Macrophyte Survey

Shell Lake
Washburn County Wisconsin
WBIC: 2496300

August 2006

Updated January, 2007

Sponsored by:
City of Shell Lake

Prepared by:
Harmony Environmental
Amery, Wisconsin

Table of Contents

Tables

Figures

Appendices

Introduction

This report presents a summary and analysis of data collected in a baseline aquatic plant survey completed in August of 2006 on Shell Lake, Washburn County Wisconsin. The survey was conducted in early August of 2006. All data presented here is available in spreadsheet format upon request and will be forwarded to the Wisconsin Department of Natural Resources. The primary goals of the project are to establish a baseline for long-term monitoring of aquatic plant populations and to document and map the locations of non-native invasive aquatic plant species such as *Potamogeton crispus* (curly leaf pondweed) and *Myriophyllum spicatum* (Eurasian water milfoil).

Shell Lake (WBIC: 2496300) is a 2580-acre lake in Washburn County, Wisconsin in the City of Shell Lake, Town of Beaver Brook (T38N R12W S31). Shell Lake is a seepage lake, but has added a diversion or reducing lake levels. The City of Shell Lake sponsored this aquatic plant survey.

Field methods

A point intercept method was employed for macrophyte sampling. The Wisconsin Department of Natural Resources (Wisconsin DNR) generated the sampling point grid of 1585 points. The littoral zone was initially defined as any depth less than 25 feet, leading to approximately 516 points to sample. A handheld Global Positioning System (GPS) located the sampling points in the field.

At each sample location, a double-sided rake was used to rake a 1m tow off the bow of the boat. All plants contained on the rake and those that fell off of rake when removing from lake were identified and rated as to rake fullness. The rake fullness value were used based on the criteria as follows:

Rake fullness rating	Criteria for rake fullness rating
1	Plant present, occupies less than ½ of tine space
2	Plant present, occupies more than ½ tine space
3	Plant present, occupies all or more than tine space
v	Plant not sampled but observed within 6 feet of boat

The depth and predominant bottom type was also recorded for each sample point. All plants needing verification were bagged and cooled for later examination. Two plants from each species were also collected for creation of a voucher or herbarium collection.

Data analysis methods

Data collected was entered into a spreadsheet for analysis. The following statistics were generated from the spreadsheet:

- Frequency of occurrence for all sample points in lake
- Frequency of occurrence in littoral zone sample points
- Relative frequency
- Total sample points
- Sample points with vegetation
- Simpson's diversity index
- Maximum plant depth
- Species richness
- Floristic Quality Index

The following are explanations of the various analysis values:

Frequency of occurrence for each species- Frequency is expressed as a percentage and there are two values for this. The first is the percentage of all littoral sample points that this plant was sampled. The second is the percentage of vegetated sample points that the plant was sampled. The first value shows how often the plant would be encountered in the defined littoral zone of the lake, while the second value shows if only within points plants are sampled. In either case, the greater this value, the more frequent the plant is in the lake. If one wants to compare to the whole lake, we look at the frequency of all points and if one wants to focus only where plants are more probable, then one would look at frequency at depths less than maximum at which plants were found.

Frequency of occurrence example:

Plant A sampled at 35 of 150 total points = 35/150 = 0.23 = 23%

Plant A's frequency of occurrence (littoral zone) = 23% considering whole littoral sample.

Plant A sampled at 12 of 40 vegetated points = 12/40 = 0.3 = 30%

Plant A's frequency of occurrence = 30%

These two frequencies can tell us how common the plant was sampled in the littoral zone or how common the plant was sampled at points with vegetation. Generally the second (vegetated areas) will have a higher frequency since that is where plants grow. We need the first value to determine degree of coverage by plants in the depths plants may be found.

Relative frequency-This value shows, as a percentage, the frequency of a particular plant relative to other plants. This is not dependent on the number of points sampled. The relative frequency of all plants will add to 100%. This means that if plant A had a relative frequency of 30%, it occurred 30% of the time compared to all plants sampled or makes up 30% of all plants sampled. This value allows us to see which of the plants are the dominant species in the lake. The higher the relative frequency the more common the plant is compared to the other plants.

Relative frequency example:

Suppose we were sampling 10 points in a very small lake and got the following results:

	Frequency sampled
Plant A present at 3 sites	3 of 10 sites
Plant B present at 5 sites	5 of 10 sites
Plant C present at 2 sites	2 of 10 sites
Plant D present at 6 sites	6 of 10 sites

So one can see that Plant D is the most frequent sampled at all points with 60% (6/10) of the sites having plant D. However, the relative frequency allows us to see what the frequency is compared the other plants, without taking into account the number of sites. It is calculated by dividing the number of times a plant is sampled by the total of all plants sampled. If we add all frequencies (3+5+2+6), we get a sum of 16. We can calculate the relative frequency by dividing by the individual frequency.

Plant A = 3/16 = 0.1875 or 18.75%
Plant B = 5/16 = 0.3125 or 31.25%
Plant C = 2/16 = 0.125 or 12.5%
Plant D = 6/16 = 0.375 or 37.5%

Now we can compare the plants to one another. Plant D is still the most frequent, but the relative frequency tells us that of all plants sampled at those 10 sites, 37.5% of them are Plant D. This is much lower than the frequency of occurrence (60%) because although we sampled Plant D at 6 of 10 sites, we were sampling many other plants too, thereby giving a lower frequency when compared to those other plants. This then gives a true measure of the dominant plants present.

Total sample points-This is the total number of points created for sampling on the lake. This may not be the same as the actual points sampled. When doing a survey, we don't sample at depths outside of the littoral zone (the area where plants can grow). Once the maximum depth of plants is established, many of the points deeper than this are eliminated to save time and effort.

Sample sites with vegetation- The number of sites where plants were actually sampled. This gives a good idea of the plant coverage of the lake. If 10% of all sample points had vegetation, it implies about a 10% coverage of plants in the whole lake, assuming an adequate number of sample points have been established. We also look at the number of sample sites with vegetation in the littoral zone. If 10% of the littoral zone had sample points with vegetation, then the plant coverage in the littoral zone would be estimated at 10%.

Simpson's diversity index-To measure how diverse the plant community is, Simpson's index is calculated. This value can run from 0 to 1.0. The greater the value, the more diverse the plant community is in a particular lake. In theory, the value is the chance that two species sampled are different. An index of "1" means that the two will always be different (very diverse) and a "0" would indicate that they will never be different (only one species found). The more diverse the plant community, the better the lake ecosystem.

> Simpson's diversity example:
>
> If one went into a lake and found just one plant, the Simpson's diversity would be "0." This is because if we went and sampled randomly two plants, there would be a 0% chance of them being different, since there is only one plant.
>
> If every plant sampled were different, then the Simpson's diversity would be "1." This is because if two plants were sampled randomly, there would be a 100% chance they would be different since every plant is different.
>
> These are extreme and theoretical scenarios, but they do make the point. The greater the Simpson's index is for a lake, the greater the diversity since it represents a greater chance of two randomly sampled plants being different.

Maximum depth of plants-This depth indicates the deepest that plants were sampled. Generally more clear lakes have a greater depth of plants while lower water clarity limits light penetration and reduces the depth at which plants are found.

Species richness-The number of different individual species found in the lake. There is a number for the species richness of plants sampled, and another number that takes into account plants viewed but not actually sampled during the survey.

Floristic Quality Index-The Floristic Quality Index (FQI) is an index developed by Dr. Stanley Nichols of the University of Wisconsin Extension. This index is a measure of the plant community in response to development (and human influence) on the lake. It takes into account the species of aquatic plants found and their tolerance for changing water quality and habitat quality. The index uses a conservatism value assigned to various plants ranging from 1 to 10. A high conservatism value indicates that a plant is intolerant while a lower value indicates tolerance. Those plants with higher values are more apt to respond adversely to water quality and habitat changes, largely due to human influence. The FQI (I) is calculated using the number of species (N) and the average conservatism value (C) of all species used in the index ($I=C\sqrt{N}$). Therefore, a higher FQI, indicates a healthier lake plant community. This value can then be compared to the median for other lakes in the assigned eco-region. There are four eco-regions used throughout Wisconsin. These are Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. Shell Lake is in the Northern Lakes and Forest eco-region.

Summary of Northern Lakes and Forest Mean Values for Floristic Quality Index:

Median species richness = 13; lower quartile 7; upper quartile 20

Median average conservatism = 6.7; lower quartile 6.1; upper quartile 7.7

Median Floristic Quality = 24.3*; lower quartile 17.8; upper quartile 30.2

*Floristic Quality has a significant correlation with area of lake (+), alkalinity(-), conductivity(-), pH(-) and Secchi depth (+). In a positive correlation, as that value rises so will FQI, while with a negative correlation, as a value rises, the FQI will decrease and vice versa.

Results

Table 1: Species richness

Species	Common name	Relative Freq	Freq in littoral	Freq occur.
Elodea nuttallii	Slender waterweed	23.7%	28.01%	51.14%
Nitella sp	Nitella or stonewort	18.8%	22.2%	15.15%
Ranunculus aquatilis	Stiff water crowfoot	9.3%	11.00%	20.08%
Filamentous algae	Filamentous algae	7.1%	8.37%	15.15%
Najas flexilis	Bushy pondweed	7.1%	8.37%	15.15%
Vallisneria americana	Wild celery	6.9%	8.16%	14.77%
Potamogeton richarsonii	Clasping leaf pondweed	6.4%	7.53%	13.64%
Potamogeton pusillus	Small pondweed	4.1%	4.81%	8.71%
*Ceratophyllum echinatum**	Spiny hornwort	3.9%	4.60%	8.33%
Isoetes sp.	Quillwort	2.8%	3.35%	6.06%
Potamogeton amplifolius	Large leaf pondweed	2.6%	3.14%	5.68%
Chara sp.	Muskgrass	2.3%	2.72%	4.92%
Potamogeton robbinsii	Fern pondweed	1.4%	1.67%	3.03%
Ranunculus flabellaris	Yellow buttercup	1.04%	1.24%	2.27%
Elatine minima	Waterwort	0.7%	0.84%	1.52%
Myriophyllum tenellum	Dwarf water milfoil	0.7%	0.84%	1.52%
Eriocaulon aquaticum	Pipewort	0.35%	0.42%	0.76%
Polygonum amphibium	Water smartweed	0.18%	0.21%	0.38%
Potamogeton foliosus	Leafy pondweed	0.18%	0.21%	0.38%
Ranunculus flammula	Creeping spearwort	0.18%	0.21%	0.38%
Sagittaria rigidia	Stiff-leaved arrowhead	0.18%	0.21%	0.38%
Lythrum salicaria	Purple loosestrife	visual only		
Nuphar variegata	Spatterdock	visual only		
Nymphaea odorata	White water lily	visual only		

Sagittaria latifolia	Common arrowhead	visual only
Sagittaria graminea	Grass-leaved arrowhead	visual only
Schoenoplectus acutus	Hardstem bulrush	visual only
Schoenoplectus tabernaemontani	Softstem bulrush	visual only
Typha latifolia	Broad-leaved cattail	visual only
Zosterella dubia	Water stargrass	visual only

*Species of special concern in Wisconsin

Floristic Quality Index:

Shell Lake contained in the Northern Lakes and Forests-Lakes Ecoregion (NLFL)

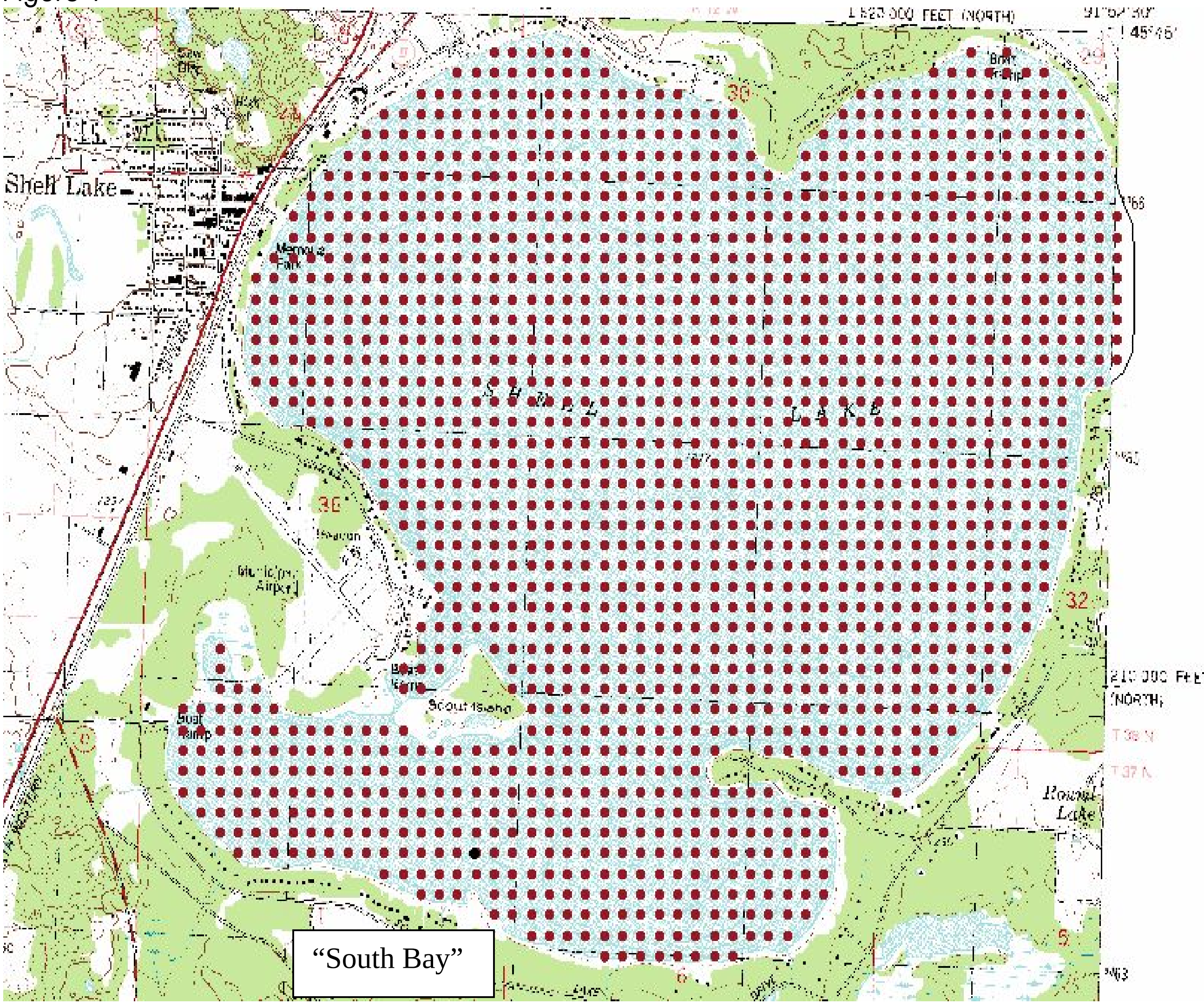
Table 2:Floristic Quality Index

Index category	Shell Lake	Median for NLFL
Number of species used	27	13
Avg conservatism	7	6.7
Floristic Quality Index	36.2	24.3

Table 3: Miscellaneous Data

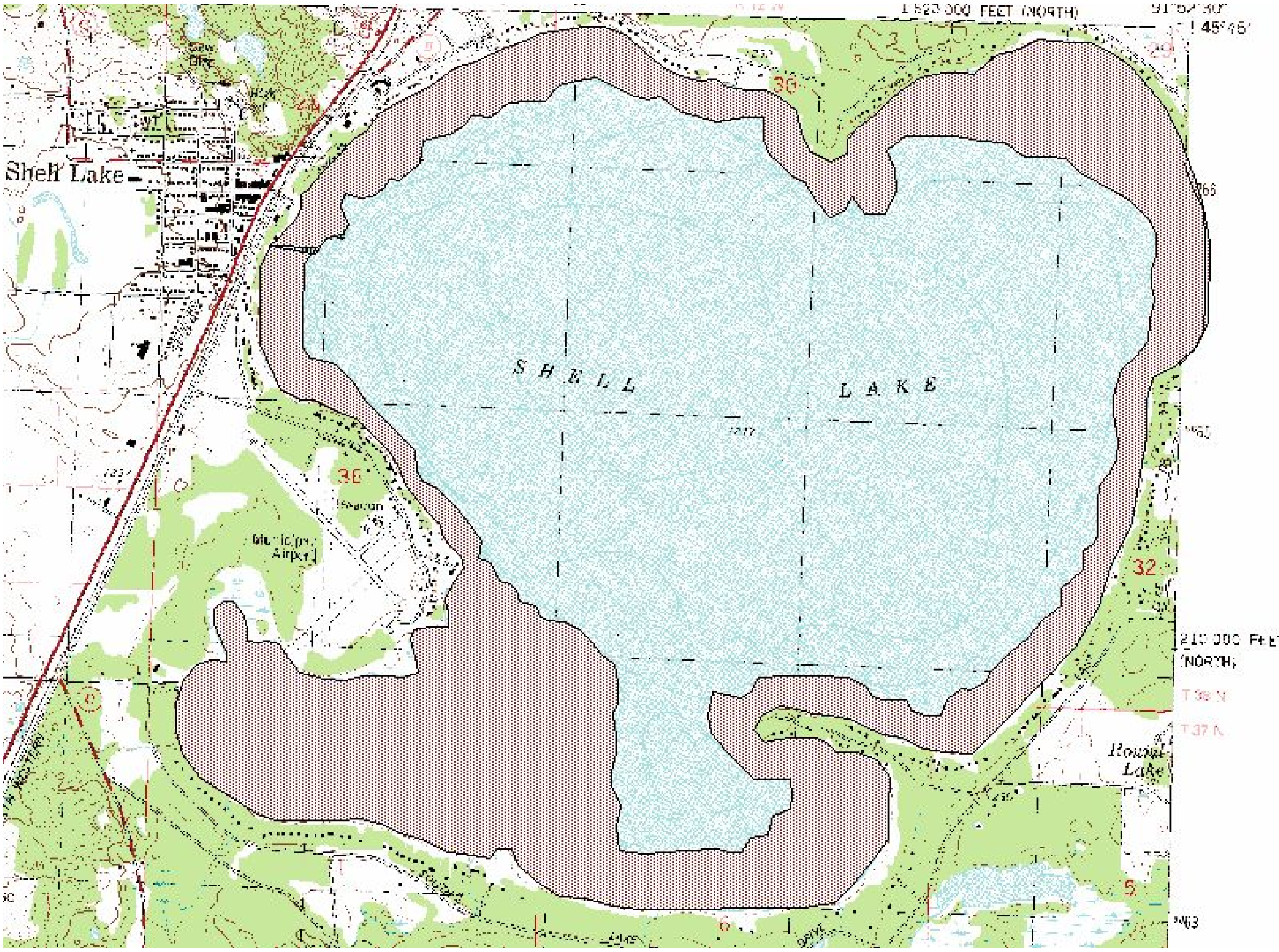
Description	Value
Number of points sampled in littoral zone	493
Number of points with vegetation	264
Percentage of littoral zone with plants	53.50%
Percentage of entire lake with plants	16.70%
Greatest depth plants sampled	25.3
Average number of species per site in littoral	1.17
Average number of species per site when vegetated	2.13
Simpson's diversity index	0.87

Figure 1



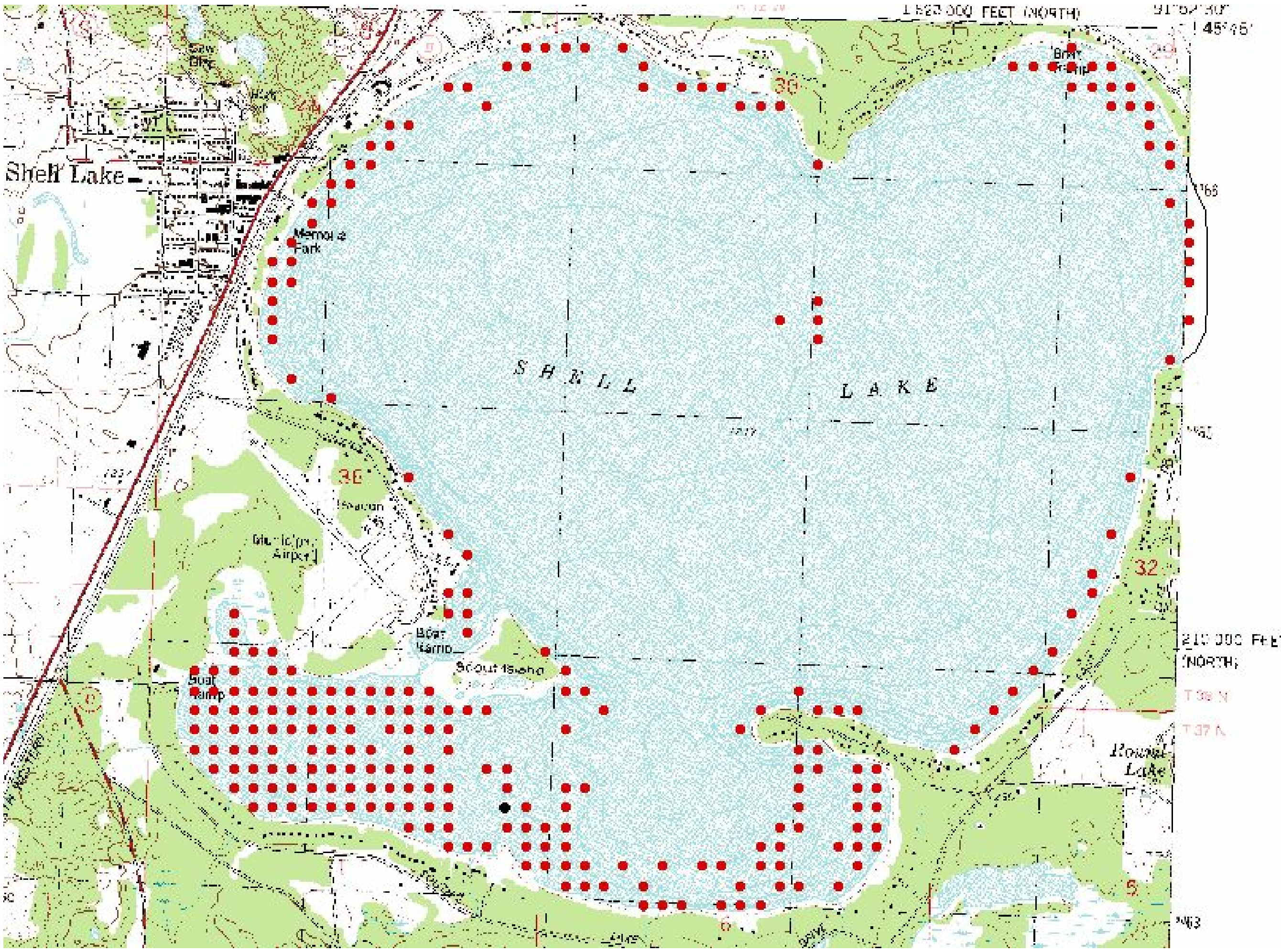
Above is the sample grid that was established by the Wisconsin DNR for Shell Lake. Note the label for "South Bay" that will be referred occasionally.

Figure 2



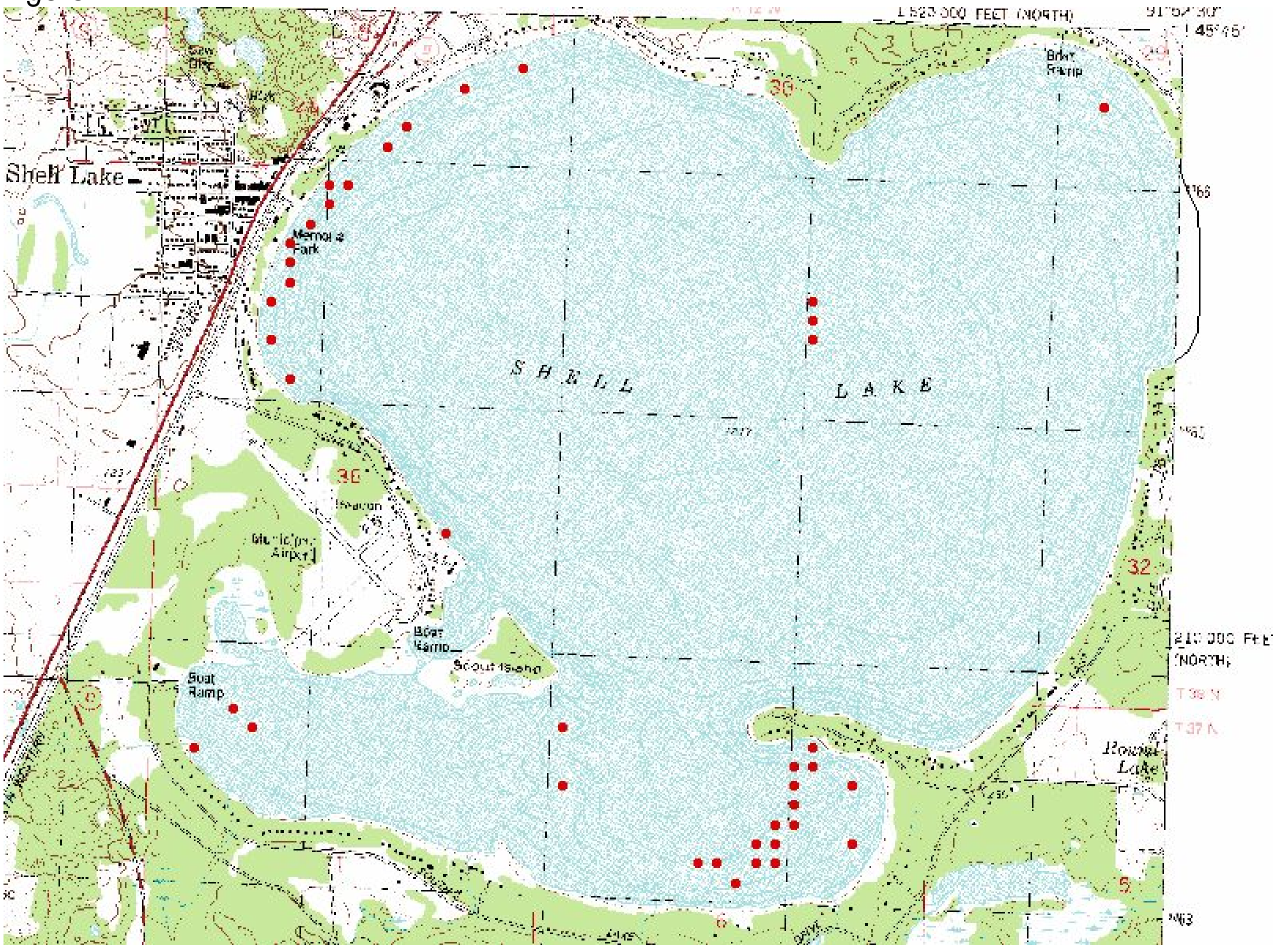
This is the area with points that fell within the depth of plants, thereby defining the potential littoral zone. All points in this area were sampled for plants. More points were sampled but if they exceeded 27 feet, they were not generally sampled and therefore not necessarily mapped.

Figure 3



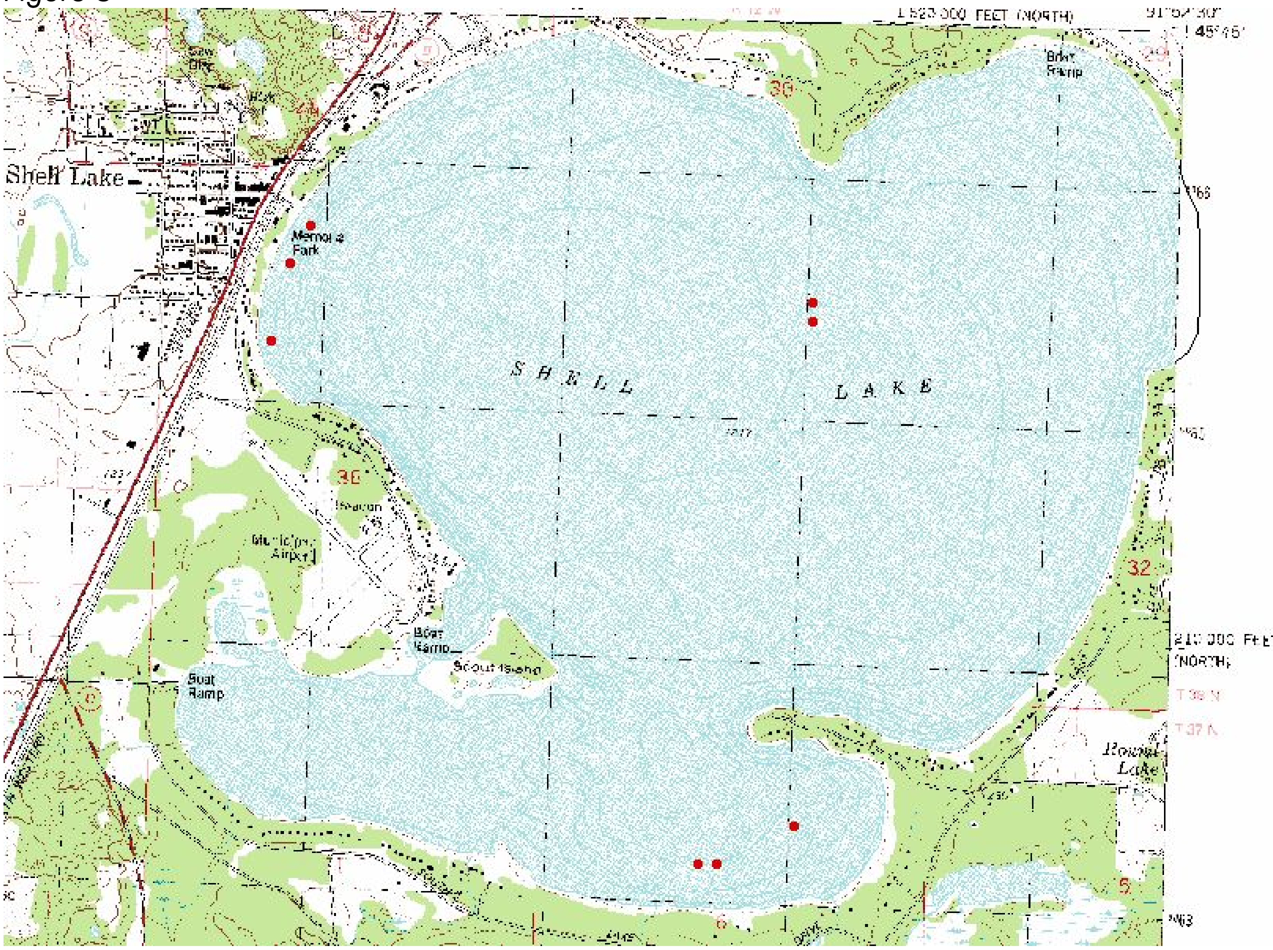
These points are where plants were actually sampled within the littoral zone. As one can see, most plants are limited to a very narrow band in the littoral zone around the lake and the "south bay" region of the lake.

Figure 4



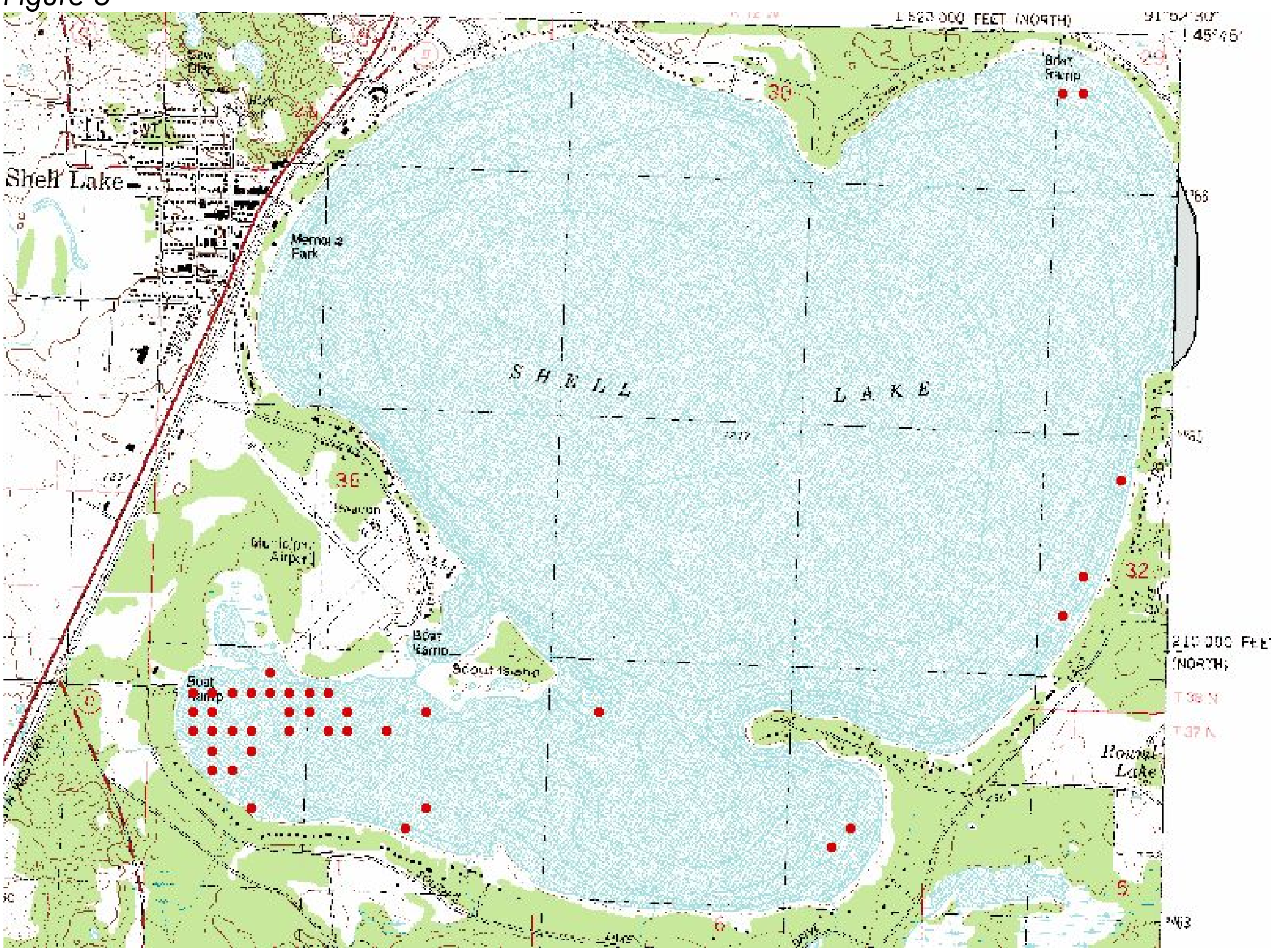
This maps shows all of the sample point filamentous algae was sampled. It is a limited number and is of no concern.

Figure 5



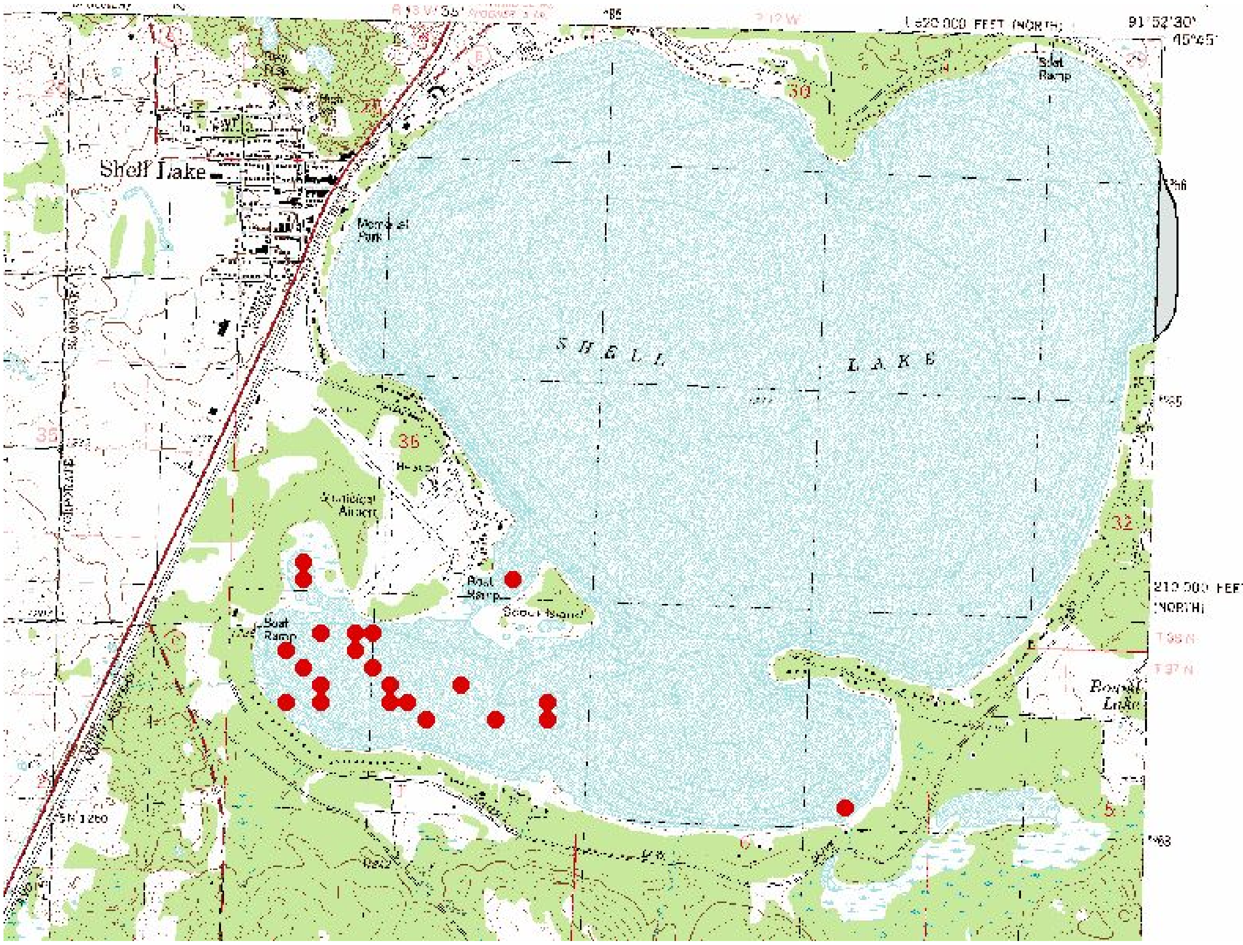
These areas show the presence of filamentous algae at density ratings of 2 or 3. Filamentous algae can become a problem in a lake but the few points shown here demonstrate that this is not the case in Shell Lake. This growth should continue to be monitored as it can indicate increasing nutrient levels in the lake.

Figure 6



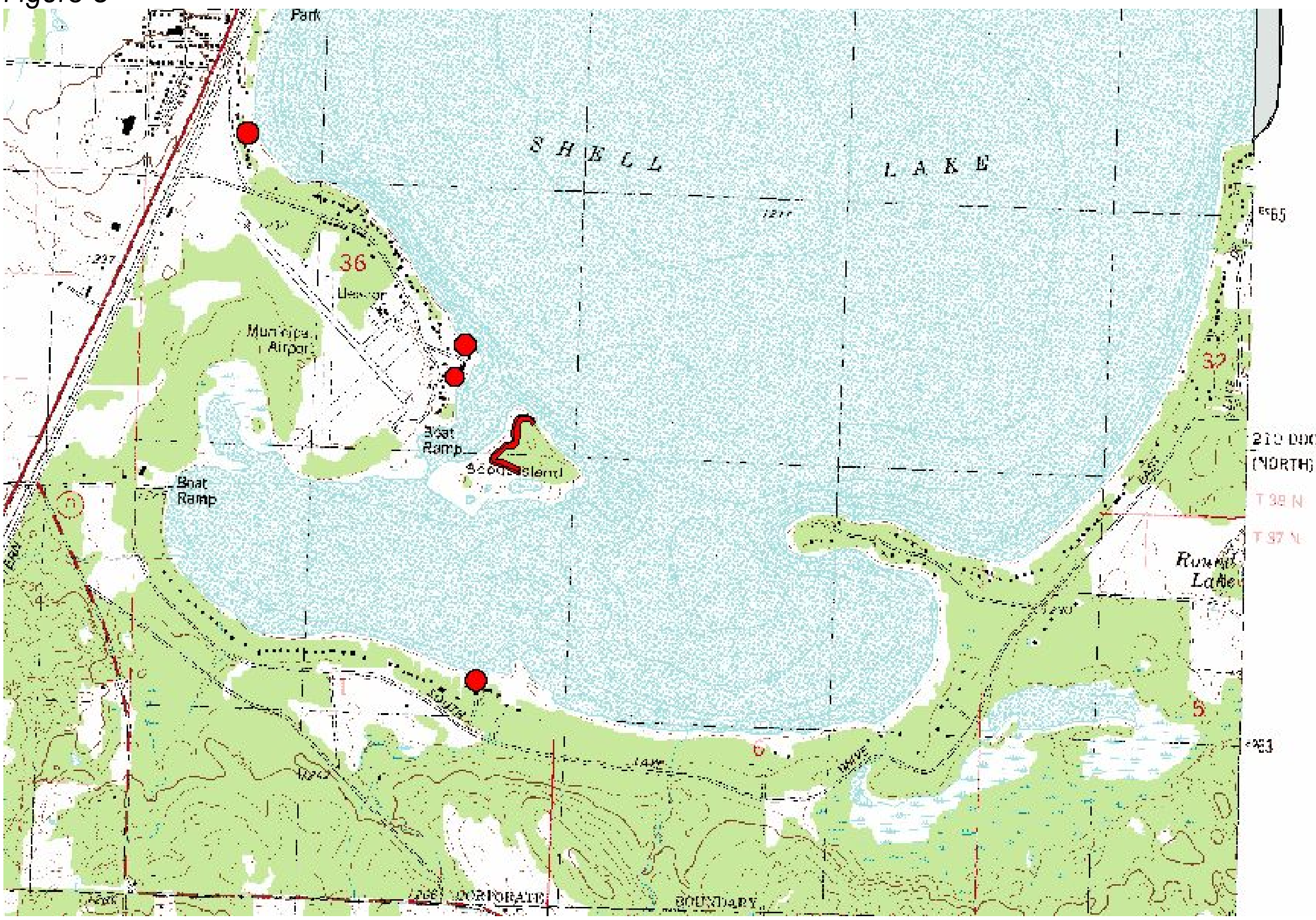
The most frequent plant sampled was *Elodea nuttallii* (Slender waterweed). This map shows where it was sampled. Most of the growth is limited to the western most portion of the "south bay" region. Its growth was not viewed as "nuisance" levels at any point.

Figure 7



This map shows the location of *Ceratophyllum echinatum* (Spiny hornwort). The species of plant is listed as one of special concern in Wisconsin. This indicates that this plant is limited in locations throughout Wisconsin and is intolerant of habitat changes. The presence of this plant is an indication of a good plant community.

Figure 8



This map shows the locations that *Lythrum salicaria* (purple loosestrife) was observed. Notice the large area on Scout Island. Some areas on the island, especially the southwest shoreline of the island, are getting fairly dense. The location in the south bay area is located on private property. Other areas had just one or two plants observed.

Discussion of results

Shell Lake holds a very diverse, but limited plant community. As can be seen in table 1, there were twenty-one species actually sampled and a total of thirty species observed (species richness). This high species richness shows good diversity in the aquatic plant community. The Simpson's diversity index is high (0.87), which means it is very likely that two plants sampled will be different, again representing a high diversity in plants. When viewing table 3, the coverage of plants in the lake is quite limited with 53.5% samples containing plants in the littoral zone and only 16.7% of the entire lake sample points with plants sampled. Both of these numbers indicate limited plant coverage, with much of the lake being void of aquatic plants.

Of the plants sampled, no one plant dominated the community. *Elodea nuttallii* (slender waterweed)[1] had the highest relative frequency of about 24% and was sampled at 28% of the littoral points. Although this represents nearly 25% of all plants sampled, it is not alarmingly high. The elodea did have a few high-density areas, but did not appear to be at nuisance levels that could adversely affect recreation, fishing, etc. In addition, the species list has a nice distribution of frequencies, which supports a rather balanced plant community.

Another plant to note is filamentous algae (figures 4). The filamentous algae coverage is getting to be a concern in some lakes with increased nutrients. In Shell Lake, filamentous algae have a relative frequency of only 7% and were sample at only 8.4% of the littoral zone sites. Therefore, it is not a concern in Shell Lake at this point. Figure 5 maps the filamentous sites of higher density.

One species sampled, *Ceratophyllum echinatum* (Spiny hornwort), is listed as a species of special concern in Wisconsin. This indicates that this is a rather rare plant in Wisconsin Lakes and should be preserved as it is very intolerant of poor habitat and disturbances.

Shell Lake also contains some plants that are of special mention. First is dwarf water milfoil (*Myriophyllum tenellum)*, which is very susceptible to poor water quality and its presence is an indicator of high water quality. Quillwort *(Isoetes sp.)* and pipewort *(Eriocaulon aquaticum)* are two plants found that are specially adapted to living in low nutrient substrates, which are the predominate substrates in Shell Lake. These are also rather susceptible plants and their presence is a good indicator of higher water quality. In the emergent zone, two relatively uncommon arrowhead species (*Sagittaria rigida* and *Sagittaria graminea*) were visually observed.

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[1] It appeared that all *Elodea sp*. sampled was *Elodea nutalli*. *Elodea canadensis* may be present, but didn't appear to be sampled. Several samples were retained for identification and verification.

All submersed plants sampled were native plants. No early season survey was conducted for curly leaf pondweed, but in the August survey no curly leaf pondweed was observed. Curly leaf pondweed often times is not sampled in August even if present as it usually dies off in July. Eurasian water milfoil was also not observed in this survey. Purple loosestrife, a non-native wetland plant was observed in numerous locations. Please refer to the map (Figure 7) of *Lythrum salicaria* (purple loosestrife) to see these locations.

Various emergent and floating leaf stands were located, but they are very limited in this lake. Most were limited to the "south bay" area of the lake. This is probably due to the very limited substrate that is conducive to growth of these plants. However, the stands that were present contained very desirable emergent and floating vegetation such as bulrush, white water lily, and arrowhead.

The Floristic Quality Index reflects some good characteristics of the Shell Lake plant community. The number of species used for the index and the average conservatism were both higher than the mean for that ecoregion (see table 2). The Floristic Quality Index was much higher with a value of 36.2 compared to the mean of 24.3. This means that the plant community is showing less human development that can impact the lake. In other words, the plant community indicates a very healthy lake.

The maximum depth of plants was 25.3 feet, which is rather deep for plants to grow. This is due to the high water clarity of Shell Lake, which allows adequate light penetration to that depth. Compared to many lakes, this is a high value and helps indicate high water quality for Shell Lake once again.

Considerations for management

Considering that Shell Lake has limited plant coverage, it is recommended that the present plant community be preserved. The littoral zone is very narrow around Shell Lake. Therefore, if very many residents control plant growth, the littoral zone would be further reduced. Plants offer the lake ecosystem very important functions. Fish and other organisms rely on plants for food and habitat. Furthermore, plants can provide stabilization for substrates and absorb nutrients that could be available for unicellular algae to bloom, thereby lowering water clarity.

One species of special concern was sampled, *Ceratophyllum echinatum* (Spiny hornwort). It was sampled in numerous locations in the south bay area. Steps should be taken to preserve this plant. These would include no chemical treatment or harvesting in this bay.

Filamentous algae should be monitored to make sure it is not increasing in growth too rapidly. This growth can indicate an increase in nutrients into Shell Lake. There are a couple of areas where filamentous algae is at a density of rating 2 to 3 (medium to high). Monitoring would help keep track of any increase in density in other areas of the lake.

Fortunately no curly leaf pondweed (*Potamogeton crispus*) or Eurasian water milfoil (*Myriophyllum spicatum*) was found. However, with the extensive boat traffic into Shell Lake, the concern for introduction is high. It appears the Shell Lake has instituted a Clean Boats, Clean Waters program and should continue with this indefinitely. In addition, the lake residents should be educated about identifying these plants so the in-lake monitoring can be carried out annually. More people paying close attention to the presence of these plants helps reduce infestations occurring.

Purple loosestrife (*Lythrum salicaria*) is present in some areas and seems to be fairly dense in couple of areas, particularly on Scout Island. This plant should be eradicated as soon as possible. It was also observed that some riparian owners had this plant growing in their lawns. These individuals need to be informed about the significance of purple loosestrife and should be eradicated.

It is also recommended that Shell Lake complete an Aquatic Plant Management Plan. These plans allow for the management of aquatic plants should issues arise. Monitoring and action against invasive plant species is an important component of the plan.

Recommendations:

- Preserve native plant community present in the lake.
- Preserve emergent and floating vegetation stands.
- Monitor filamentous algae locations and density.
- Eradicate all purple loosestrife in all areas around the lake.
- Complete an Aquatic Plant Management Plan (APM).
- Continue Clean Boats/Clean Waters campaign.
- Monitor for aquatic invasive species routinely.

References

Borman, Susan, Robert Korth and Jo Tempte. *Through the Looking Glass*. University of Wisconsin-Extension. Stevens Point, Wisconsin. 1997. 248 p.

Crow, Garrett E. and C. Barre Hellquist. *Aquatic and Wetland Plants of Northeastern North America*. The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000. 880p.

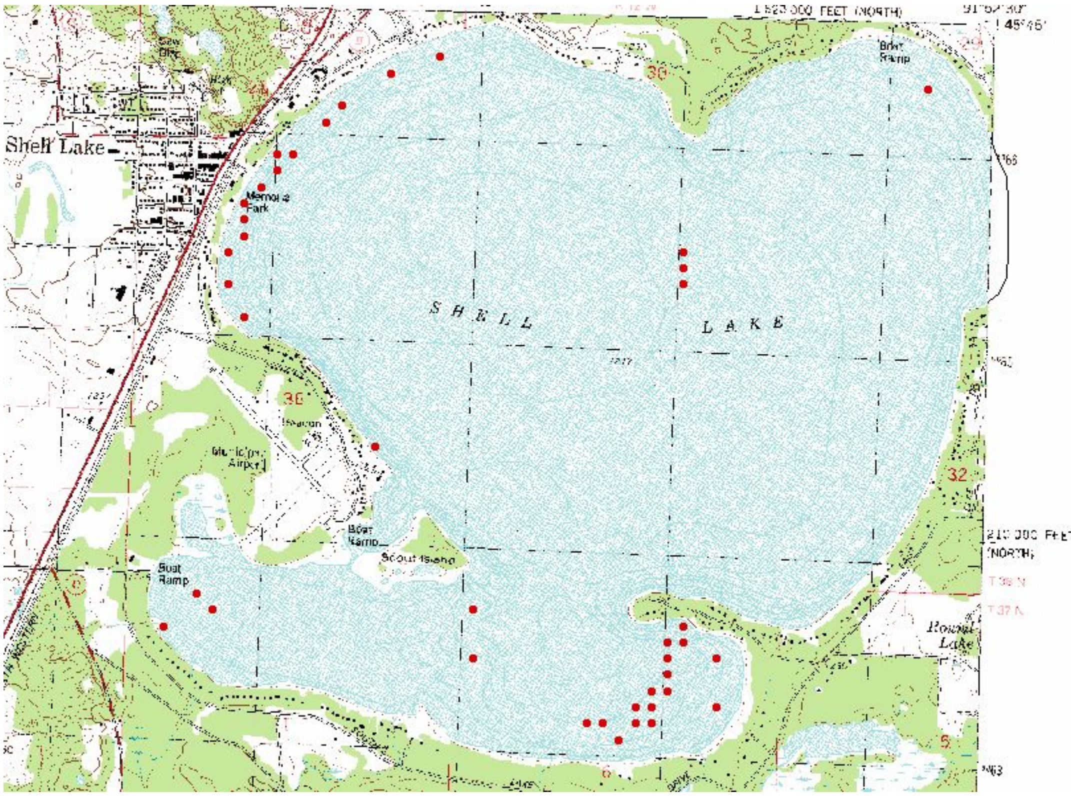
Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 12+ vols. New York and Oxford. <http://www.eFloras.org/flora_page.aspx?flora_id=1>

Nichols, Stanley A. *Distribution and Habitat Descriptions of Wisconsin Lake Plants*. Wisconsin Geological and Natural History Survey. Bulletin 96. Madison Wisconsin. 1999. 266 p.

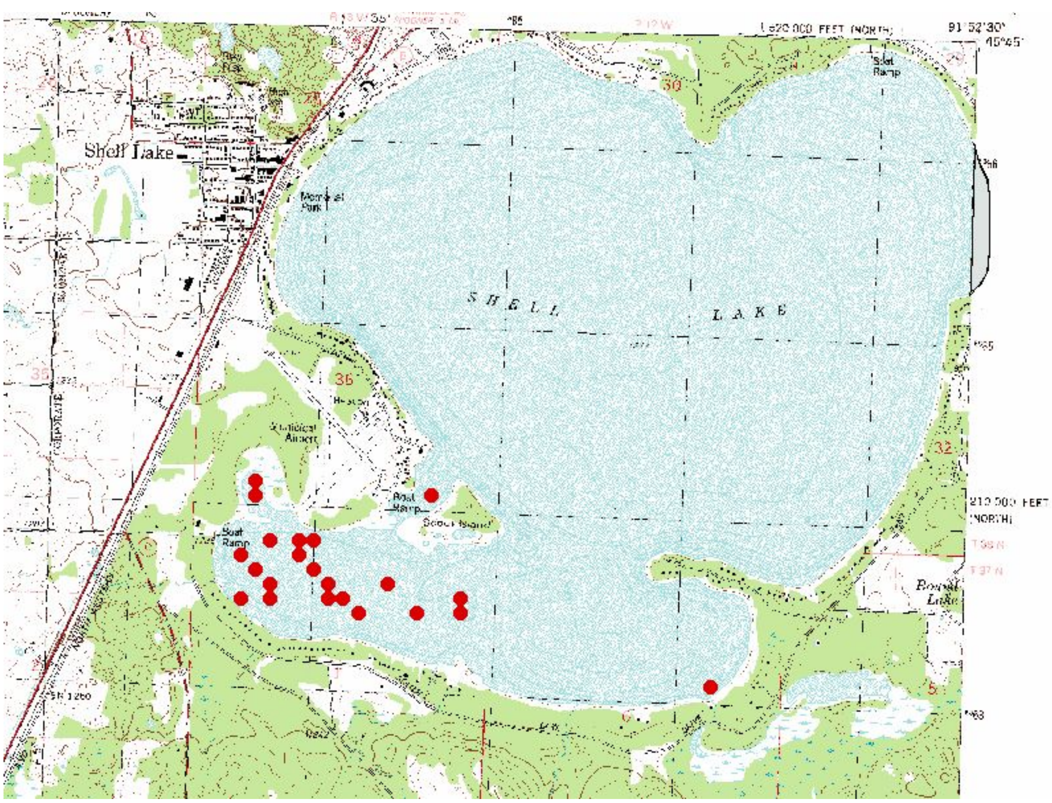
Nichols, Stanley A. *Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications*. Journal of Lake and Reservoir Management 15 (2): 133-141. 1999.

University of Wisconsin-Extension. *Aquatic Plant Management in Wisconsin*. April 2006 Draft. 46 p.

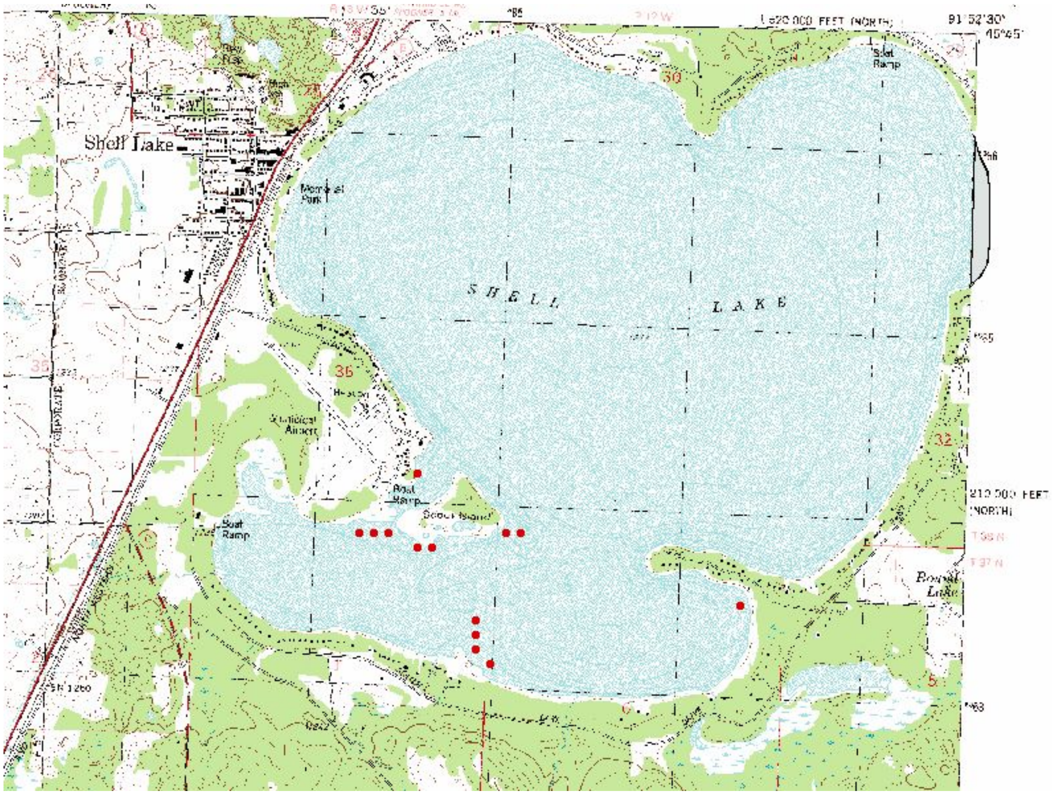
Appendix A: Maps of all species



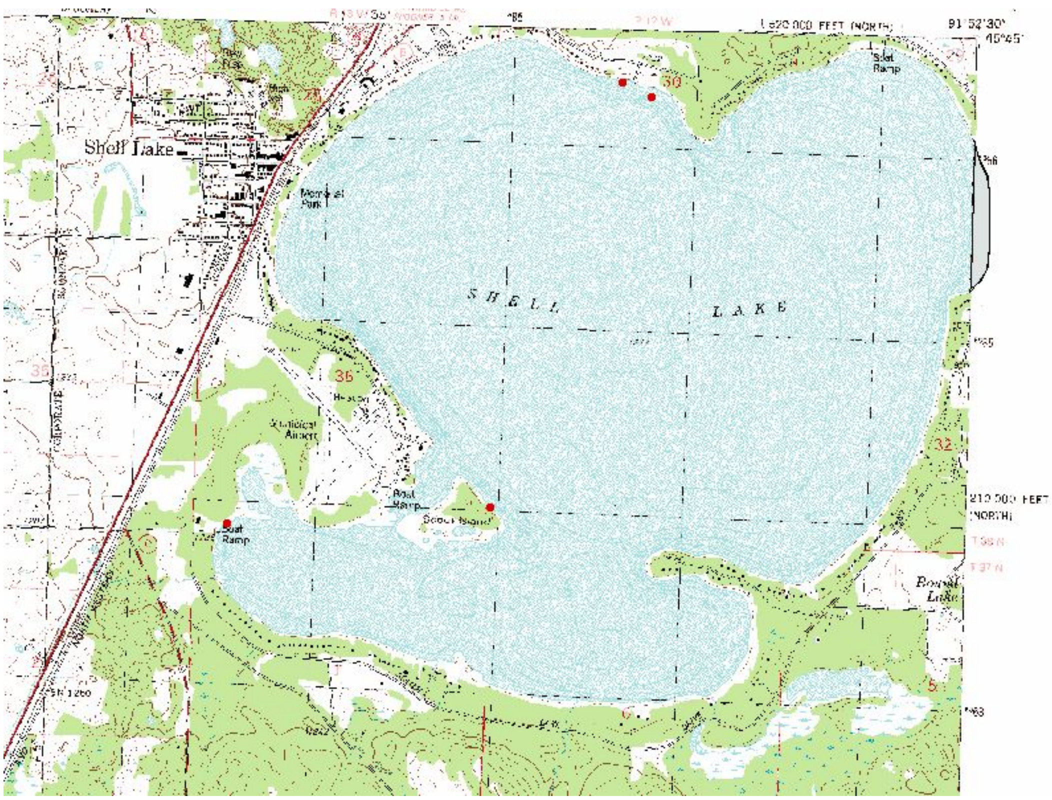
Filamentous algae



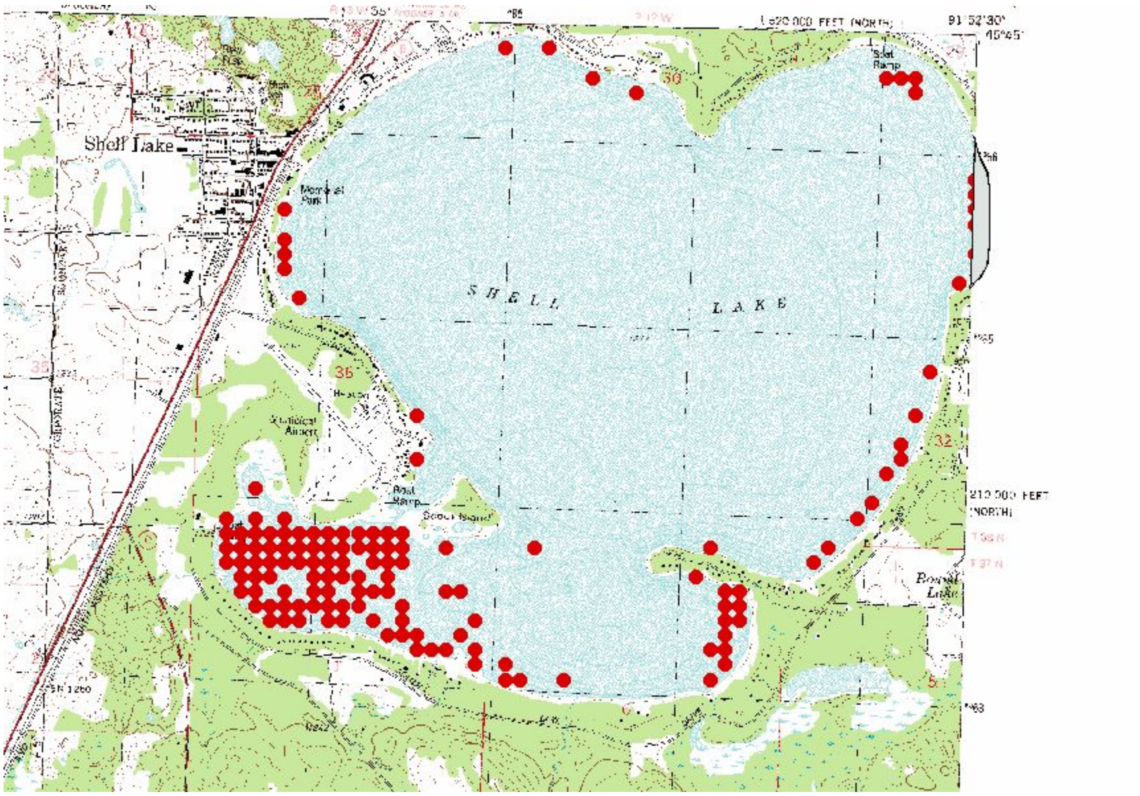
Ceratophyllum echinatum (Spiny hornwort)



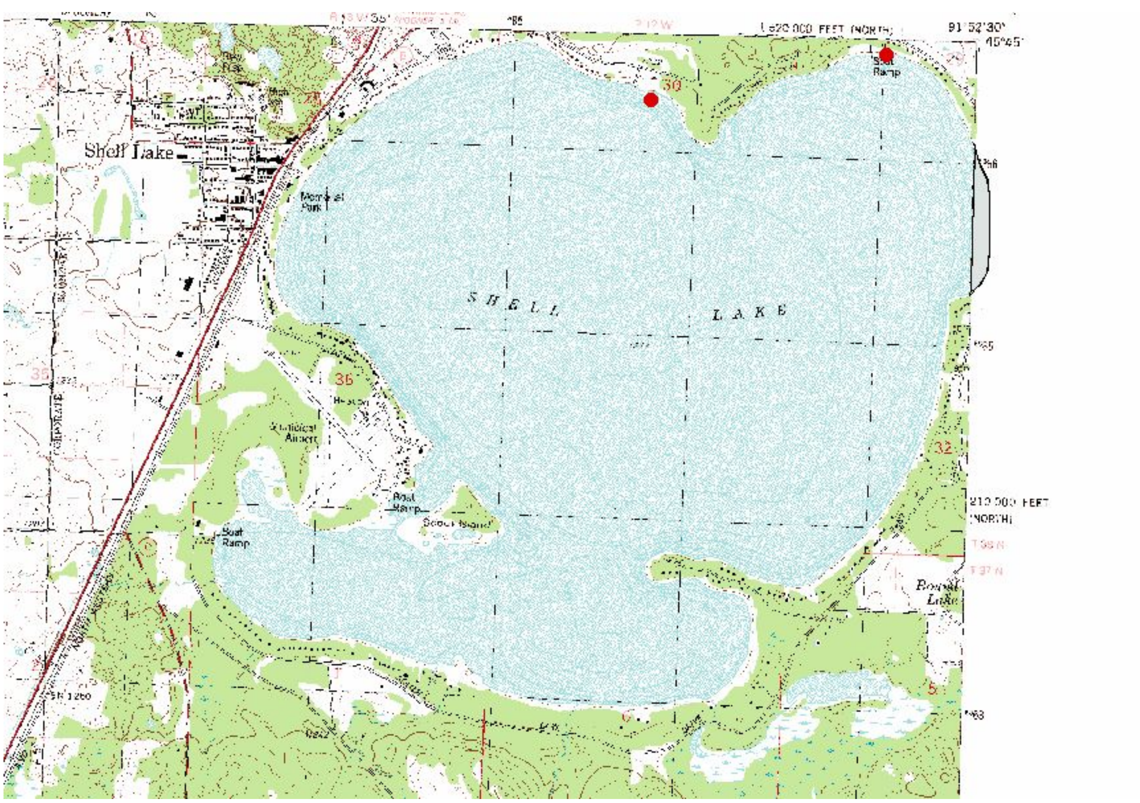
Chara sp. (Muskgrass)



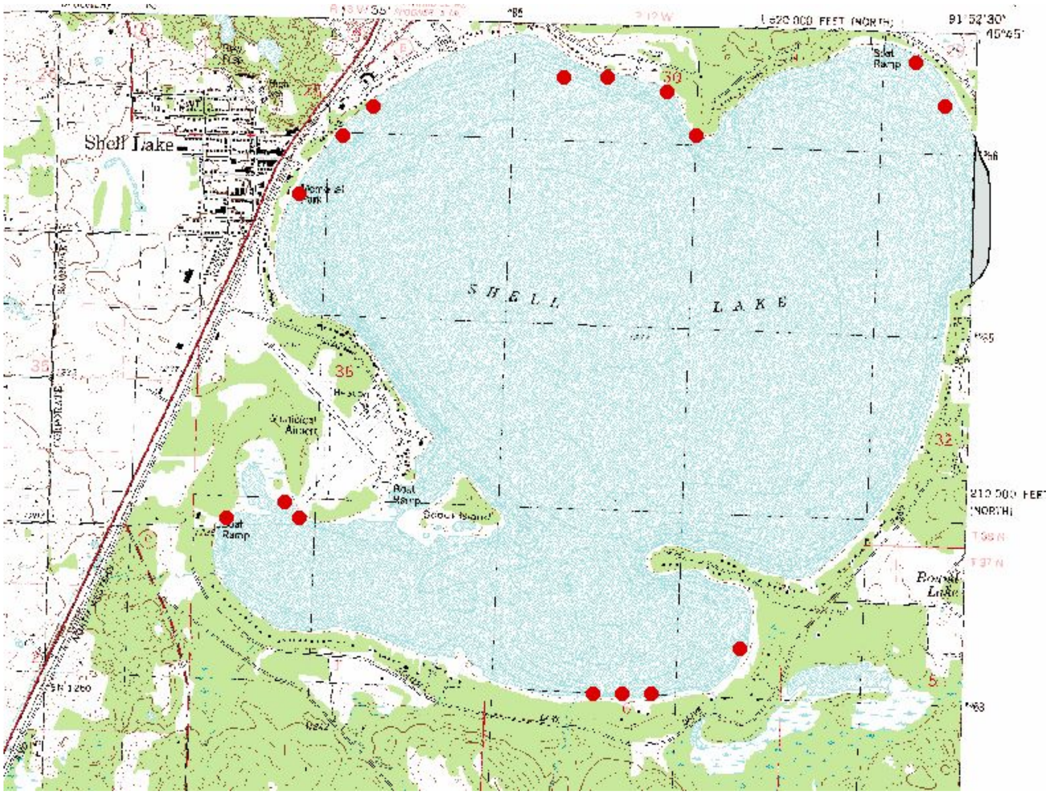
Elatine minima (Waterwort)



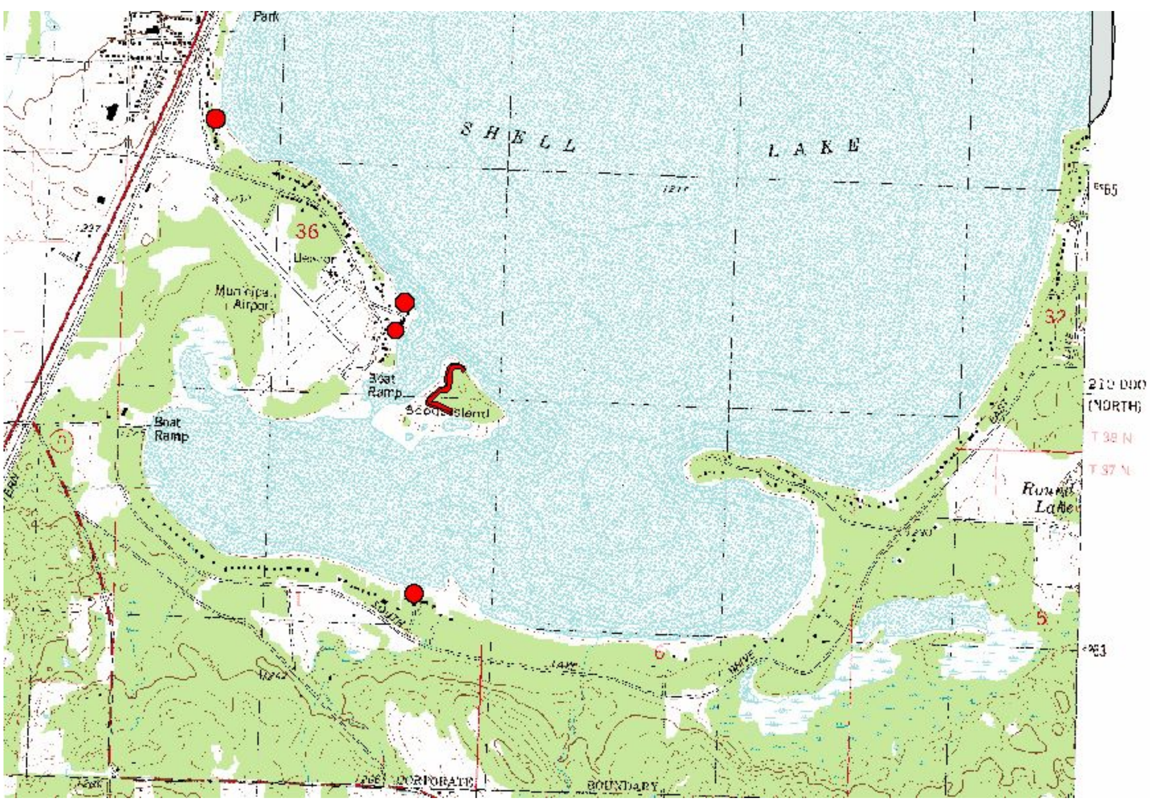
Elodea nuttallii (Slender waterweed)



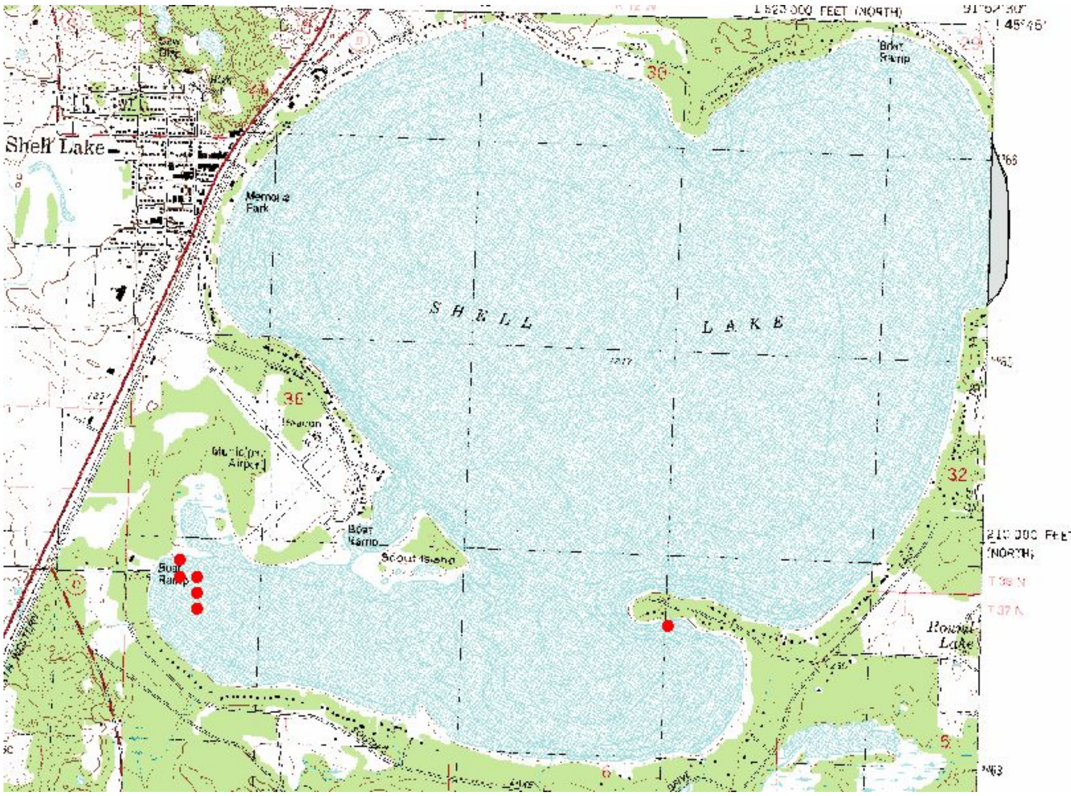
Eriocaulon aquaticum (Pipewort)



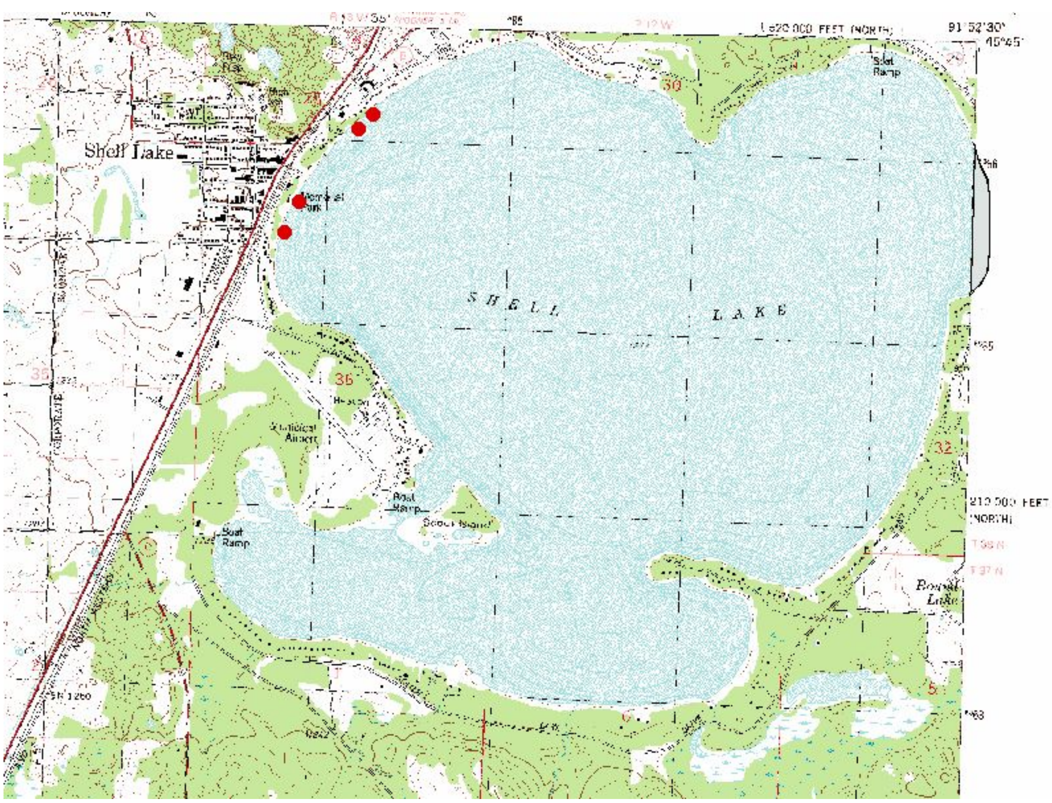
Isoetes sp. (Quillwort)



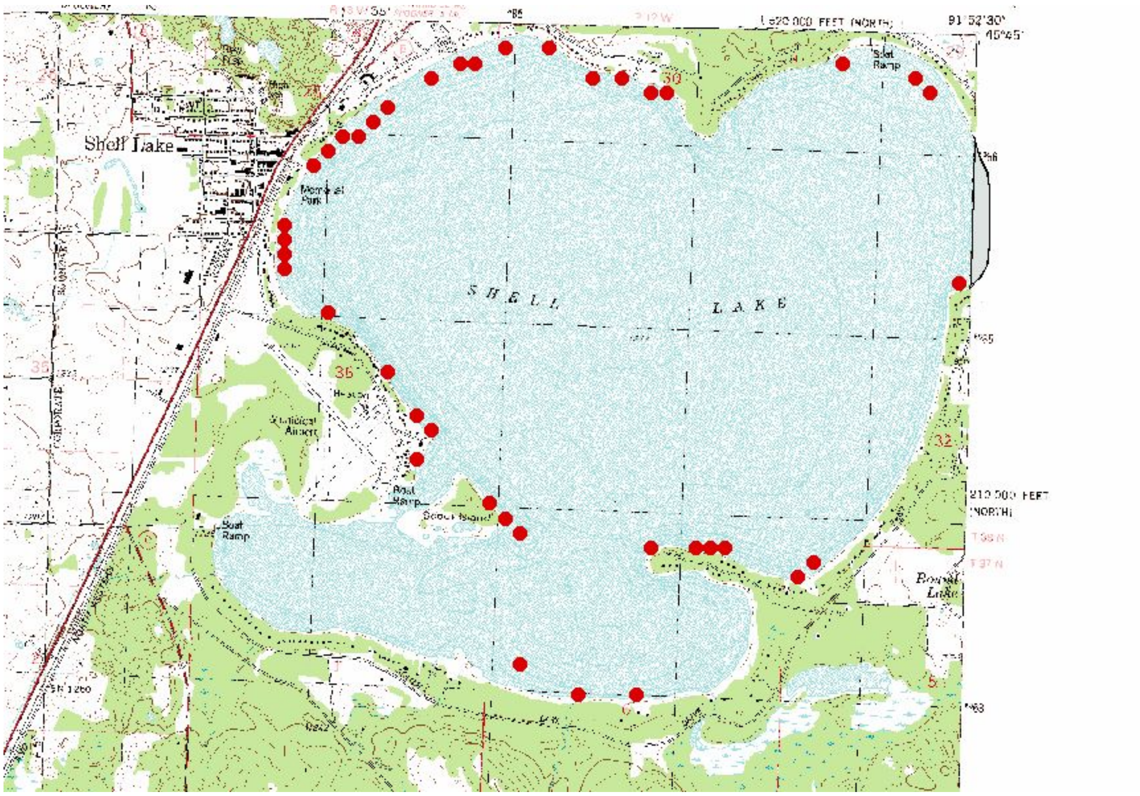
Lythrum salicaria (Purple loosestrife)



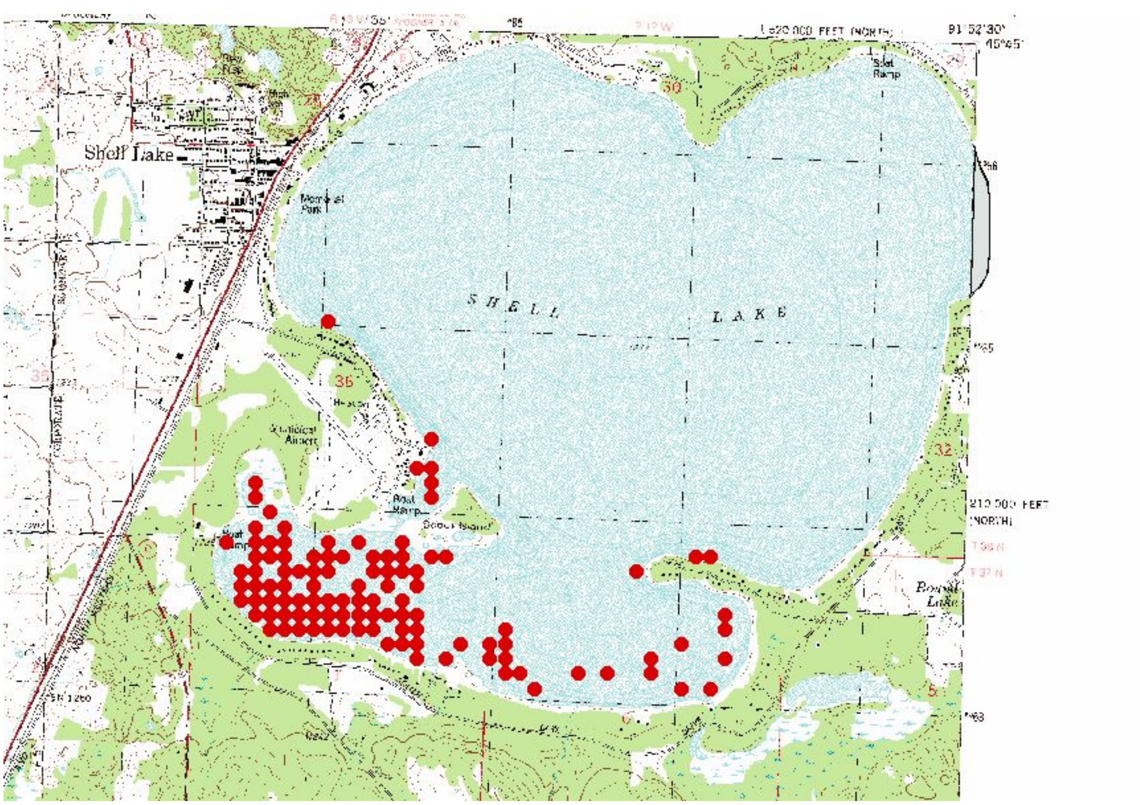
Megalodonta beckii (Water marigold)



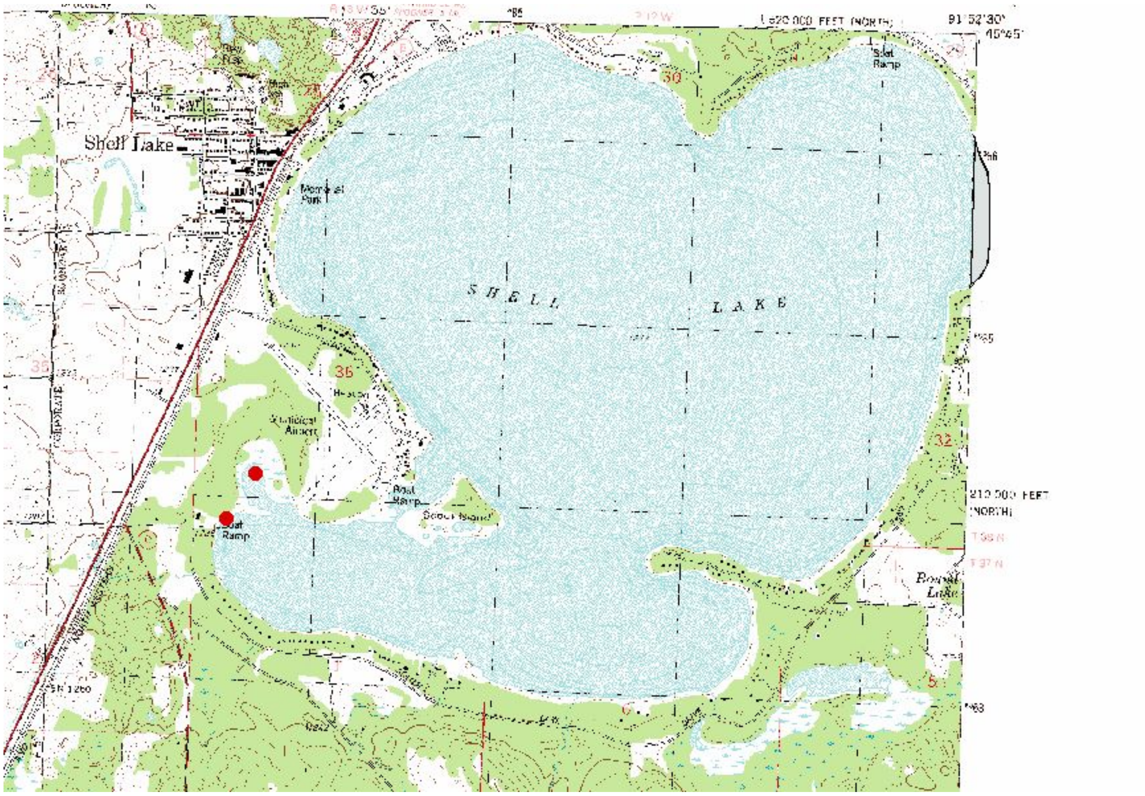
Myriophyllum tenellum (Dwarf watermilfoil)



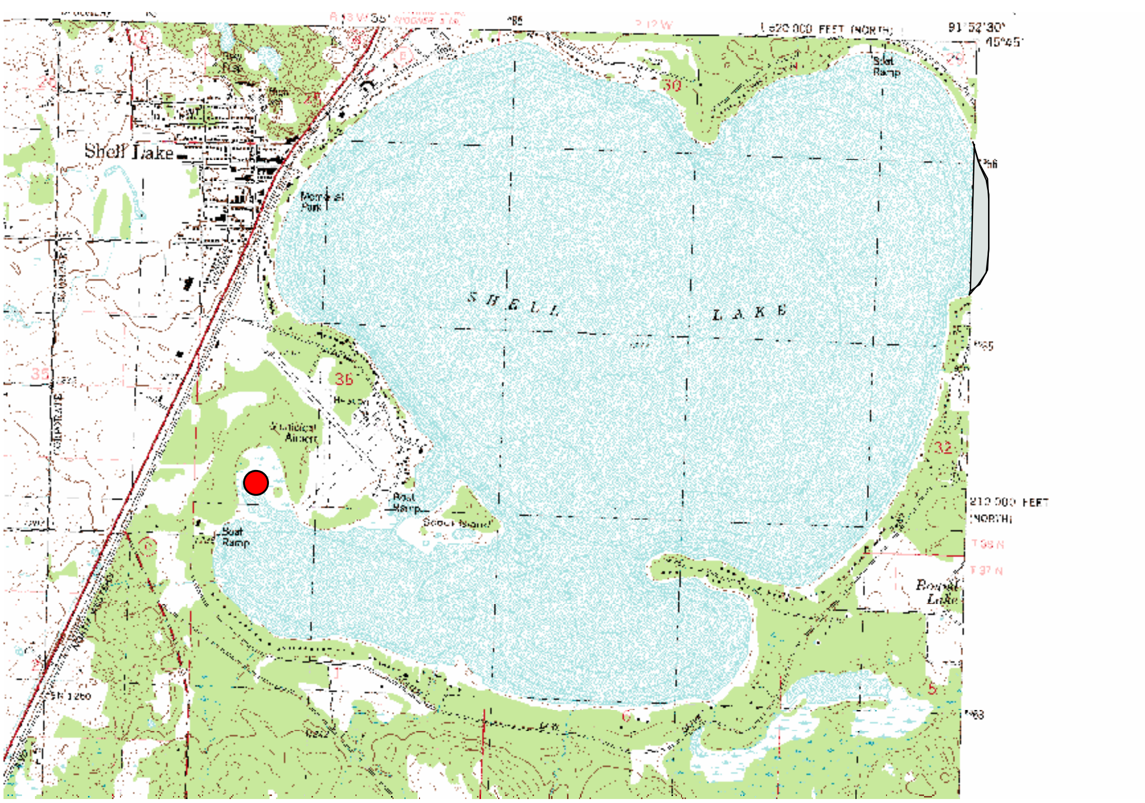
Najas flexilis (Bushy pondweed)



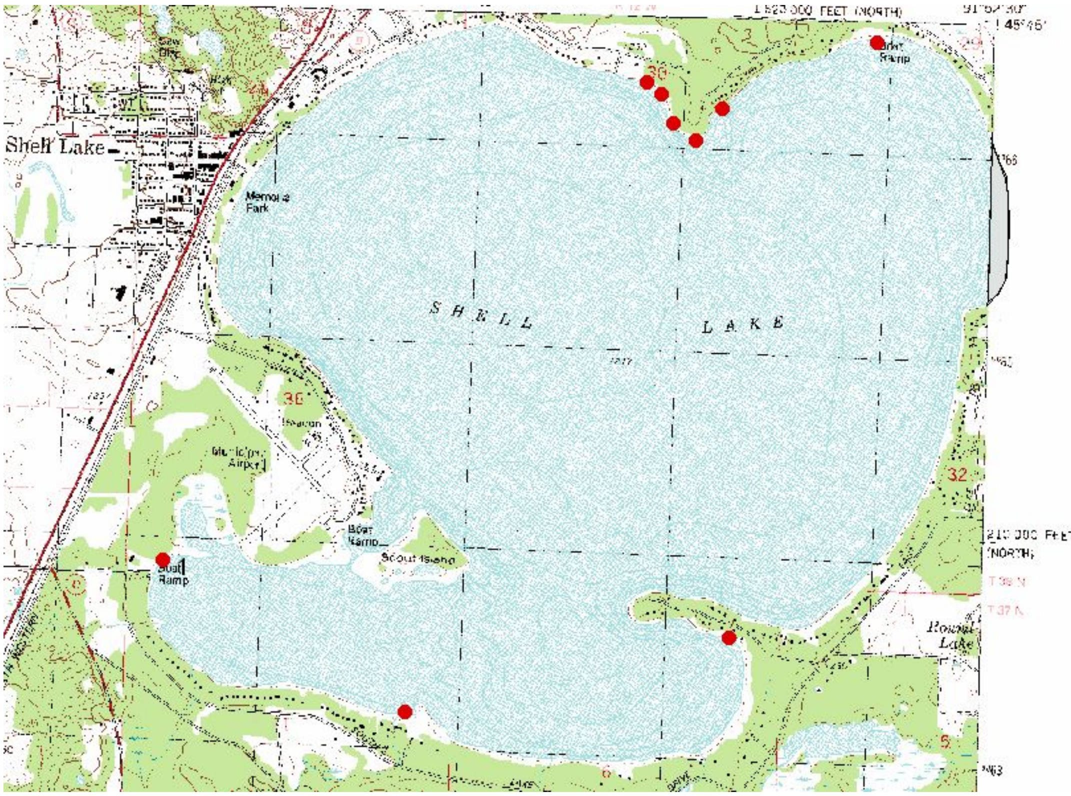
Nitella sp.



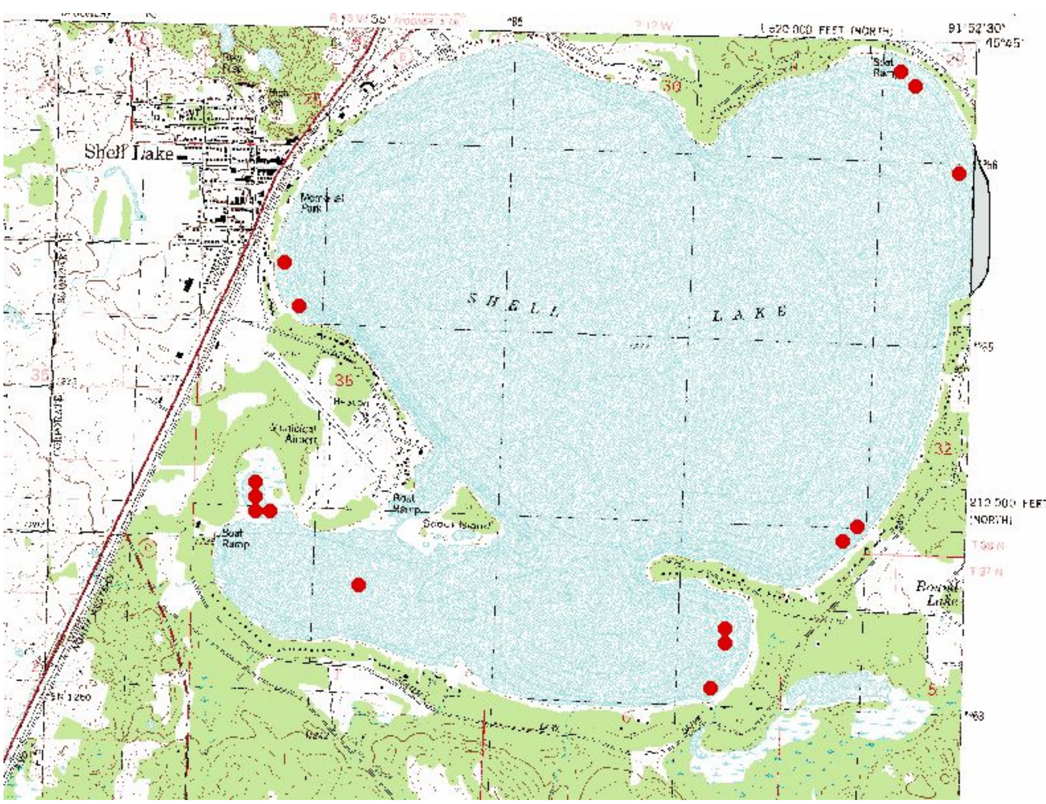
Nuphar variegata (Spatterdock)



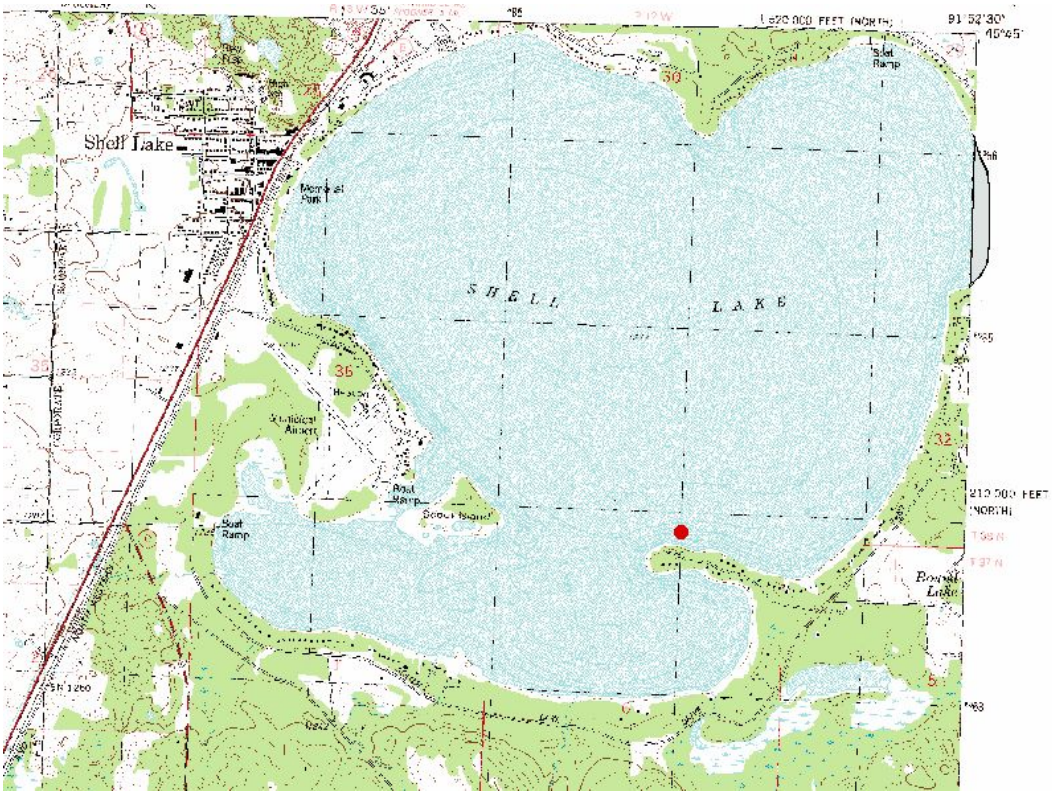
Nymphaea odorata (White water lily)



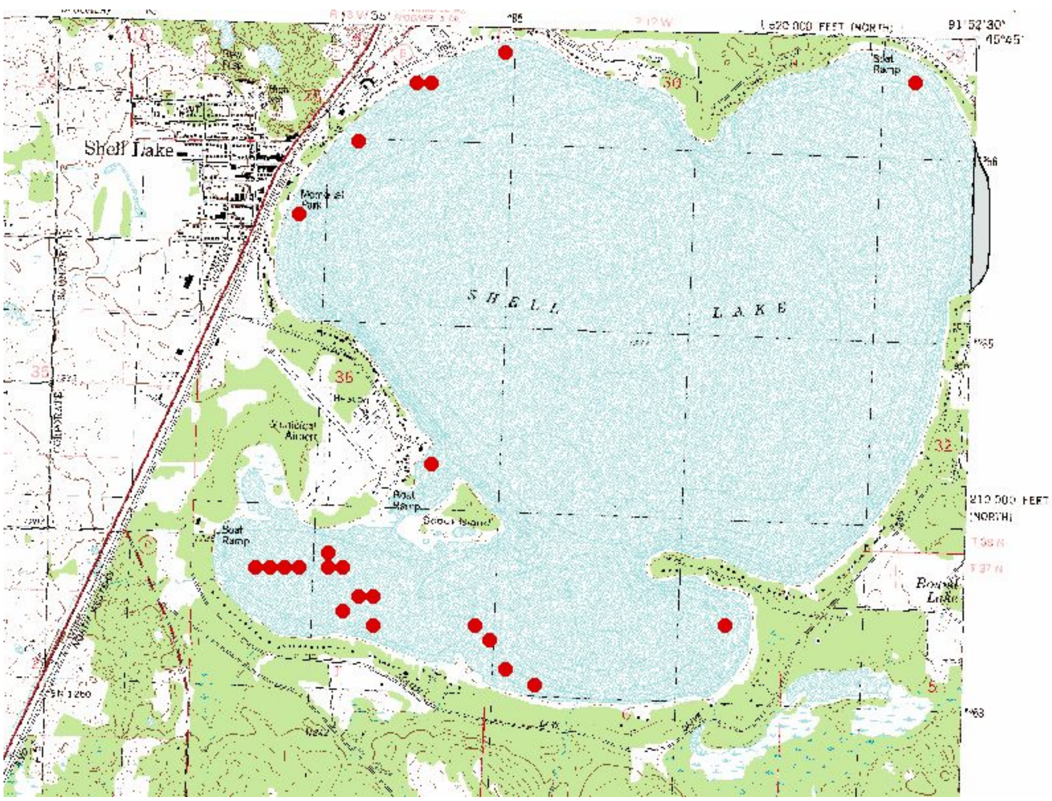
Polygonum amphibium (Water smartweed)



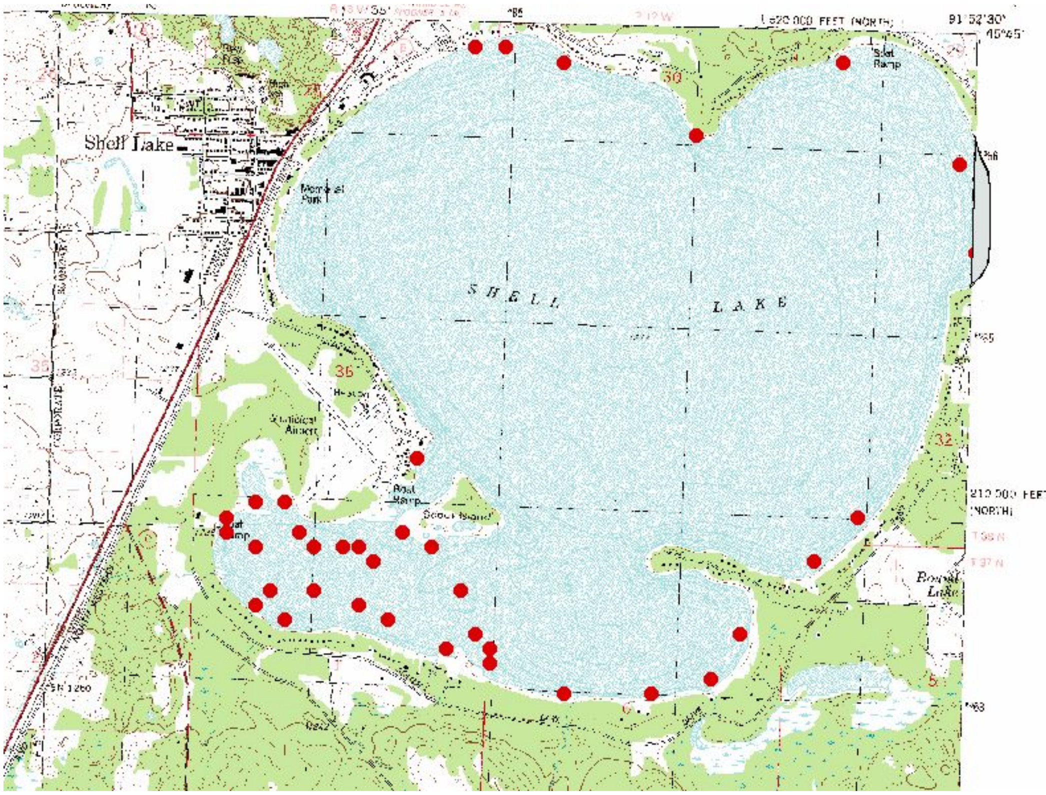
Potamogeton amplifolius (Large leaf pondweed)



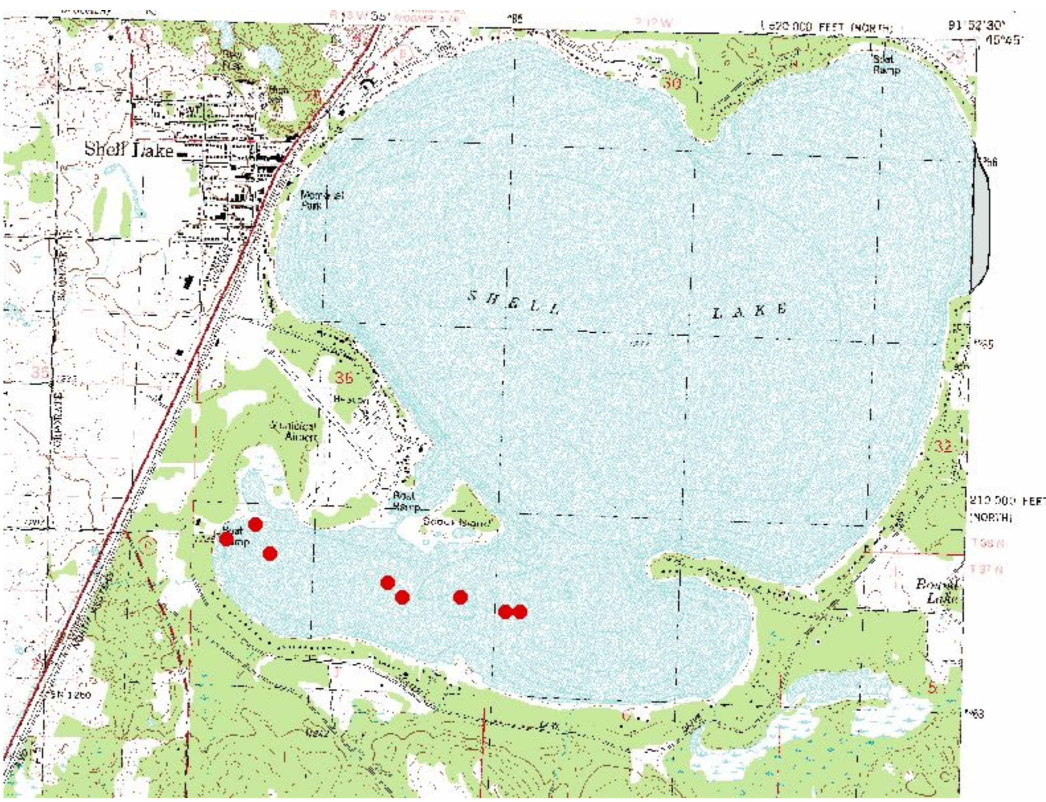
Potamogeton foliosus (Leafy pondweed)



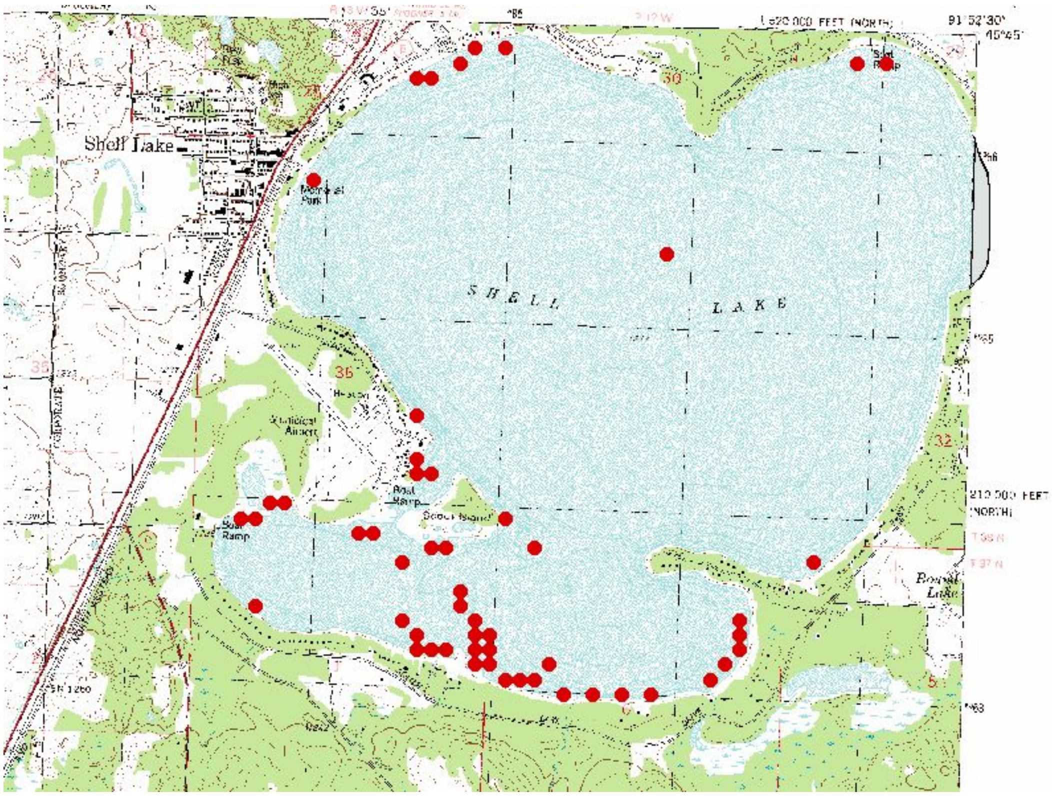
Potamogeton pusillus (Small pondweed)



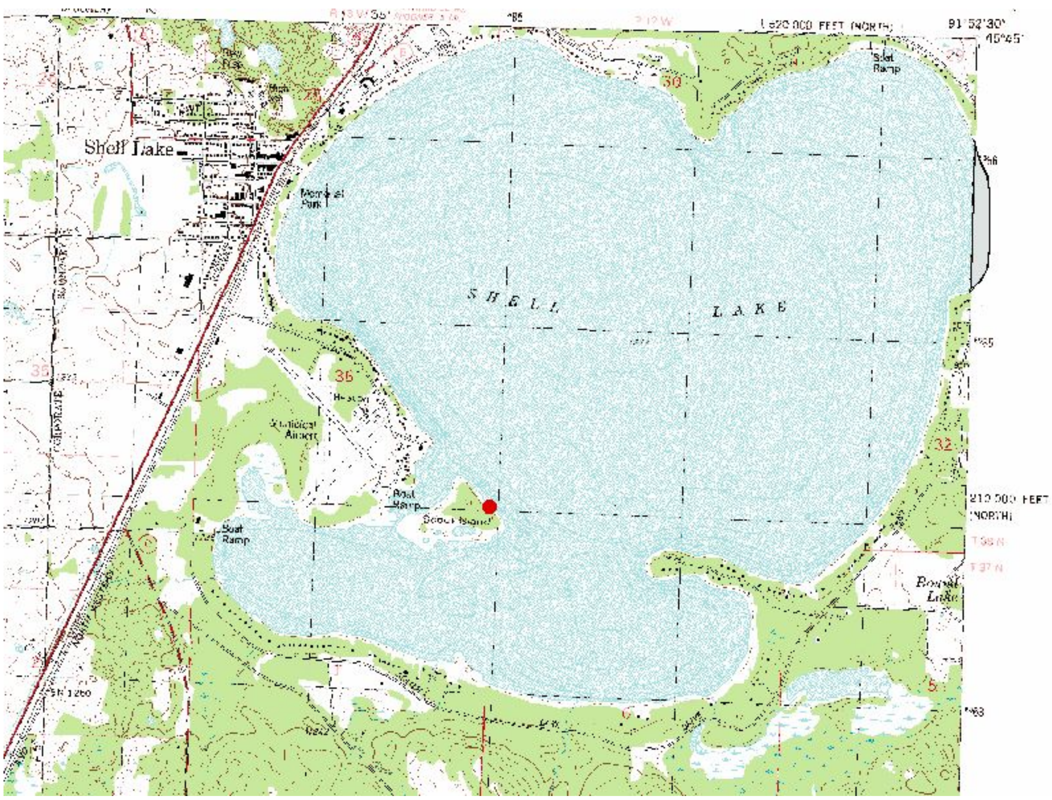
Potamogeton richardsonii (Clasping leaf pondweed)



Potamogeton robbinsii (Fern pondweed)

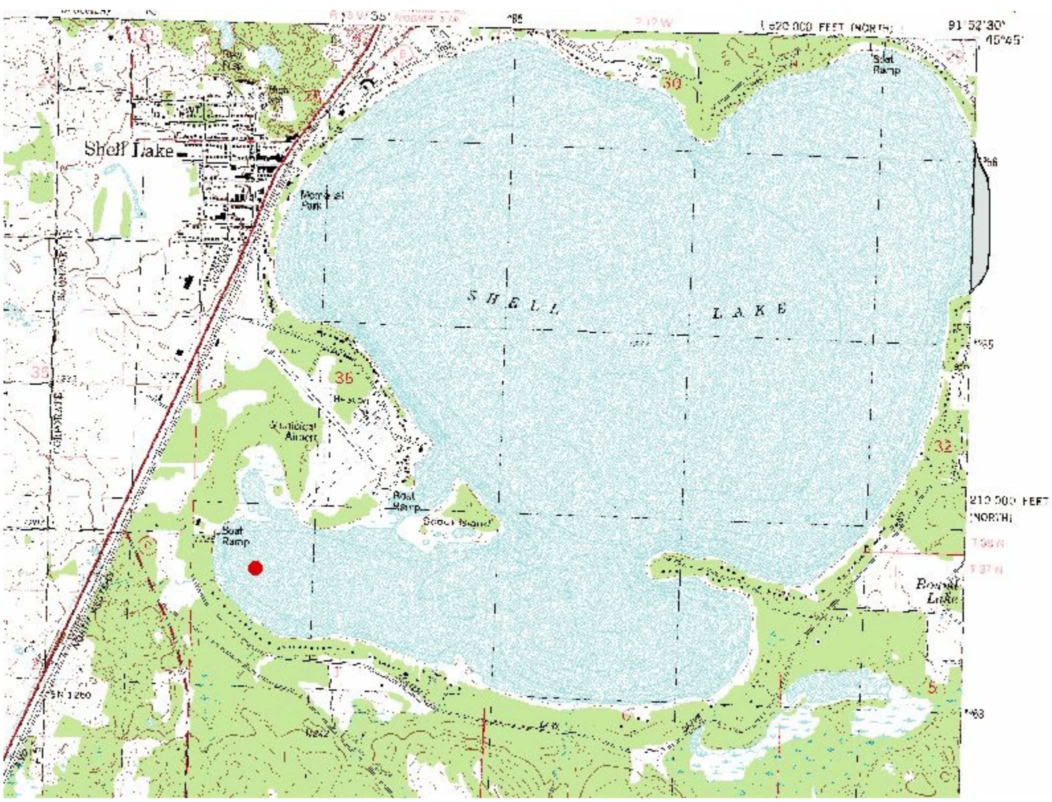


Ranunculus aquatilis (Stiff water crowfoot)

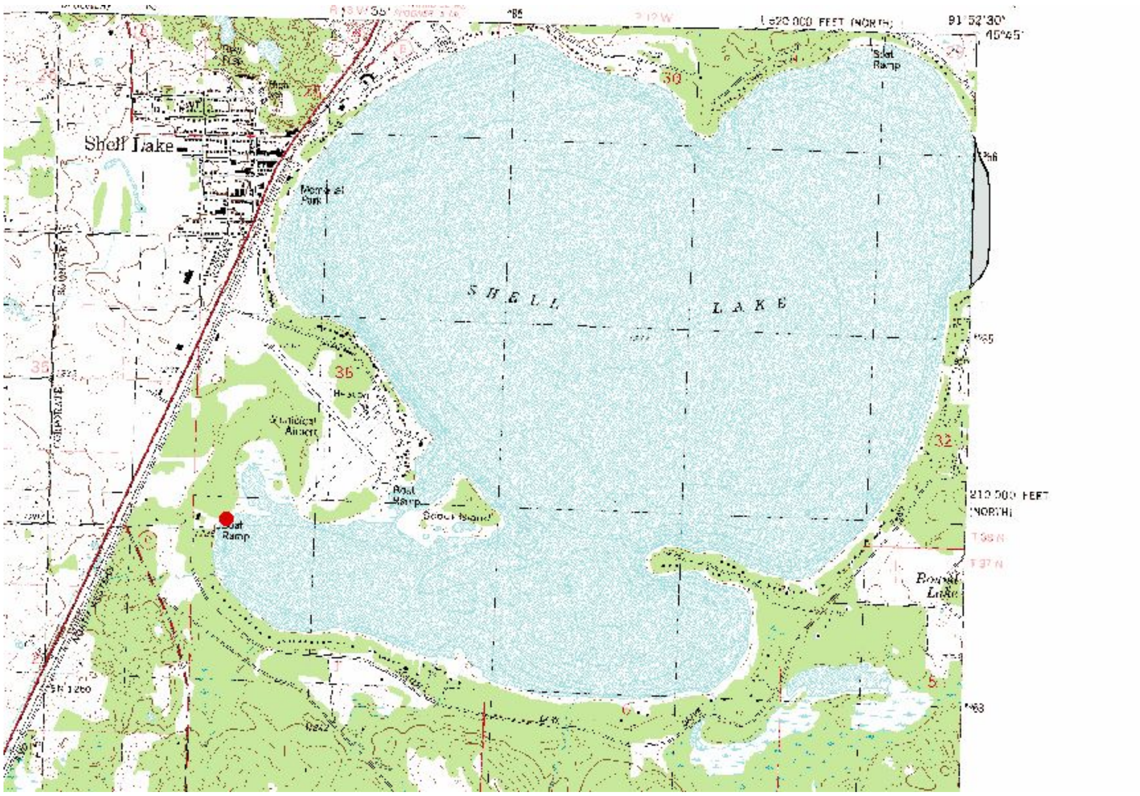


Ranunculus flammula (Creeping spearwort)

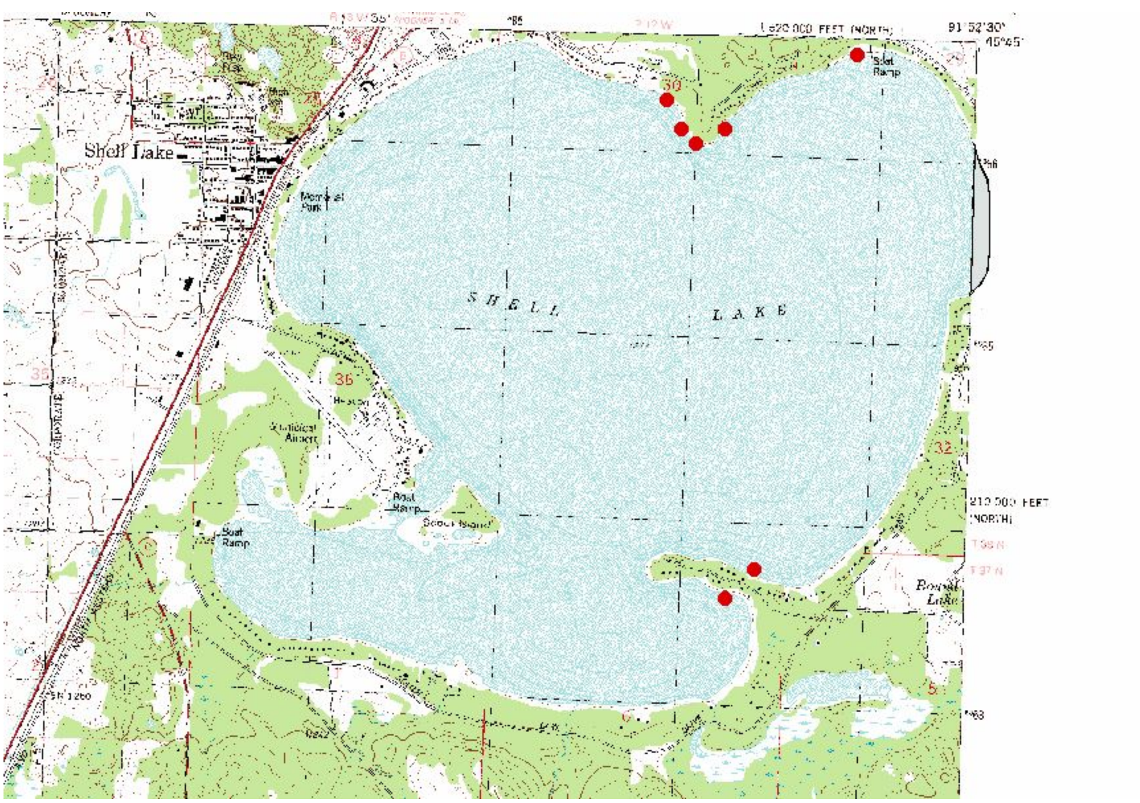
Sagittaria graminea (Grass-leaved arrowhead)



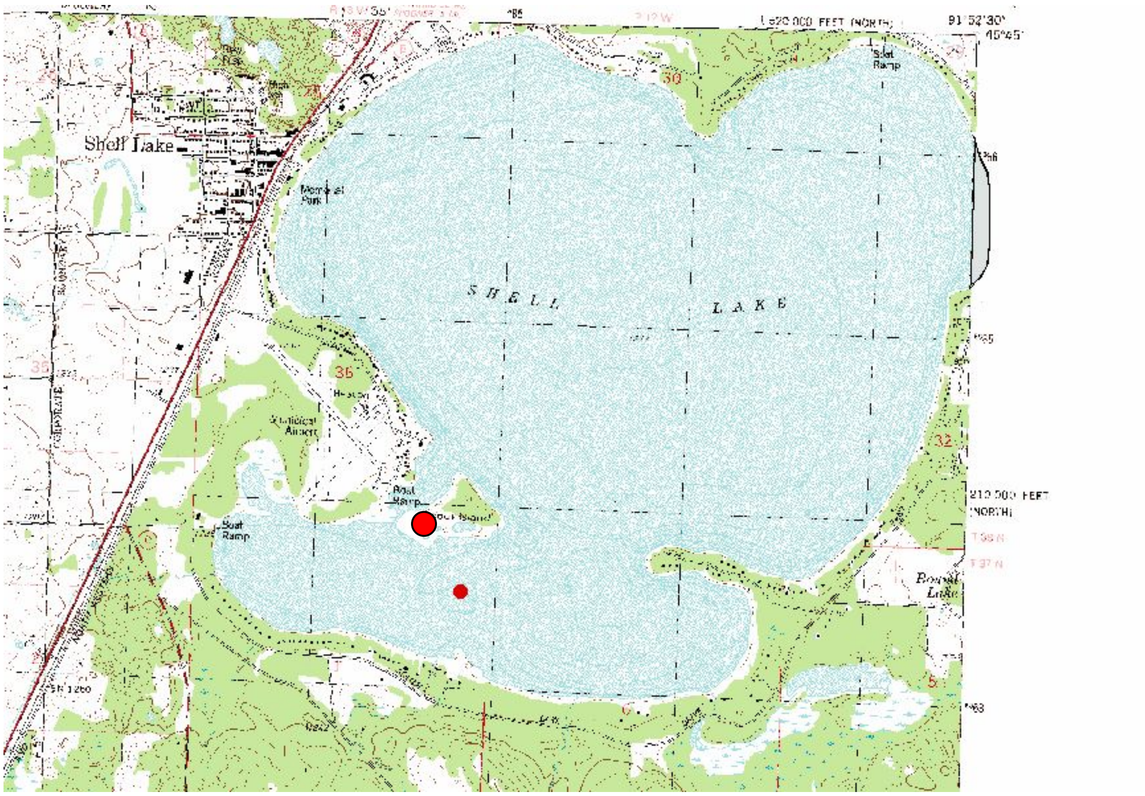
Sagittaria rigida (Stiff arrowhead)



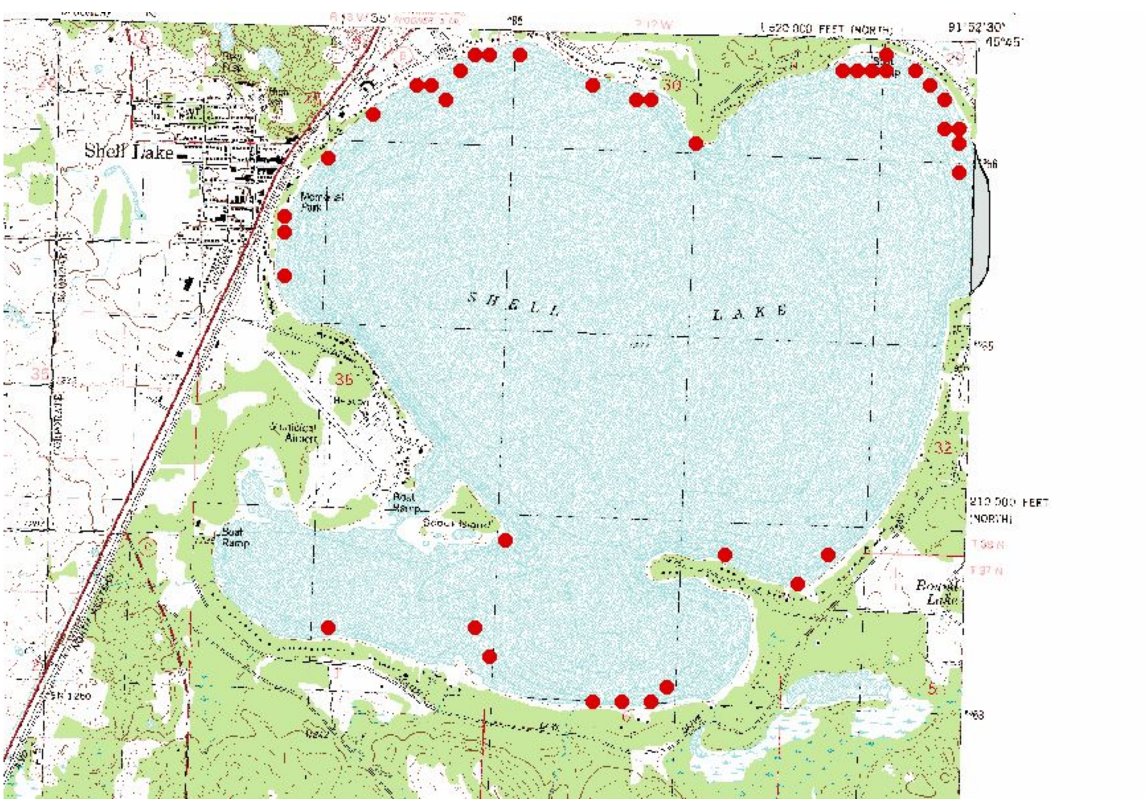
Sagittaria latifolia (Arrowhead)



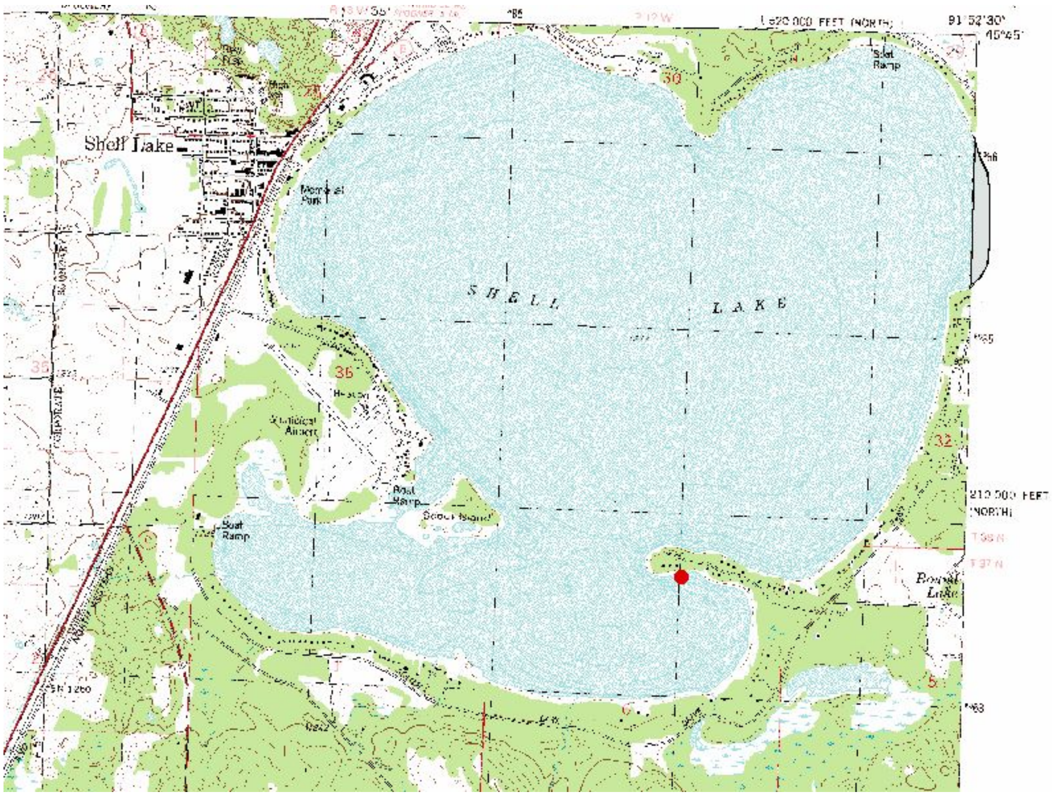
Schoenoplectus sp. (Softstem and hardstem bulrush)



Typha latifolia (Broad-leaf cattail)



Vallisneria Americana (Wild celery)



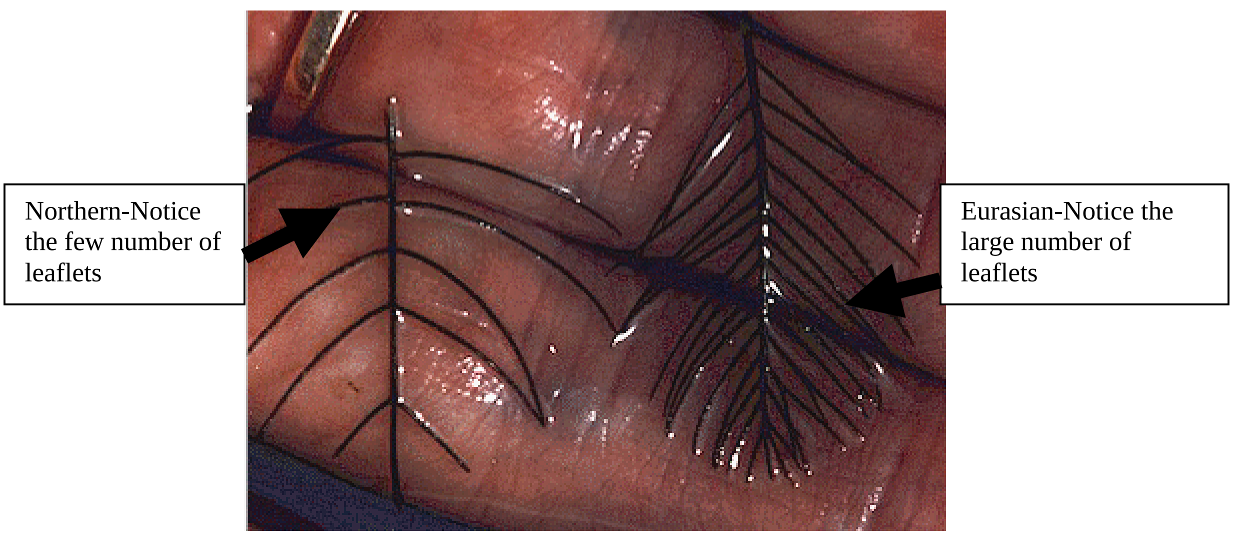
Zosterella dubia (Water stargrass)

Appendix B: Information on Eurasian watermilfoil and curly leaf pondweed.

Information and identification of Eurasian Watermilfoil and curly leaf pondweed

Eurasian water milfoil (*Myriophyllum spicatum*)[1]

Eurasian water milfoil is a submersed aquatic plant native to Europe, Asia and northern Africa. It is the only non-native milfoil in Wisconsin. Like the native milfoils, the Eurasian variety has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. The flowers are located in the axils of the floral bracts, and are four-petaled or without petals. The leaves are threadlike, typically uniform in diameter, and aggregated into a submersed terminal spike. The stem thickens below the inflorescence and doubles its width further down, often curving to lie parallel with the water surface. The fruits are four-jointed nut-like bodies. Without flowers or fruits, it is difficult to distinguish from Northern water-milfoil, which is native to Wisconsin. Eurasian watermilfoil usually has more than 12 pairs of leaflets per leaf, while Northern watermilfoil typically has less than 12. Sometimes coontail is mistaken for milfoils, but does not have individual leaflets.



Eurasian watermilfoil grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is restricted to areas of nutrient-rich sediments. It has a history of becoming dominant in eutrophic, nutrient-rich lakes, although this pattern is not universal. It is an opportunistic species that prefers highly disturbed lakebeds, lakes receiving nitrogen and phosphorus-laden runoff, and heavily used lakes. Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

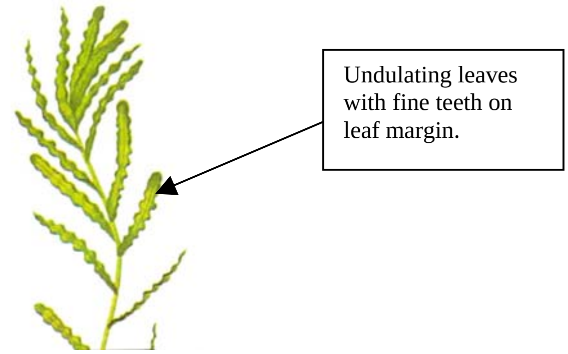
Unlike many other plants, Eurasian watermilfoil does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. Milfoil is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist.

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, Eurasian watermilfoil is adapted for rapid growth early in spring. Dense stands of Eurasian watermilfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake used on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead." Cycling of nutrients from sediments to the water column by Eurasian watermilfoil may lead to deteriorating water quality and algae blooms of infested lakes.

It is very important for lake organizations to monitor their lake for Eurasian water-milfoil. Prevention of the introduction of this plant is the best method to avoid infestation.

Curly leaf pondweed (*Potamogeton crispus*)[2]

Curly leaf pondweed is an invasive aquatic species found in a variety of aquatic habitats, including permanently flooded ditches and pools, rivers, ponds, inland lakes, and even the Great Lakes. Curly leaf pondweed prefers alkaline or high nutrient waters 1 to 3 meters deep. Its leaves are strap-shaped with rounded tips and undulating and finely toothed edges. Leaves are not modified for floating, and are generally alternate on the stem. Stems are somewhat flattened and grow to as long as 2 meters. The stems are dark reddish-green to reddish-brown, with the midvein typically tinged red. Curly leaf pondweed is native to Eurasia, Africa and Australia and is now spread throughout most of the United States and southern Canada.



New plants typically establish in the fall from freed turions (branch tips). The winter form is short, with narrow, flat, relatively limp, bluish-green leaves. This winter from can grow beneath the ice and is highly shade tolerant. Rapid growth begins with warming water temperatures in early spring, well ahead of native aquatic plants.

Curly leaf pondweed reproduces typically vegetatively. Numerous turions are produced in the spring. These turions consist of modified, hardened, thorny leaf bases interspersed with a few to several dormant buds. The turions separate from the plant by midsummer, and may be carried in the water column supported by several leaves. Humans and waterfowl may also disperse turions. Stimulated by cooler water temperatures, they germinate in the fall, over-wintering as a small plant. The next summer they mature, producing reproductive tips of their own. Curly leaf pondweed rarely produces flowers.

Rapid early season growth may form large, dense patches at the surface. This canopy overtops most native aquatic plants, shading them and significantly slowing their growth. The canopy lowers water temperature and restricts absorption of atmospheric oxygen into the water. The dense canopy formed often interferes with recreational activities such as swimming and boating.

In late spring, curly leaf pondweed dies back, releasing nutrients that may lead to algae blooms. Resulting high oxygen demand caused by decaying vegetation can adversely affect the lake ecosystem.

[1] Wisconsin Department of Natural Resources Invasive Species Fact sheets from www.dnr.state.wi.us

[2] Information from GLIFWC Plant Information Center (http://www.glifwc.org/epecenter)

Appendix C: Glossary

Glossary

Ecosystem-Any complex of living organisms together with all biotic and abiotic (non-living) factors which affect them.

Emergent plant-Aquatic plants that are rooted or anchored in sediment and have stems and leaves extending well above the water surface.

Floating-leafed plant-Plants with leaves floating on the water surface and are rooted or attached to sediments by long, flexible stems.

Habitat-The physical place where an organism lives.

Herbarium-A collection of plants sampled.

Littoral zone-The region of a body of water extending from the shoreline outward to the greatest depth occupied by rooted aquatic plants.

Macrophyte-Large, rooted or floating aquatic plants that may bear flowers and seeds. Some plants are free floating and are not attached to the bottom.

Nutrient-Any chemical element, ion or compound required by an organism for the continuation of growth, reproduction, and other life processes.

Photosynthesis-Production of organic matter (carbohydrate) from inorganic carbon and water in the presence of light.

Sediment-Solid material deposited in the bottom of a basin.

Submergent plant-Aquatic plant that grows with all or most of its stems and leaves below the water surface.

Voucher-A collection of specimens sampled in a particular location.

Watershed-The entire surface landscape that contributes water to a lake or river.

Appendix D: Spreadsheets of data collected