Northeast Aquatic Research

North and South Riga Lakes 2019 Monitoring Report

Prepared for the Mount Riga Association

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Northeast Aquatic Research, LLC ⁘ 74 Higgins Highway, Mansfield, CT 06250 ⁘ 860-456-3179

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SYNOPSIS OF 2019 RESULTS

1. **Water clarity** at North Riga in mid-summer was worse than in previous years. Clarity readings collected in recent years suggest declining clarity. Water clarity in South Riga remained excellent in 2019, with the Secchi disk reaching the bottom of the deep spot in the lake through the entire sampling season.

2. **Total phosphorus (TP)** at both lakes was generally acceptable in 2019, with the exception of a few elevated mid-summer readings.

3. **Total nitrogen (TN)** was very good at both lakes for the entire season, with concentrations similar to those seen in 2018.

4. **Aquatic Plants** – North Riga had 13 native aquatic plant species and of these, *Lobelia dortmanna* (water lobelia), *Eriocaulon* (pipewort), *Sparganium fluctuans* (floating bur-reed) were the most abundant. South Riga contained 19 native species, of which *Utricularia purpurea* (purple bladderwort) and *Eleocharis acicularis* (needle spikerush) were the most abundant. No invasive species were found in either of the lakes in 2018. The Connecticut State Listed Endangered Species *Potamogeton confervoides* appears to be spreading in both lakes.

BACKGROUND

North Riga Lake (also known as Upper Riga) and South Riga Lake (also known as Lower Riga) are located at the top of Mount Riga in Salisbury, Connecticut. Water quality monitoring of the two lakes has been conducted intermittently since 1986. Initially, monitoring consisted of collected water clarity readings, as well as temperature and dissolved oxygen profiles. NEAR has monitored the two lakes roughly every year since 2007, with the exception of 2009 and 2017. In 2018 and 2019, volunteer monitors conducted the lake monitoring approximately once per month for the duration of the summer sampling season.

Between 2010 and 2019, NEAR has surveyed the two lakes once per year, except in 2017. In 2019, NEAR surveyed the two lakes on September 25th to assess the presence and density of all aquatic plant species in the lakes. The annual aquatic plant survey also searched intensively for invasive species. No invasive species were found.

MONITORING RESULTS

In 2019, water quality monitoring at North Riga was conducted by volunteer monitors once in May, twice each in July and August, and once per month in September and October. At South Riga, volunteers monitored the lake once in June, twice in July, and once per month in September, October, and November.

The lake data is assessed using the CT DEEP categorization of lakes, which is primarily based on the amount of nutrients in surface waters during summer conditions (**Table 1**). A trophic category is a way to classify the degree of plant and algae growth that occurs in a lake, which increases with overall water quality decline. Very clear water with no weeds or algae results from very low nitrogen and phosphorus conditions. These clear-water and low-nutrient lakes are considered oligotrophic. Lakes with excessive amounts of weeds and very green water resulting from high nutrient concentrations are eutrophic. **Table 1** shows lake Trophic Status. Target criteria are highlighted in blue: TP <10ppb, TN <200ppb, and Secchi >6m.

Table 1 - Lake trophic categories and ranges of indicator parameters.

Category	T.P. (ppb)	T. Nitrogen (ppb)	Secchi Depth (m)	Chlorophyll *a* (ppb)
Oligotrophic	0 – 10	0 – 200	6+	0 – 2
Oligo-mesotrophic	10 – 15	200- 300	4 – 6	2 – 5
Mesotrophic	15 – 25	300 - 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 +

**Source = CT DEP 1982*

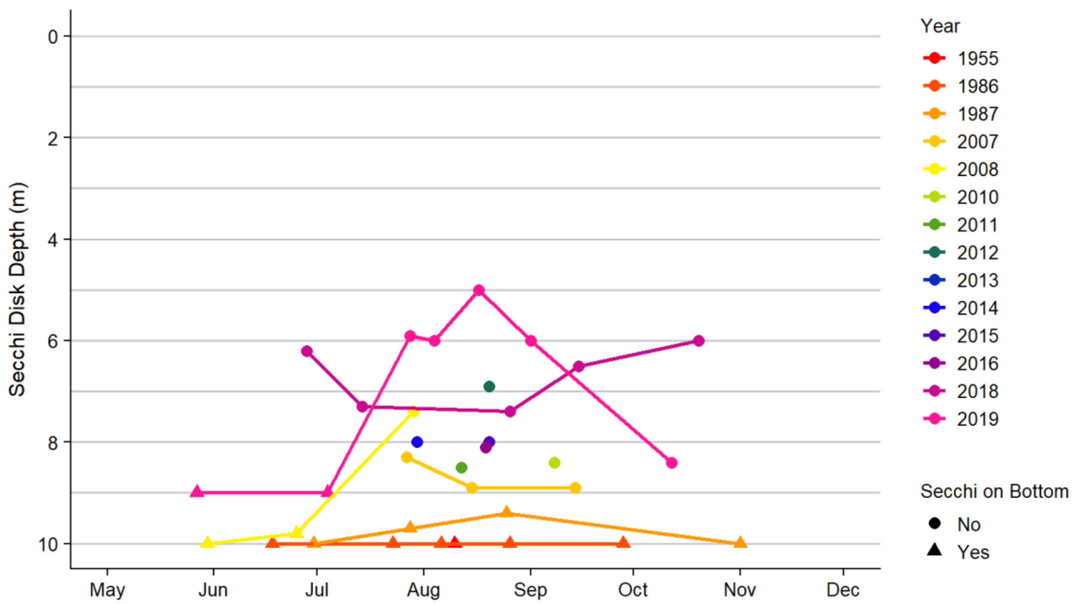
**Chlorophyll-a not included in testing*

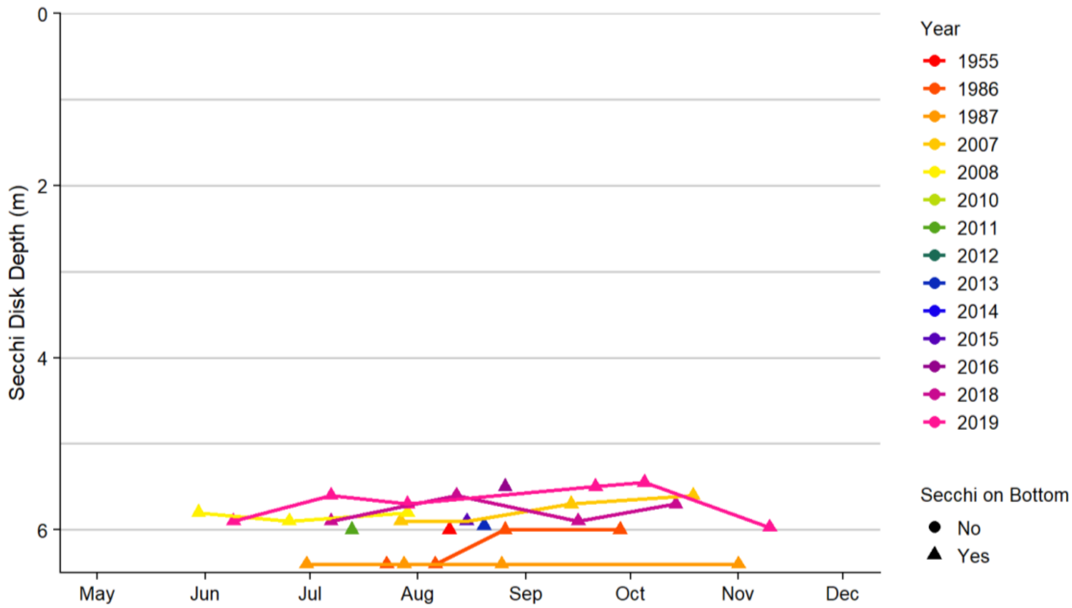
Water Clarity / Secchi Disk Depth

North Riga is approximately 10 meters deep at its deepest spot. In 2018, clarity remained in the range of approximately 6 to 7.5 meters between June and late October (**Figure 1**). Between 2007 and 2017, the single mid-summer reading ranged from 7 meters to 9 meters. In 2019, the Secchi disk could be seen at the bottom of the monitoring location in May and early July. However, by late July, clarity had worsened to approximately 6 meters and remained between 5 meters and 6 meters until early September. These are the worst clarity measurements recorded at North Riga over the 14 years of monitoring. The final sampling event in mid-October showed much improved clarity.

South Riga Lake fluctuates between 5.5 meters and 6 meters at its deepest spot. In the 14 years of measuring water clarity at South Riga, the Secchi disk has always been visible on the lake bottom. If the Secchi disk ever does not reach the bottom of the lake, that will be a clear sign that the water quality of the lake is declining.

Figure 1. Historical Secchi disk depth measurements at North Riga (first figure) and South Riga (second figure).





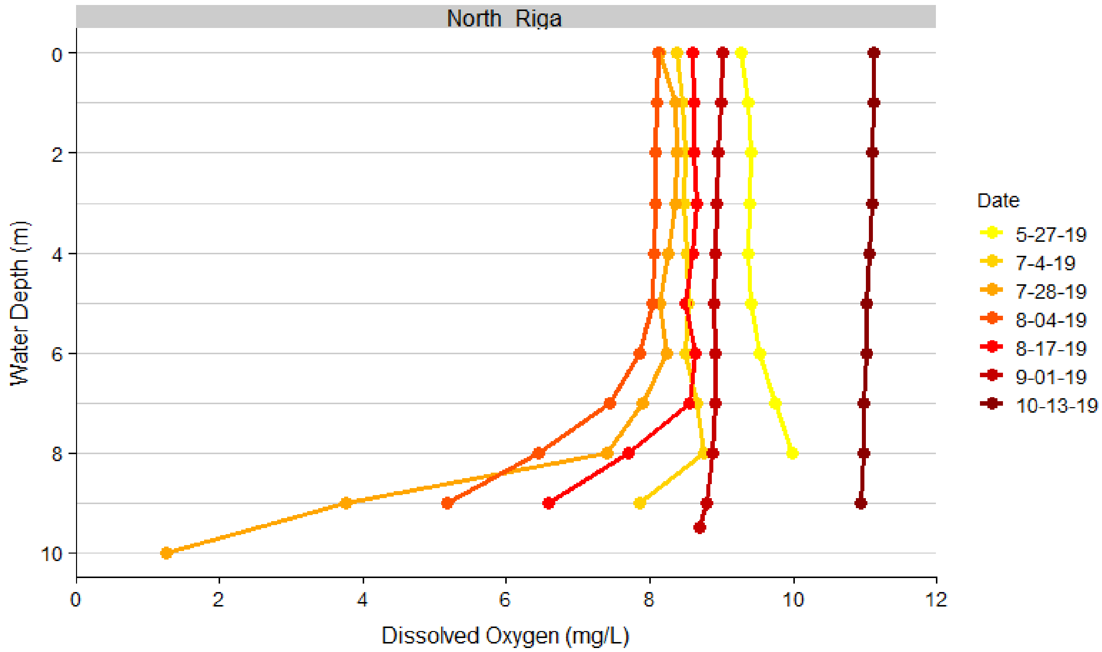
Dissolved Oxygen

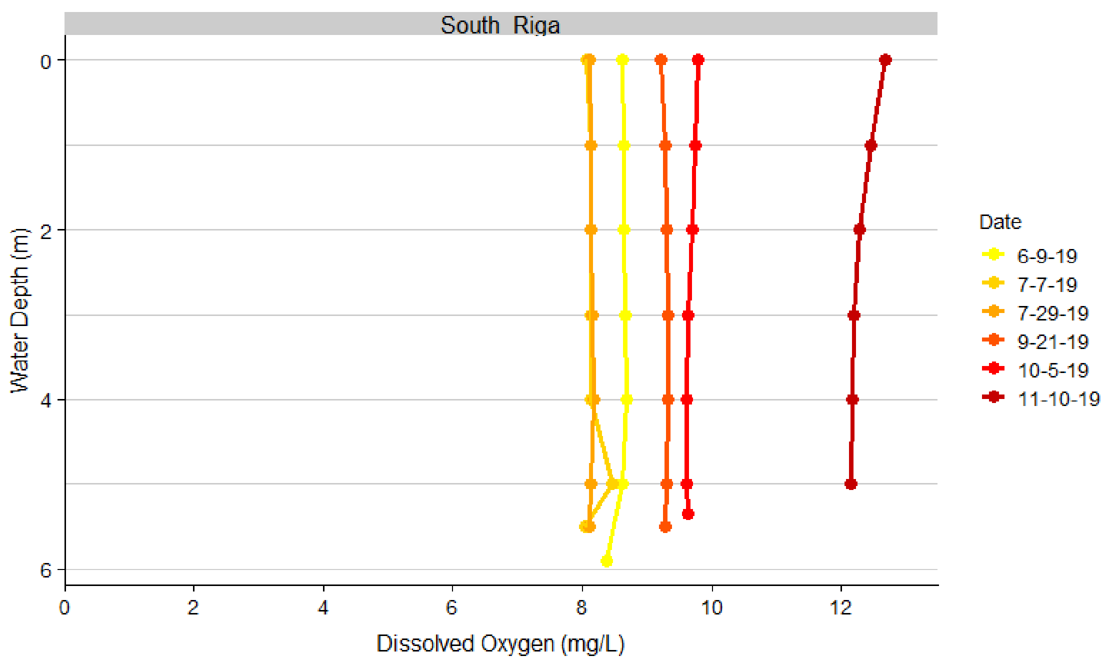
Dissolved oxygen (DO) in a lake is essential to aquatic organisms. At the surface of the lake, the water is in contact with the air, and atmospheric oxygen is dissolved into the water as a result of diffusion and wind mixing. As water mixing takes place, the dissolved oxygen is circulated throughout the water column. The decomposition of rooted aquatic plants and algae by bacteria requires dissolved oxygen (Biological Oxygen Demand) and can deplete the oxygen levels in the bottom waters below the thermocline. This phenomenon can lead to anoxic (<1 mg/l of DO) conditions in the deeper waters. Water that is anoxic (devoid of oxygen) is not suitable for fish and other aerobic aquatic organisms. When the water at the bottom of a lake is anoxic, nutrients trapped in the sediment at the lake bottom are released into the water through the process known as internal loading.

At North Riga, oxygen declined below 6 meters at the height of the season, when oxygen demand was heightened (**Figure 2**). In late July, DO at the very bottom of the deep spot decreased to 1.25 mg/L – very close to becoming anoxic. It is possible that a thin layer of water at the bottom of the deep spot was anoxic for a short period in mid-July, between sampling events. By early August, DO concentrations in the bottom water had increased, and continued to increase until the water column was fully mixed in the fall.

South Riga, the shallower of the two lakes, maintained consistent oxygen concentrations throughout the water column for the entire sampling season. If, in future years, DO levels in South Riga decline over the summer, this would suggest increased aerobic activity in the lake, related to an overall increase in nutrients.

Figure 2. Dissolved oxygen profiles at North Riga and South Riga, 2019.

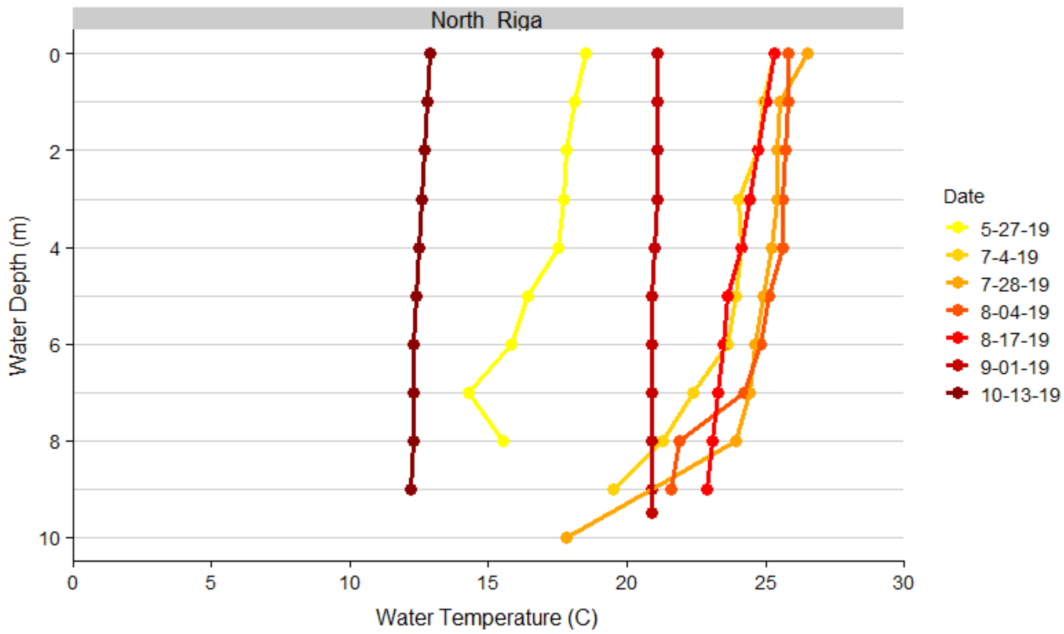


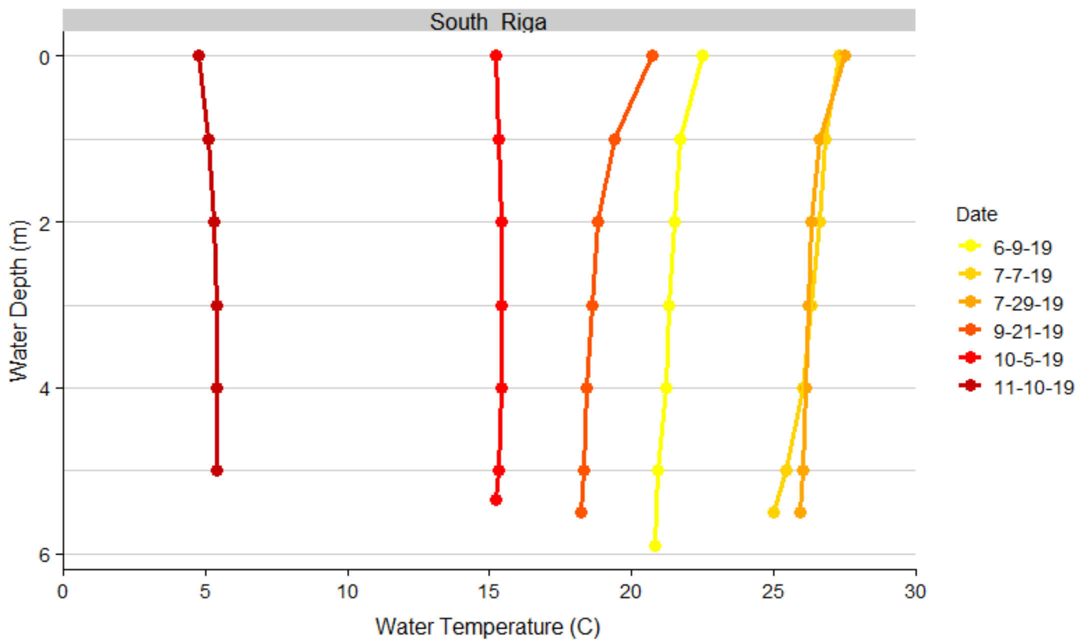


Temperature

Water temperature in lakes and ponds in the northeast follows a seasonal pattern of warming and cooling. As the sun's rays penetrate the water column during the summer, the water warms; but the depth extent of this warming is dependent on the water's clarity. Clearer water allows for more sunlight penetration and deeper water column warming. At both North Riga and South Riga, the temperature profile remained relatively consistent from top to bottom over the summer season due to the good water clarity at both lakes (**Figure 3**). A slight thermocline did develop at the lake bottom at North Riga in late July (7/28), which may be the reason behind the loss of oxygen at the lake bottom and the worsened clarity on the same date.

Figure 3. Temperature profiles at North Riga and South Riga, 2019.





Total Phosphorus

Phosphorus and Nitrogen are the two principal plant nutrients that drive aquatic plant and algae growth. Both nutrients are present in all lakes at some level. When the concentrations of these nutrients, particularly phosphorus, start to increase, algae can grow rapidly and reach nuisance conditions. Nutrients can come from the watershed in the form of natural wetland inputs, septic leachate, farm runoff, lawn fertilizers, and sedimentation from roads or streams. In freshwater systems, phosphorus tends to be the limiting factor for algae growth and is more heavily monitored for the health of inland ecosystems. Low phosphorus in a water body typically equates to lower phytoplankton abundance and greater overall Secchi clarity.

Due to lake temperature stratification with depth, nutrients are generally not present in the same quantities throughout the lake. Typically, the bottom of the lake accumulates more phosphorus and nitrogen as the summer progresses due to internal loading (when bottom sediments release nutrients in the presence of anoxic water). However, at North Riga and South Riga, the bottom water rarely becomes anoxic, meaning internal loading is not the primary source of nutrient input.

In July 2018, the water at the bottom of the deep spot in North Riga became anoxic, leading to elevated TP concentrations. In 2019, the bottom water remained oxygenated for the entire season, or only lost oxygen for a very short period in mid-July. As a result, total phosphorus concentrations were lower in 2019, ranging from 5ppb to 17ppb during the sampling season (**Table 1, Figure 4**). These concentrations are generally good, though ideally, TP should remain below 10ppb.

One water sample was collected from the inlet to North Riga in July. This sample had a TP concentration of 16ppb. This concentration is normal for a baseline undeveloped inlet, yet it is higher in concentration that the open lake water, confirming background nutrient loading from the watershed.

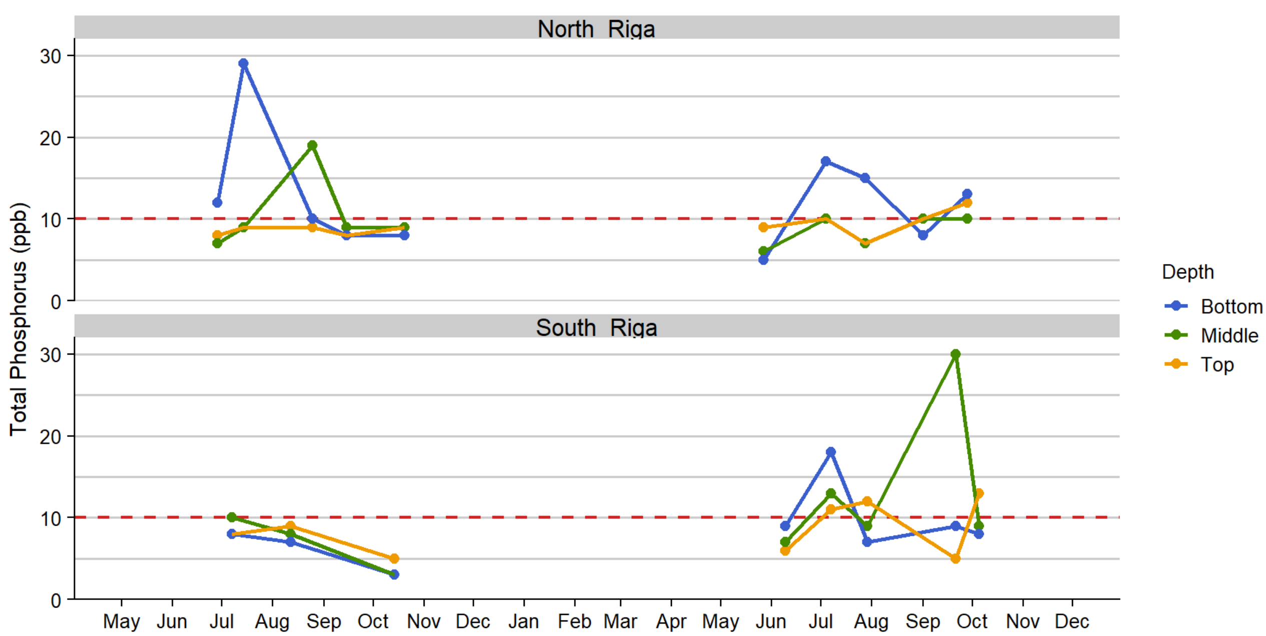
Total phosphorus concentrations in South Riga were somewhat elevated in 2019. In June and July, TP ranged from 6ppb to 18ppb. In September, phosphorus was low in the top and bottom samples, but the sample collected from the middle of the water column had 30ppb of phosphorus. By October, TP was lower at the middle sampling depth, but was slightly elevated in the surface water. Total phosphorus concentrations in 2019 were higher than 2018 levels, when TP remained below 10ppb for the entire season.

Table 2. Total phosphorus results from the top, middle and bottom depths at North Riga and South Riga.

North Riga Total Phosphorus (ppb)					
	May-27	**Jul-4**	**Jul-28**	**Sep-1**	**Sep-28**
Top	9	10	7	10	12
Middle	6	10	7	10	10
Bottom	5	17	15	8	13

South Riga Total Phosphorus (ppb)					
	Jun-9	**Jul-7**	**Jul-29**	**Sep-21**	**Oct-5**
Top	6	11	12	5	13
Middle	7	13	9	30	9
Bottom	9	18	7	9	8

Figure 4. Total phosphorus results from the top, middle, and bottom depths at North Riga and South Riga, 2019.



Total Nitrogen

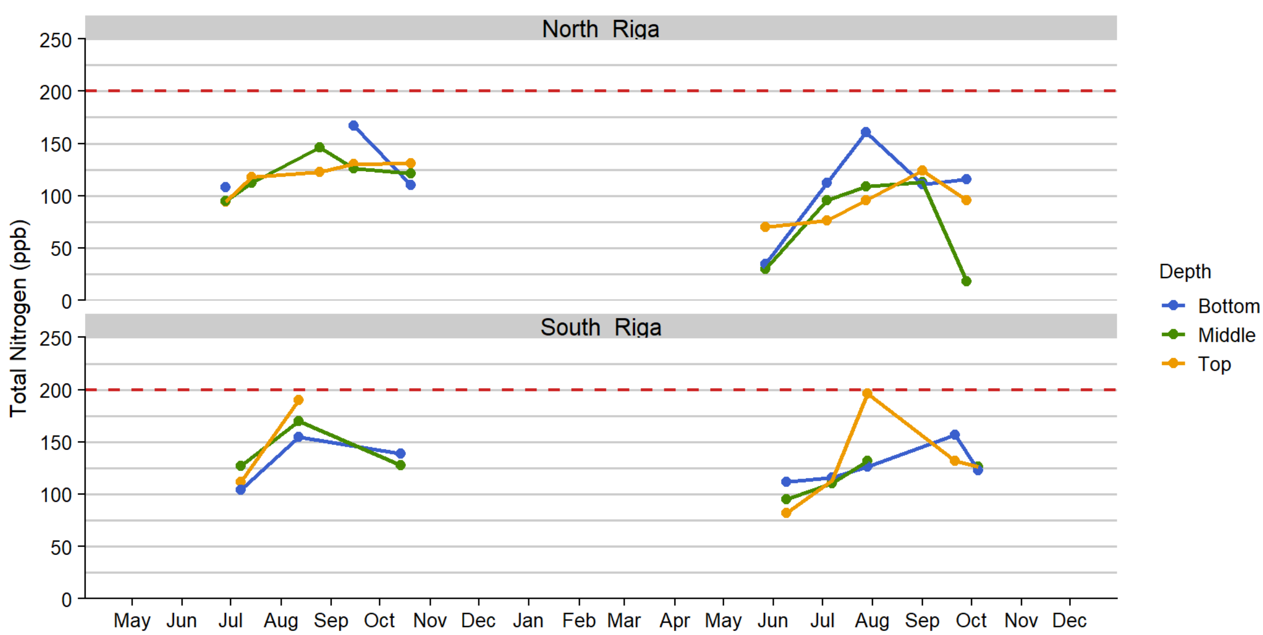
Total nitrogen (TN) includes fractions of nitrate, ammonia, and organic components. Ideally, TN should remain below 200ppb, placing the lakes in the 'oligotrophic' category. At both North Riga and South Riga, TN remained below this 200ppb cutoff for the entire 2019 season (**Table 3, Figure 5**).

Table 3. Total nitrogen results from the top, middle and bottom depths at North Riga and South Riga, 2019.

North Riga Total Nitrogen (ppb)					
	May-27	**Jul-4**	**Jul-28**	**Sep-1**	**Sep-28**
Top	70	76	96	124	96
Middle	30	96	109	113	18
Bottom	35	112	161	111	116

South Riga Total Nitrogen (ppb)					
	Jun-9	**Jul-7**	**Jul-29**	**Sep-21**	**Oct-5**
Top	82	113	196	132	126
Middle	95	110	132		126
Bottom	112	116	126	157	123

Figure 5. Total nitrogen results from the top, middle, and bottom depths at North Riga and South Riga, 2019.



Aquatic Plants

The aquatic plants in North Riga and South Riga were surveyed on September 25. No invasive aquatic plants were found in either of the lakes in 2019.

In North Riga, 13 species were recorded in the lake (**Table 4**). *Lobelia dortmanna* (water lobelia) and *Eriocaulon* (pipewort), both of which are semi-emergent species, were the two most abundant species in the lake (**Figure 6**). *Sparganium fluctuans* (floating bur-reed) was also dominant, meaning it was present at greater than 20% frequency.

19 native plant species were recorded in South Riga. *Utricularia purpurea* (purple bladderwort) and *Eleocharis acicularis* (needle spikerush) were the only dominant species (**Figure 7**).

Potamogeton confervoides (Tuckerman's pondweed) is categorized as a Connecticut State Listed Endangered Species, pursuant to the federal Endangered Species Act. *P. confervoides* was found in two locations in North Riga and several locations in South Riga during the 2019 surveys. It appears that the species has spread since 2018, suggesting that the Riga lakes contain good habitat for the species. A species is listed as endangered when there are no more than five occurrences of the species within the state. This means that the Riga lakes are vital for the survival of *P. confervoides*.

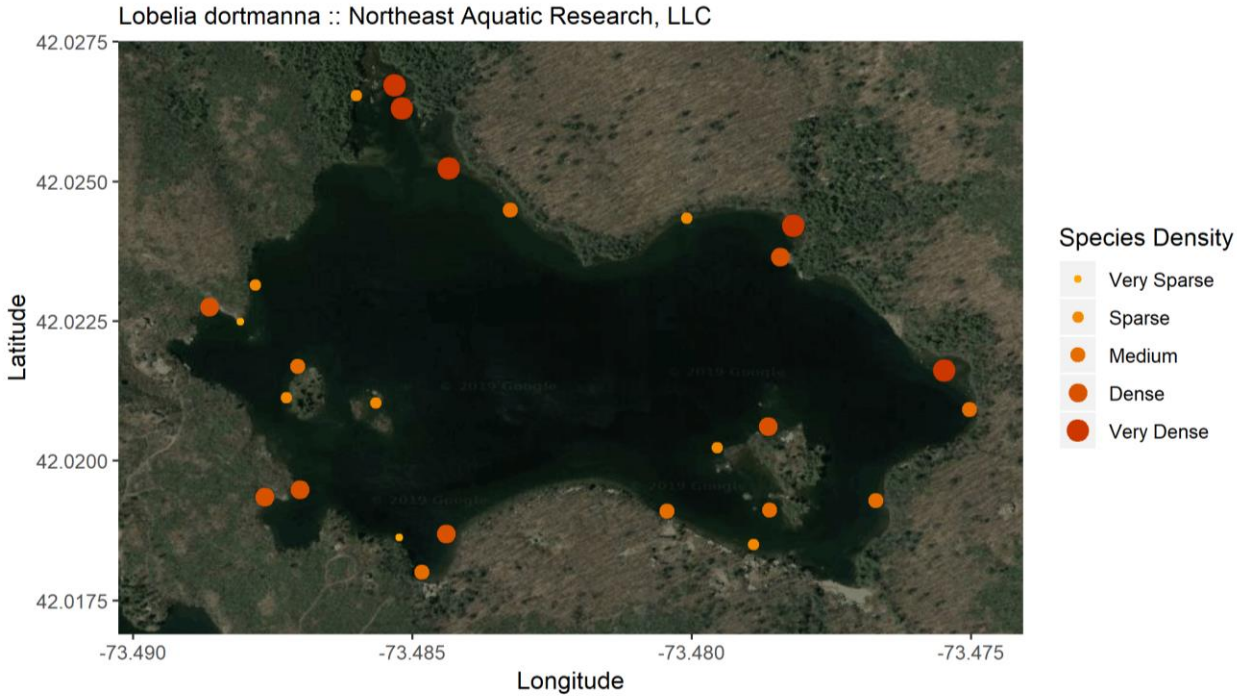
At both North Riga and South Riga, some coves contained filamentous algae and slime-covered plants and rocks. This may suggest elevated nutrient levels in these areas, possibly caused nutrients entering the lake in these areas via inlets or seeps.

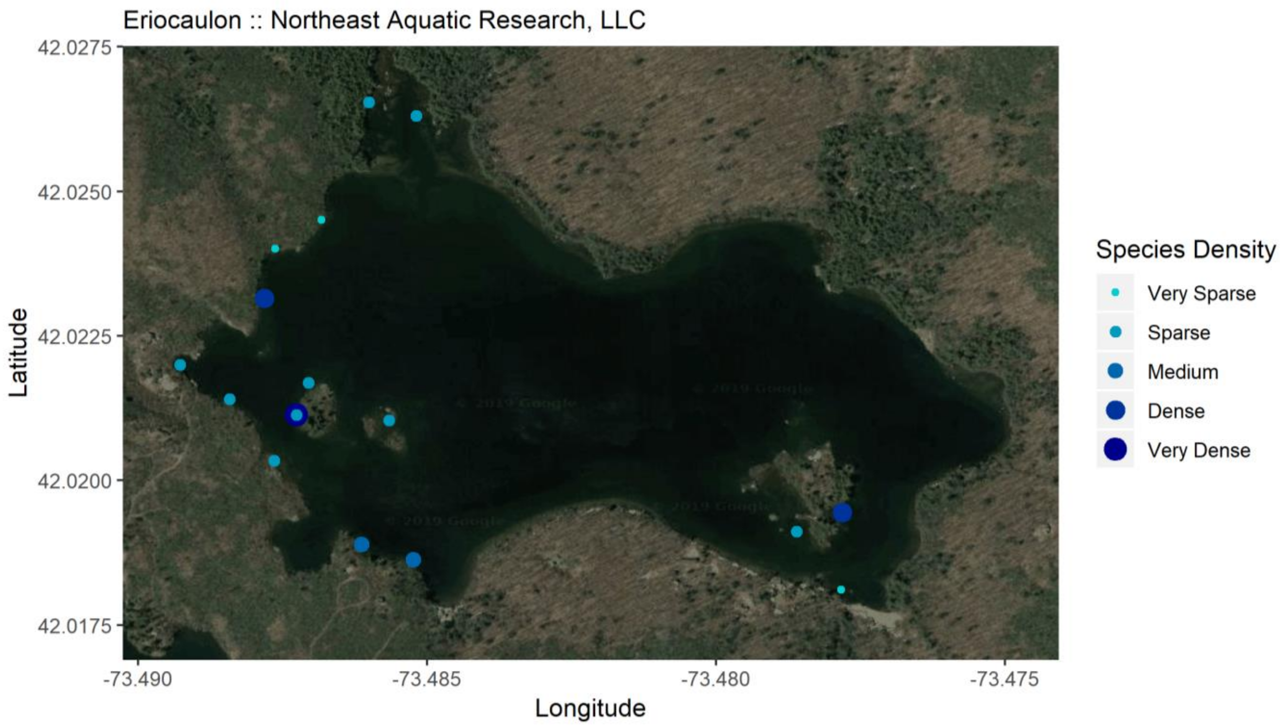
Table 4. Aquatic plants in North and South Riga lakes, September 2019.

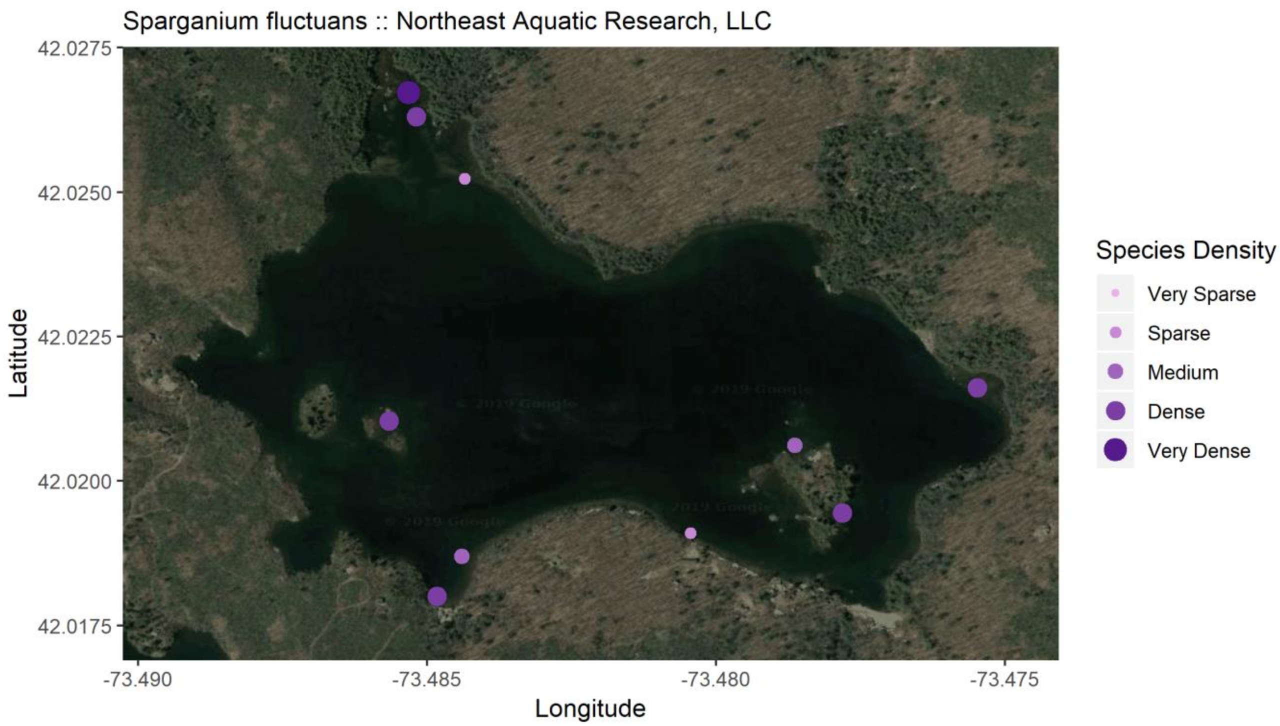
North Riga		
Species	**Frequency**	**Density**
Lobelia dortmanna	55	39.1
Eriocaulon sp	46.7	20.3
Sparganium fluctuans	25	51
Eleocharis acicularis	18.3	35.7
Myriophyllum humile	18.3	66
Emergent sparganium	11.7	NA
Utricularia purpurea	10	30
Nuphar variegata	8.3	5
Nymphaea odorata	6.7	15
Potamogeton confervoides	3.3	40.5
Emergent eleocharis	1.7	100
Fontinalis sp	1.7	10
Isoetes sp	1.7	NA

South Riga		
Species	**Frequency**	**Density**
Utricularia purpurea	45.5	54.0
Eleocharis acicularis	28.1	45.3
Eriocaulon sp	17.4	42.9
Emergent sparganium	16.5	44.4
Nitella sp	14.0	12.1
Nuphar variegata	11.6	25.4
Potamogeton confervoides	10.7	16.8
Chara sp	9.9	7
Sparganium fluctuans	9.1	21.4
Elatine sp	8.3	10.8
Epihydrus sp	7.4	49
Filamentous algae	7.4	63.9
Lobelia dortmanna	7.4	28.8
Nymphaea odorata	5.0	35.8
Potamogeton nodosus	5.0	51
Fontinalis sp	4.1	31
Isoetes sp	3.3	15
Myriophyllum humile	1.7	80
Potamogeton oakesianus	0.8	40

Figure 6. Aquatic plants of interest in North Riga Lake, September 25, 2019.






Sparganium fluctuans :: Northeast Aquatic Research, LLC
42.0275
42.0250
42.0225
42.0200
42.0175
Latitude
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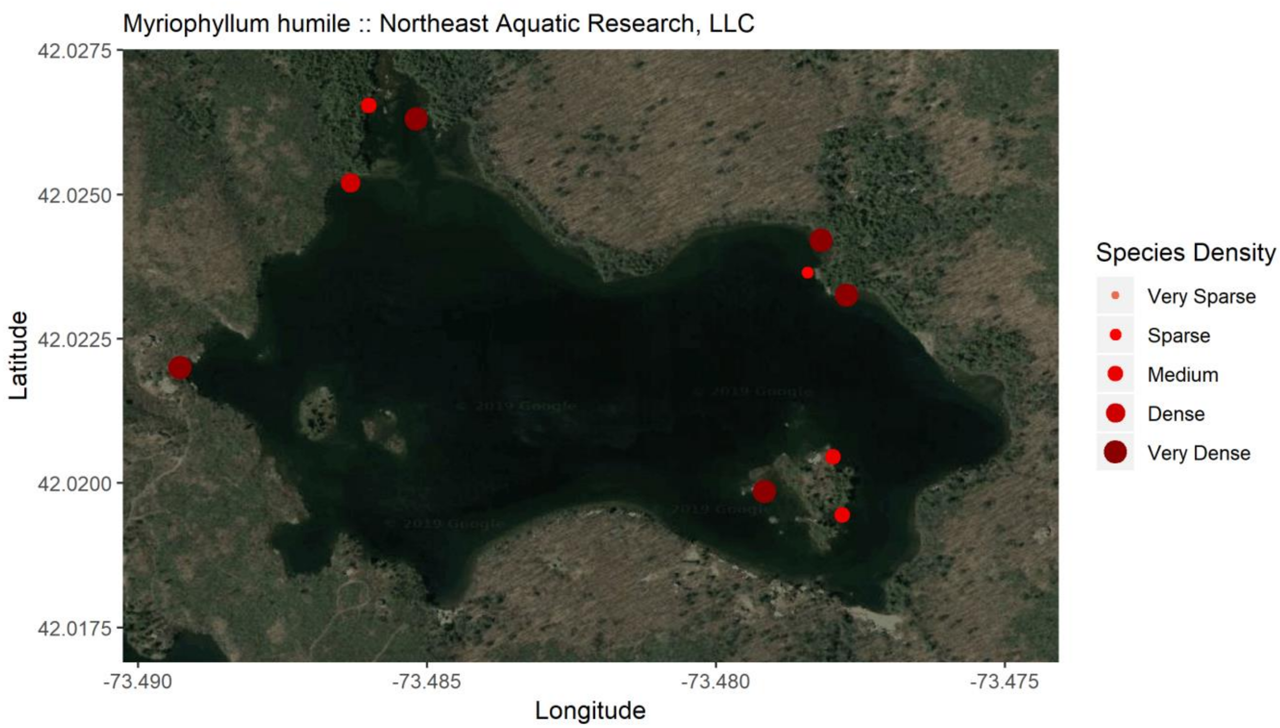
-73.485
-73.480
-73.475
Longitude
Species Density
Very Sparse
Sparse
Medium
Dense
Very Dense


Myriophyllum humile :: Northeast Aquatic Research, LLC
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Species Density
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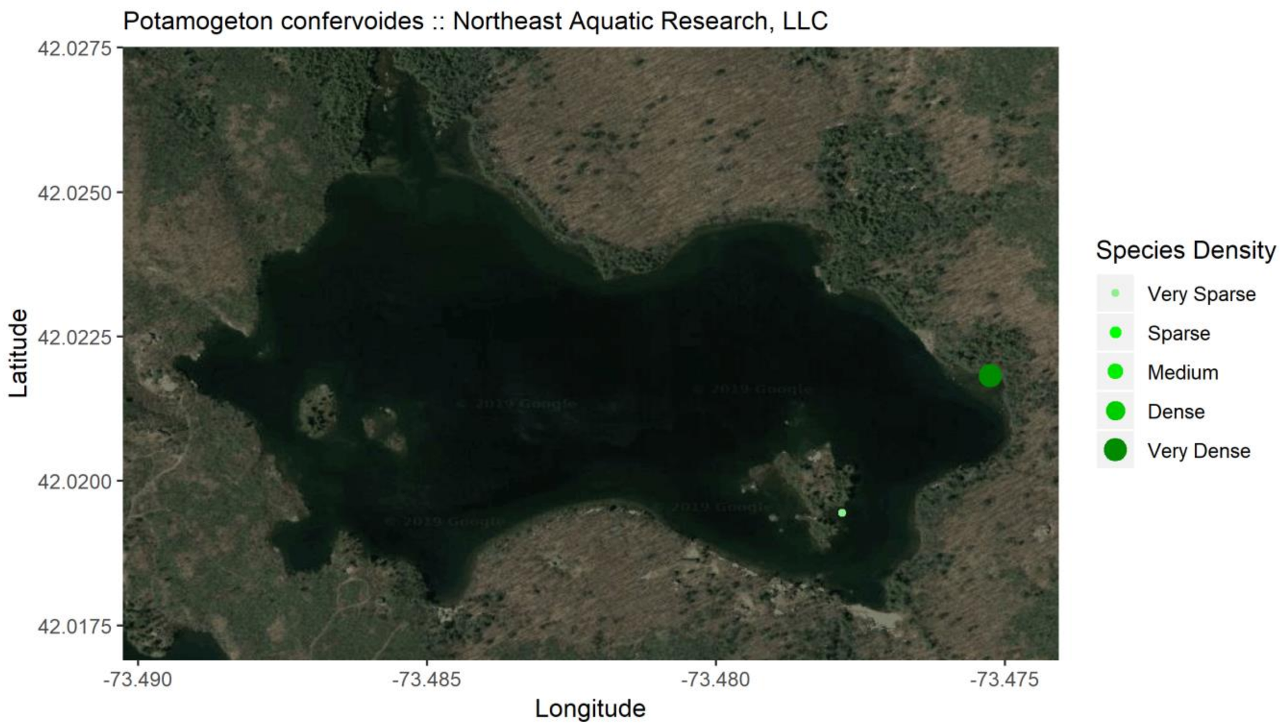
Potamogeton confervoides :: Northeast Aquatic Research, LLC
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Latitude
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Species Density
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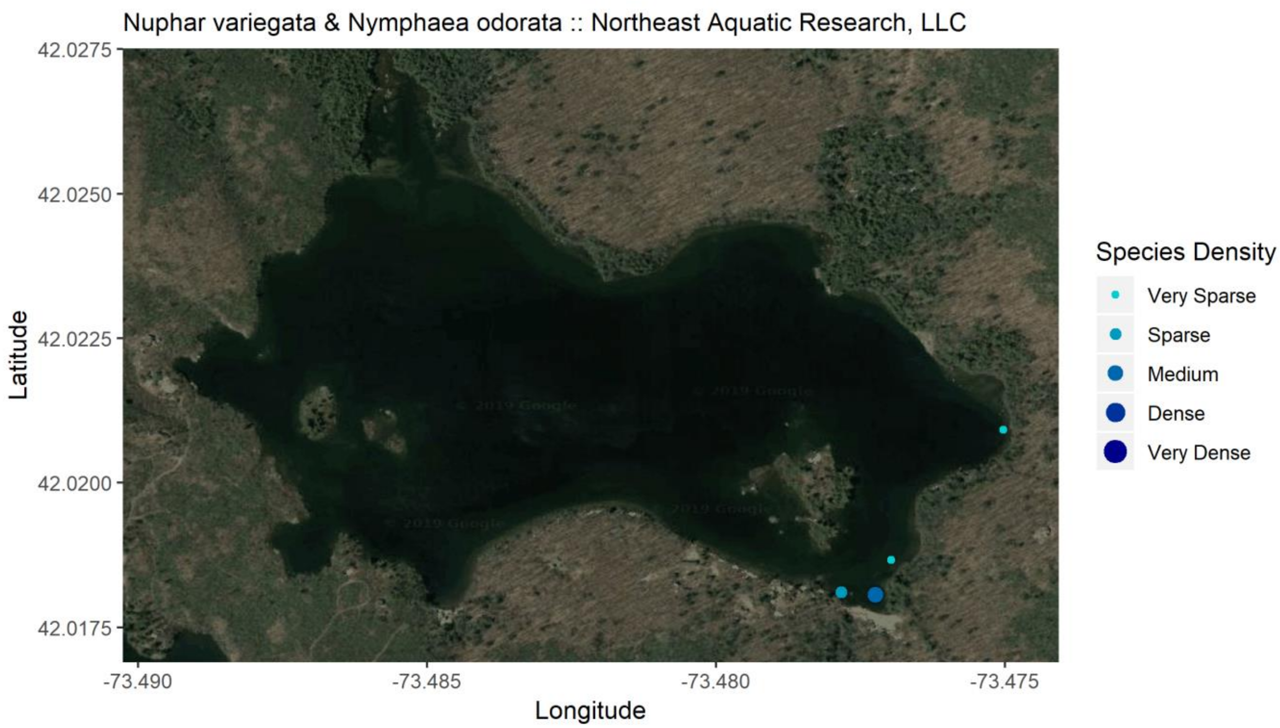
Nuphar variegata & Nymphaea odorata :: Northeast Aquatic Research, LLC
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Species Density
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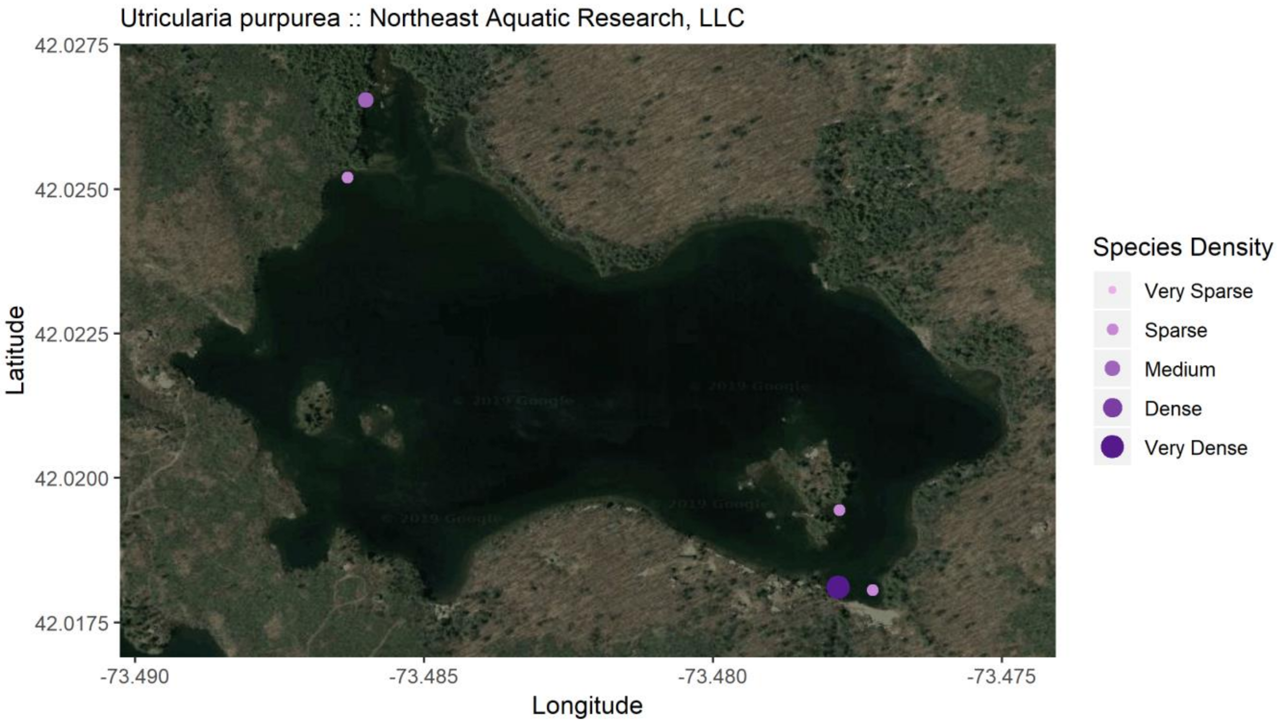
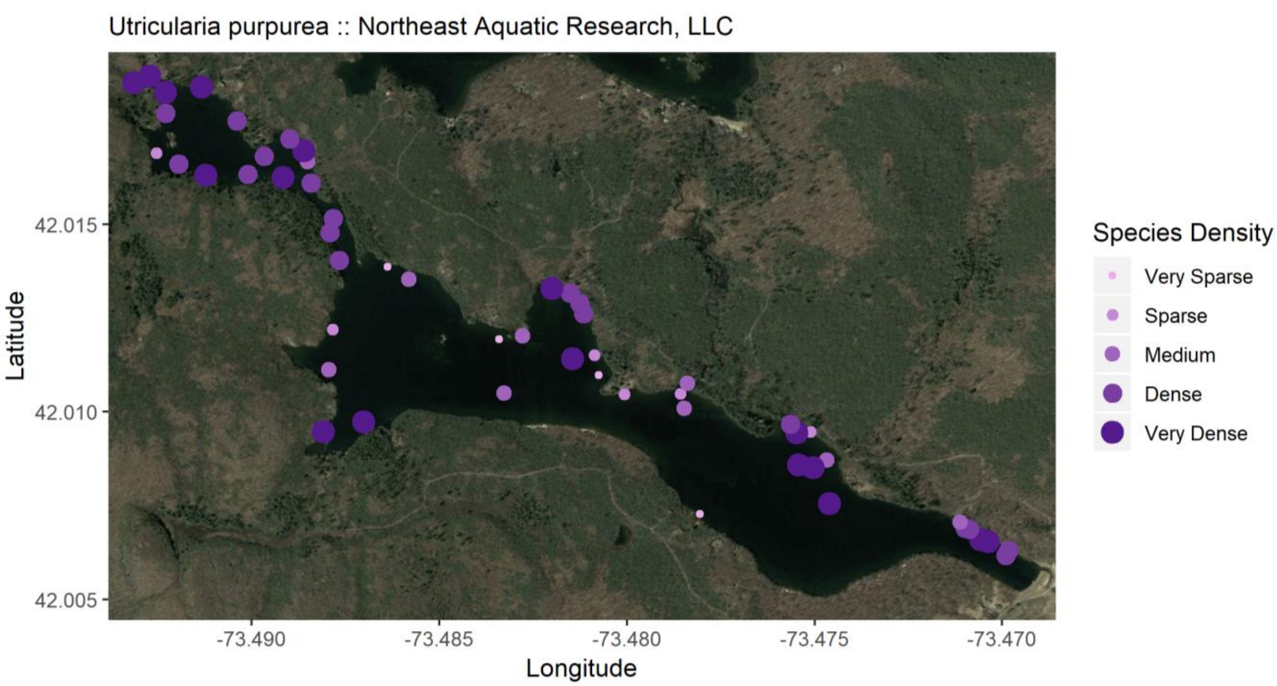
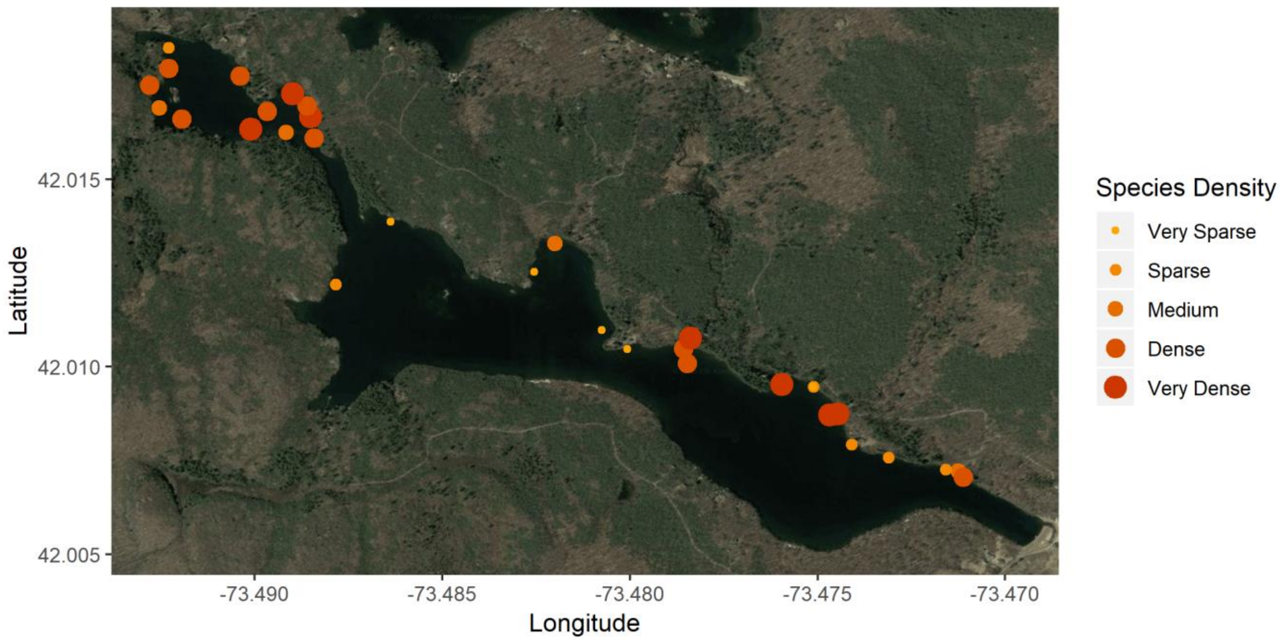


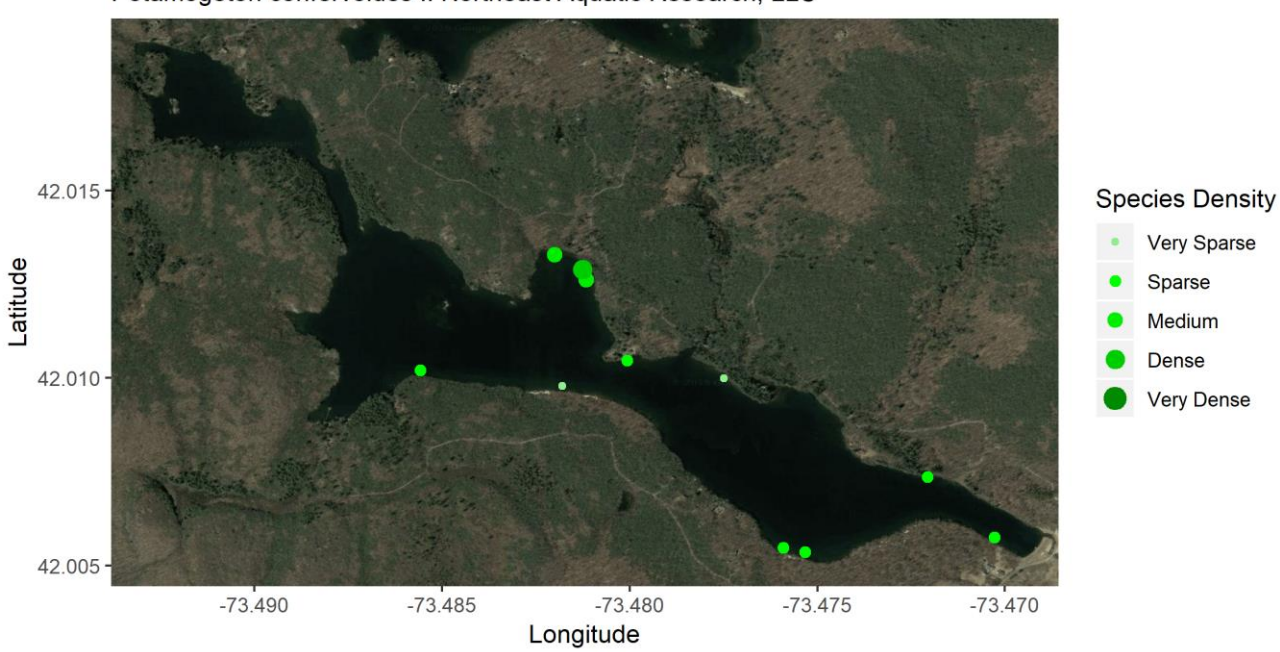
Figure 7. Aquatic plants of interest in South Riga Lake, September 25, 2019.

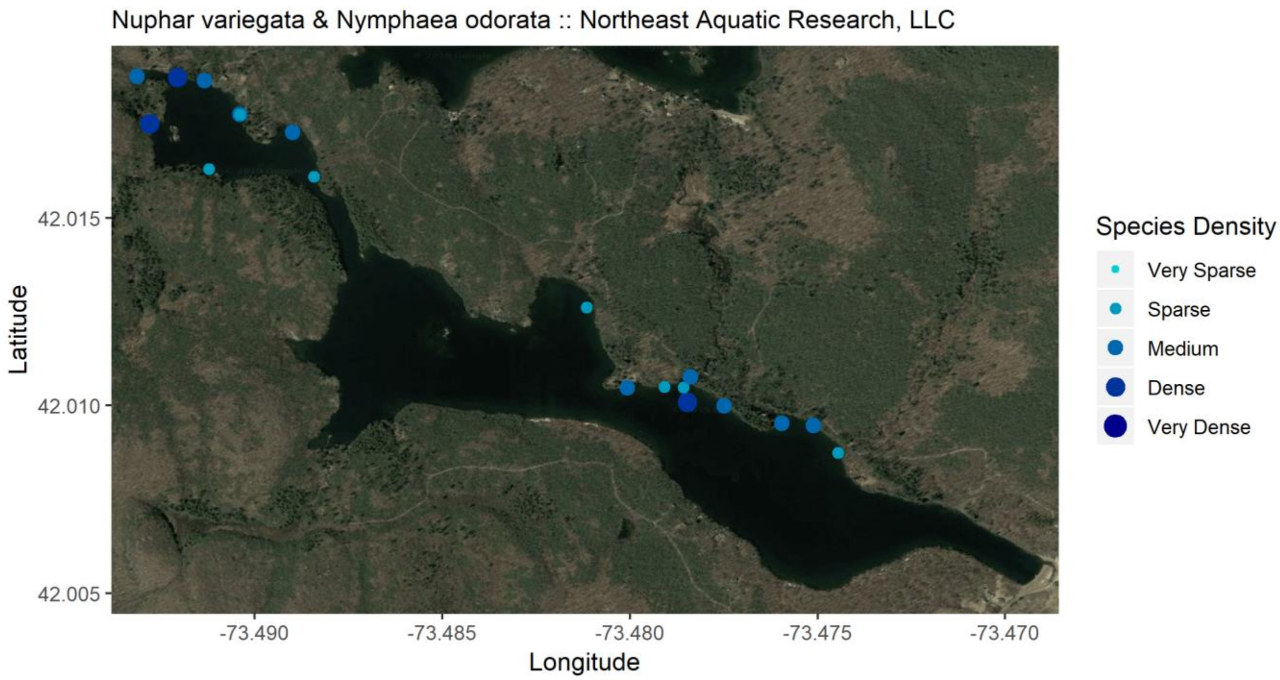


Eleocharis acicularis :: Northeast Aquatic Research, LLC



Potamogeton confervoides :: Northeast Aquatic Research, LLC





RECOMMENDATIONS

Suggested 2020 Actions

1. Continue the in-lake water quality monitoring, ideally from May through October, to track the full extent of seasonal fluctuations, including peak extent of anoxic water, best and worst seasonal clarity, and peak nutrient concentrations.

2. Collect inlet samples from all flowing inlets in May and again in August to assess watershed nutrient loading. The samples should be tested for total phosphorus, total nitrogen, and nitrate nitrogen.

3. Conduct late-season full-lake aquatic plant surveys at the two lakes to document the presence and abundance of aquatic plant species in the lake and to search for invasive species.

4. The Riga Lakes residents should begin to discuss watershed protection efforts, including limiting development, road maintenance to prevent erosion, onsite wastewater updates for local camps, and potential in-lake management efforts. The NEAR team will gladly participate in a conference call with the Mount Riga Association to discuss watershed protection.