Northeast Aquatic Research

North and South Riga Ponds
2021 Monitoring Report

Prepared for the Mount Riga Association

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BACKGROUND

North Riga Pond (also known as Upper Riga or North Pond) and South Riga Pond (also known as Lower Riga or South Pond) are located on Mount Riga in Salisbury, Connecticut. Water quality monitoring of the two lakes has been conducted intermittently since 1986. Initially, monitoring consisted of collecting water clarity readings, as well as temperature and dissolved oxygen profiles. Between 2007 and 2016, NEAR monitored the two lakes roughly every year. From 2018 through 2021, volunteer monitors have conducted the lake monitoring.

Between 2010 and 2021, NEAR has surveyed the two ponds once per year, with the exception of 2017. The 2021 surveys were conducted on September 3rd to assess the presence and density of all aquatic plant species in each of the lakes. The aquatic plant surveys also involved intensive searching for invasive aquatic species. No invasive species were found in either of the ponds in 2021.

MONITORING RESULTS

In 2021, water quality monitoring at North Riga was conducted by volunteer monitors once in May, once in June, and once in August. At South Riga, volunteers monitored the pond once per month in April, May, June, August, and September.

The lake data is assessed using the CT DEEP categorization of lakes, which is primarily based on the amount of nutrients present in surface waters during spring and summer conditions (**Table 1**). A trophic category is a way to classify the degree of plant and algae growth that occurs in a lake, using only 4 parameters. In a waterbody with declining water quality, total phosphorus concentration is typically the first parameter to decline, with the other three parameters following as phosphorus increases. With very low phosphorus concentrations, lakes have very clear water with no weeds or algae. As the amount of phosphorus in a lake increases, phytoplankton grow, water clarity declines, and aquatic plants proliferate. **Table 1** shows the gradient of lake conditions based on increasing phosphorus concentration, and assigns names to each step in concentration. It is important to pay attention to the loss of Secchi disk depth as the phosphorus concentration increases, since the change is not linear but instead exponential with clarity declining much faster than the phosphorus increases. Target condition of both lakes is for all measured parameters to fall in the first row, Oligotrophic, highlighted in blue: TP <10ppb, TN <200ppb, and Secchi disk depth >6m.

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

Category	T.P.	T. Nitrogen	Secchi Depth	Chlorophyll *a*
	(ppb)	(ppb)	(m)	(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 because samples are very time-sensitive.*

Water Clarity / Secchi Disk Depth

The water clarity in North Riga has historically been good, but clarity has been reduced in the past four years (**Figure** 1). 2021 had the worst spring clarity on record, at 6.3 meters. The clarity improved slightly in July, with a reading of 7 meters. However, a view scope was not used on this date, so clarity was likely slightly better than the recorded depth. By August, the clarity had again worsened to 6.3 meters. It is unclear whether a view scope was used when measuring the Secchi depth in May and August. It is important to use the view scope for every water clarity measurement because it allows for a more accurate reading.

In South Riga, the water clarity was good in April, May, and June, with the Secchi disk visible on the lake bottom (**Figure 2**). Water quality monitoring was not conducted in July, but by the end of August, clarity was reduced, with the Secchi disk visible approximately 1-meter off the lake bottom. It is possible that bladderwort plants on the lake bottom could cover the Secchi disk, causing lost visibility. However, if the poor Secchi disk measurement was in fact caused by poor water clarity, this is a very concerning indicator of declining water quality. Clarity improved by late September, with the Secchi disk again visible on the bottom. 2020 and 2021 are the only two years on record in which the Secchi disk was not visible on the lake bottom during a sampling event. This is concerning, as it suggests that the water quality of South Riga is declining.

Again, it is unclear whether a view scope was used for all water clarity measurements in South Riga.

Figure 1. Historical Secchi disk depth measurements at North Riga.

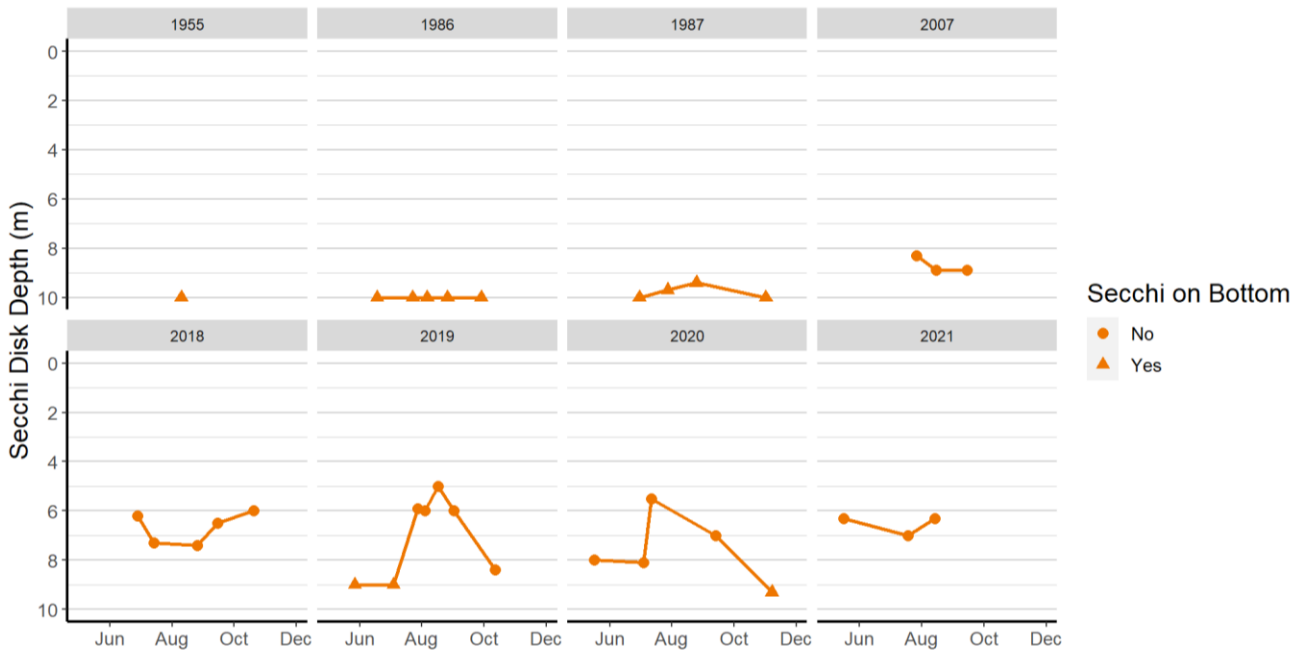
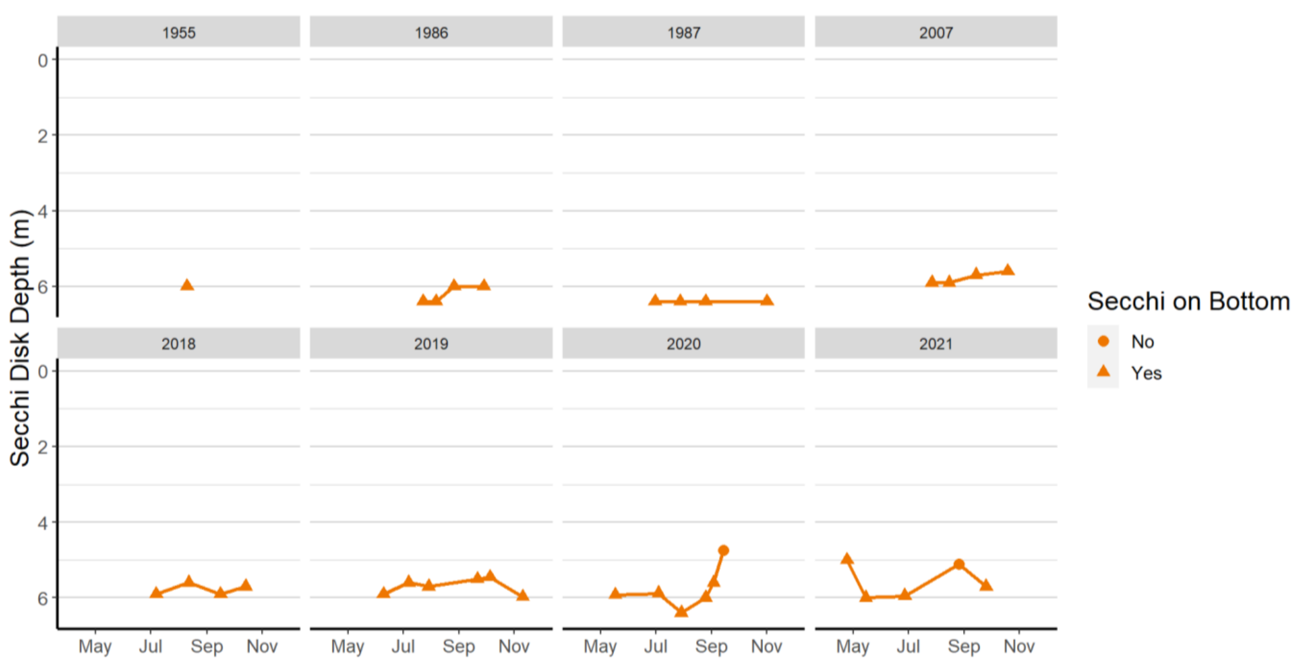


Figure 2. Historical Secchi disk depth measurements at South Riga.



In the above figures, it appears that the water level in both ponds has changed somewhat over time, or that the bottom has become slightly shallower

Table 2. North Riga and South Riga Secchi disk depth measurements, 2021.

North Riga Secchi Disk Depths (m)	
16-May	14-Aug
6.3	6.3

South Riga Secchi Disk Depths (m)				
24-Apr	15-May	27-Jun	26-Aug	25-Sep
On bottom	On bottom	On bottom	5.1	On bottom

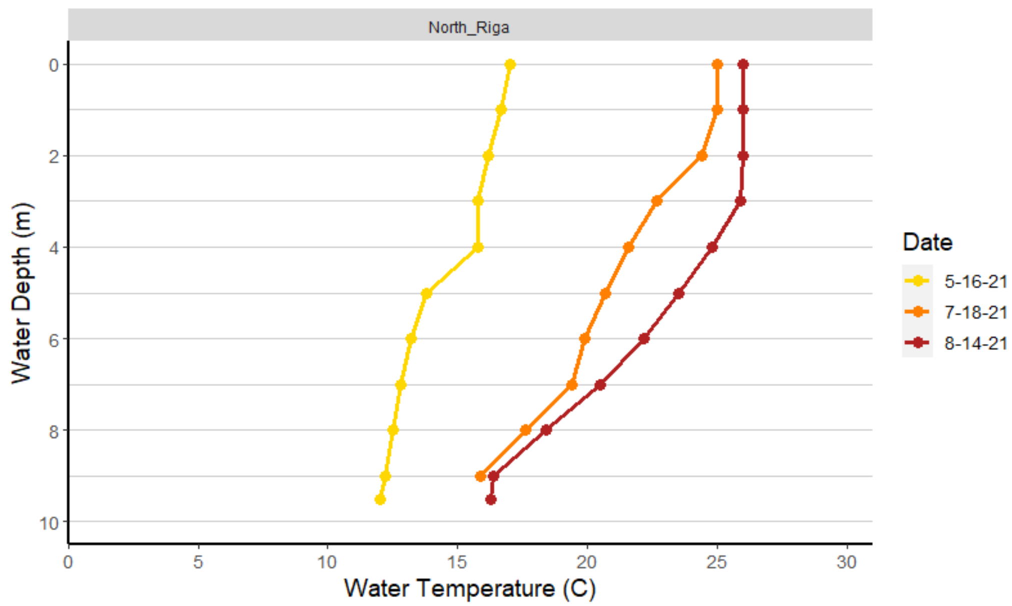
Water Temperature

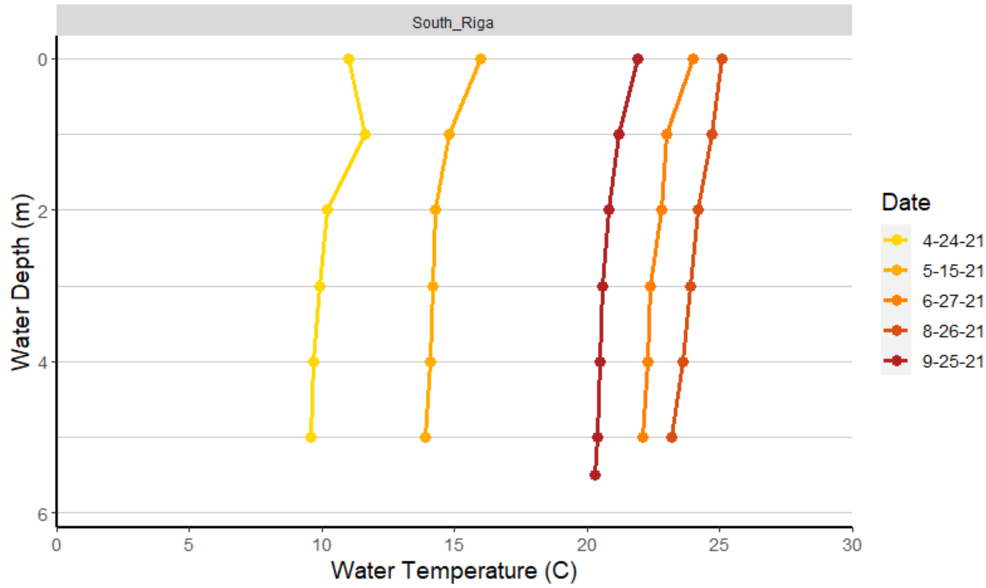
Water temperature in lakes and ponds in the northeast follows a seasonal pattern of warming and cooling. As the sun's rays penetrate the water column during the summer, the water warms; but the depth extent of this warming is dependent on the water's clarity. Clearer water allows for more sunlight penetration and deeper water column warming.

In North Riga in May, the water temperature declined slightly between 4- and 5-meters (**Figure 3**). By July, the water column had become stratified, and stratification intensified into August.

In South Riga, the water column remained well-mixed throughout the summer.

Figure 3. Temperature profiles at North Riga and South Riga, 2021.





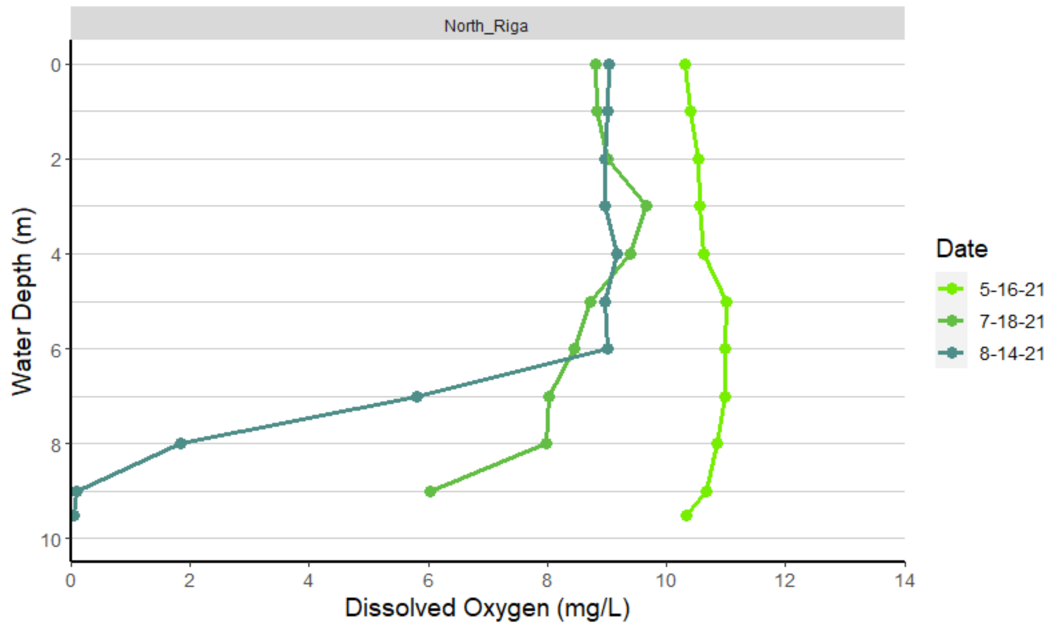
Dissolved Oxygen

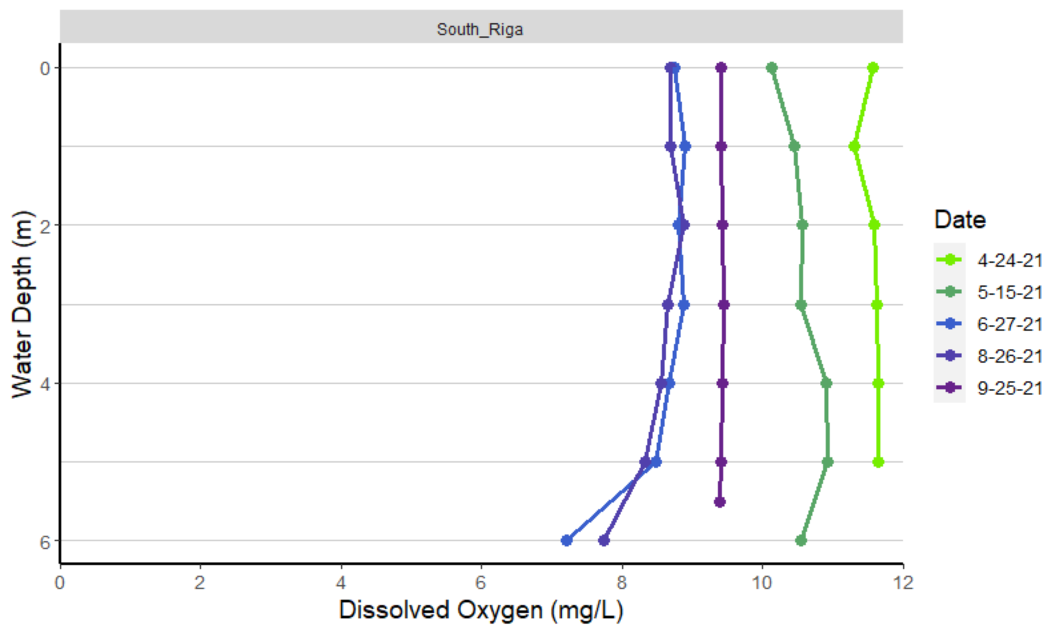
Dissolved oxygen (DO) in a lake is essential to aquatic organisms. At the surface of the lake, the water is in contact with the air, and atmospheric oxygen is dissolved into the water as a result of diffusion and wind mixing. As water mixing takes place, the dissolved oxygen is circulated throughout 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 a process known as internal loading.

North Riga in May, the water column was well-oxygenated throughout (**Figure 4**). By July, DO declined below 4 meters, with a sharp decline in the bottom meter of water. In August, the bottom 1-meter of the pond's deep spot was anoxic. This is the first time since 2018 that anoxic water has been recorded in North Riga. Because monitoring was not conducted in North Riga after August, we cannot determine the maximum height of anoxic water, or when oxygen returned to the bottom water later in the season. This information is vital for understanding the severity of the issue.

In South Riga, the entire water column remained fairly well oxygenated throughout the summer, with just a slight decline in DO in the mid-summer months.

Figure 4. Dissolved oxygen profiles at North Riga and South Riga, 2021.





Total Phosphorus

Phosphorus and Nitrogen are the two principal 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 enter the lake 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 waterbody typically equates to lower phytoplankton abundance and greater overall Secchi clarity.

Nutrients are generally not present in the same quantities throughout the water column. 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), along with settling of material from the upper water column and inputs from the watershed. However, internal loading has not historically been an issue for the Riga Ponds do to the absence of anoxic water.

In North Riga, Total Phosphorus (TP) concentrations were slightly elevated above 10ppb in May (**Figure 5**, **Table 3**). Ideally, TP should remain below 10ppb, particularly in the spring. At the time of the August monitoring visit, the deepest 2 meters of water were devoid of dissolved oxygen. It is likely that this worsened into September. This anoxia caused internal loading of phosphorus into the bottom water, increasing the TP concentration to 29ppb, nearly three times the surface and middle depth concentrations. The top and middle depth concentrations remained similar between May and August at 11.5ppb, slightly over the target 10ppb.

In South Riga, total phosphorus remained close to 10ppb (8-12ppb) for the entire season at all three sampling depths. These levels are better than those recorded in the prior two years when phosphorus has been as high as 30ppb.

Figure 5. Total phosphorus concentrations at North Riga and South Riga, 2018-2021.

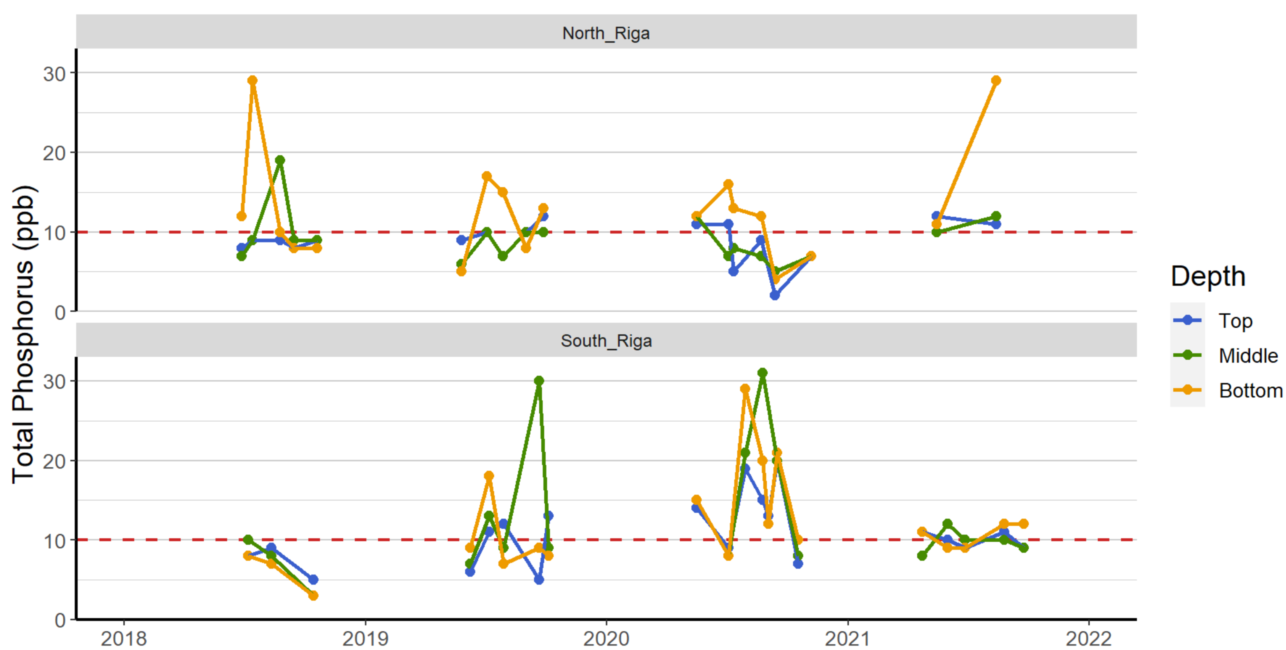


Table 3. Total phosphorus concentrations at the top, middle and bottom depths at North Riga and South Riga, 2021.

North Riga Total Phosphorus (ppb)		
	May 16	**Aug 14**
Top	12	11
Middle	10	12
Bottom	11	29

South Riga Total Phosphorus (ppb)					
	Apr 24	**June 1**	**June 27**	**Aug 26**	**Sept 25**
Top	11	10	9	11	9
Middle	8	12	10	10	9
Bottom	11	9	9	12	12

Total Nitrogen

Total nitrogen (TN) includes fractions of nitrate, ammonia, and organic components. Ideally, TN should remain below 200ppb, placing the ponds in the 'oligotrophic' category. In both North Riga and South Riga in 2021, TN remained below 200ppb at all three sampling depths (**Figure 6**, **Table 4**). However, TN in South Riga did spike slightly in June at the top and middle sampling depths. This could have been caused by watershed inputs.

Figure 6. Total nitrogen concentrations at North Riga and South Riga, 2018-2021.

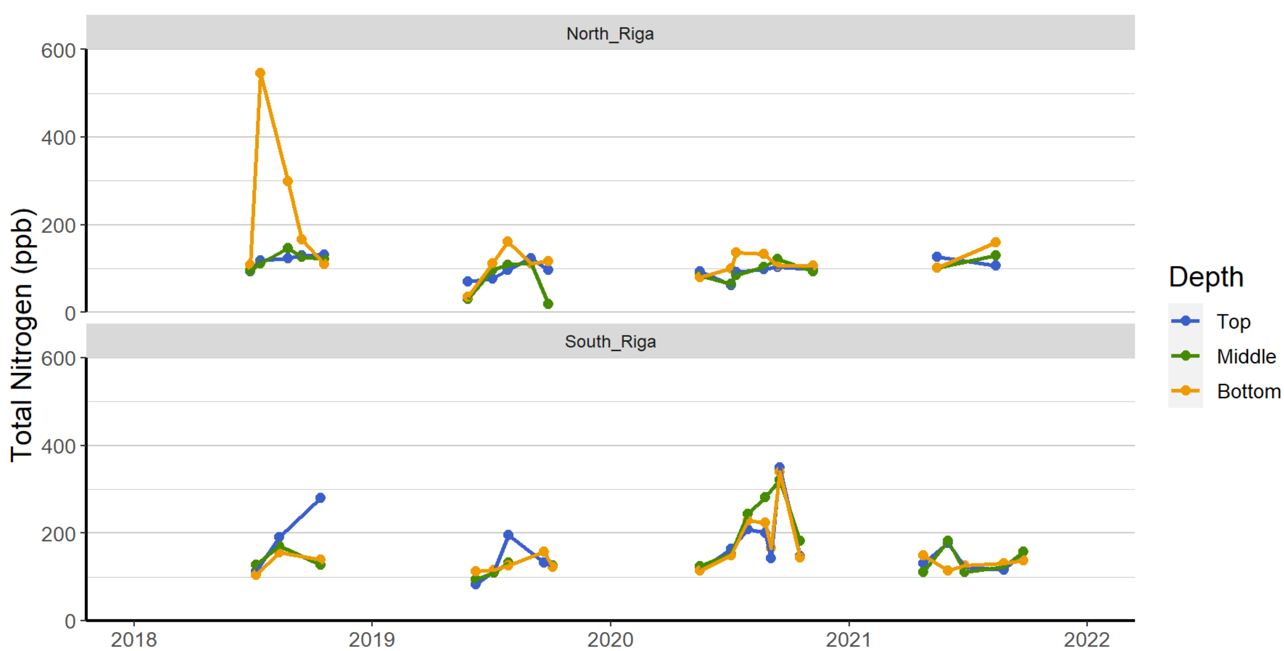


Table 4. Total nitrogen concentrations at the top, middle and bottom depths at North Riga and South Riga, 2021.

North Riga Total Nitrogen (ppb)		
	May 16	Aug 14
Top	126	107
Middle	102	130
Bottom	101	160

South Riga Total Nitrogen (ppb)					
	Apr 24	June 1	June 27	Aug 26	Sept 25
Top	131	178	122	116	158
Middle	111	182	111	122	158
Bottom	149	114	126	131	138

Aquatic Plants

Aquatic plant surveys of North Riga and South Riga were conducted on September 3rd, 2021. The surveys circumnavigated the entire littoral zone of each pond. Waypoints were created approximately every 150 feet. All aquatic plant species present at each waypoint were documented, along with an associated average density and growth form for each species.

North Riga contained eleven native plant species (**Table 5**), four of which were dominant – *Utricularia purpurea*, *Lobelia dortmanna, Eleocharis acicularis*, and *Sparganium fluctuans* (**Figure 7**). Dominant species are those with 20% or greater frequency.

South Riga contained fifteen native plant species, along with filamentous algae (**Figure 8**). Only two species, *Nitella sp.* and *Utricularia purpurea*, were dominant. Clouds of filamentous algae were present in four locations along the northern shoreline of South Riga (**Figure 9**). Filamentous algae often occurs in areas where nutrient concentrations are elevated, such as at the mouth of inlets that are carrying a high concentration of nutrients into the waterbody.

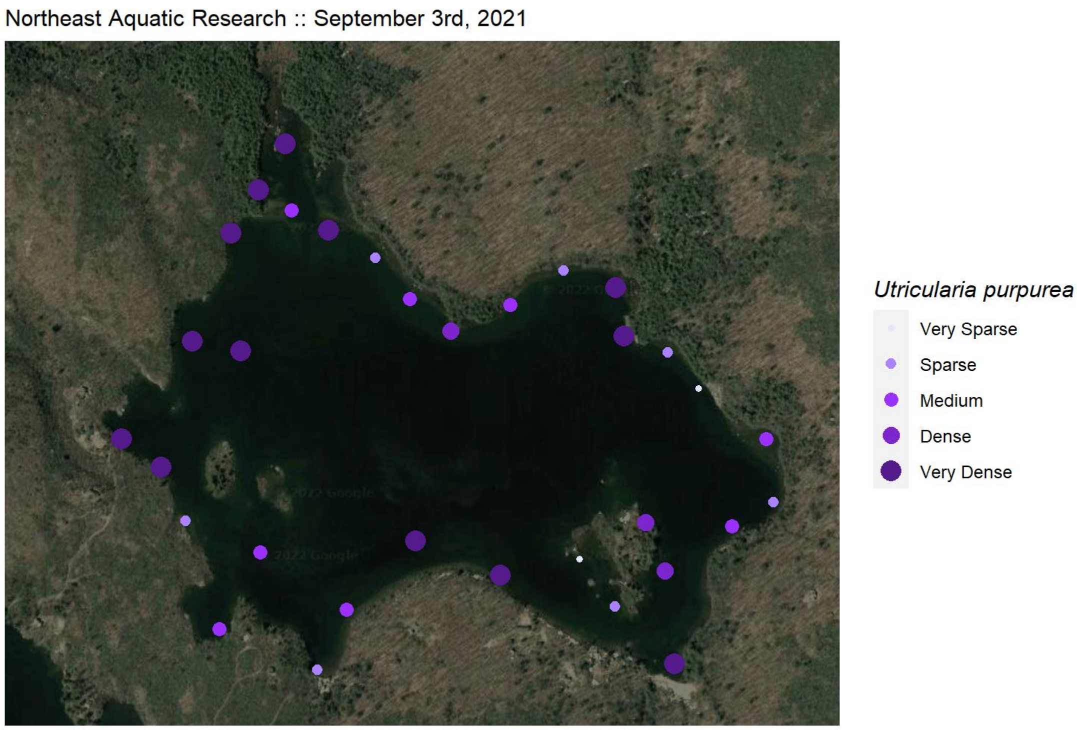
No invasive species were found in either of the ponds.

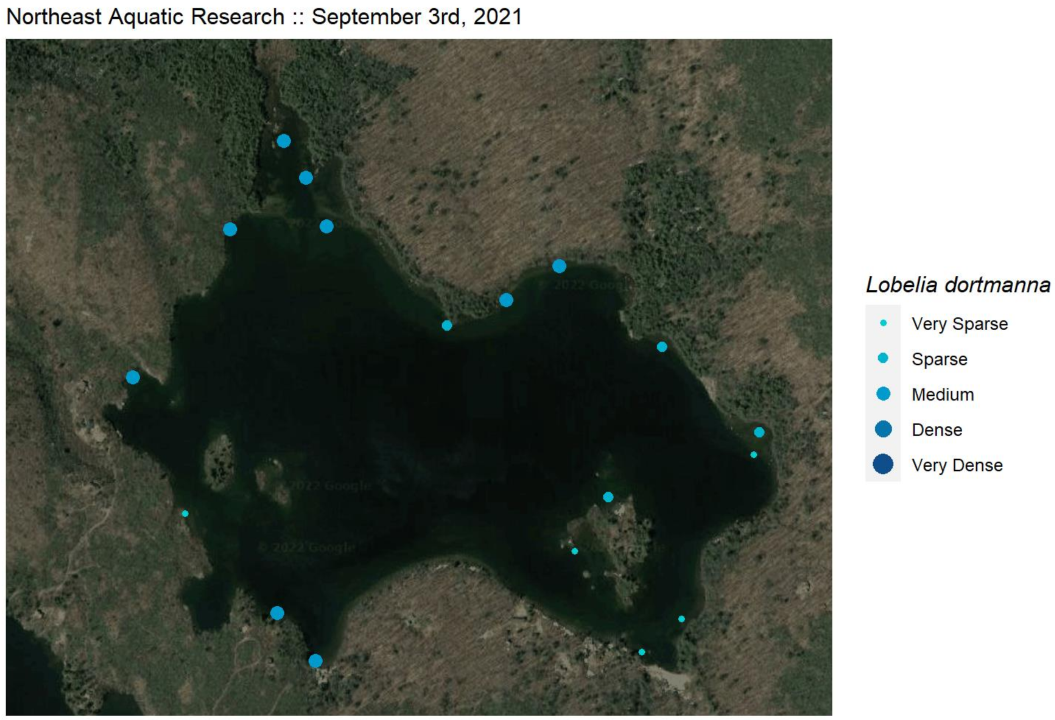
Table 5. Aquatic plants in North Riga and South Riga Ponds, September 3, 2021.

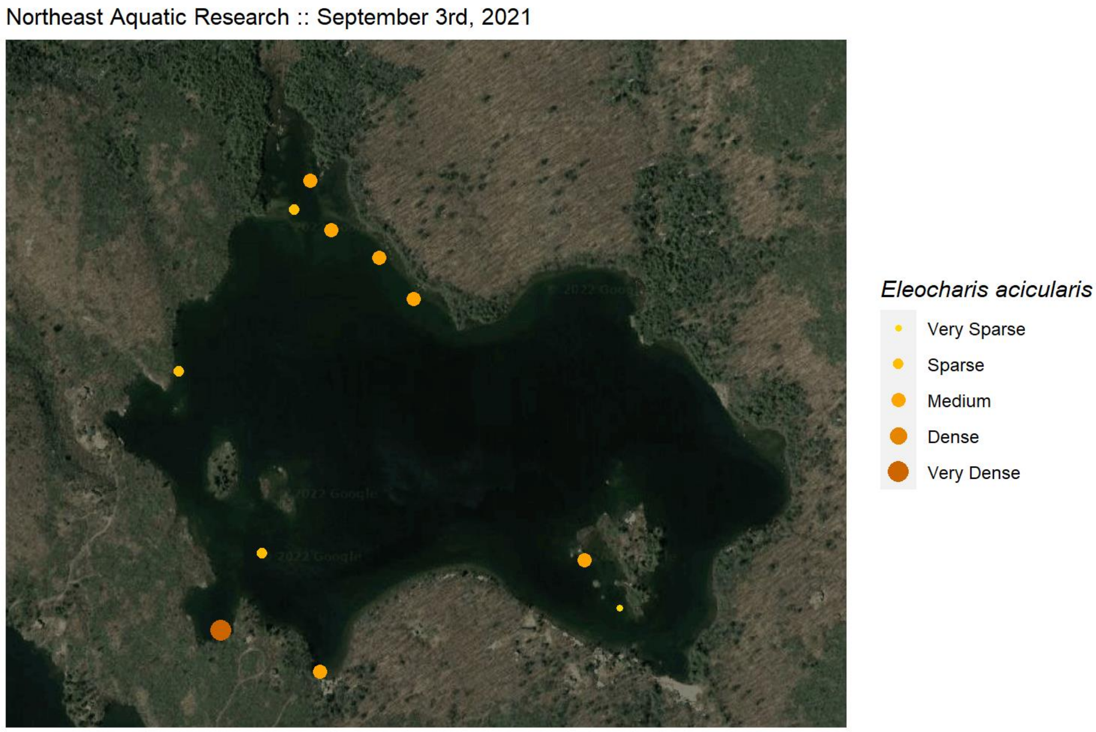
North Riga		
Species	**% Frequency**	**Avg. Density**
Utricularia purpurea	62	54
Lobelia dortmanna	33	20
Eleocharis acicularis	20	28
Sparganium fluctuans	20	36
Nuphar variegata	18	10
Nymphaea odorata	6	50
Eleocharis robbinsii	4	60
Fontinalis sp.	4	10
Eriocaulon aquaticum	2	70
Isoetes sp.	2	5
Myriophyllum humile	2	10

South Riga		
Species	**% Frequency**	**Avg. Density**
Nitella sp.	39	13
Utricularia purpurea	29	26
Emergent sparganium	18	19
Nuphar variegata	12	13
Eleocharis robbinsii	12	19
Eriocaulon aquaticum	10	16
Potamogeton confervoides	9	34
Sparganium fluctuans	5	22
Filamentous algae	4	7.5
Potamogeton bicupulatus	4	21
Potamogeton epihydrus	4	24
Nymphaea odorata	4	25
Potamogeton natans	4	55
Myriophyllum humile	3	5
Eleocharis acicularis	2	10
Lobelia dortmanna	2	10

Figure 7. Dominant aquatic plants in North Riga Pond, September 3, 2021.




Northeast Aquatic Research :: September 3rd, 2021
Lobelia dortmanna
Very Sparse
Sparse
Medium
Dense
Very Dense


Northeast Aquatic Research :: September 3rd, 2021
Eleocharis acicularis
Very Sparse
Sparse
Medium
Dense
Very Dense

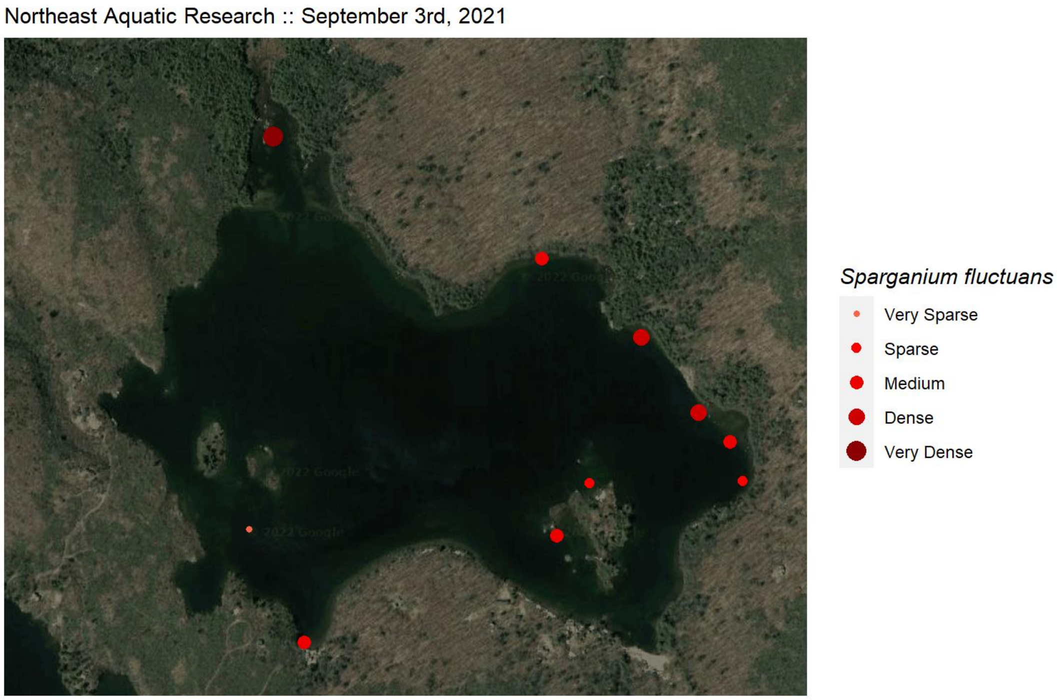
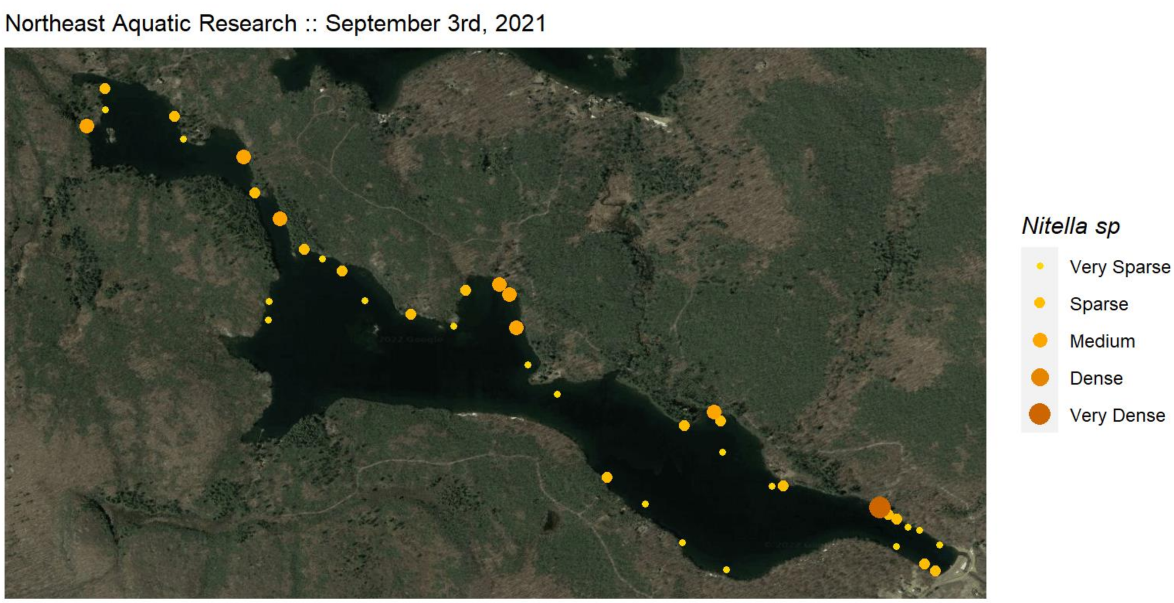


Figure 8. Dominant aquatic plants in South Riga Pond, September 3, 2021.



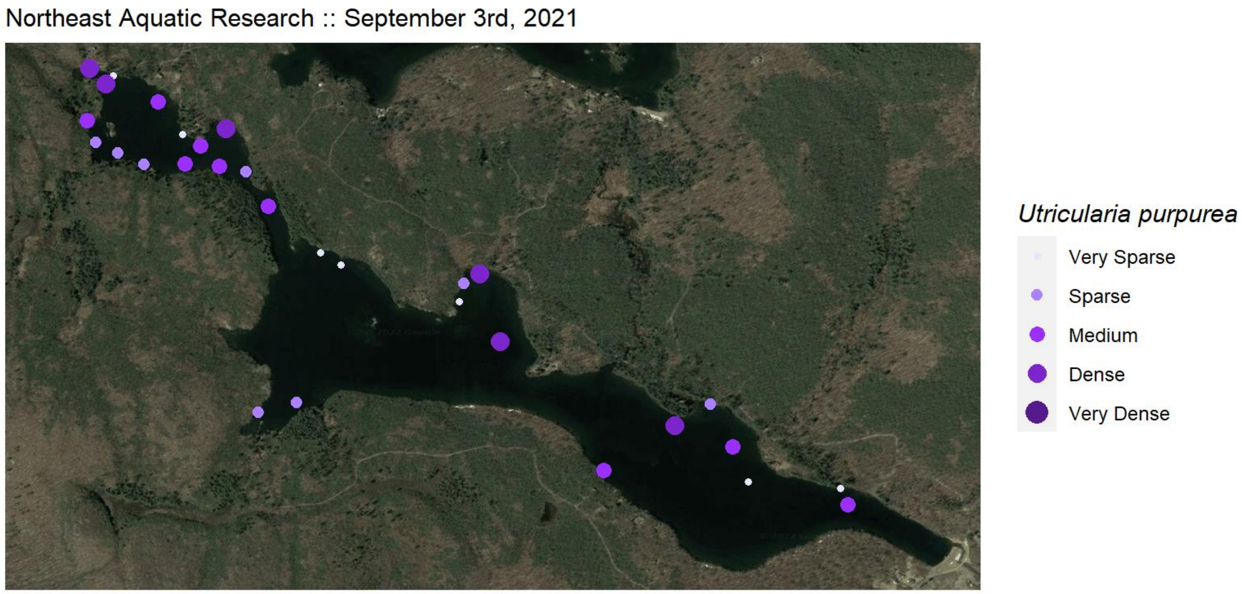


Figure 9. Locations of Filamentous Algae in South Riga Pond.

Suggested 2022 Actions

Both North Riga and South Riga are exhibiting declining water quality, with worsening clarity in both ponds, along with the presence of anoxic water in North Riga coupled with phosphorus release from bottom sediments. Though both ponds are still considered oligotrophic, or borderline oligotrophic, at this time, this categorization could change quickly. Once the water quality in a pond begins to show signs of decline, the quality often declines at an exponential rate without the appropriate management. This is why the signs of declining water quality in the Riga ponds are so concerning.

The following steps would aid in understanding the source of the declining water quality:

1. Conduct in-lake water quality monitoring from May through October in both ponds, to track the full extent of seasonal fluctuations, including peak extent of anoxic water, best and worst seasonal clarity, and peak nutrient concentrations. It is important to collect all sampling parameters (water clarity, profiles, and water samples) each month. We request that one person take charge of monitoring oversight, to ensure that monitoring is conducted monthly and on a regular schedule. Creating a monitoring schedule at the beginning of the summer, assigning volunteers to each date, and then assigning one person to confirm that the monitoring is completed on or close to the assigned date, will aid in gathering sufficient data for both ponds. Due to the declining water quality in both ponds, monthly data collection is vital. If volunteers cannot commit to monthly monitoring, then NEAR should take over the monitoring responsibilities.
2. Conduct an early-spring virtual training for all volunteer monitors, to refresh the volunteers regarding the monitoring guidelines and to teach new volunteers.
3. In addition to analysis of total phosphorus and total nitrogen in both ponds, the North Riga bottom water samples should be tested for ammonia to confirm whether this nutrient makes up the majority of the bottom water nitrogen in the pond. Nitrate nitrogen should be added to the 1-meter samples in South Riga to determine the cause of the fluctuations in surface water nitrogen.
4. Understanding the composition of phytoplankton in North Riga would provide valuable insight into the lake's water quality. Volunteer monitors could collect the phytoplankton samples during the monthly monitoring.
5. Mount Riga Lakes, Inc. should invest in a continuous data logger set-up in both lakes to better track the oxygen and temperature dynamics at the lake bottoms, between volunteer monitoring events. These systems can also be paired with a water level data logger to track water fluctuation throughout the season. Continuous water level data would provide a good understanding of the quantity of water reaching the

lakes after particular rainfall events, which translates to greater understanding of watershed nutrient dynamics.

6. Collect inlet samples from all flowing inlets once per month from May through October to assess watershed nutrient loading. The samples should be tested for total phosphorus, total nitrogen, and nitrate nitrogen. The shoreline areas where filamentous algae is located in **Figure 9** should be inspected for inlets and seeps.
7. Conduct late-summer full-lake aquatic plant surveys at the two ponds to document the presence and abundance of aquatic plant species in the lake and to search for invasive species.
8. The Riga Lakes residents should discuss watershed protection efforts, including limiting development, road maintenance to prevent erosion, onsite wastewater updates for local camps, and potential in-lake management efforts.
9. Any water pulled from the pond for drinking purposes should be filtered. Pond water can contain parasites and bacteria that are hazardous to humans. Parasites and bacteria can concentrate in one area (i.e., if there is a dead animal in the water) and so testing at one site may not pick up issues in another area of the pond. Many lake water filters are available for purchase online.