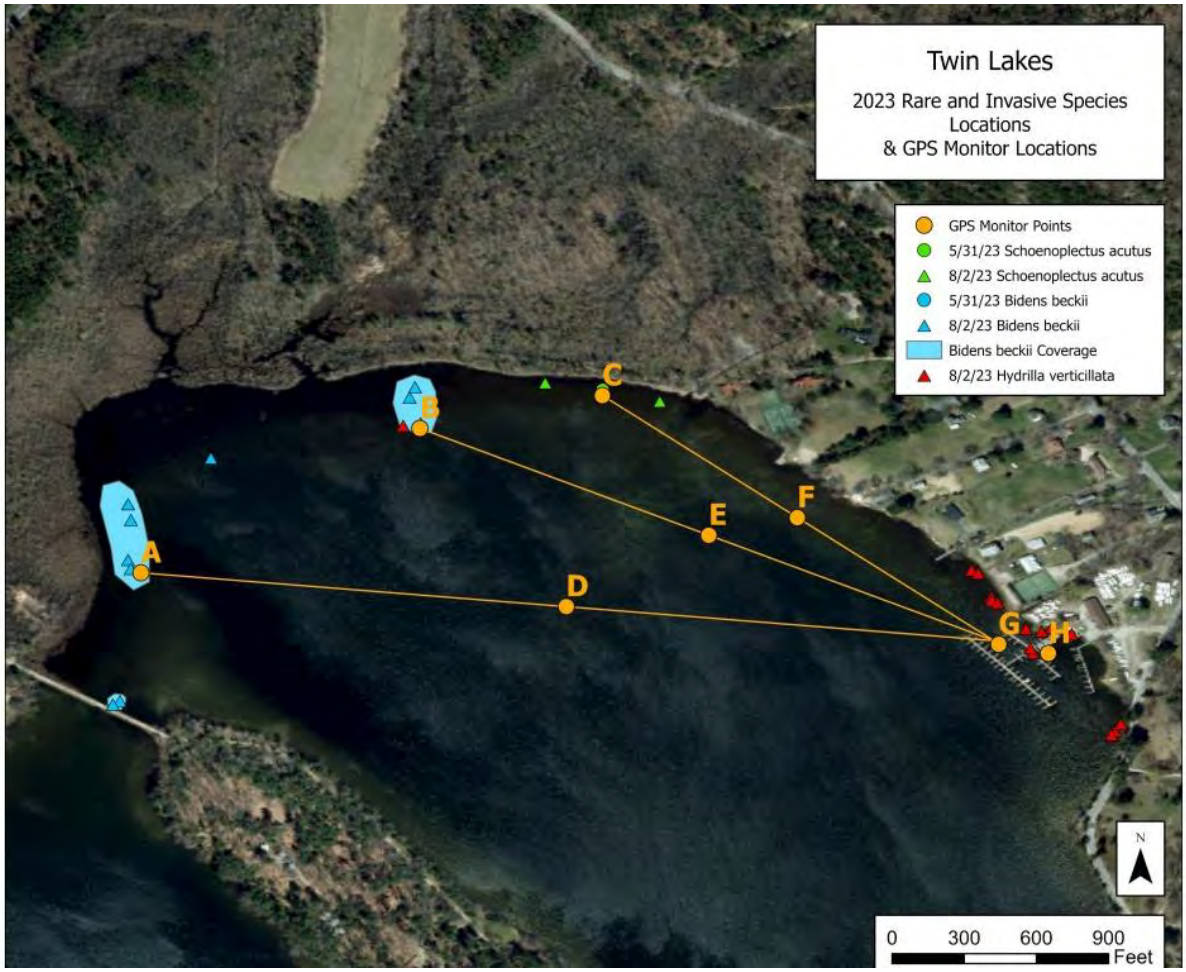


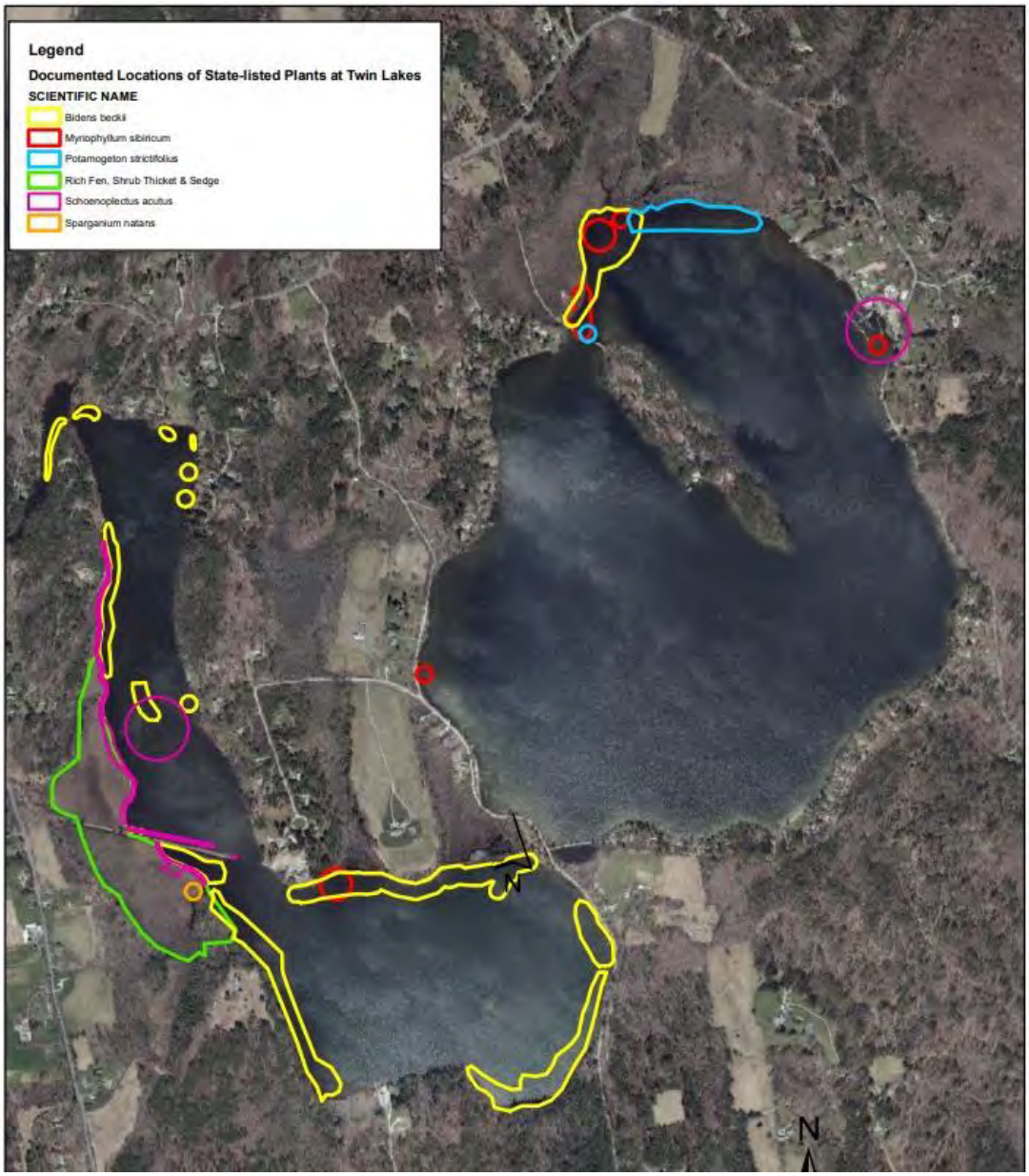
Table 4. Concentrations of ProcellaCOR (ppb) in treatment area, at *Bidens beckii* beds, and halfway between.

	ProcellaCOR in ppb, Days After Treatment			
Site	**0 (6hrs)**	**1**	**4**	**7**
A – at *Bidens beckii*	<1	<1	<1	<1
B – at *Bidens beckii*	<1	<1	<1	<1
C – at *Bidens beckii*	<1	<1	<1	<1
D – halfway to *Bidens beckii*	<1	<1	<1	<1
E – halfway to *Bidens beckii*	<1	<1	<1	<1
F – halfway to *Bidens beckii*	<1	<1	<1	<1
G – treatment area	<1	<1	<1	<1
H – treatment area	77.5	3.4	<1	<1

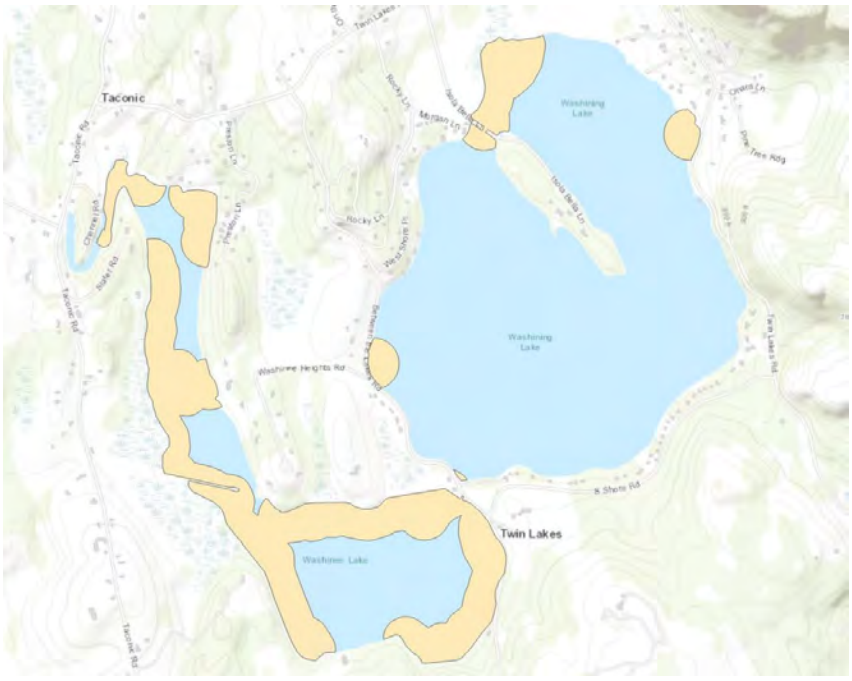
RECOMMENDATIONS FOR ONGOING INVASIVE SPECIES MONITORING & MANAGEMENT

Twin Lakes has three robust invasive aquatic plants: Eurasian Milfoil, Curly-leaf Pondweed, and now Hydrilla. Control of invasive species must consider the presence of the five protected aquatic plant species that have been identified in various locations around the lake at different times by different biologists (**Map 19**). CT NDDB created polygons for each of the 5 species: magenta for Hard-stem Bullrush (*Schoenoplectus acutus*), yellow for Water Marigold (*Bidens beckii*), red for Northern Milfoil (*Myriophyllum sibiricum*), orange for Small Bur-reed (*Sparganium natans*), and blue for Straight-leaved Pondweed (*Potamogeton strictifolius*) to develop no treatment zones when using ProcellaCOR (**Map 20**), or Diquat (**Map 21**).

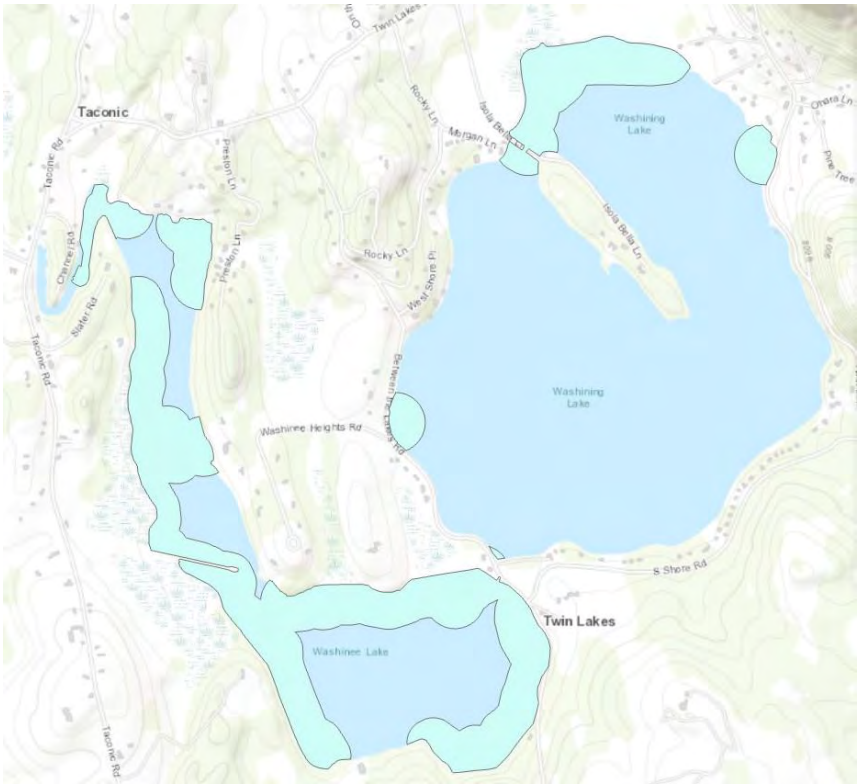
Map 19. CT DEEP areas where NDDB has records of protected aquatic plants.



Map 20. CT DEEP no treatment areas for ProcellaCOR.



Map 21. CT DEEP no treatment areas for Diquat.



2024 Management Recommendations

The three invasive species require different control strategies. However, as shown in **Map 22** and **Map 23**, each of the three species grows within no-treatment zones. NEAR proposed two concurrent studies for 2024: the first to determine the effectiveness of the two treatments conducted in 2023 and specific oversight of treatments in 2024, and the second, to conduct intensive surveys to update **Map 17** to show all existing populations of protected species.

Eurasian Milfoil

The ProcellaCOR treatment in 2023 will most likely substantially decrease regrowth of Eurasian Milfoil in 2024. NEAR expects little Milfoil will return in either treatment area, much less so in the marina area. Based on the distribution of Milfoil shown in **Map 7,** there are significant areas of Milfoil outside of non-treatment areas that can be treated in 2024. The non-treatment area polygons are based on a setback distance of 300 feet. This distance may or may not be suitable. Based on chemical testing, ProcellaCOR was found to be undetectable at the outer edge of the treatment area on the day of treatment. If the dissipation of the herbicide is extremely rapid, there may be a clear boundary between affected and unaffected Milfoil. To verify the 300-foot setback requirement, NEAR will seek to document whether ProcellaCOR effect drifts into non-treatment zones or if Milfoil outside of the treatment zones remains unaffected. A similar process can be conducted in 2024 where the extent of Milfoil control outside of the treatment area can be determined.

Curly-leaf Pondweed

This invasive species has developed a wide range in West and Middle Twin, but less so in East Twin. Curly-leaf Pondweed is present throughout the non-treatment areas of Middle Twin, and both within non-treatment areas and outside the setback (**Map 8**). At this time, treatment of Curly-leaf Pondweed in West Twin is recommended. Treatment of Curly-leaf Pondweed in Middle Twin is recommended for 2025, if a hand pulling operation is not initiated in that water body. We recommend that Diquat is used prior to May 1st to treat as much Curly-leaf Pondweed in West Twin as is limited by the permit. An early season treatment with Diquat may have only minor, if any, effects on Water Marigold at that time of year. All the Water Marigold we observed during our May/June survey were small single stem plants of less than 9 inches, most only 3 to 4 inches. This suggests that there may be only very tiny shoots of Water Marigold present in early April. To gain more insight on the necessary setback distance, the Curly-leaf Pondweed in the adjacent non-treatment zones will be examined for lethality. NEAR did not find Water Marigold in West Twin, except for one sighting at the junction with Middle Twin in late September. We also suggest sampling the water for Diquat at specific distances to determine if the herbicide spreads significantly outside the treatment area. If Diquat cannot be

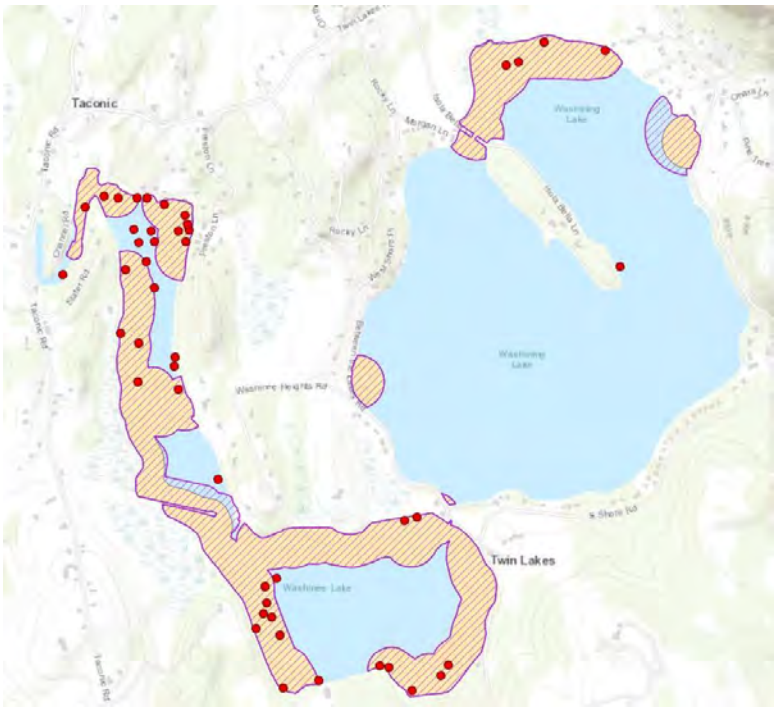
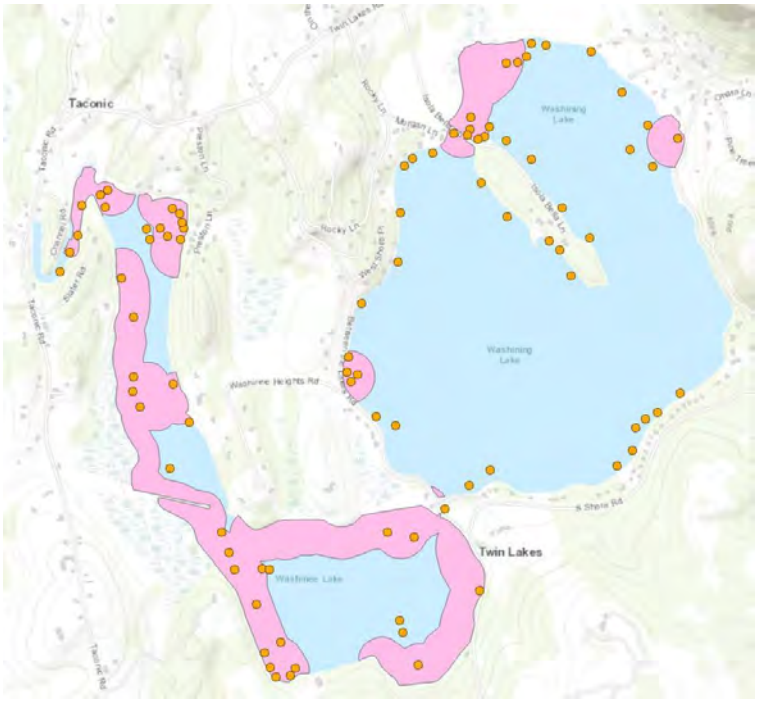
detected outside the treatment area, a confined trial treatment of Curly-leaf Pondweed in Middle Twin is warranted to determine whether Diquat affects Water Marigold when the species has not yet germinated or is mostly undeveloped. This early season treatment in Middle Twin would target a small bed of Curly-leaf Pondweed that is somewhat remote from most Water Marigold but does include some Water Marigold plants.

HYDRILLA

The Hydrilla in the treated zone around the marina needs to be carefully examined for regrowth over the course of the 2024 season. Should any Hydrilla shoots be found anywhere in the marina area, NEAR recommends applying pelletized SONAR to the whole of the 4-acre marina area. There is a high degree of certainty that new Hydrilla be found in the marina area based on the presence of turions on most dying plants in September and October 2023.

The Hydrilla in the northern bay of East Twin will almost certainly need to be corralled with limno-barrier. This may be a difficult process but all the Hydrilla growing in that area needs to be found. A barrier will need to be installed around these beds regardless of what management is chosen. NEAR recommends using low dose SONAR within the corralled area. There is limited literature that suggests low dose SONAR may have low lethality on Water Marigold. However, if SONAR is applied, Fast-test should be used to determine if there is any spread outside of the barrier. ProcellaCOR could also be added but the effectiveness of this herbicide on Hydrilla in the marina area needs to be evaluated first of long term control.

Map 22. CT DEEP Diquat no treatment areas and locations of the target Curly-leaf Pondweed in 2023.



Map 23. CT DEEP ProcellaCOR no treatment areas and locations of the target Eurasian Milfoil in 2023.