

North Twin PI Survey (July, 2019) Summary of Results

Summary Statistics	
Total number of sites shallower than maximum depth of plants	320
Total number of sites with vegetation	309
Frequency of occurrence at sites shallower than maximum depth of plants	96.56%
Simpson Diversity Index	0.88
Maximum depth of plants	17.70 ft
Mean depth of plants	7.73 ft
Average number of all species per site (shallower than max depth)	3.07
Average number of all species per site (veg. sites only)	3.17
Average number of native species per site (shallower than max depth)	3.06
Average number of native species per site (veg. sites only)	3.15
Species Richness	36
Species Richness (including visuals)	38

Table 1: Summary of plant survey data for North Twin Lake, 2019.

North Twin Lake has a diverse aquatic plant community with extensive coverage of plants around the lake. Nearly 97% of the littoral zone (defined by the depth of plants) has plants growing. The species richness was 36 sampled (38 with viewed species), with the Simpson's diversity index reasonably high at 0.88. The maximum depth of plants reflects good, consistent water clarity, with plants sampled as deep as 17.7 feet.

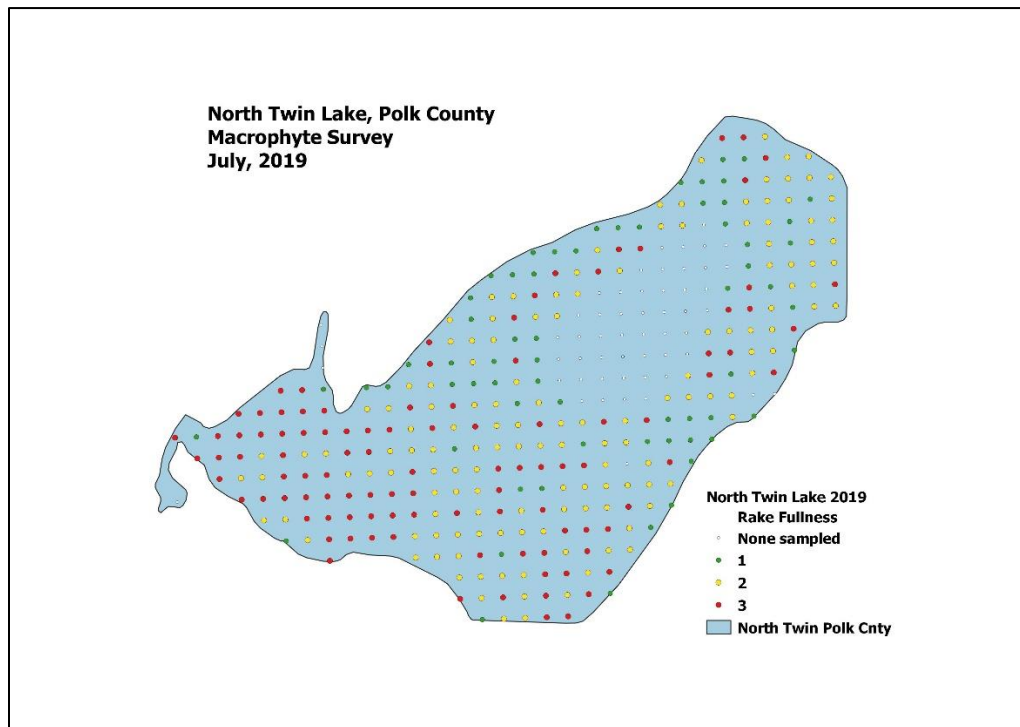


Figure 1: Rake fullness map showing where plants were sampled and the density of all plants on the rake.

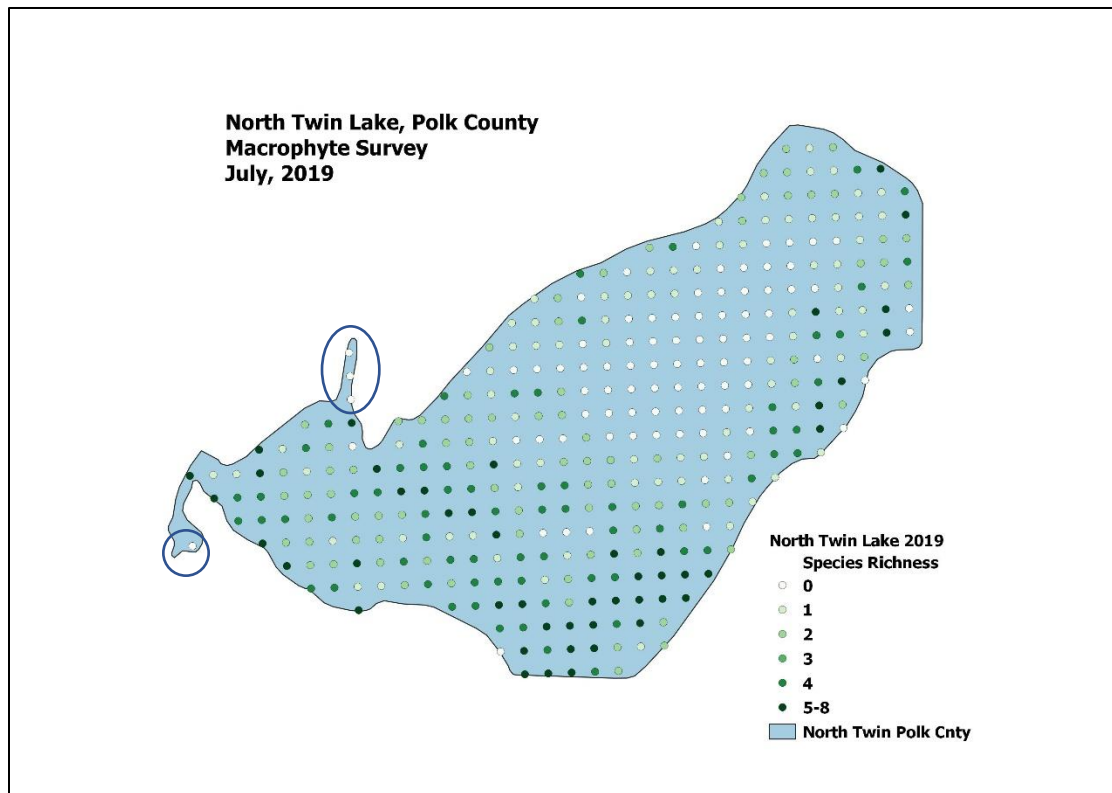


Figure 2: Species richness at each sample point. The circled areas are areas that could not be navigated but do have extensive plant growth.

The locations with the most species per point were the southern bay and the west bay near the narrows from Pike Lake. This area also has a high rake fullness (density) of plants sampled. Eight species were the highest number in any sample point. Many sample points had four or more species sampled.

Species	FOO Vegetated	FOO Littoral	Relative freq	# sampled	Mean rake fullness	# viewed
<i>Potamogeton robbinsii</i> , Fern pondweed	57.93	55.94	18.5	179	1.66	1
<i>Ceratophyllum demersum</i> , Coontail	55.02	53.13	17.6	176	1.28	
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	44.66	43.13	14.3	138	1.10	
<i>Myriophyllum sibiricum</i> , Northern water-milfoil	36.89	35.83	11.4	114	1.07	6
<i>Elodea canadensis</i> , Common waterweed	27.51	26.56	8.8	85	1.02	
<i>Potamogeton praelongus</i> , White-stem pondweed	16.50	15.90	5.3	51	1.16	4
<i>Potamogeton richardsonii</i> , Clasping-leaf pondweed	14.24	13.75	4.6	44	1.02	4
<i>Vallisneria americana</i> , Wild celery	8.74	8.46	2.8	27	1.00	
<i>Potamogeton pusillus</i> , Small pondweed	8.09	7.84	2.6	25	1.16	
<i>Bidens beckii</i> , Water marigold	7.12	6.9	2.3	22	1.00	1
<i>Chara sp.</i> , Muskgrasses	5.50	5.33	1.8	17	1.41	
<i>Potamogeton natans</i> , Floating-leaf pondweed	4.85	4.70	1.6	15	1.00	1
<i>Nymphaea odorata</i> , White water lily	3.88	3.76	1.2	12	1.00	3

Species	FOO Vegetated	FOO Littoral	Relative freq	# sampled	Mean rake fullness	# viewed
<i>Brasenia schreberi</i> , Watershield	3.56	3.45	1.1	11	1.18	2
<i>Nuphar variegata</i> , Spatterdock	2.27	2.19	0.7	7	1.00	2
<i>Potamogeton strictifolius</i> , Stiff pondweed	1.94	1.88	0.6	6	1.00	1
<i>Najas flexilis</i> , Slender naiad	1.62	1.57	0.5	5	1.00	1
<i>Ranunculus aquatilis</i> , White water crowfoot	1.62	1.57	0.5	5	1.00	1
<i>Myriophyllum spicatum</i>, Eurasian water milfoil	1.29	1.25	0.4	4	1.00	
<i>Potamogeton amplifolius</i> , Large-leaf pondweed	0.97	0.94	0.3	3	1.00	4
<i>Potamogeton gramineus</i> , Variable pondweed	0.97	0.94	0.3	3	1.00	1
<i>Sagittaria cristata</i> , Crested arrowhead	0.97	0.94	0.3	3	1.00	
<i>Elodea nuttallii</i> , Slender waterweed	0.65	0.63	0.2	2	1.00	
<i>Heteranthera dubia</i> , Water star-grass	0.65	0.63	0.2	2	1.00	2
<i>Myriophyllum alterniflorum</i> , Alternate-flowered water-milfoil	0.65	0.63	0.2	2	1.00	
<i>Pontederia cordata</i> , Pickerelweed	0.65	0.63	0.2	2	1.00	2
<i>Potamogeton foliosus</i> , Leafy pondweed	0.65	0.63	0.2	2	1.00	1
<i>Stuckenia pectinata</i> , Sago pondweed	0.65	0.63	0.2	2	1.00	
<i>Isoetes echinospora</i> , Spiny spored-quillwort	0.32	0.31	0.1	1	1.00	
<i>Lemna trisulca</i> , Forked duckweed	0.32	0.31	0.1	1	1.00	
<i>Nitella sp.</i> , Nitella	0.32	0.31	0.1	1	1.00	
<i>Potamogeton friesii</i> , Fries' pondweed	0.32	0.31	0.1	1	1.00	
<i>Sparganium natans</i> , Small bur-reed	0.32	0.31	0.1	1	1.00	
<i>Typha angustifolia</i>, Narrow-leaved cattail	0.32	0.31	0.1	1	1.00	
<i>Utricularia purpurea</i> , Large purple bladderwort	0.32	0.31	0.1	1	1.00	1
<i>Utricularia vulgaris</i> , Common bladderwort	0.32	0.31	0.1	1	1.00	
<i>Sparganium eurycarpum</i> , Common bur-reed	viewed	only				1
<i>Typha latifolia</i> , Broad-leaf cattail	viewed	only				1

Table 2: Species richness list and frequency data for North Twin Lake, 2019. Red species are invasive species.

The most common species distributed in North Twin Lake was fern pondweed (*Potamogeton robbinsii*), with a relative frequency of 18.5%. Fern pondweed has a mean conservatism value of “8”, which is quite sensitive. The most dominant plant's high conservatism indicates a healthy plant community. The relative frequencies indicate that no one plant dominates the plant community, as less than 1 in 5 plants sampled were the dominant species. Fern pondweed was followed by coontail (*Ceratophyllum demersum*) and flat-stem pondweed (*Potamogeton zosteriformis*) as most common plants sampled in 2019.

Sensitive species/FQI

No endangered, threatened, or species of special concern were sampled or viewed. Three species are considered sensitive based on their conservatism value, which is 9 or 10.

Sensitive species (high conservatism)	Number sampled	Conservatism value
<i>Myriophyllum alterniflorum</i> - alternate flowered milfoil	2	10
<i>Sparganium natans</i> -small bur-reed	1	9
<i>Utricularia purpurea</i> -large purple bladderwort	1	9

Table 3: List of sensitive plants sampled in North Twin Lake, 2019.

The FQI for North Twin Lake was much higher than the eco-region median. Both the higher number of species and the mean conservatism value contributed to this higher FQI.

Parameter	North Twin Lake 2019	Eco-region median
Number of species (used in FQI)	34	14
Mean Conservatism	6.5	5.6
FQI	37.9	20.9

Table 4: FQI values for North Twin Lake, 2019.

Invasive Species

Two non-native, invasive species were sampled in North Twin Lake in 2019: *Myriophyllum spicatum* (Eurasian watermilfoil) and *Typha angustifolia* (narrow-leaved cattail). Eurasian watermilfoil (EWM) was first discovered in 2019 and treated with herbicide before this survey was conducted.

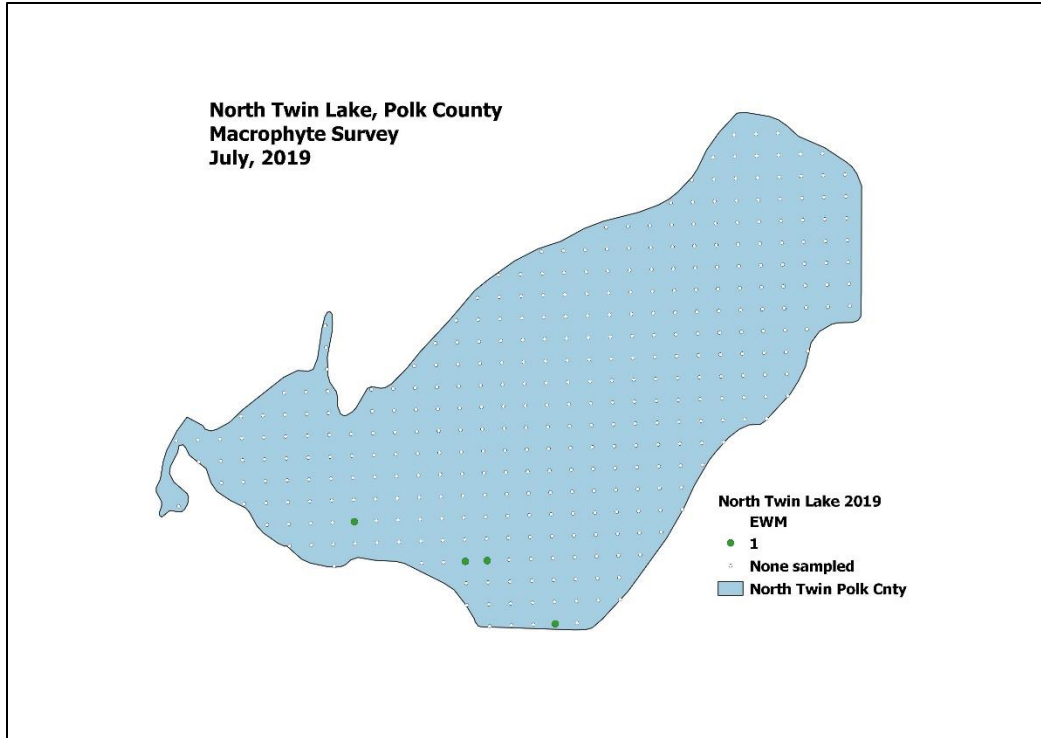


Figure 3: Map of Eurasian watermilfoil (EWM), North Twin Lake 2019. This map was created after an herbicide treatment occurred in the area where EWM is distributed in this map.

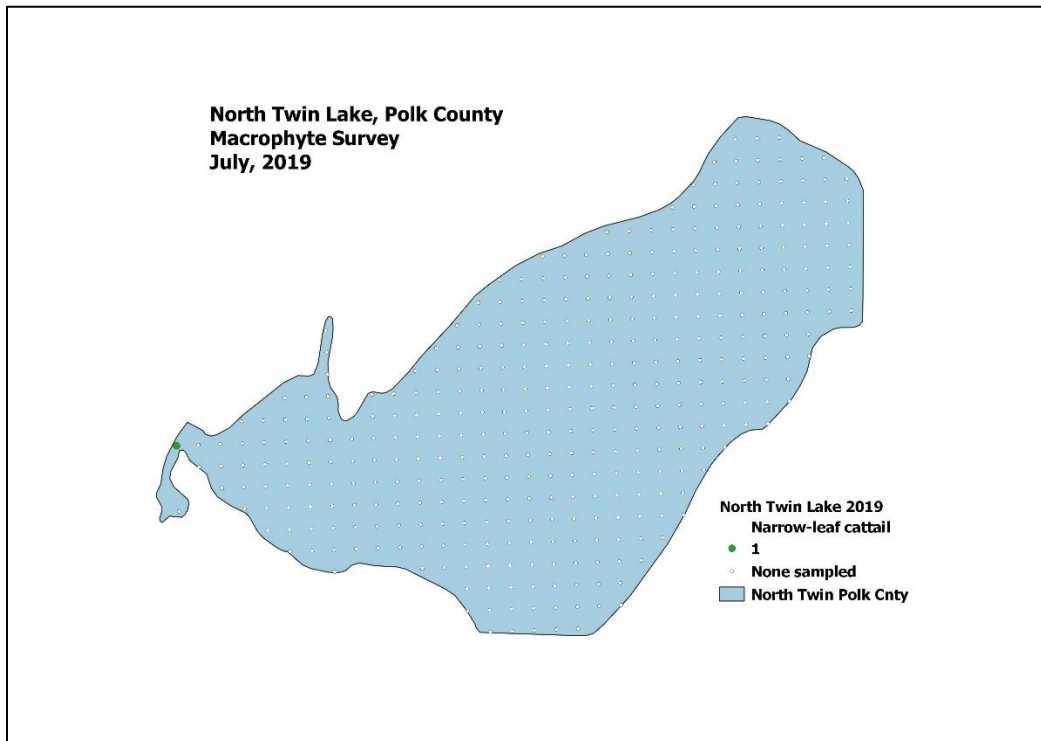


Figure 4: Map showing the sampled location of narrow-leaved cattail in North Twin Lake, 2019.

Curly-leaf pondweed (CLP)(*Potamogeton crispus*) exists in North Twin Lake. It was sampled in the 2012 survey, which included an early season survey when CLP is growing (it dies in July). The 2019 survey did not include an early season survey, and no CLP was sampled in July or August. This does not indicate that CLP is no longer in North Twin Lake. Each spring, Amery High School surveys CLP, and there have been no beds to delineate; only small clumps of plants have been observed since 2012.

Comparison to the 2012 survey

An aquatic macrophyte survey was conducted in 2012, allowing for a comparison of the 2019 and 2012 results. Small changes occurred within the plant community over the seven years. First, there were 21 fewer sample points with plants present from 2012 to 2019. This decrease is not likely due to the herbicide application in 2019 because no reduction in native plants was observed in the pre-and post-herbicide treatment survey within the bed treated. The maximum depth of plants changed little, with a decrease of 0.8 feet from 2012 to 2019.

North Twin Lake Survey Parameter	2012	2019
Number of points with plants sampled	321	309
% of the defined littoral zone with plants	97.5	96.56
Maximum depth plants sampled	18.5	17.7
Species richness	29	36
Simpson’s Diversity Index	0.87	0.88
FQI	31.9	37.9

Table 5: Comparison of some important parameters from 2012 and 2019 surveys.

2019 showed greater diversity, with seven more species sampled, and the Simpson’s diversity index was slightly larger. The FQI also was higher in 2019. Since 2019 was the only year plant management occurred in North Twin Lake, the negative changes are likely natural or sample variation. The positive changes indicate that the plant community is healthy and not degrading.

Each plant species sampled in 2012 and 2019 is compared using a chi-square analysis to determine whether changes (increases or decreases) are statistically significant. Six native species and one invasive species increased statistically significantly from 2012 to 2019. Since 2019 was the first year EWM was discovered, it is logical that there was an increase.

Species with Statistically Significant Increase	P value	Significance
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	0.01	**
<i>Potamogeton pusillus</i> , Small pondweed	0.01	**
<i>Bidens beckii</i> , Water marigold	0.0002	***
<i>Chara sp.</i> , Muskgrasses	0.01	*
<i>Potamogeton natans</i> , Floating-leaf pondweed	0.02	*
<i>Potamogeton strictifolius</i> , Stiff pondweed	0.01	*
<i>Myriophyllum spicatum</i> , Eurasian water milfoil	0.04	*

Table 6: The species list with a statistically significant increase from 2012 to 2019. The more * indicates a greater significance of the change.

Three native species decreased statistically significantly compared to one non-native, invasive species. The most significant native decrease was in coontail, which is highly prevalent in North Twin Lake. This may be due to natural or sample variations. It is possible that herbicide use could have reduced this plant frequency as well but one would expect northern milfoil to have been affected as well.

Species with Statistically Significant Decrease	P value	Significance
<i>Ceratophyllum demersum</i> , Coontail	0.006	**
<i>Potamogeton amplifolius</i> , Large-leaf pondweed	0.04	*
<i>Lemna trisulca</i> , Forked duckweed	0.04	*

Table 7: The species list with a statistically significant decrease from 2012 to 2019. The more * indicates a greater significance of the change.

The changes in the plant community were subtle and did not indicate any concerns. The statistical increases were more profound than the decreases. Furthermore, the significant decreases occurred with (two of the three species that decreased) species with low relative frequency.