Northeast Aquatic Research

# Robinson Pond 2022
# Water Quality and Aquatic Plant Report

**Prepared for the Taconic Shores Property Owner's Association**
**March 1st, 2023**

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# Introduction

Northeast Aquatic Research (NEAR) made monthly visits to Robinson Pond between April and October 2022 to collect water samples and limnological data. At the deepest location in the pond (WQ Monitoring Station 1, **Figure 1**), we measured water clarity using a Secchi disk and view scope and collected water temperature and oxygen profiles. Nutrient samples were collected from the top, middle, and bottom of the water column and analyzed for total phosphorus, total nitrogen, and ammonia nitrogen. During all visits except for June and July, when flow was very low, we collected a sample from the Roeliff-Jansen Kill inlet (Roe-Jan). The Roe-Jan inlet samples were analyzed for total phosphorus and total nitrogen. The outlet station was not sampled in 2022. On June 30$^{th}$ and July 1$^{st}$, we conducted a full-pond aquatic plant survey. A brief plant investigation was conducted on July 21$^{st}$, approximately 2 weeks after a ProcellaCOR treatment which targeted Eurasian watermilfoil (*Myriophyllum spicatum*). 2022 marked the second full season of water quality and plant monitoring on Robinson Pond by NEAR staff.


***Figure 1**. Locations of the in-pond water quality sampling station, Roe-Jan inlet station and outlet station.*

The Taconic Shores Property Owners Association (TSPOA) subdivided the pond into eight management zones used to communicate priority harvesting zones, among other management activities (**Figure 2**). These zones will be referred to periodically throughout the report.

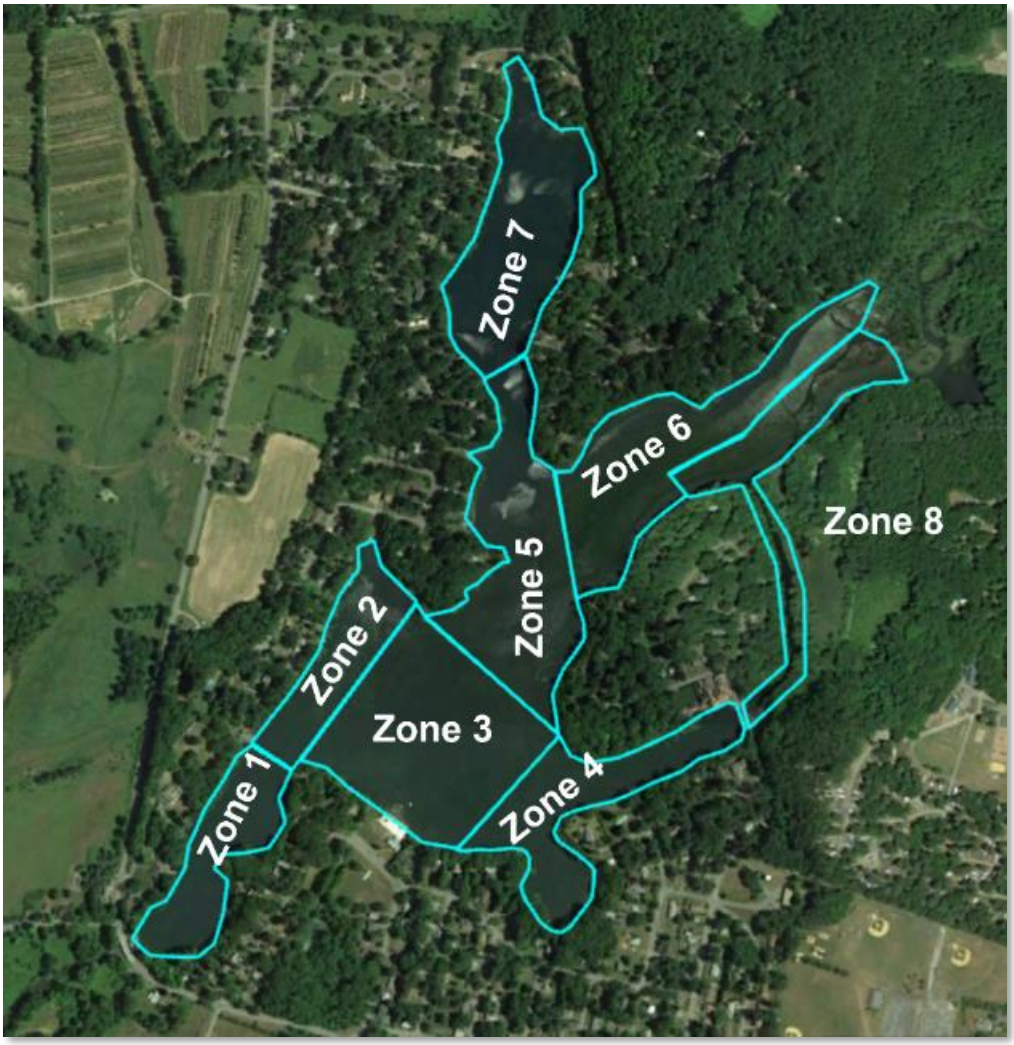


***Figure 2**. Robinson Pond management zones.*

# Water Quality Results

## Water Clarity

Water clarity was generally good in June, September, and October but poor in other months. The best clarity, 6.1m, was recorded in May (**Figure 3**). Clarity was poor from June to August. The worst clarity, 1.9m, was recorded in July. The drastic decline in water clarity from May to July was associated with increased cyanobacteria density (refer to Phytoplankton section). Clarity improved in September and October.

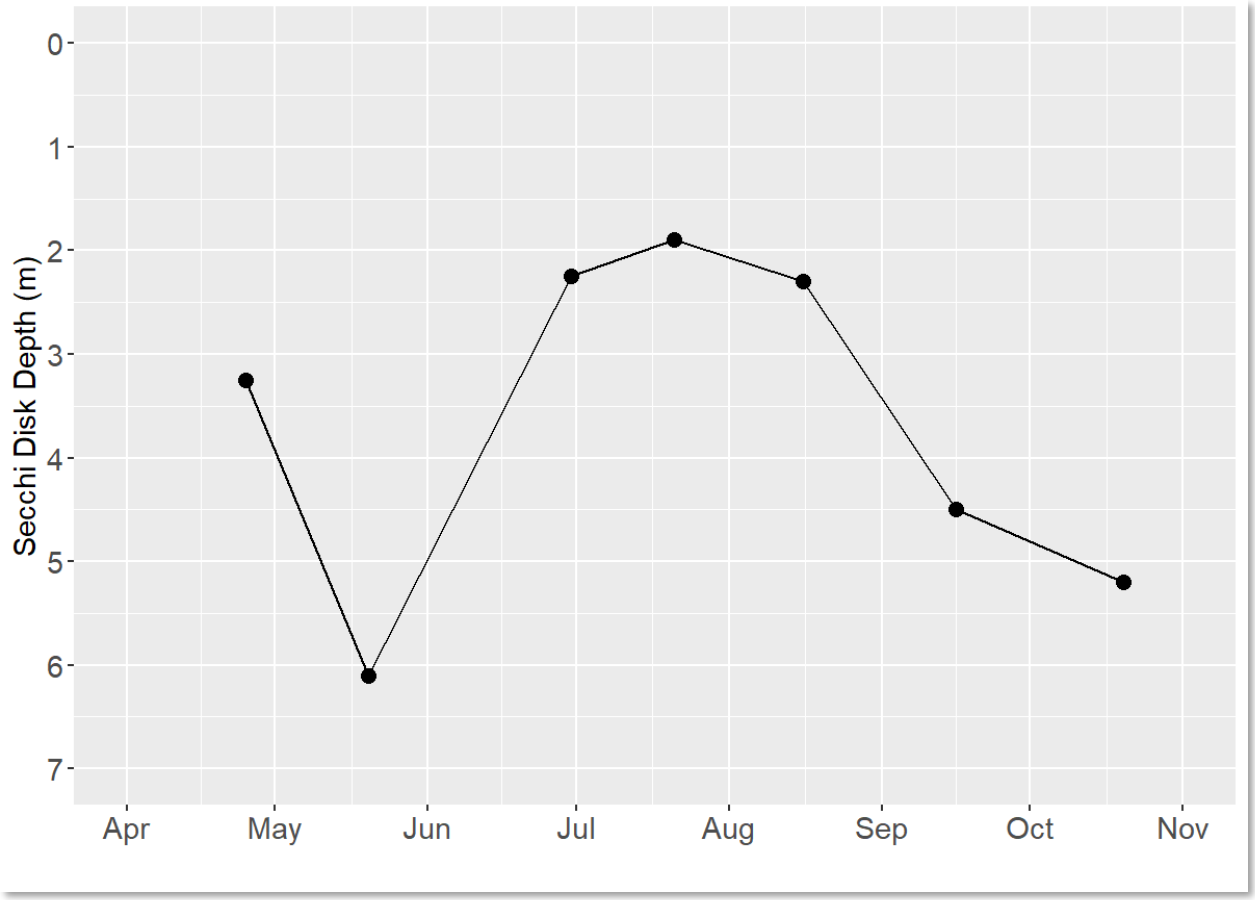


***Figure 3**. Water clarity at the deep station in 2022.*

## Water Temperature and RTRM

The pond did not stratify during the 2022 monitoring period. Stratification occurs when the temperature change between two meters of water along the water column is greater than or equal to 1°C. The water circulator installed in the deepest section of the pond (Zone 7) prevented stratification. These systems are designed to mix water, resulting in a water column that is uniform in temperature from the surface to the bottom. The water temperature during each sampling visit did not vary significantly between surface and bottom. The water temperature warmed as the summer progressed. The warmest surface temperature, 27.7°C, was recorded in August (**Figure 4**).

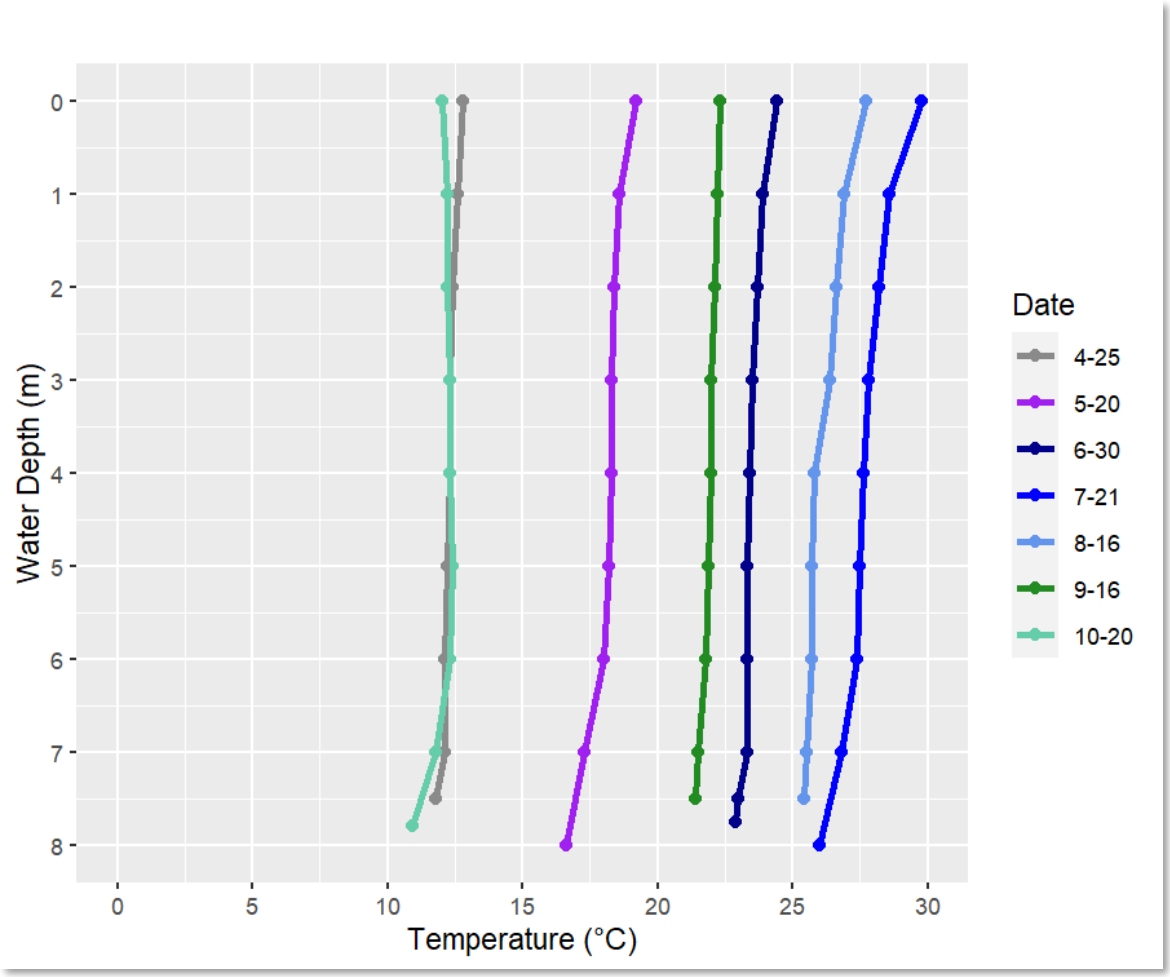


***Figure 4**. Temperature profiles at the deep station in 2022.*

Relative Thermal Resistance to Mixing (RTRM) is a unit-less ratio that describes the difference in water density between each meter of water. Higher RTRM numbers indicate stronger thermal stratification. The RTRM is a relative number that distinguishes the intensity and depth of the thermocline. RTRM values describe how the lake is or is not mixing with respect to layers of water at specific depths. RTRM values under 30 indicate no resistance to mixing, values between 30

and 80 indicate weak resistance to mixing, and values above 80 indicate strong resistance to mixing.

The RTRM values at the deep station in 2022 were very low, with only one value exceeding 30 (**Figure 5**). The lower RTRM values are attributed to the circulation system maintaining near, but not completely, isothermal conditions during the season.

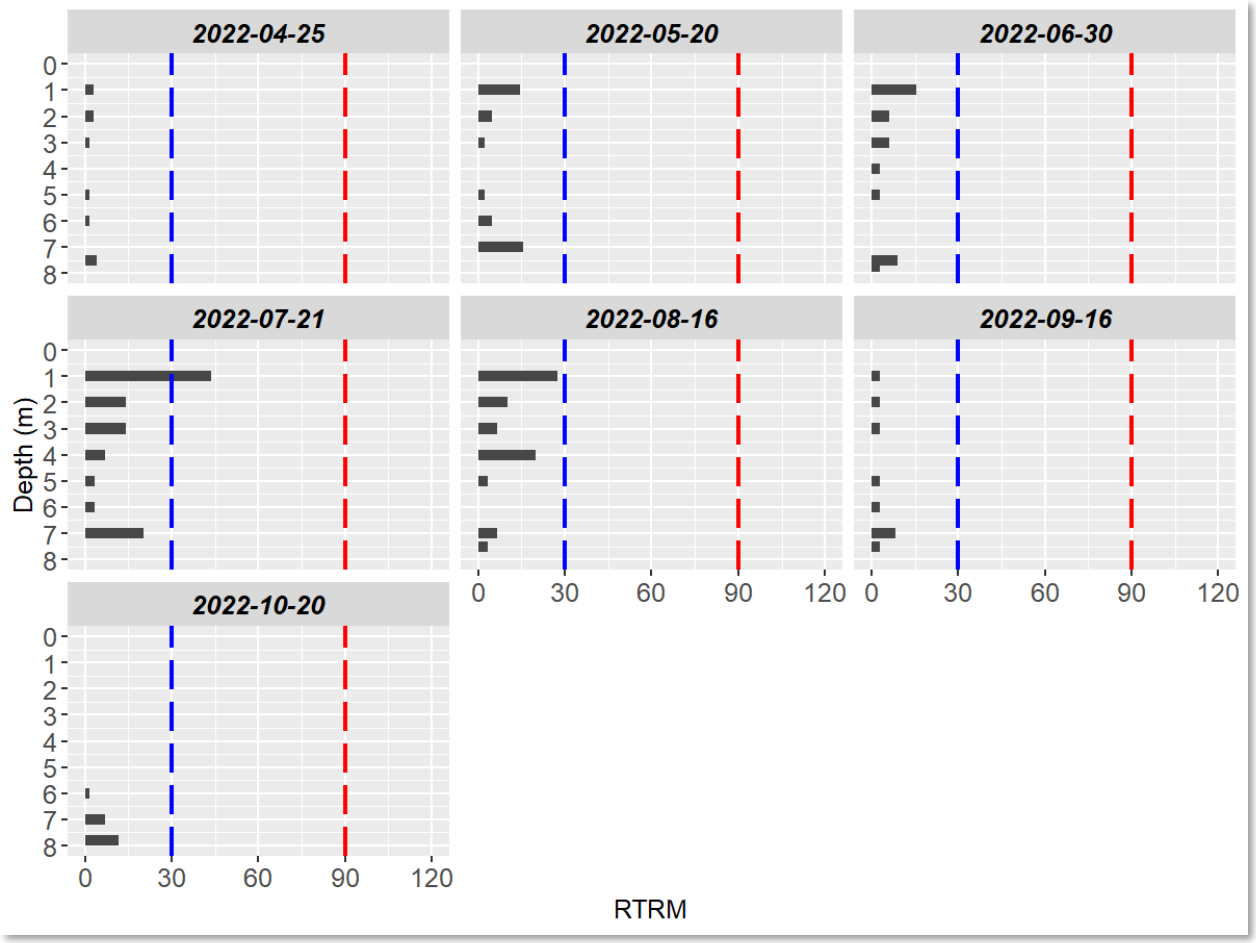


***Figure 5**. Relative thermal resistance to mixing (RTRM) at the deep station in 2022.*

## Dissolved Oxygen

The pond contained anoxic water (<1mg/L of dissolved oxygen) just once during the 2022 monitoring period (**Figure 6**) in July, when water at the very bottom of the pond lost dissolved oxygen. Dissolved oxygen concentrations in remaining waters ranged from 6.9mg/L to 12.6mg/L throughout the season. On most sampling dates, the dissolved oxygen concentration was similar from surface to close to the bottom, indicating the circulator maintained mixed, well-oxygenated conditions in the water column. Typically, the bottom meter of water had slightly higher or slightly lower concentrations than the water column. On one date, July 21st, dissolved oxygen concentration was elevated near the surface and anoxic at the bottom suggesting poor circulation at that time.

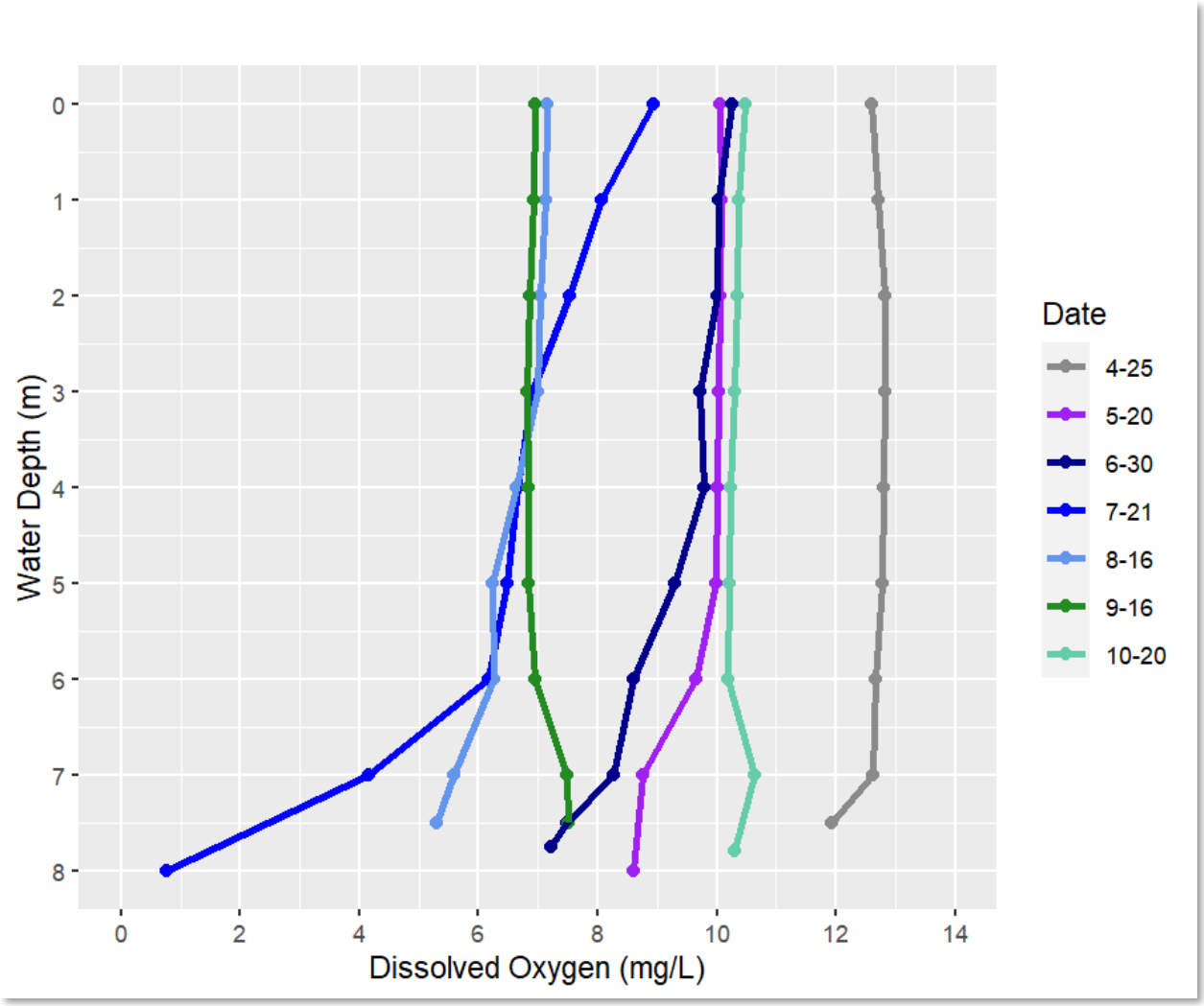


***Figure 6.*** *Dissolved oxygen concentrations at the deep station in 2022.*

## Anoxic Boundary

There was only one instance of anoxia during the 2022 sampling period, at the very bottom of the pond's deep station in July (**Figure 7**). The pond was fully oxygenated during every other sampling visit. In 2021, the circulation system suffered a few malfunctions, which may partially explain why there were more dates in 2021 with anoxic waters.

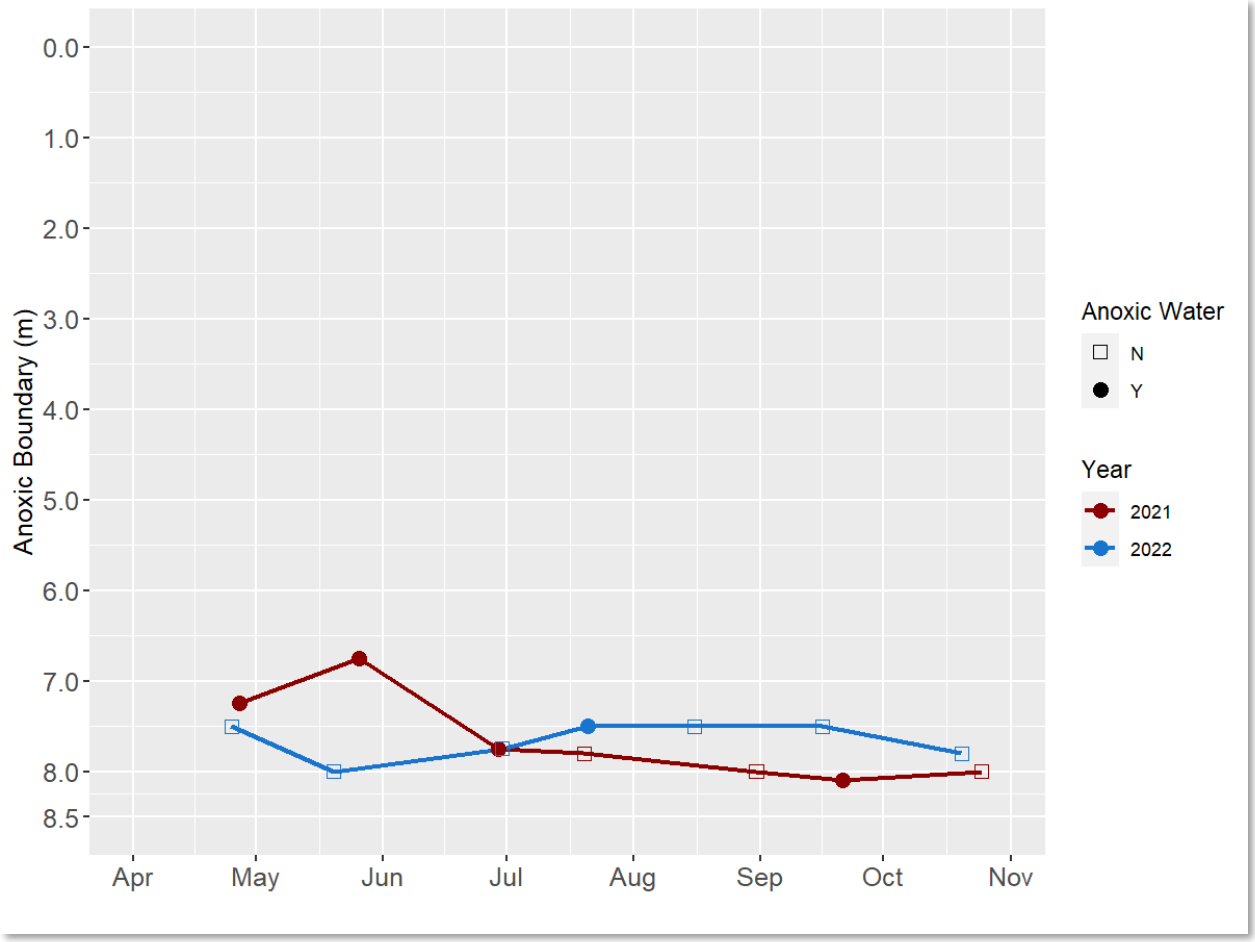


***Figure 7**. Anoxic boundary at the deep station in 2021 and 2022. Closed circles represent dates where water was anoxic and open squares represent dates where the water was oxic.*

## Phytoplankton

The peak of diatoms during the summer months is likely attributed to the circulation system, which keeps diatoms from sinking out of the water column. Cyanobacteria increased from June to September and peaked at 22,040 cells/mL (**Figure 8**). This is slightly above the World Health Organization (WHO) recreational guideline of 20,000 cells/mL for low risk for acute health effects.

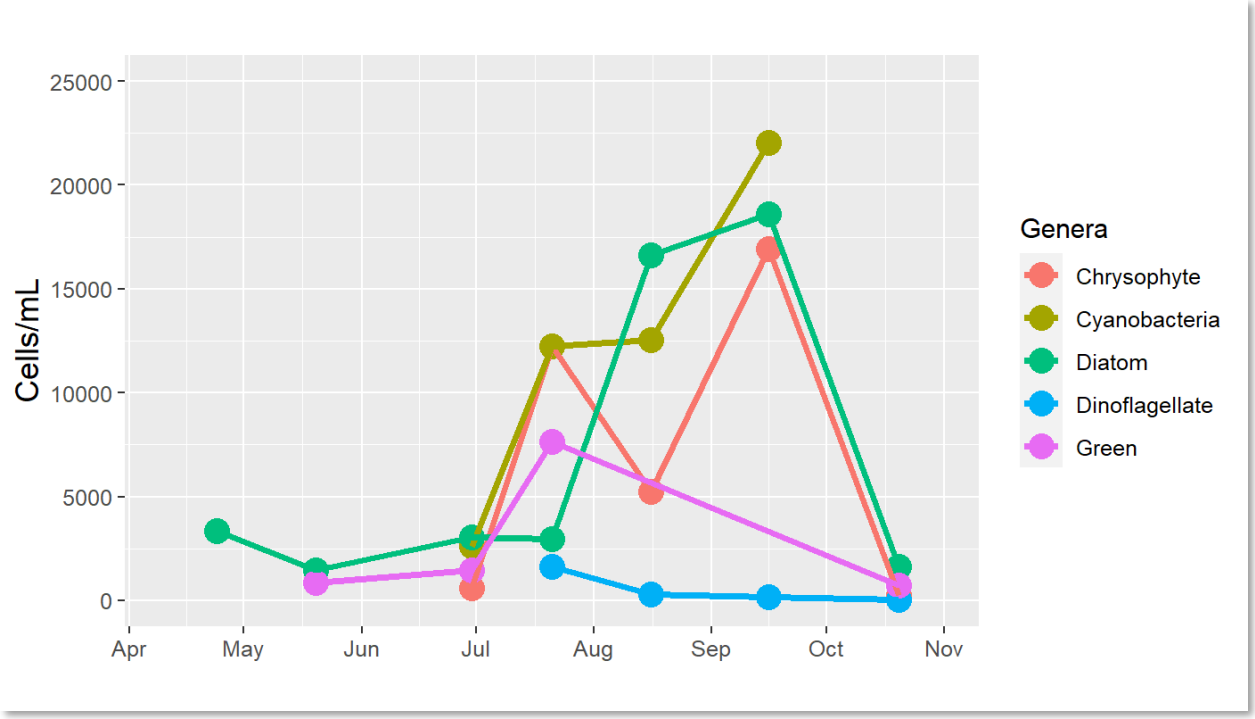


***Figure 8**. Dominant phytoplankton (algae) groups identified and enumerated in 2022.*

*Dolichospermum* was the dominant cyanobacteria species during the months where cyanobacteria were present (**Figure 9**).

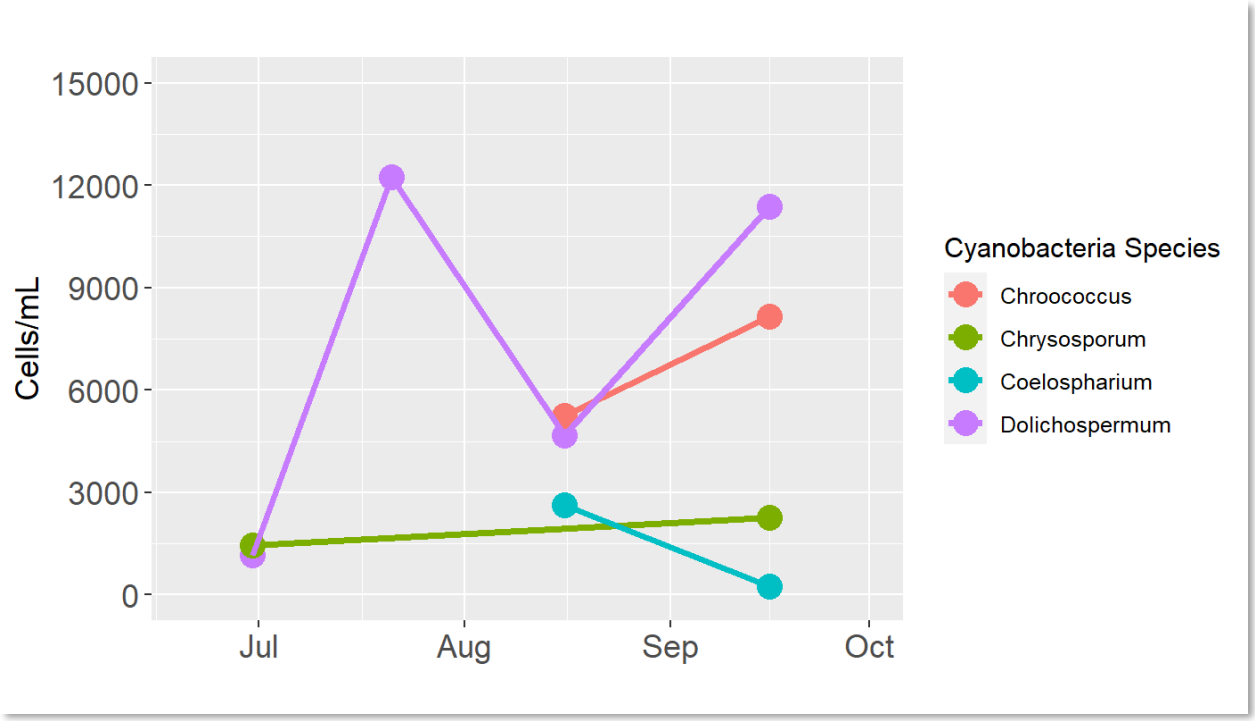


***Figure 9**. Cyanobacteria species identified and enumerated in 2022.*

# Nutrients

## In-Lake

Nutrient samples were collected from the top (1m), middle (4m), and bottom (7m) of the water column during each visit. We use the Connecticut standard for evaluating lake trophic state, rather than the NY standards, which are too coarse-grained (**Table 1**).

***Table 1**. Parameters and defining ranges for trophic states of lakes in Connecticut.*

| Category | Total phosphorus (µg/L) | Total Nitrogen (µg/L) | Secchi Depth (m) | Chlorophyll *a* (µg/L) |
|---|---|---|---|---|
| Oligotrophic | 0 -- 10 | 0 -- 200 | 6 + | 0 -- 2 |
| Oligo-mesotrophic | 10 -- 15 | 200 -- 300 | 4 -- 6 | 2 -- 5 |
| Mesotrophic | 15 -- 25 | 200 -- 500 | 3 -- 4 | 5 -- 10 |
| Meso-eutrophic | 25 -- 30 | 500 -- 600 | 2 -- 3 | 10 -- 15 |
| Eutrophic | 30 -- 50 | 600 -- 1000 | 1 -- 2 | 15 -- 30 |
| Highly Eutrophic | 50 + | 1000 + | 0 -- 1 | 30 + |

## In-Lake Nutrient 2022 Results

### Phosphorus

Total phosphorus (TP) concentrations were over 30 µg/L at all three sampling depths from June to September (**Table 2**). In April and May, concentrations were elevated at the bottom of the pond. The elevated top TP in July and August may have been caused by the circulation system mixing anoxic waters from the bottom. Even though there was no anoxia in August, concentrations may have been higher and therefore mixed throughout the water column. In October, TP was uniform throughout the water column (**Figure 10**).

***Table 2**. Total phosphorus concentrations (µg/L) in the water column during 2022. Colors indicate the rating system presented in **Table 1**.*

| | 4/24/22 | 5/20/22 | 6/30/22 | 7/21/22 | 8/16/22 | 9/16/22 | 10/20/22 |
|---|---|---|---|---|---|---|---|
| **Top** | 21 | 18 | 31 | 52 | 45 | 49 | 20 |
| **Middle** | 20 | 29 | 33 | 44 | 36 | 40 | 20 |
| **Bottom** | 37 | 33 | 33 | 34 | 32 | 51 | 21 |

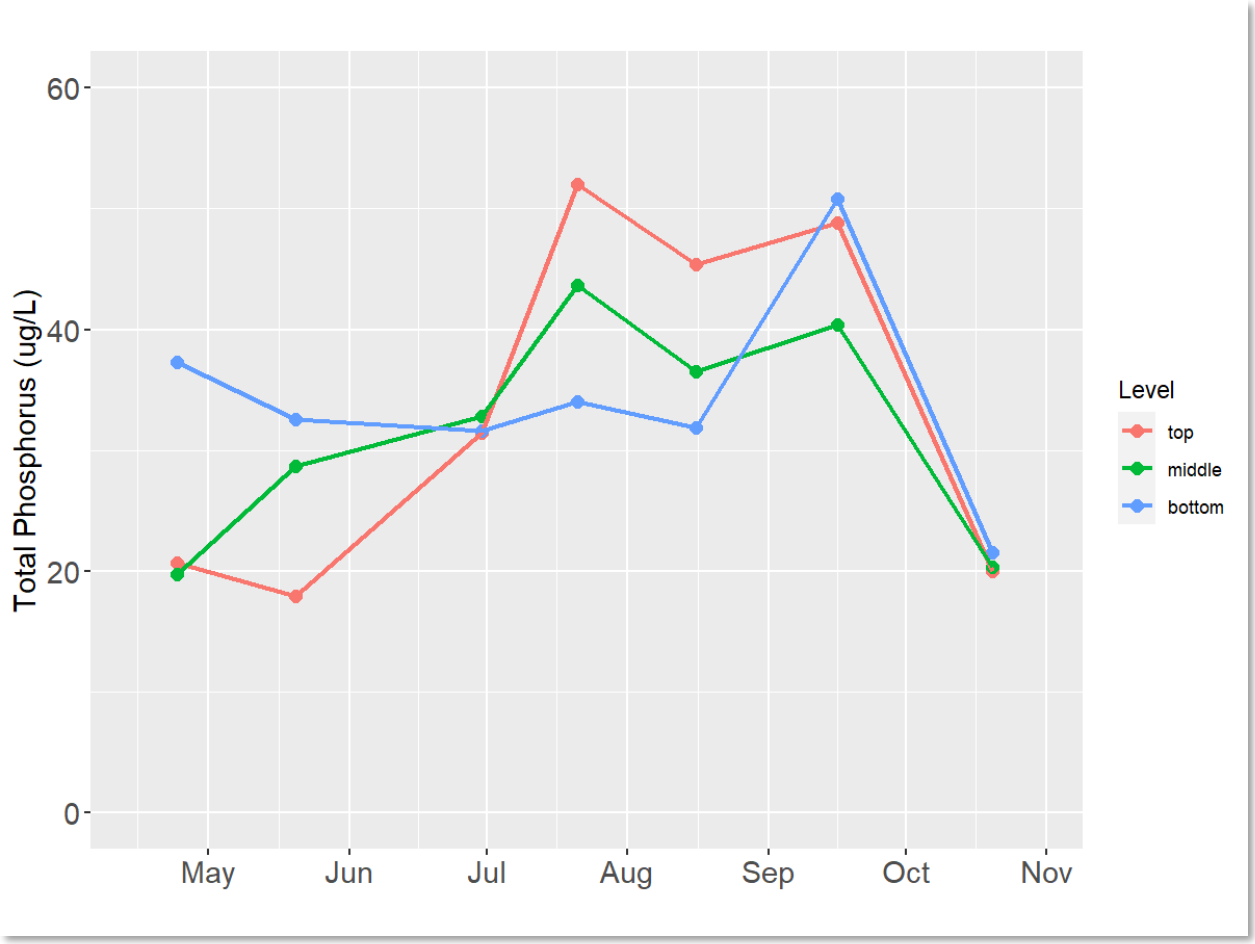


***Figure 10**. Graphical representation of total phosphorus concentrations at the deep station in 2022.*

## Nitrogen

Total nitrogen (TN) was elevated in the pond for most of the sampling period, but especially in April (**Table 3**). TN decreased at all sampling depths from April to August (**Figure 11**). This may be due to decreased nutrient input from the watershed. In 2022, the northeast experienced moderate to extreme drought conditions.

***Table 3**. Total nitrogen (µg/L) concentrations at the deep station in 2022. Colors indicate the rating system presented in **Table 1**.*

| | 4/24/22 | 5/20/22 | 6/30/22 | 7/21/22 | 8/16/22 | 9/16/22 | 10/20/22 |
|---|---|---|---|---|---|---|---|
| **Top** | 1,256 | 928 | 963 | 746 | 523 | 625 | 431 |
| **Middle** | 1,272 | 1,080 | 851 | 686 | 469 | 669 | 429 |
| **Bottom** | 1,428 | 976 | 866 | 698 | 412 | 602 | 411 |

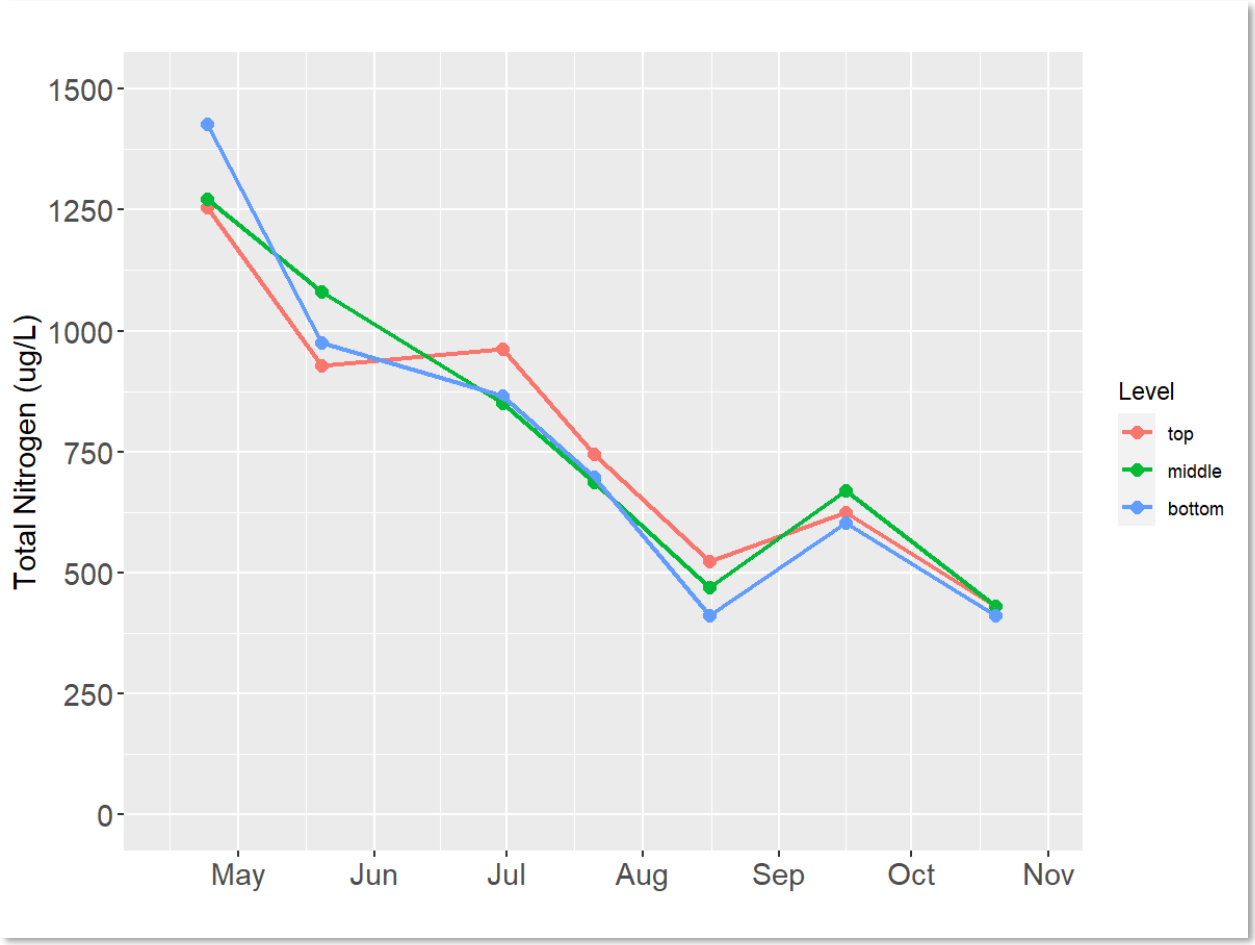


*Figure 11. Graphical representation of total nitrogen concentrations at the deep station in 2022.*

## Ammonia-Nitrogen

Total ammonia-nitrogen ($NH_3$) concentrations in the water column ranged from <10 µg/L to 233 µg/L (**Table 4**). $NH_3$ was highest in the pond from May to July.

***Table 4**. Total ammonia nitrogen ($NH_3$) concentrations at the deep station in 2022. "<LOD" indicates sample was less than the limit of detection (LOD=10 µg/L).*

| | 4/24/22 | 5/20/22 | 6/30/22 | 7/21/22 | 8/16/22 | 9/16/22 | 10/20/22 |
|---|---|---|---|---|---|---|---|
| **Top** | 45 | 101 | 123 | 135 | 60 | 83 | 259 |
| **Middle** | <LOD | 109 | 129 | 169 | 72 | 130 | 52 |
| **Bottom** | <LOD | 141 | 159 | 233 | 43 | 154 | 100 |

## Roe-Jan Inlet

The Roe-Jan inlet was sampled on 5 occasions during the 2022 monitoring period. TP was high in April, May and August, but concentrations were lower in September and October (**Table 5**). TN was elevated during all months, especially April, May, August and September. Nutrients remain elevated in the Roe-Jan, even when flow is not as high.

***Table 5**. Roe-Jan Kill inlet total phosphorus and total nitrogen (µg/L) concentrations in 2022.*

| | 4/24/22 | 5/20/22 | 8/16/22 | 9/16/22 | 10/20/22 |
|---|---|---|---|---|---|
| **TP (µg/L)** | 34 | 25 | 33 | 19 | 15 |
| **TN (µg/L)** | 1,160 | 1,264 | 1,479 | 1,286 | 673 |

The Roe-Jan was generally clear throughout the sampling period, unlike in 2021 when turbidity increased during high rainfall events. The pictures in **Figure 12** display decreasing water levels as the season progressed, but generally clearer water than 2021.


***Figure 12**. Visual conditions of the Roe-Jan inlet during select sampling dates in 2022.*

# Aquatic Plants

## Results

NEAR conducted a full-pond pre-treatment survey over two days, on June 30th and July 1st. A total of 188 waypoints were visited, consisting of a combination of previous waypoints created during the 2021 survey and new waypoints made during the 2022 survey. NEAR documented a total of 19 aquatic plant species, along with filamentous algae, water net algae and *Lyngbya wollei*. Four invasive species, Eurasian watermilfoil (*Myriophyllum spicatum*), water chestnut (Trapa natans), brittle naiad (Najas minor), and Curly-leaf pondweed (Potamogeton crispus) were documented. The most dominant species was the invasive Eurasian watermilfoil, followed by coontail (*Ceratophyllum demersum*), duckweed (*Lemna minor*), water net algae, watermeal (*Wolffia sp.*), sago pondweed (*Stuckenia pectinata*), and filamentous algae (**Table 6**). All dominant (species present at greater than 20% frequency) and all invasive species maps are included in this report.

***Table 6**. Scientific and common names of all plants found during the 2022 survey in order of decreasing frequency. Invasive species are highlighted in red.*

| Scientific Name | Common Name | Percent Occurrence | Average Percent Cover |
|---|---|---|---|
| ***Myriophyllum spicatum*** | Eurasian Watermilfoil | 66 | 28 |
| ***Ceratophyllum demersum*** | Coontail | 63 | 35 |
| ***Lemna minor*** | Duckweed | 44 | 23 |
| | Water net algae | 38 | 30 |
| ***Wolffia sp.*** | Watermeal | 35 | 25 |
| ***Stuckenia pectinata*** | Sago pondweed | 30 | 44 |
| | Filamentous algae | 25 | 22 |
| ***Spirodela sp.*** | Greater duckweed | 13 | 12 |
| ***Elodea canadensis*** | Canadian waterweed | 13 | 24 |
| ***Elodea nuttallii*** | Nuttall's waterweed | 10 | 10 |
| ***Lyngbya wollei*** | Cyanobacteria mat | 8 | 32 |
| ***Trapa natans*** | Water chestnut | 7 | 14 |
| ***Najas minor*** | Brittle naiad | 4 | 12 |
| ***Potamogeton crispus*** | Curly-leaf pondweed | 4 | 16 |
| ***Typha sp.*** | Cattail | 4 | 13 |
| ***Nitella sp.*** | Stonewort | 4 | 9 |
| ***Potamogeton nodosus*** | Long-leaf pondweed | 2 | 14 |
| ***Ranunculus sp.*** | Water crowfoot | 2 | 18 |
| ***Ludwigia sp.*** | Water purslane | <1 | 10 |
| ***Nuphar variegata*** | Yellow water lily | <1 | 15 |
| ***Nymphaea odorata*** | White water lily | <1 | 20 |
| ***Sagittaria latifolia*** | Broadleaf arrowhead | <1 | 15 |

During the pre-treatment survey, milfoil was the most frequently observed species in the pond (**Figure 13**). Milfoil was widespread throughout the entire littoral zone and the majority of the plants were growing to the surface or just beneath the surface. On July 7th, The Pond and Lake Connection treated 25 acres within Zones 5 and 6 with 400 oz of ProcellaCOR.

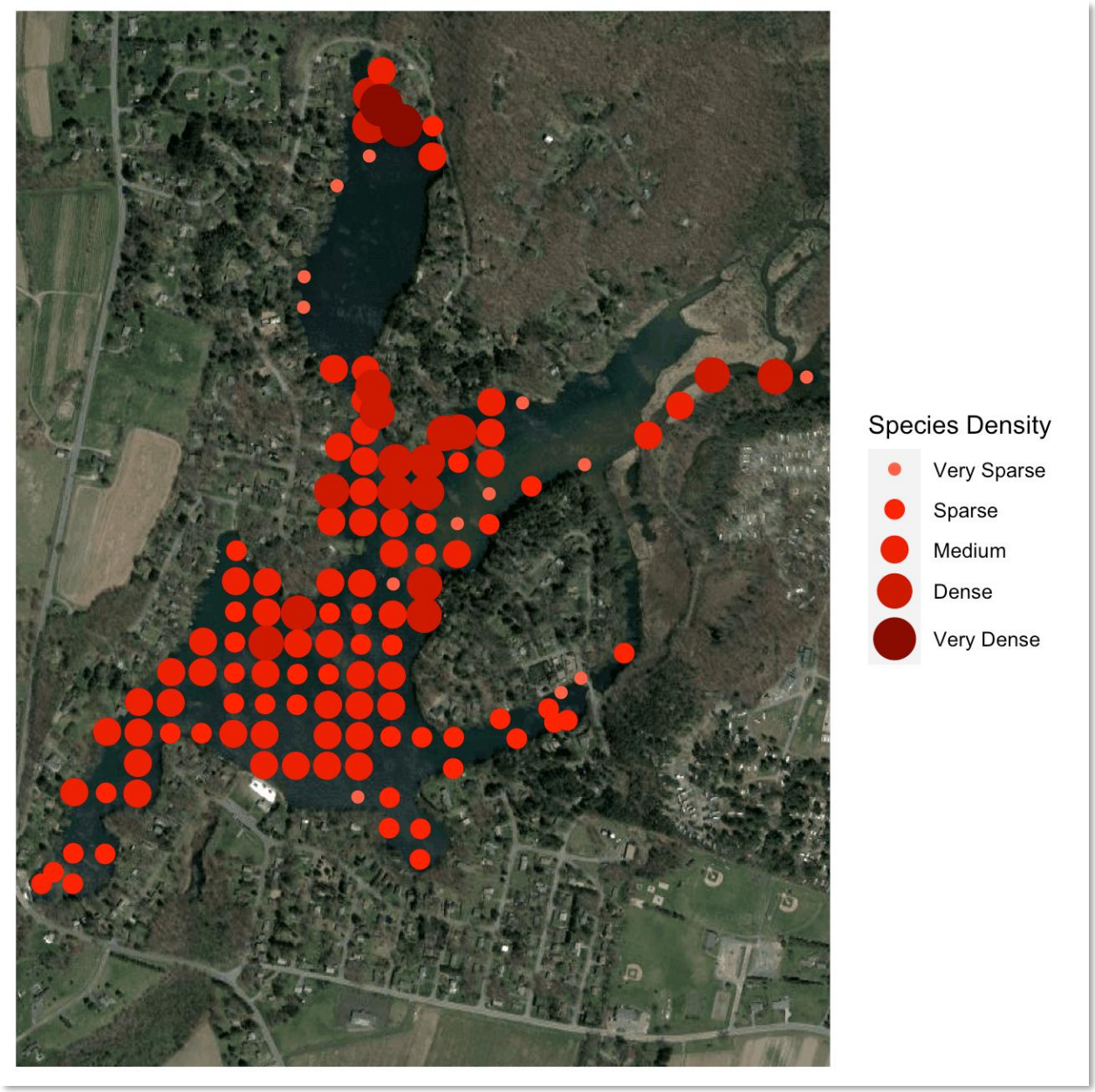


***Figure 13**. Locations and densities of Eurasian watermilfoil on June 30th and July 1st, 2022.*

On July 21st, NEAR conducted a brief post-treatment inspection and revisited 20 waypoints within Zone 5. Milfoil was observed at 14 of the 20 waypoints visited, though the majority of the milfoil plants observed were dead or mostly dead. The densities at each waypoint were reduced (**Figure 14**) compared to pre-treatment survey densities (**Figure 13**). Two weeks after treatment was early to determine final effectiveness of the treatment, but reduced densities and plants in poor condition within the treatment zone at the time was encouraging.


***Figure 14**. Locations and densities of subset of waypoints visited during July 21st, 2022 post-treatment area inspection.*

Coontail was the second most observed species during the pre-treatment survey and was widespread throughout the littoral zone (**Figure 15**). Coontail was most dense in Zones 1, 2, and 5, with dense patches also documented in Zones 6 and 7.


***Figure 15**. Locations and densities of coontail on June 30th and July 1st, 2022.*

Duckweed and watermeal were very abundant throughout the pond (**Figures 16** and **17**). Duckweed was the third most common species in the pond at 44% frequency, and watermeal was the fifth most common species at 35% frequency. The distribution of these species changed throughout the remainder of the pond as wind patterns changed (**Figure 18).** Historically, Zone 8 and the area of Zone 4 that connects to Zone 8 have been problem areas for duckweed and watermeal.

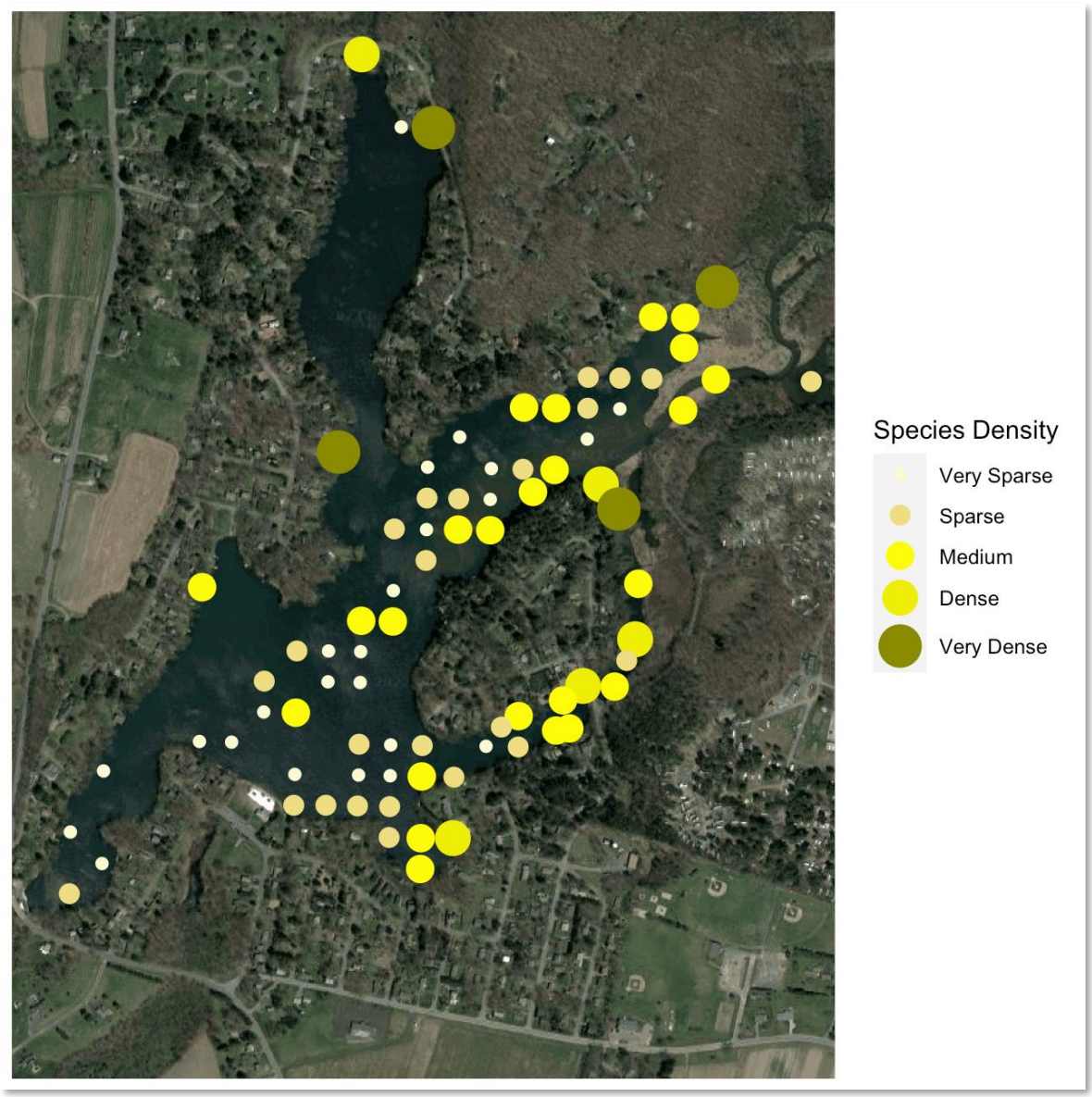


***Figure 16****. Locations and densities of duckweed on June 30th and July 1st, 2022.*

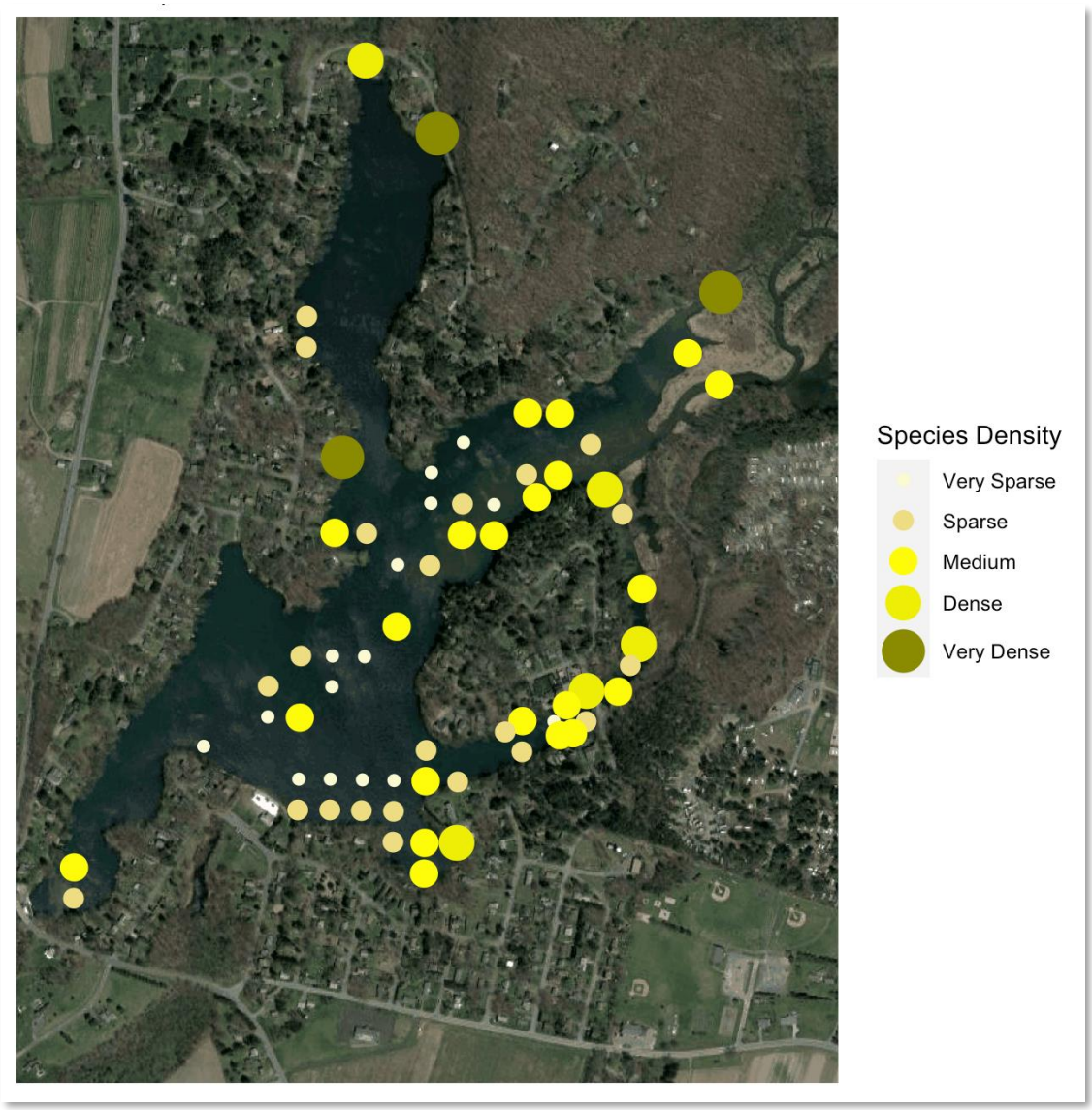


***Figure 17**. Locations and densities of watermeal on June 30th and July 1st, 2022.*

***Figure 18**. Dense duckweed and watermeal coverage on July 1st, 2022.*

Water net was present at 38% frequency and an average density of 30%. It was most abundant in Zones 1-4 (**Figure 19**). NEAR did not identify the exact species of water net, so prior to any future management of this species, proper ID should be made.

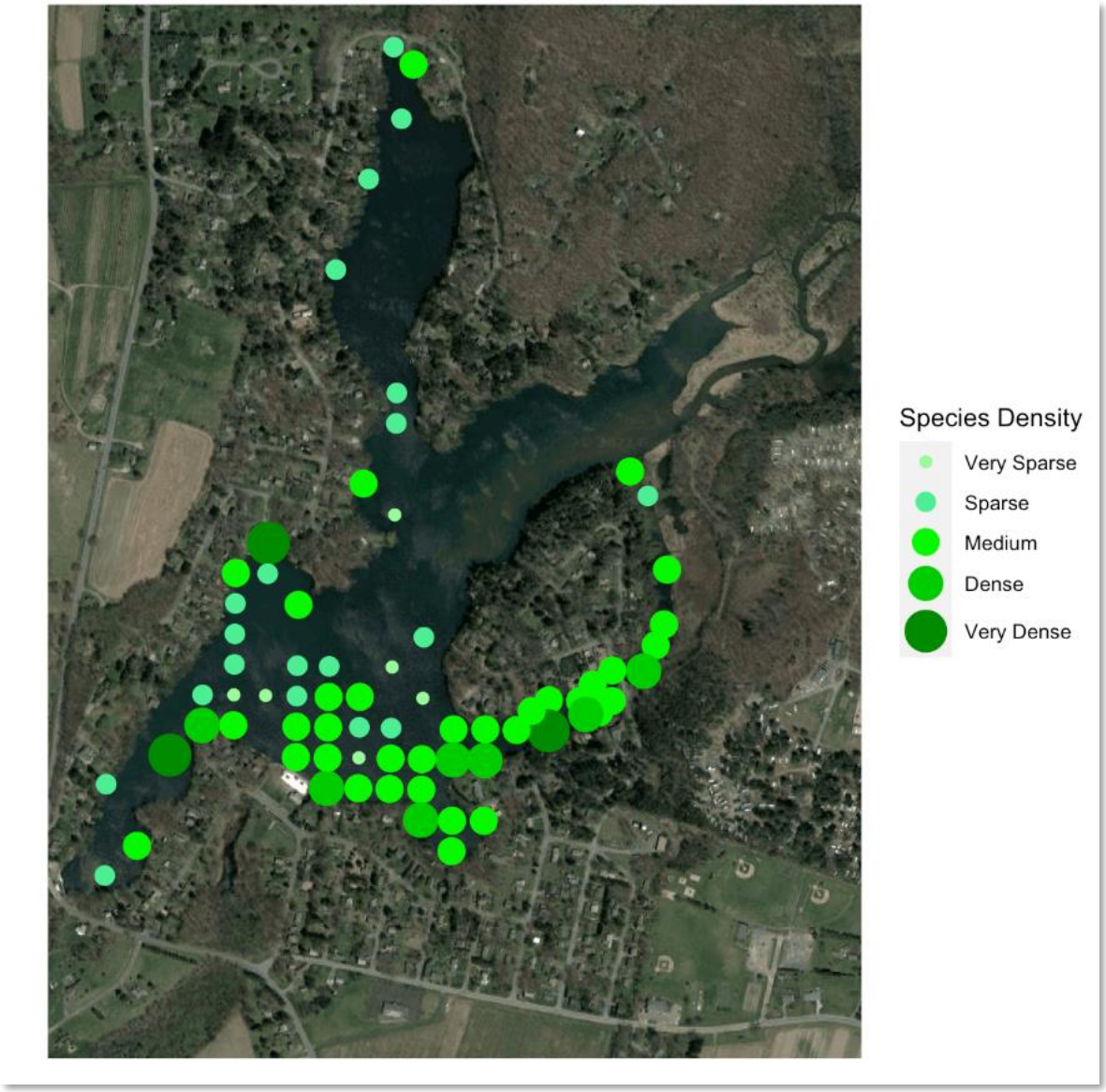


***Figure 19**. Locations and densities of water net on June 30th and July 1st, 2022.*

Sago pondweed was extremely dense in Zones 6 and 8 (**Figure 20**). It appeared that sago pondweed expanded following removal of cattail growth in this area. Sago pondweed formed very dense canopies in this area (**Figure 21, Figure 22**) and navigation was difficult. If TSPOA wishes to control this species in the future, herbicides, including Diquat, Endothal or Fluridone, should be considered.

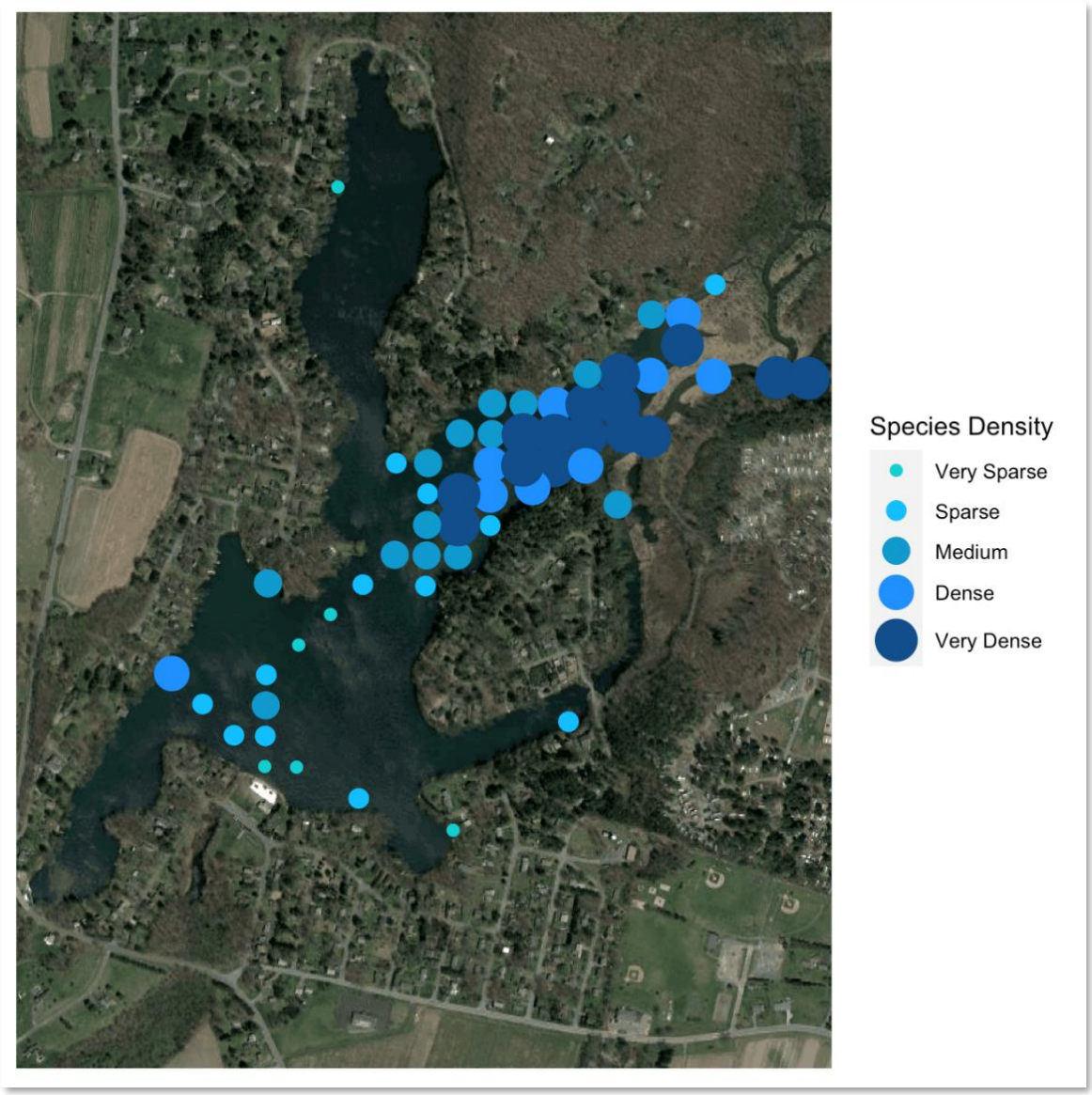


***Figure 20**. Locations and densities of sago pondweed on June 30th and July 1st, 2022.*

***Figure 21****.Very dense sago pondweed coverage in Zone 6 on June 30th, 2022.*

***Figure 22****. Close up of very dense sago pondweed.*

Filamentous algae was widespread throughout the pond (**Figure 23**). The Pond and Lake Connection treated 125 ac-ft of Zones 5 and 6 with 75 gallons of Cutrine ultra to target filamentous algae growth on August 17th. No follow-up inspection was performed by NEAR, but NEAR staff did observe filamentous algae on the surface of the pond in a few areas in September in Zones 3 and 5.

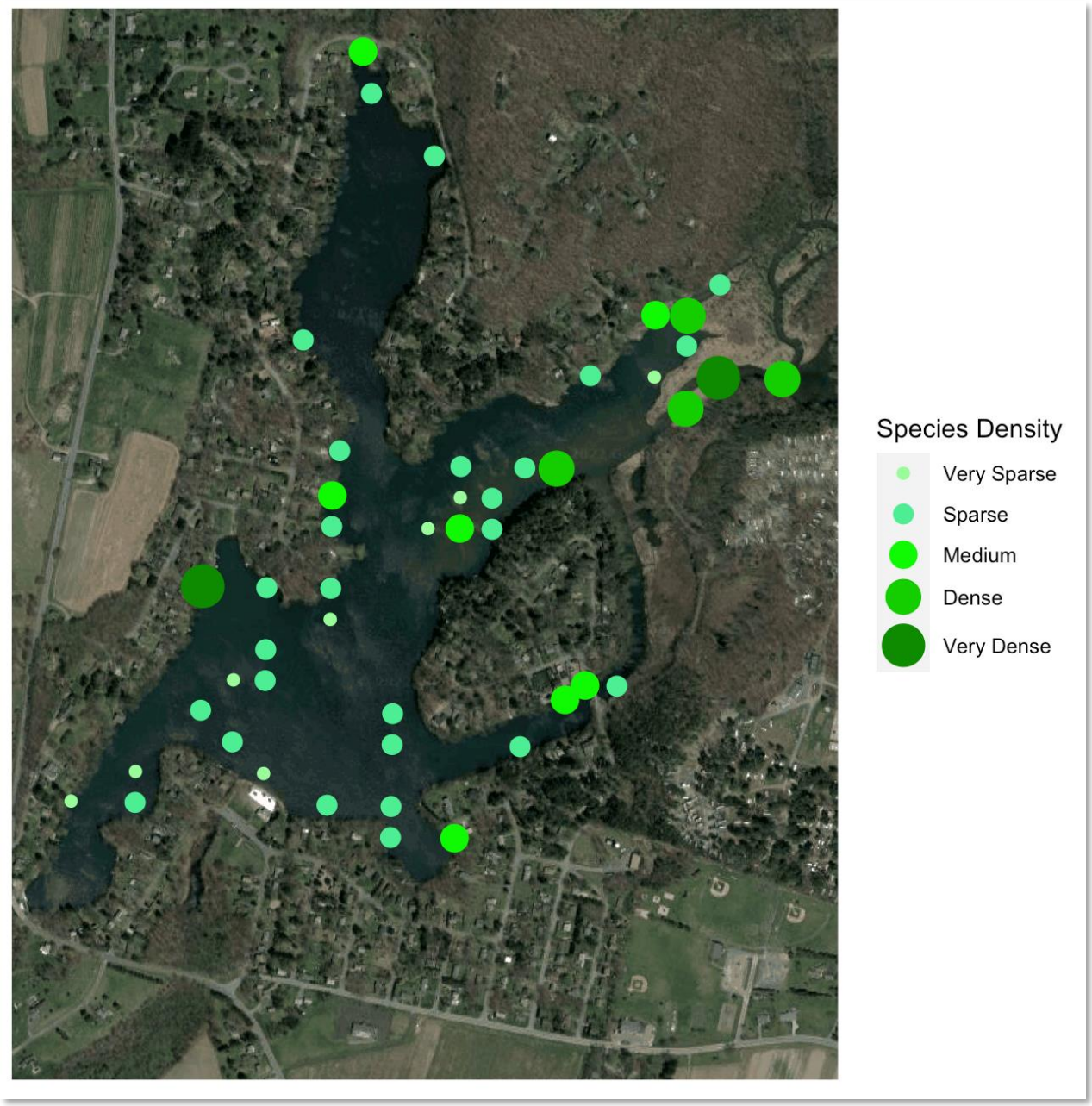


***Figure 23**. Locations and densities of filamentous algae on June 30th and July 1st, 2022.*

Curly-leaf pondweed was present at just 4% frequency. It was scattered in Zones 1, 7 and 8 (**Figure 24**). There were not any dense or very dense patches.


***Figure 24**. Locations and densities of curlyleaf pondweed on June 30th and July 1st, 2022.*

Water chestnut is spreading throughout the pond and patches are increasing in size (**Figure 25**). The photo in **Figure 26** shows a very dense patch at the northeast corner of Zone 8. It is likely that water chestnut is spreading via water currents and mechanical harvesting unintentionally spreading plants and/or nutlets.

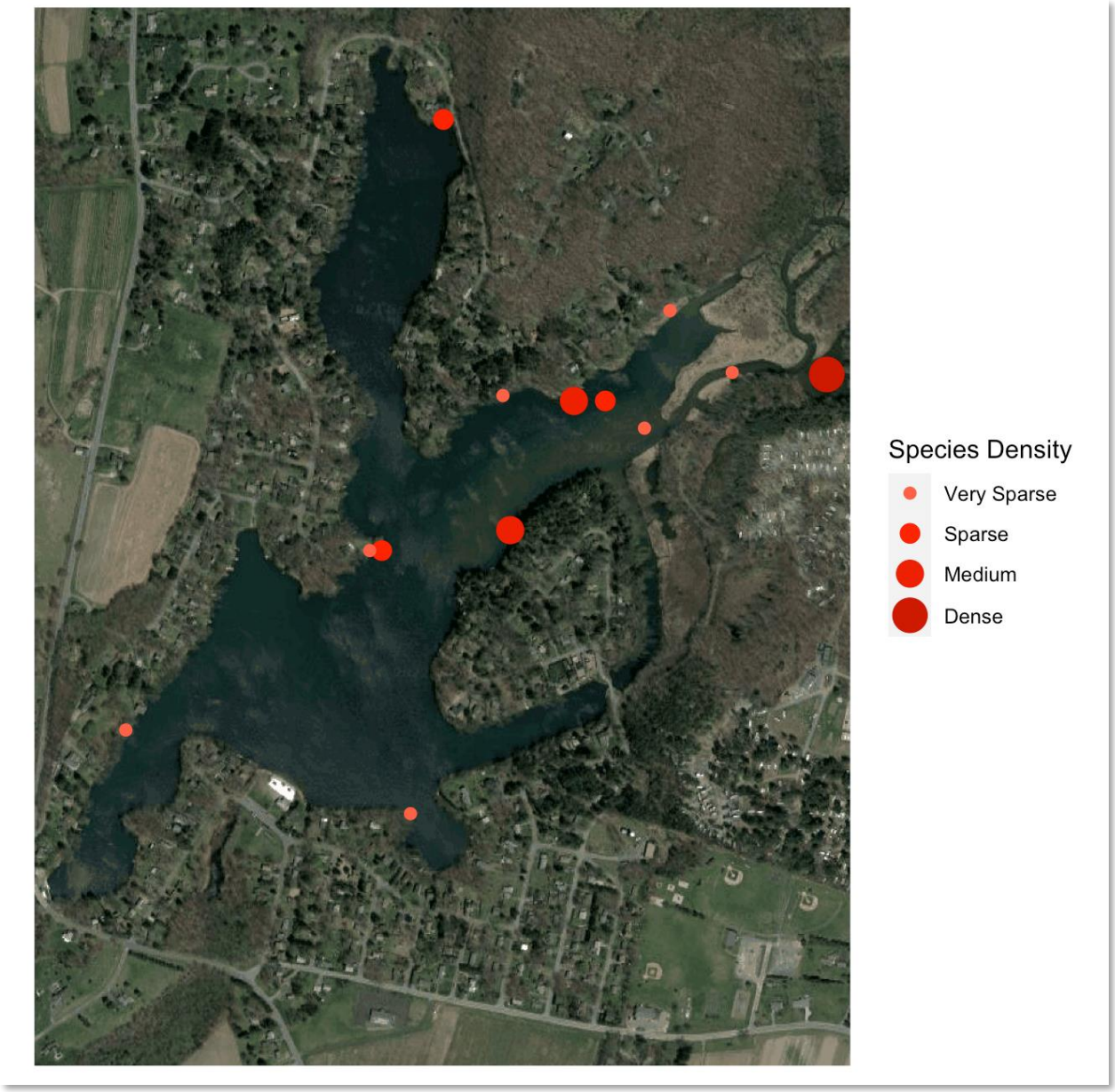


***Figure 25**. Locations and densities of water chestnut on June 30th and July 1st, 2022.*

***Figure 26**. Very dense water chestnut patch with scattered plants in Zone 8 on June 30th, 2022.*

Brittle naiad was present at 4% frequency with an average density of 12%. It was found in Zones 3, 4 and 5 (**Figure 27**).

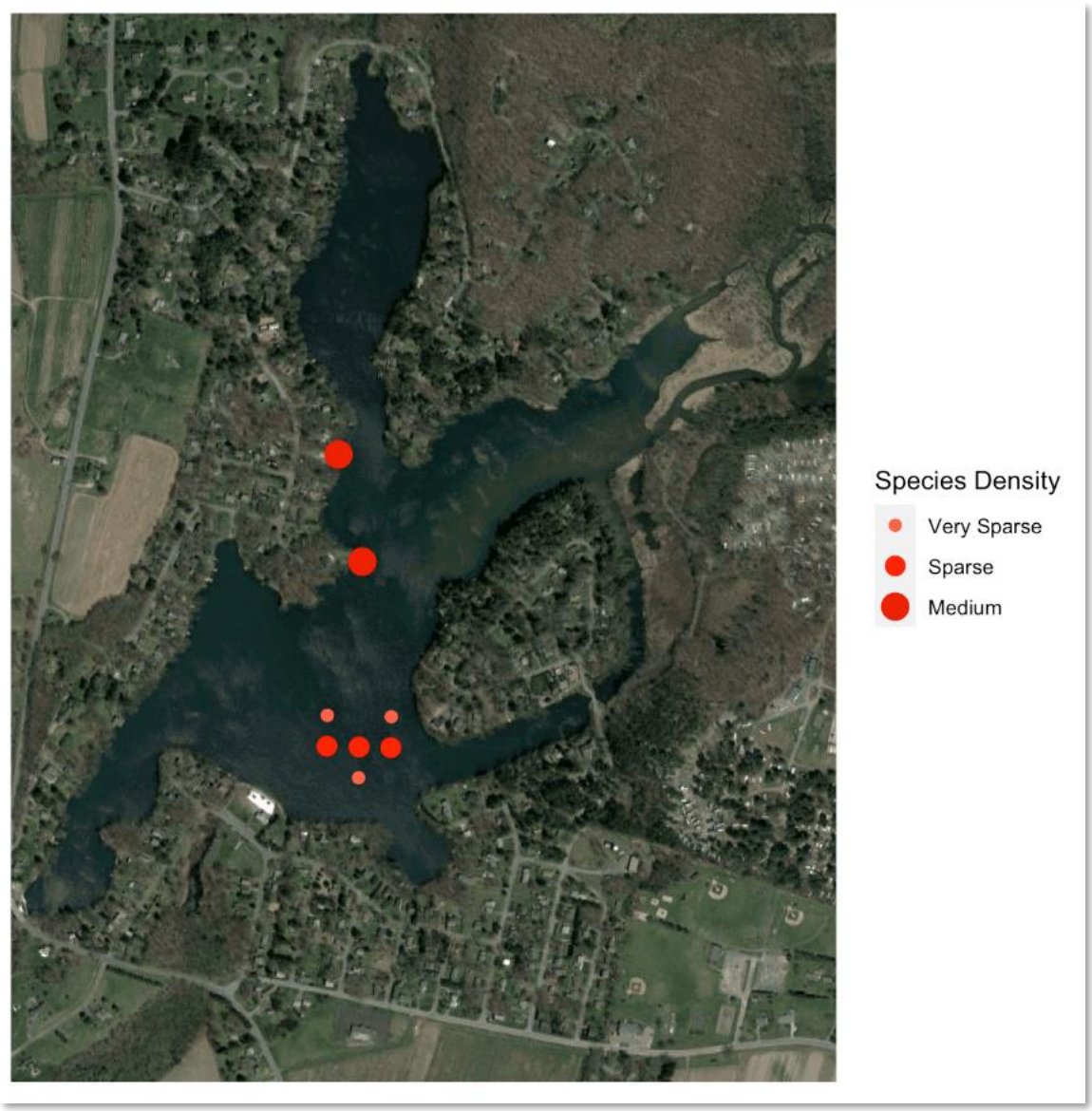


***Figure 27**. Locations and densities of brittle naiad on June 30th and July 1st, 2022.*

## Conclusions

Robinson Pond is a eutrophic waterbody with elevated nutrient concentrations and dense aquatic plant growth. The circulation system prevented stratification for the entirety of the sampling period in 2022 and anoxic conditions only occurred during one sampling month at the very bottom of the pond. Aquatic plant growth was very dense and abundant in the littoral zone of the pond. The ProcellaCOR treatment reduced the density of Eurasian milfoil at select locations in the pond and the plants were dead to mostly dead two weeks post-treatment. Roe-Jan inlet nutrient concentrations remained elevated during most of the sampling period.

## Recommendations

- Operate circulation system from March to beginning of December.
    - Can run year-round but electricity costs will be high.
- ProcellaCOR treatment in specific areas of the pond (TSPOA discussed Zones 1 and 3).
- Organize water chestnut hand-pulling by volunteers – plan this event for prior to July 1 to ensure plants are pulled prior to nutlets dropping.
    - Follow-up searches will be necessary throughout the season.