RMB Environmental Laboratories, Inc.

Lake Vermilion 69-0378-00 St. Louis County

Aquatic Vegetation Point-intercept Survey

Survey Date	29 July, 31 July – August 1 2019
Observers	Phillip Oswald and Cody Peterick
Date of Report	26 August 2019
Report Author	Phillip Oswald

Lake Summary

Lake Vermilion (DOW 69-0378-00) is one of Minnesota's largest lakes with a total surface area of 39,272 acres and located in northern St. Louis County near the city of Tower, MN. Lake Vermilion has a maximum depth of 76 feet and contains a littoral area of about 15,006 acres, 38%, which permits light penetration and allows plant growth.

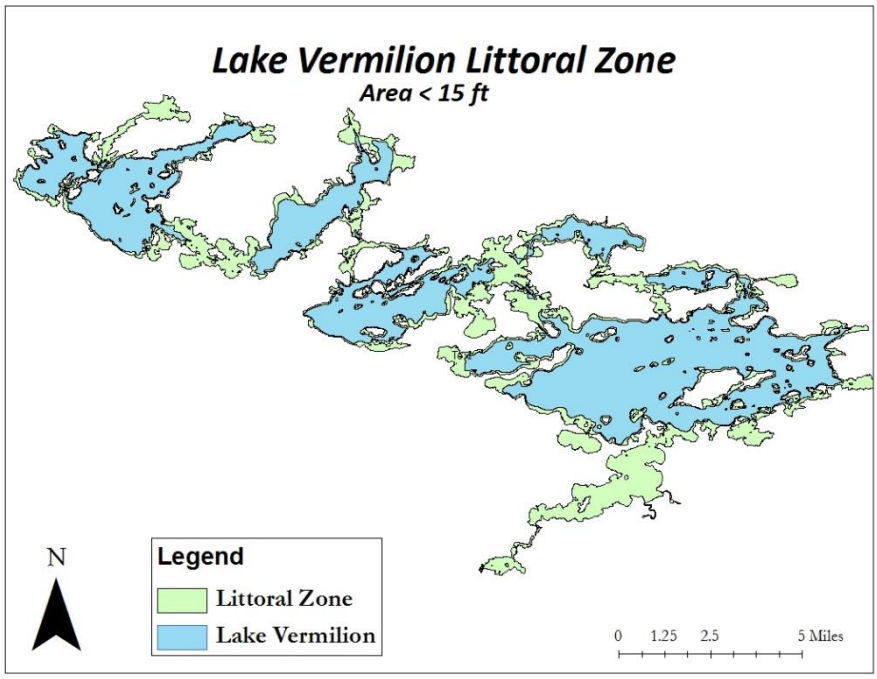
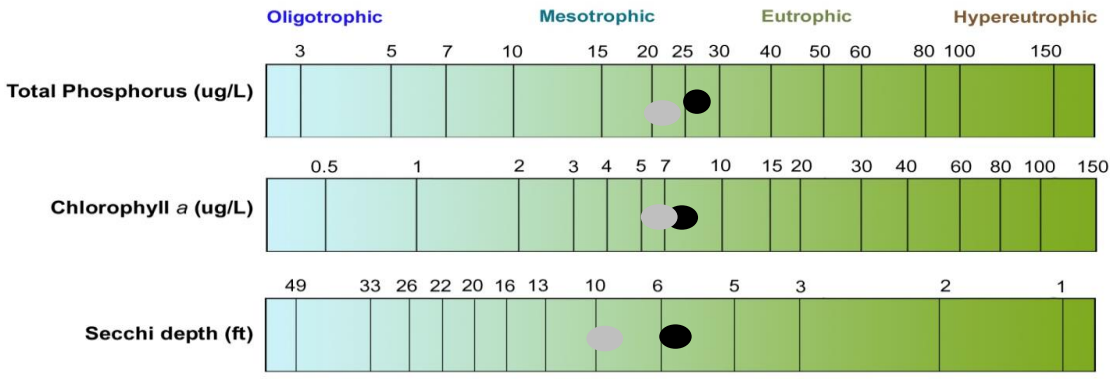


Figure 1: Lake Vermilion littoral zone, St. Louis County, MN.

Lake Vermilion is classified as a mesotrophic lake with good water clarity as measured sporadically over the past 18 years by mean Secchi depth of approximately 8.5 feet. Continual annual monitoring can help track trends in water quality in the lake. There is not enough consecutive data to determine a trend. Total phosphorus and chlorophyll-a (values that provide a measure of the amount of algae in the water) are considered moderate with mean values 25.9 and 7.3 ug/L, respectively.

Table 1. Water quality data from different areas in Lake Vermilion

Bay	MPCA established site	Years with data	Trophic State	Mean Secchi depth (ft)	Phosphorus (ug/L)	Chlorophyll a (ug/L)
Wolf Bay	69-0378-01-220	1996-2003	NA	9.7	NA	NA
Everetts Bay	69-0378-01-118	1993	Mesotrophic/ Eutrophic	5.9	28.8	7.3
Head of Lakes Bay	NA	NA	NA	NA	NA	NA
Stuntz Bay	69-0378-01-123	NA	NA	NA	NA	NA
Wakemup Narrows	69-0378-02-212	1995-2003	Mesotrophic	9.7	NA	NA
	69-0378-02-131	2000,2008, 2015	Mesotrophic	9.8	22.9	7.0



Objectives of the Survey

This survey describes the aquatic plant community of Lake Vermilion including:

1. Vegetation data to include; plant taxa observed and the estimated abundance of each taxon.
2. Identification of starry stonewort and Eurasian/hybrid watermilfoil
3. Identification of taxa to the level of species when possible.
4. Frequency of occurrence of each taxon found, stating the number of points used as the denominator for the calculations.
5. Frequency of all aquatic plants found.
6. Estimation of abundance of species sampled using MN DNR ranking system.
7. Distribution map for common species.
8. Determination of any invasive aquatic plants.

Methods

The meandering delineation survey followed methodology described by Madsen (1999). Designated areas were selected upon arrival, and the boat was driven, meandering back and forth throughout each bay. A rake was thrown throughout the meander and a waypoint was recorded. Each taxa of plant on the rake was recorded along with the density of each plant and recorded. A Global Positioning System (GPS) unit was used to navigate the boat. Water depths at each site were recorded in 1-foot increments using an electronic depth finder.

Figure 2. Double headed garden rake used to sample vegetation

A double-headed, weighted garden rake attached to a rope (Figure 2) was used to survey vegetation. Vegetation that was found under the surface by use of the double-headed garden rake was assigned a number between 0 and 4; 0 being absent, 1 being rare (≤ 1/3 of the rake head covered), 2 being scattered (>1/3 but ≤ 2/3 of the rake head covered), 3 being common (>2/3 of the rake head covered), and 4 being abundant (plants over top of rake head). Plant identification followed Blickenderfer (2007).

Frequency of occurrence was calculated for each species as the number of sites in which a species occurred divided by the total number of sample sites. The average number of plants per rake sample was calculated as the total number of plants sampled divided by the number of sample locations.

Sampling points were also grouped by water depth and separated into 5 depth zones for analysis. Depth zones included less than 3 feet, 3-5 feet, 6-8 feet, 9-11 feet and >11 feet.

Survey Results

On July 29, July 31, and Aug 1, 526 points were observed and sampled for aquatic vegetation in designated sampling areas. Sampling occurred to a maximum depth of 14 feet; however, no plants were found to be growing beyond 11 feet of water. As depths increased beyond that range, the presence of vegetation decreased and became less dense (Figure 3).

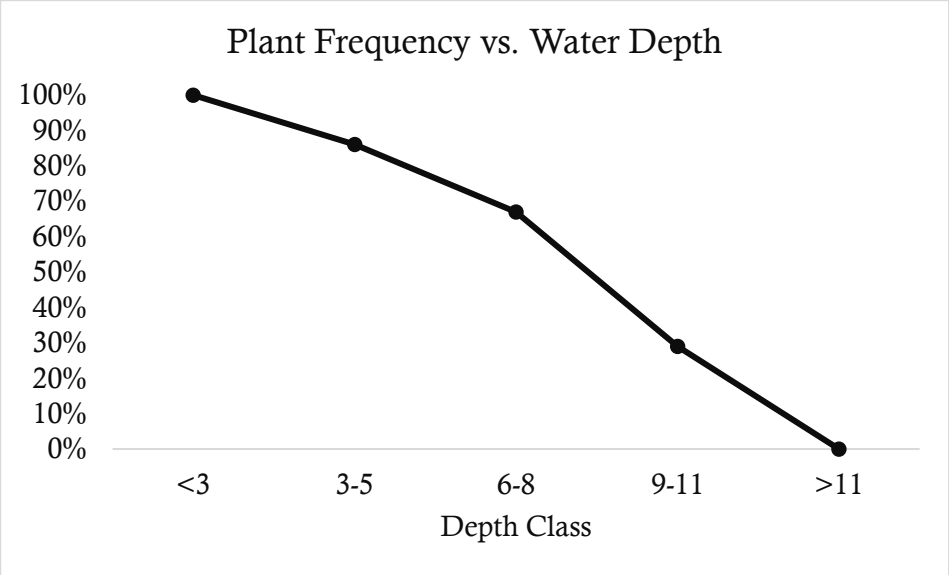


Figure 3: Plant frequency for each depth zone in Lake Vermilion.

Of the 526 sampled locations in Lake Vermillion, 150 sites had no vegetation present. The average number of plants per rake sample on Lake Vermilion was 1.6 for all sampled depths and 1.7 for points with depth less than 11 feet. Plant abundance was greatest between one and eight feet of water.

Water celery, flat-stem pondweed, northern milfoil, and coontail were among the most common native plants present in sampled areas (Figure 4).

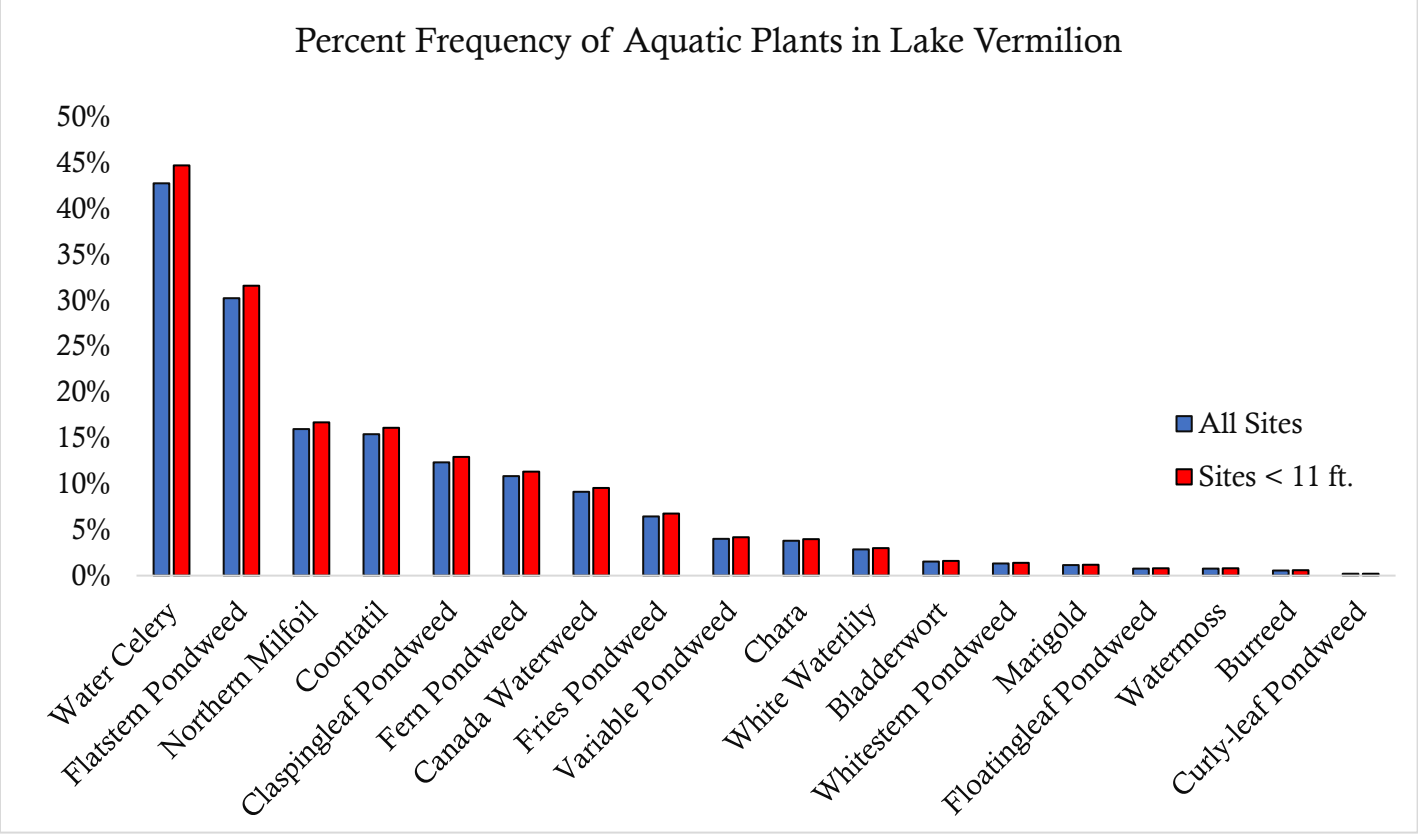


Figure 4: Frequency of aquatic plant species in Lake Vermillion, including curly-leaf pondweed and native plants

Table 2. Aquatic plants surveyed from Lake Vermilion, St. Louis County, MN.

Lake Vermilion				All sampled sites	Sites <11 feet
Life Form	**Common Name**	**Scientific Name**	**Count**	**Frequency (%)**	**Frequency (%)**
SUBMERGED – ANCHORED – These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants are often rooted or anchored to the lake bottom.	Water celery	*Vallisneria americana*	225	43%	45%
	Flat-stem pondweed	*Potamogeton zosteriformis*	159	30%	32%
	Northern milfoil	*Myriophyllum sibiricum*	84	16%	17%
	Coontail	*Ceratophyllum demersum*	81	15%	16%
	Clasping-leaf pondweed	*Potamogeton perfoliatus*	65	12%	13%
	Fern pondweed	*Potamogeton robbinsii*	57	11%	11%
	Canada waterweed	*Elodea canadensis*	48	9%	10%
	Fries pondweed	*Potamogeton friesii*	34	6%	7%
	Variable Pondweed	*Potamogeton gramineus*	21	4%	4%
	Chara	*Chara sp.*	20	4%	4%
	Common bladderwort	*Utricularia vulgaris*	8	2%	2%
	White-stem pondweed	*Potamogeton praelongus*	7	1%	1%
	Marigold	*Bidens beckeii*	6	1%	1%
	Water moss	*Fontinalis sp.*	4	1%	1%
	Curly-leaf Pondweed	*Potamogeton crispus*	1	1%	1%
FLOATING – LEAF – These plant leaves float on water and are anchored to the bottom of the lake.	White waterlily	*Nymphaea alba*	15	3%	3%
	Floating-leaf pondweed	*Potamogeton natans*	4	1%	1%
EMERGENT – These plants extend above the water surface and are found in shallow water.	American bur-reed	*Sparganium americanum*	1	1%	1%
Total number of plants (species diversity for the lake)			18		
Total number of plant occurrences			842		
Total number of sites			526		
Total number of sites <11			503		

Wolf Bay

Wolf Bay is located on the northwestern side of Lake Vermilion (Figure 5), north of Knotts' Island. Wolf Bay was sampled on 31 July 2019. 119 points were sampled all throughout the bay with 5 being the most amount of species sampled at one site (Figure 7). All but 12 sites had vegetation present, and those sites were deeper than 11 feet. Only one plant of curly-leaf pondweed was sampled, and it was found in the middle of the bay (Figure 8). Native plants found in Dago bay include flat-stem pondweed and northern watermilfoil (Figure 9 and 10).

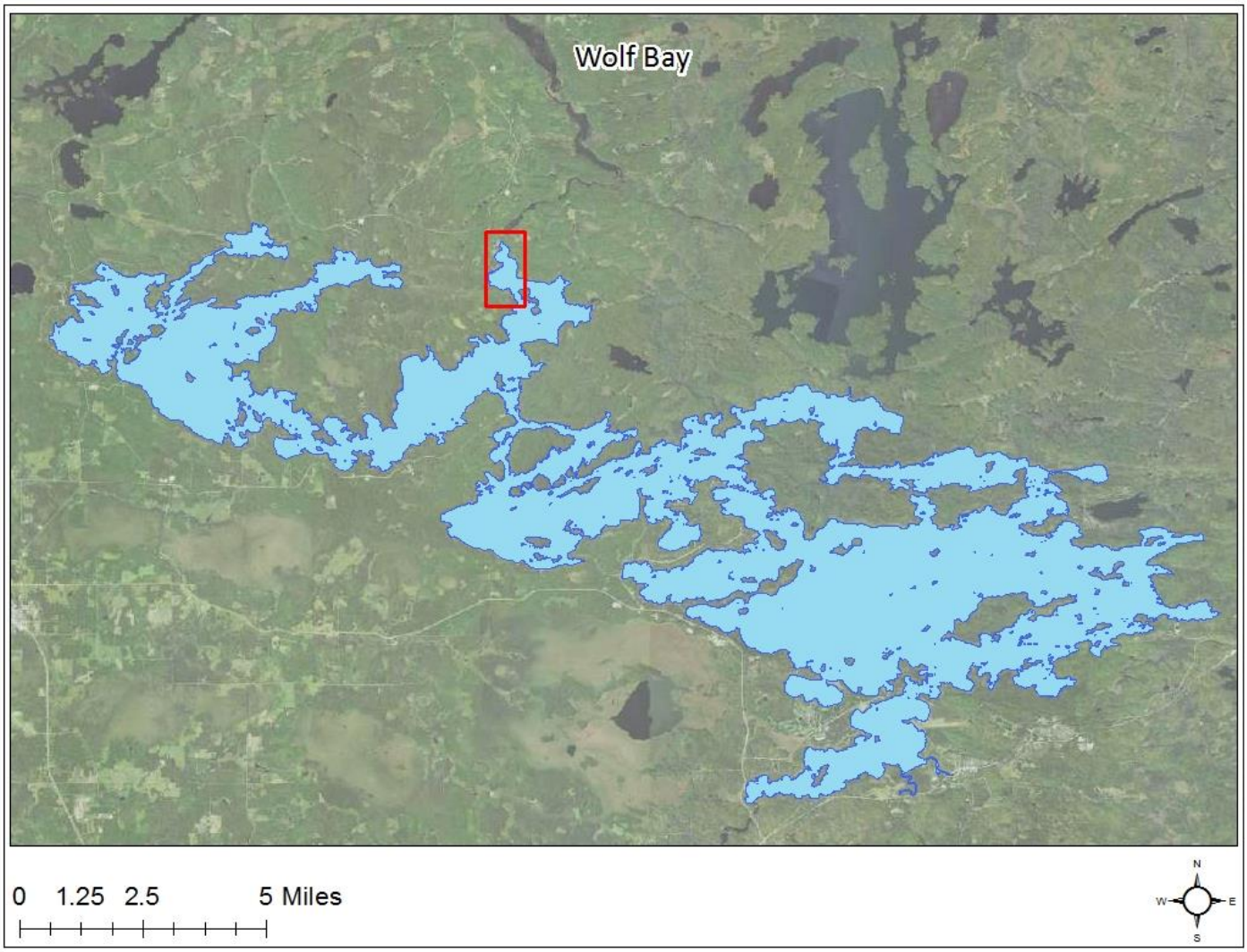


Figure 5: Location of Wolf Bay on Lake Vermilion in St. Louis County, MN.

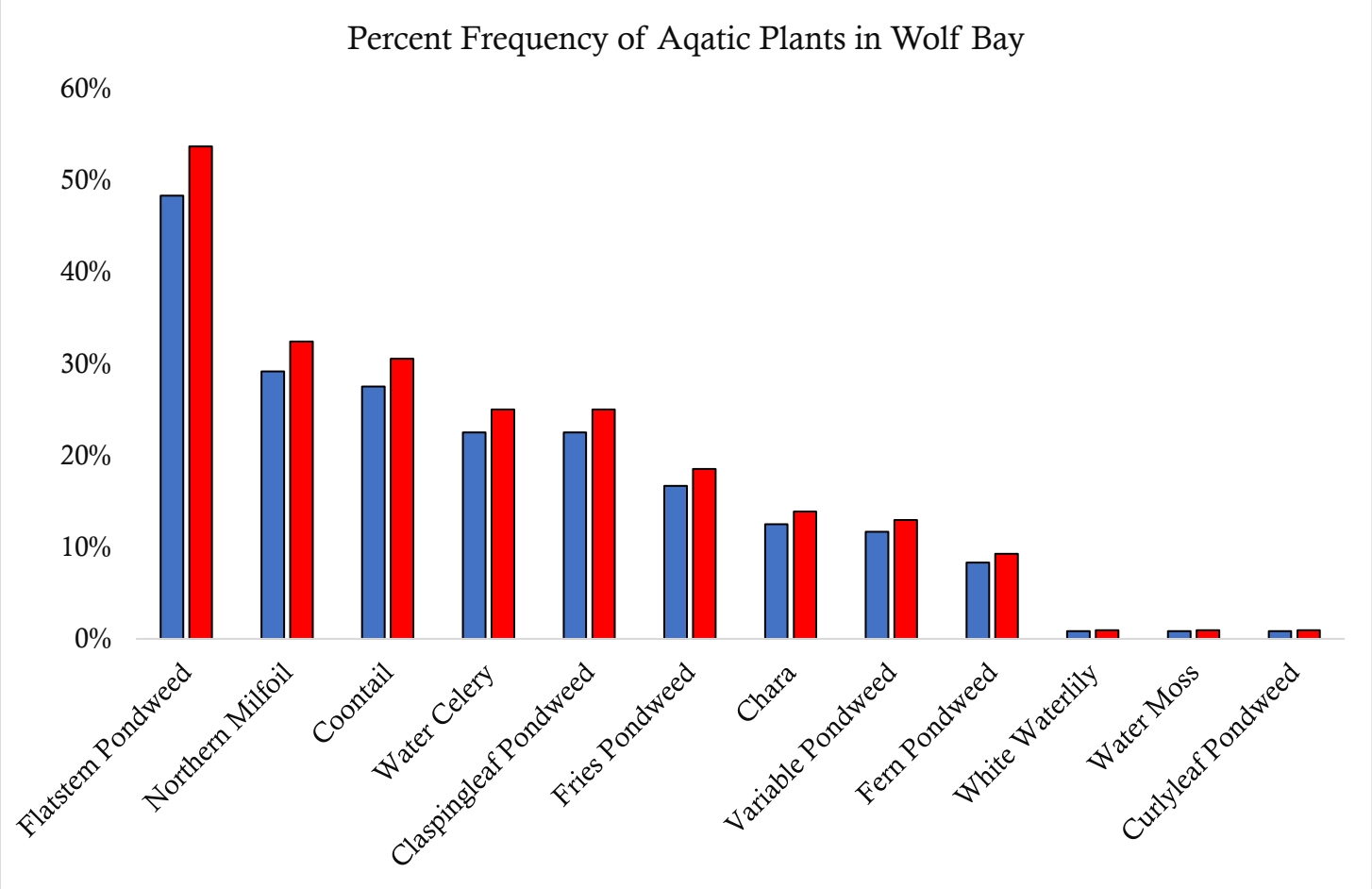


Figure 6: Frequency of plant species found in Wolf Bay on Lake Vermilion.

Table 3. Aquatic plants surveyed in Wolf Bay on Lake Vermilion, St. Louis County, MN: July 31, 2019.

Lake Vermilion				All sampled sites	Sites <11 feet
Life Form	**Common Name**	**Scientific Name**	**Count**	**Frequency (%)**	**Frequency (%)**
SUBMERGED – ANCHORED – These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants are often rooted or anchored to the lake bottom.	Flat-stem pondweed	*Potamogeton zosteriformis*	58	48%	54%
	Northern milfoil	*Myriophyllum sibiricum*	35	29%	32%
	Coontail	*Ceratophyllum demersum*	33	28%	31%
	Water celery	*Vallisneria Americana*	27	23%	25%
	Clasping-leaf pondweed	*Potamogeton perfoliatus*	27	23%	25%
	Fries pondweed	*Potamogeton freisii*	20	17%	19%
	Chara	*Chara sp.*	15	13%	14%
	Variable Pondweed	*Potamogeton gramineus*	14	12%	13%
	Fern pondweed	*Potamogeton robbinsii*	10	8%	9%
	Watermoss	*Fontinalis sp.*	1	1%	1%
	Curly-leaf Pondweed	*Potamogeton crispus*	1	1%	1%
FLOATING – LEAF – These plant leaves float on water and are anchored to the bottom of the lake.	White waterlily	*Nymphaea alba*	1	1%	1%
EMERGENT – These plants extend above the water surface and are found in shallow water.					
Total number of plants (species diversity for the bay)			12		
Total number of plant occurrences			242		
Total number of sites			120		
Total number of sites <11			108		

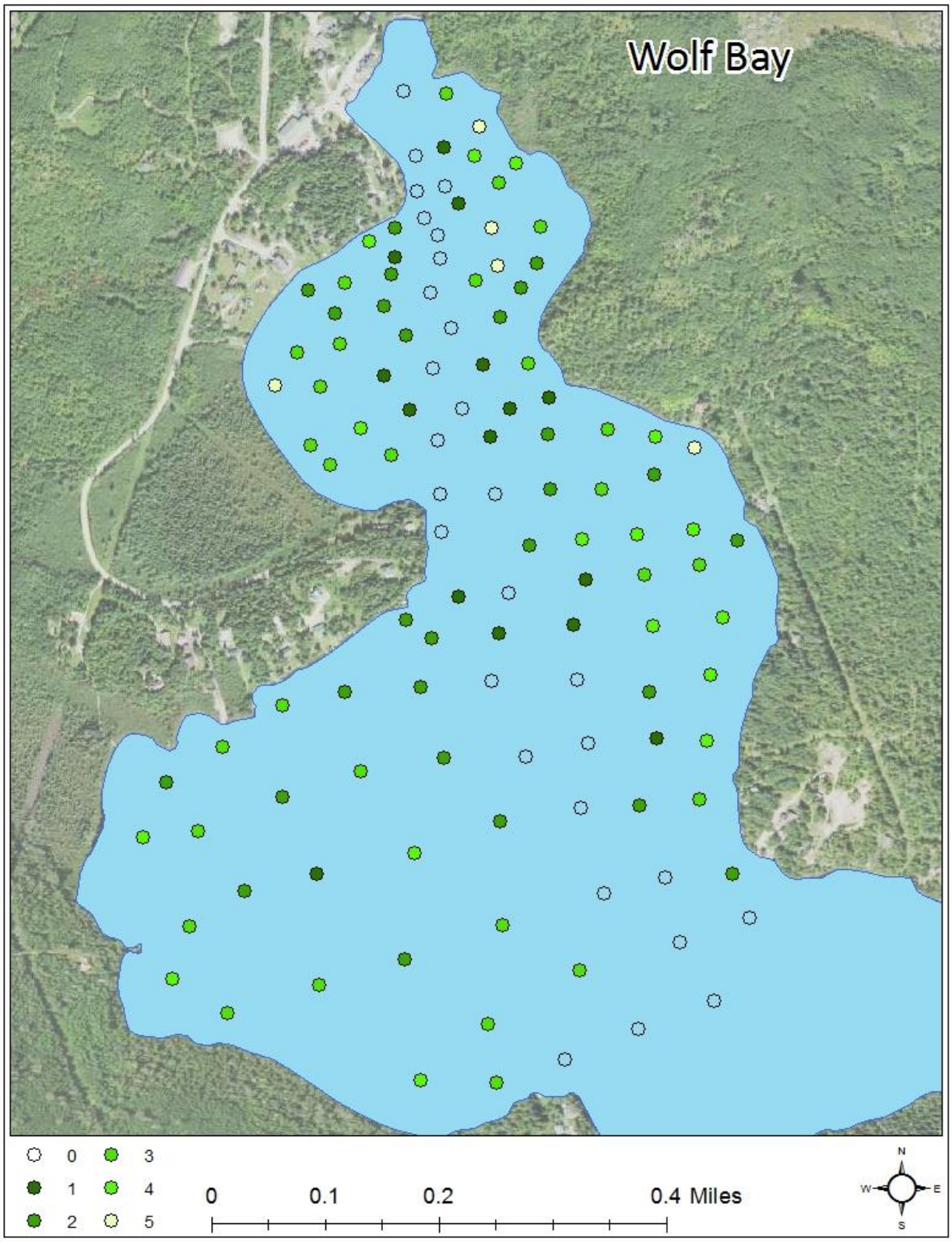


Figure 7: Number of plant species found at Lake Vermilion sample points in Wolf Bay.

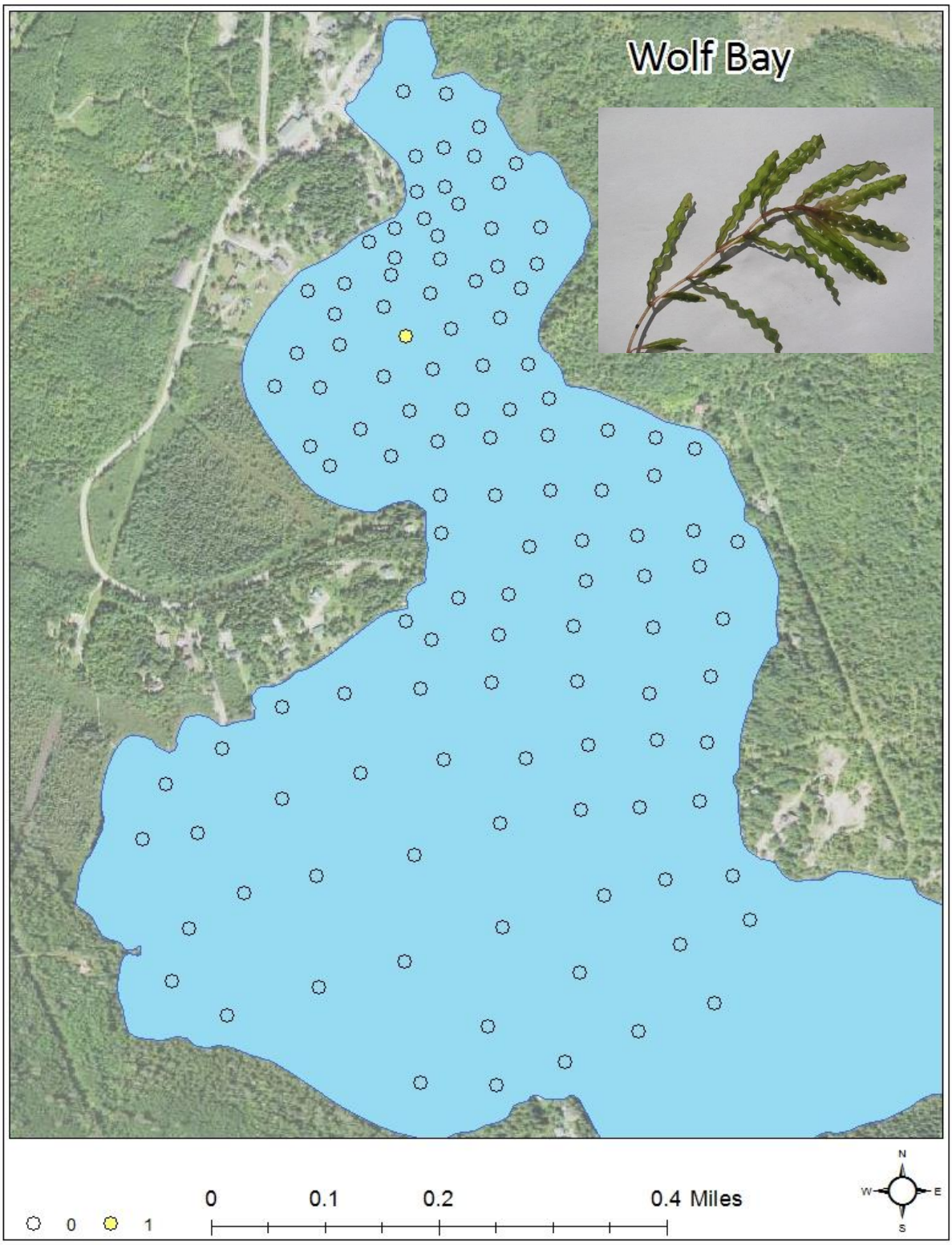


Figure 8: Curly-leaf pondweed found at Lake Vermilion in Wolf Bay

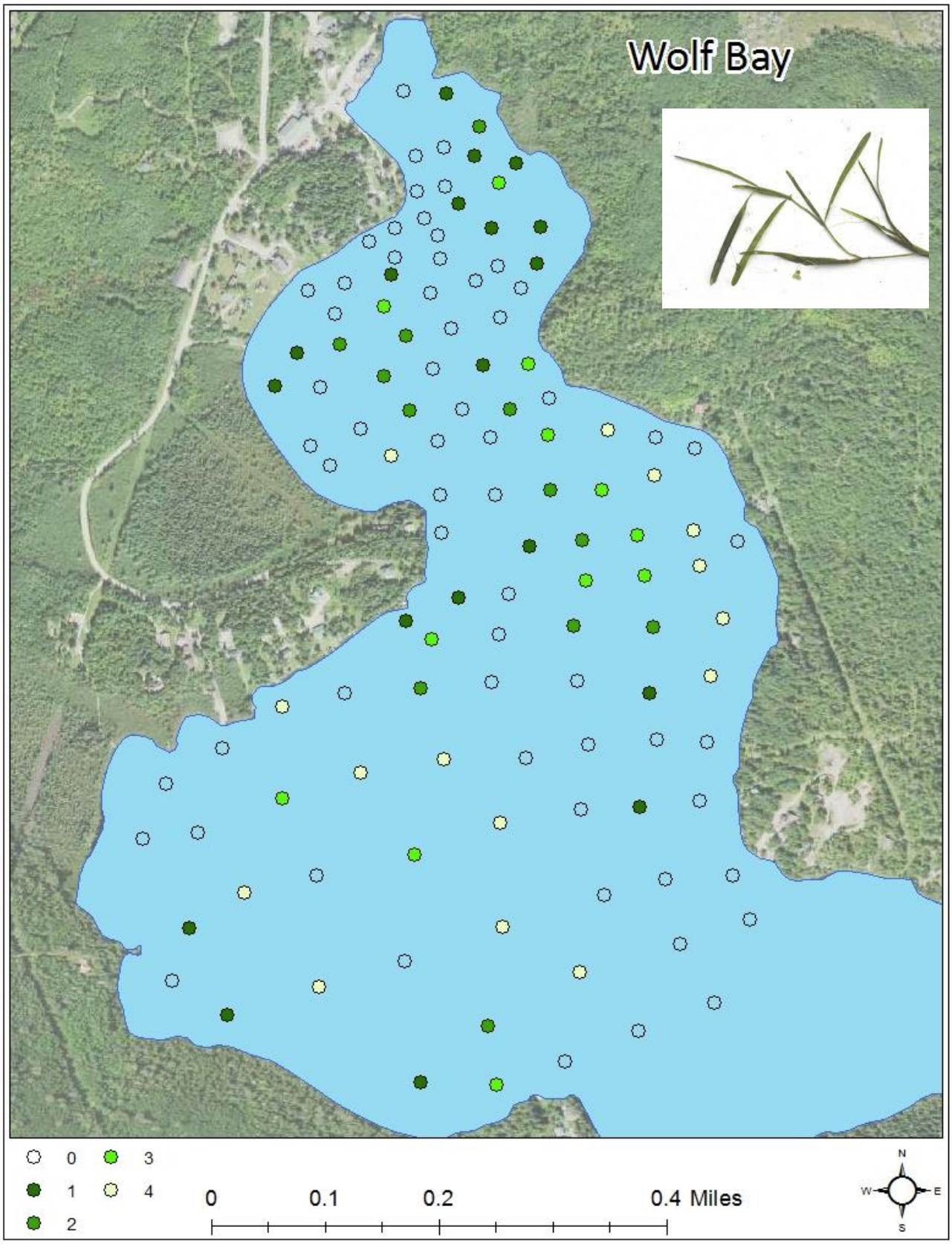


Figure 9: Density of Flat-stem pondweed at Lake Vermilion in Wolf Bay.

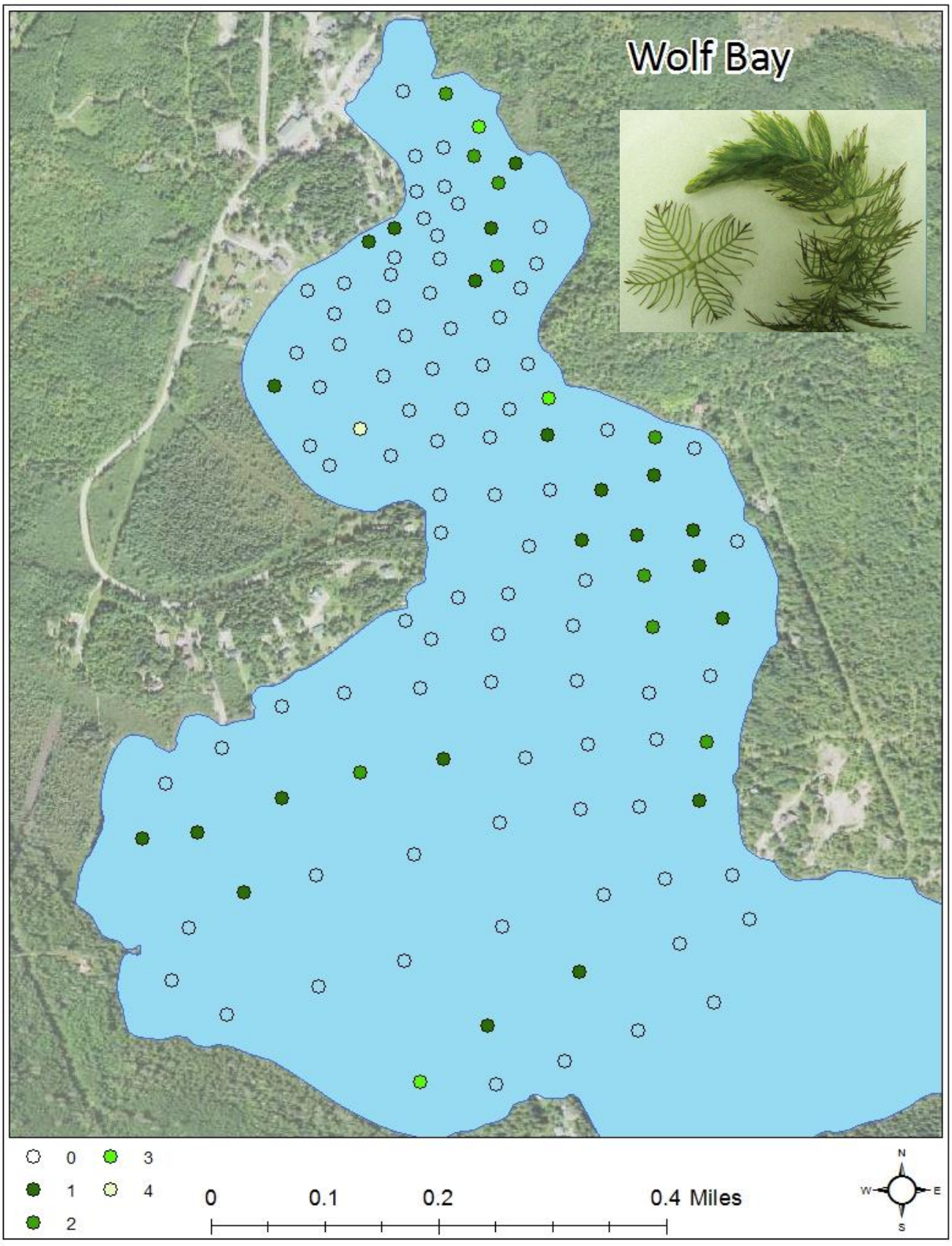


Figure 10: Density of northern watermilfoil at Lake Vermilion in Wolf Bay.

Stuntz Bay

Stuntz Bay is located on the southeast portion of Lake Vermilion (Figure 11) and was sampled on 29 July 2019. A total of 132 throughout the entire bay and 5 was the greatest number of species found at a site (Figure 13). All sample points were less than 12 feet in depth, but some points did not have vegetation due to the rocky substrate. No curly-leaf pondweed was only found in Stuntz Bay in 2019. Water celery and flat-stem pondweed and were among the common native plants found in Stuntz Bay (Figures 14 & 15).

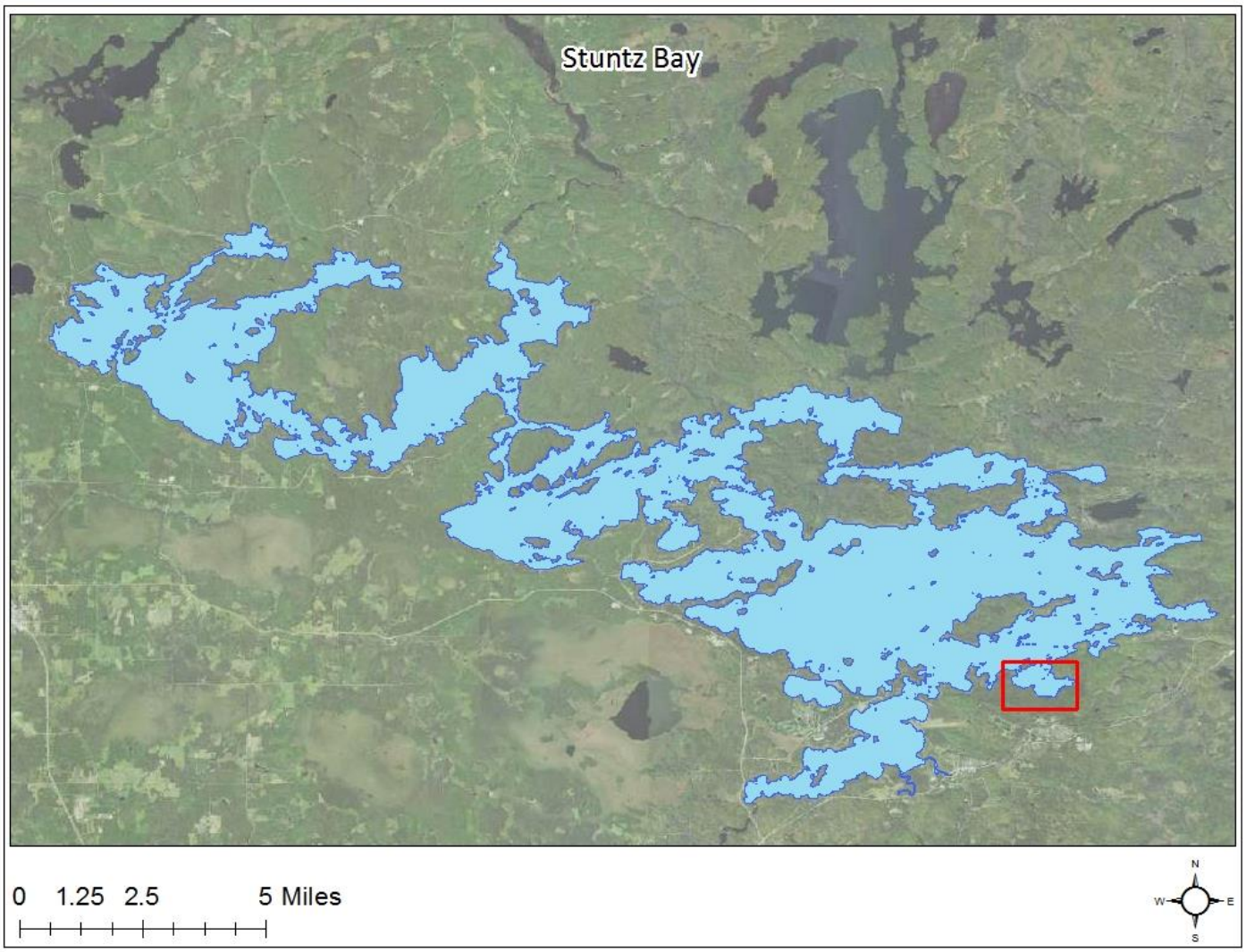


Figure 11: Location of Stuntz Bay, Lake Vermilion in, St. Louis County, MN.

Table 4. Aquatic plants surveyed from Stuntz Bay, Lake Vermilion, St. Louis County, MN: July 29 2019.

Lake Vermilion				All sampled sites	Sites <11 feet
Life Form	**Common Name**	**Scientific Name**	**Count**	**Frequency (%)**	**Frequency (%)**
SUBMERGED – ANCHORED – These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants are often rooted or anchored to the lake bottom.	Water celery	*Vallisneria Americana*	89	68%	69%
	Flat-stem pondweed	*Potamogeton zosteriformis*	45	34%	35%
	Northern milfoil	*Myriophyllum sibiricum*	27	21%	21%
	Coontail	*Ceratophyllum demersum*	25	19%	19%
	Clasping-leaf pondweed	*Potamogeton perfoliatus*	17	13%	13%
	Marigold	*Bidens beckii*	3	2%	2%
	Watermoss	*Fontinalis sp.*	3	2%	2%
	Bladderwort	*Utricularia vulgaris*	2	2%	2%
	Fern pondweed	*Potamogeton robbinsii*	1	1%	1%
	Fries pondweed	*Potamogeton freisii*	1	1%	1%
	Canada waterweed	*Elodea canadensis*	1	1%	1%
FLOATING – LEAF – These plant leaves float on water and are anchored to the bottom of the lake.	White waterlily	*Nymphaea alba*	6	5%	5%
	Floating-leaf pondweed	*Potamogeton natans*	3	2%	2%
EMERGENT – These plants extend above the water surface and are found in shallow water.					
Total number of plants (species diversity for the bay)			13		
Total number of plant occurrences			223		
Total number of sites			132		
Total number of sites <11			131		

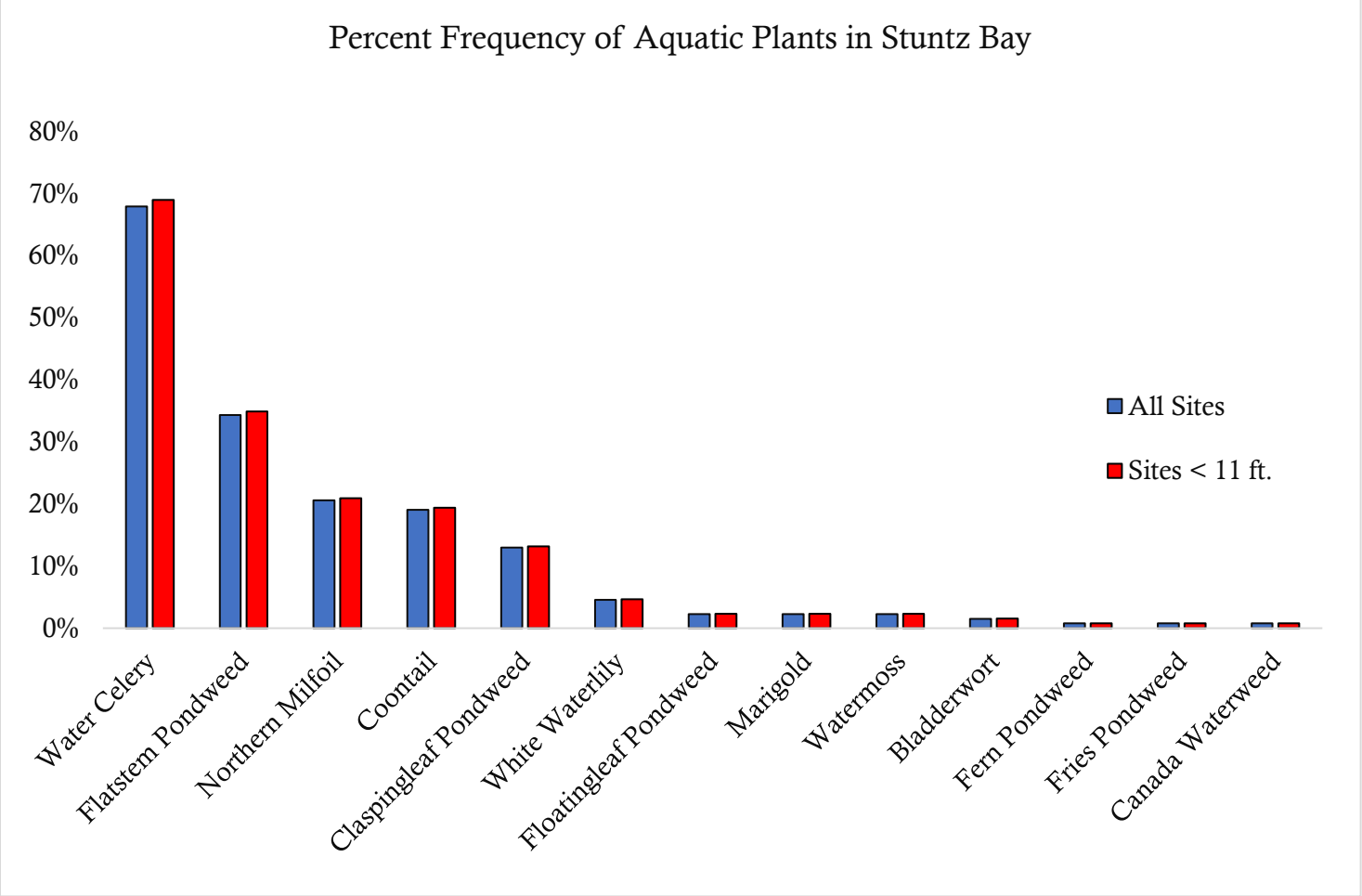


Figure 12: Percent frequency of aquatic plants in Stuntz Bay, Lake Vermilion in, St. Louis County, MN.

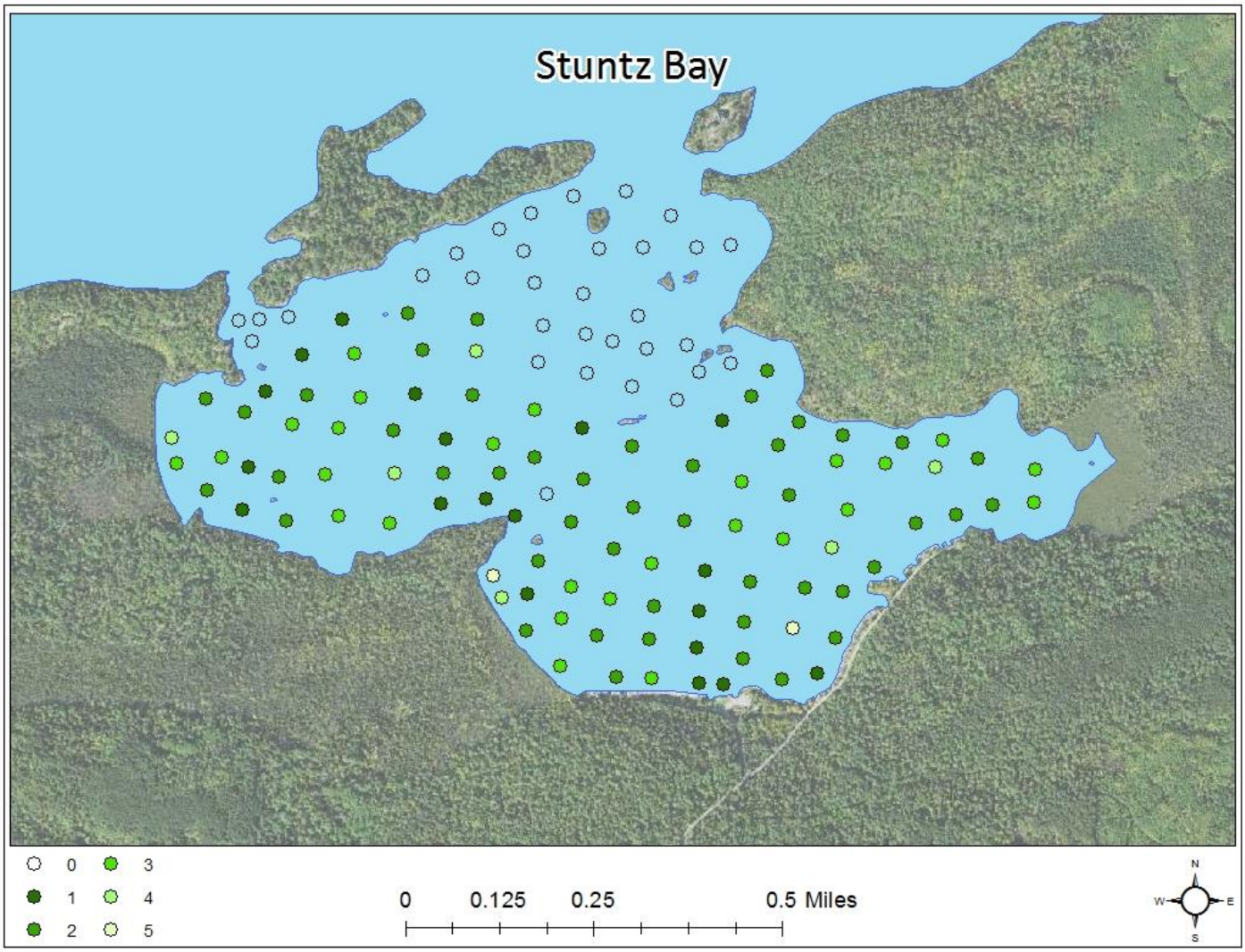


Figure 13: Number of plant species found at Lake Vermilion sample points in Stuntz Bay.

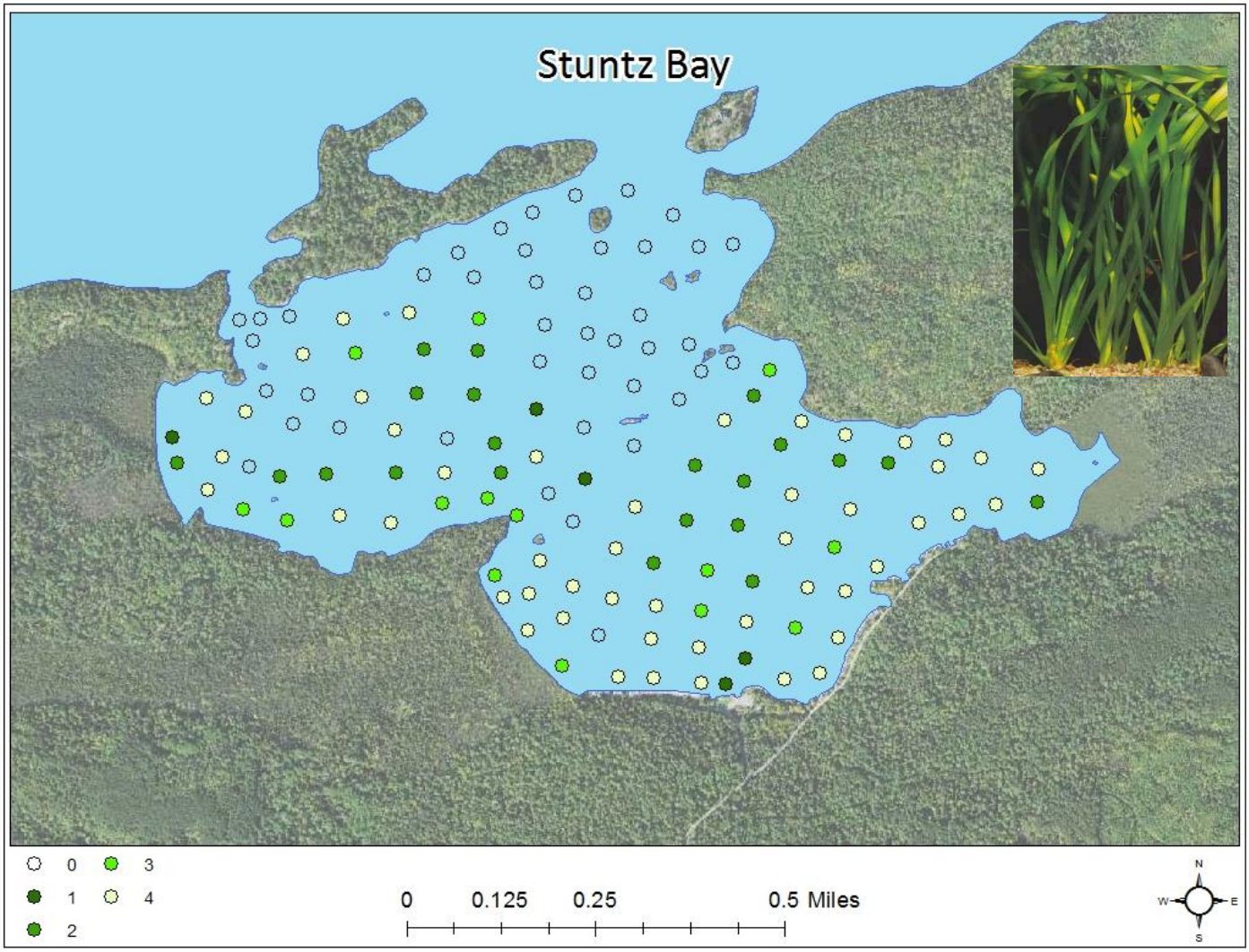


Figure 14: Abundance of water celery at Lake Vermilion sample points in Stuntz Bay.

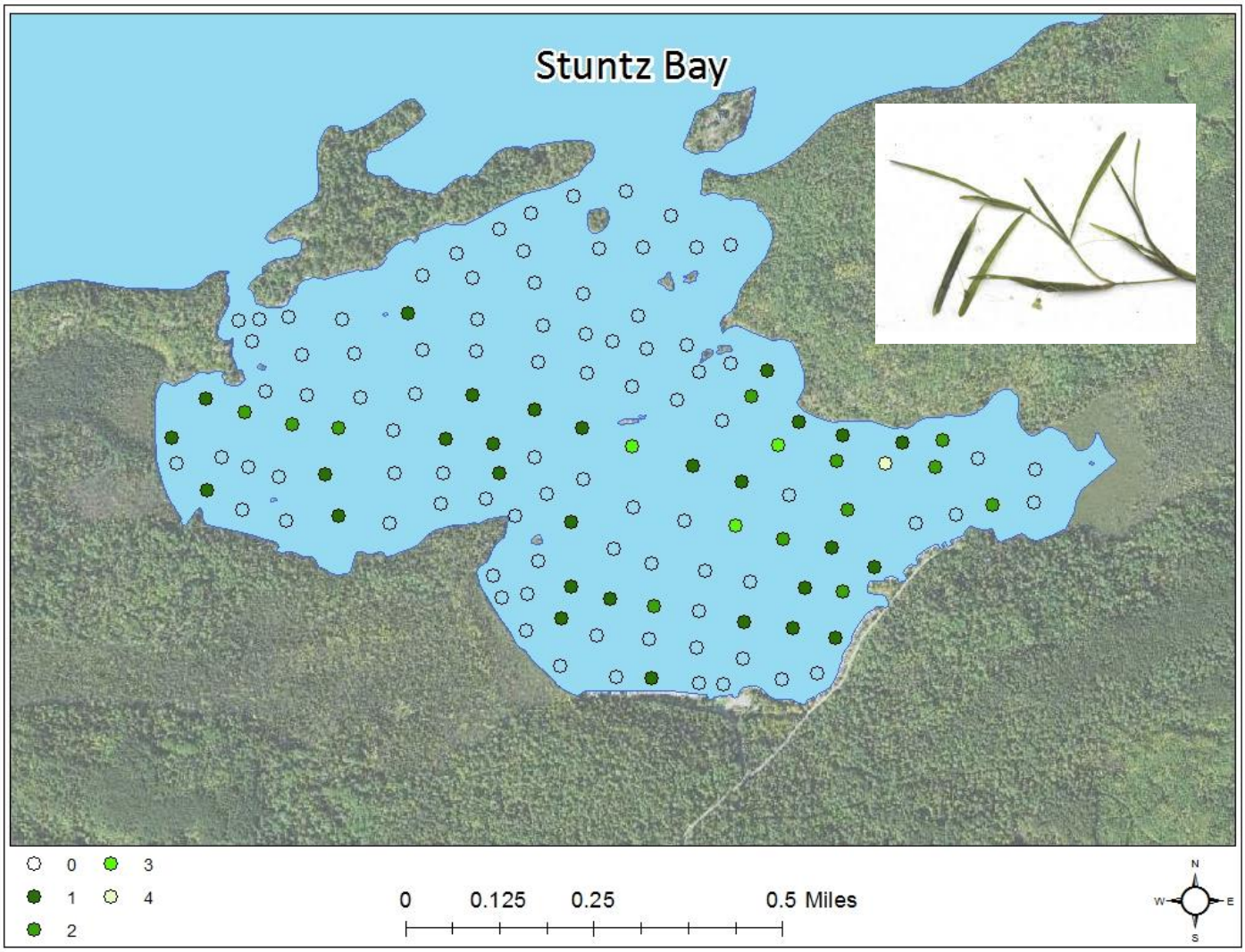


Figure 15: Abundance of flat-stem pondweed at Lake Vermilion sample points in Stuntz Bay.

Everett Bay

Everett Bay is located on the south portion of Lake Vermilion (Figure 16) and was sampled on 1 August 2019. There was a total of 129 sample points were throughout the entire bay and 5 was the greatest number of species found at a site (Figure 18). All sample points were less than 12 feet in depth, but some points did not have vegetation due to the rocky substrate. No curly-leaf pondweed was only found in Everett Bay in 2019. Water celery and flat-stem pondweed and were among the common native plants found in Everett Bay (Figures 19 & 20).

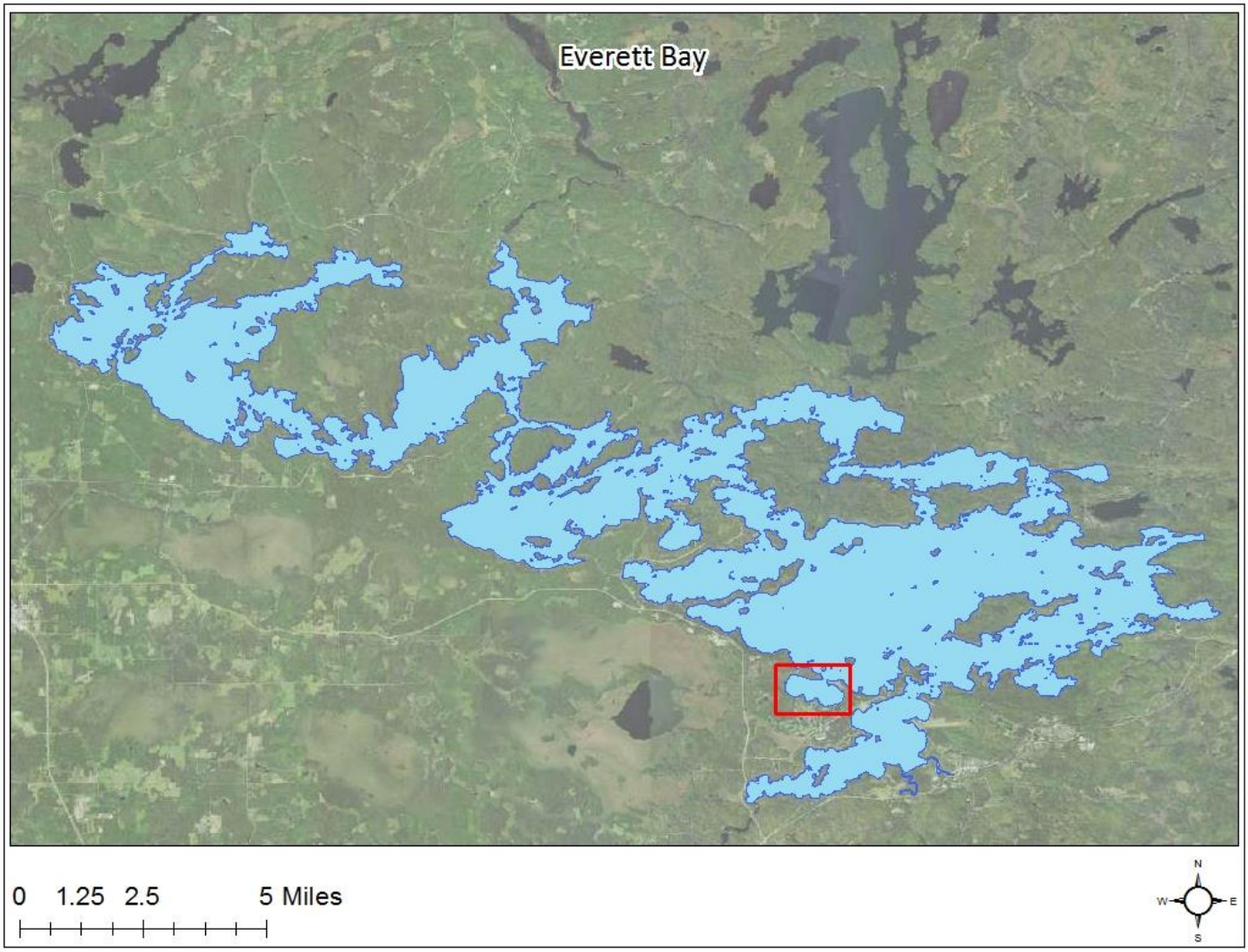


Figure 16: Location of Everett Bay on Lake Vermilion.

Table 5. Aquatic plants surveyed from Everett Bay, Lake Vermilion, St. Louis County, MN: August 1, 2019.

Lake Vermilion				**All sampled sites**
Life Form	**Common Name**	**Scientific Name**	**Count**	**Frequency (%)**
SUBMERGED – ANCHORED – These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants are often rooted or anchored to the lake bottom.	Water celery	*Vallisneria Americana*	65	51%
	Flat-stem pondweed	*Potamogeton zosteriformis*	48	38%
	Canada waterweed	*Elodea canadensis*	42	33%
	Fern pondweed	*Potamogeton robbinsii*	20	16%
	Northern milfoil	*Myriophyllum sibiricum*	17	13%
	Coontail	*Ceratophyllum demersum*	15	12%
	Clasping-leaf pondweed	*Potamogeton perfoliatus*	14	11%
	White-stem pondweed	*Potamogeton praelongus*	7	5%
	Bladderwort	*Utricularia vulgaris*	4	3%
	Chara	*Chara sp.*	4	3%
	Marigold	*Bidens beckii*	3	2%
	Variable pondweed	*Potamogeton gramineus*	2	2%
FLOATING – LEAF – These plant leaves float on water and are anchored to the bottom of the lake.	White waterlily	*Nymphaea alba*	4	3%
EMERGENT – These plants extend above the water surface and are found in shallow water.				
Total number of plants (species diversity for the bay)			13	
Total number of plant occurrences			245	
Total number of sites			129	
Total number of sites <11			129	

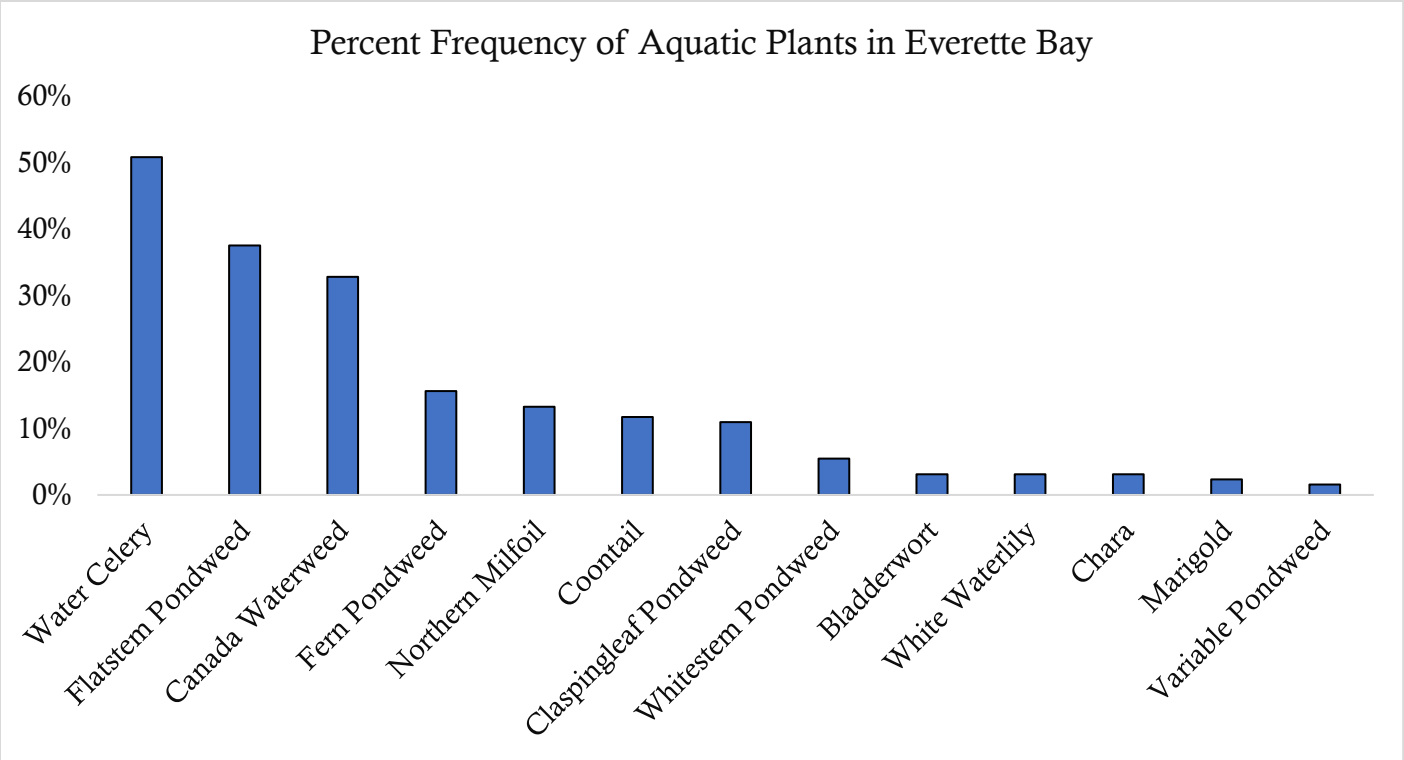


Figure 17: Percent frequency of aquatic plants in Everett Bay, Lake Vermilion in, St. Louis County, MN.

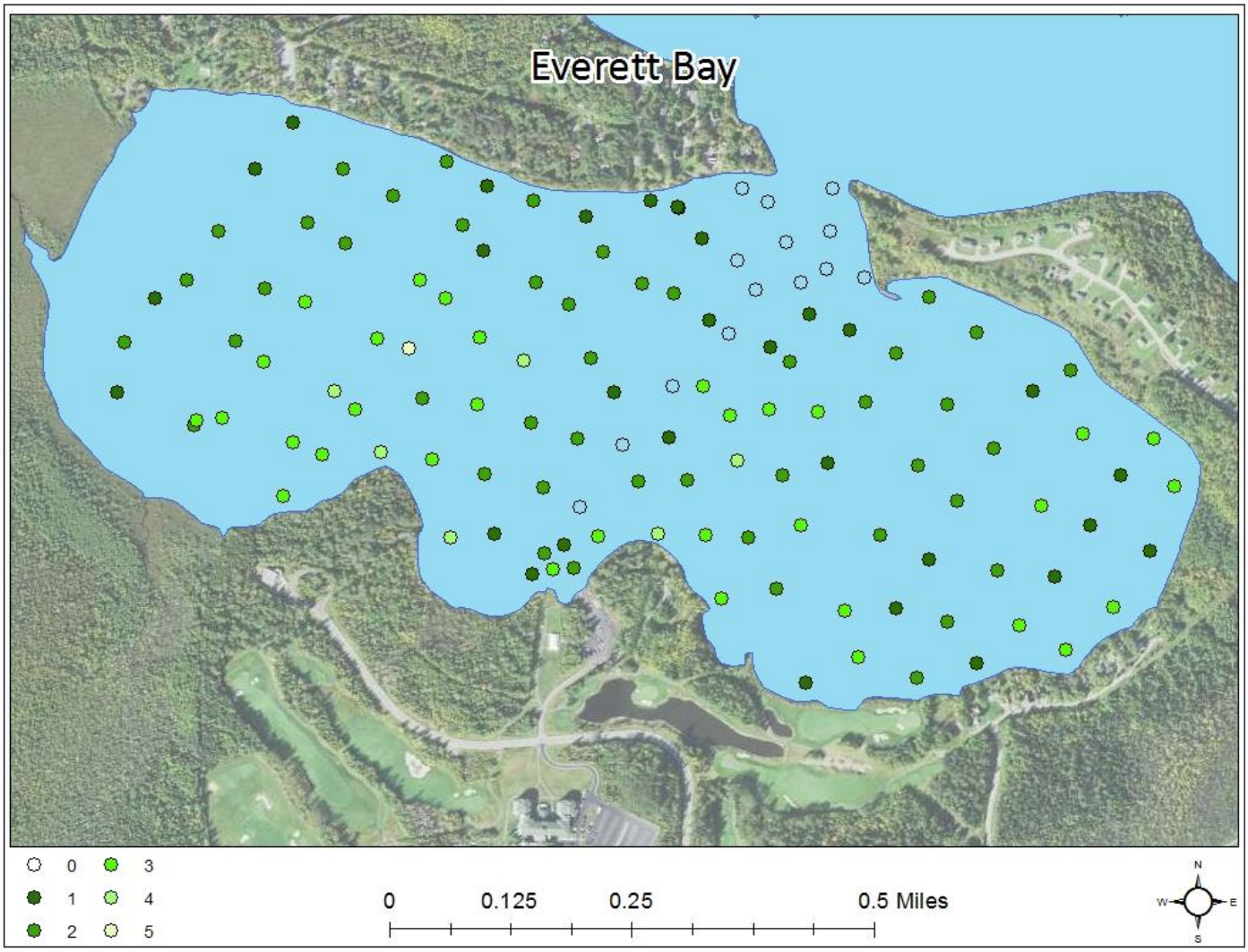


Figure 18: Number of plant species found at Lake Vermilion sample points in Everett Bay.

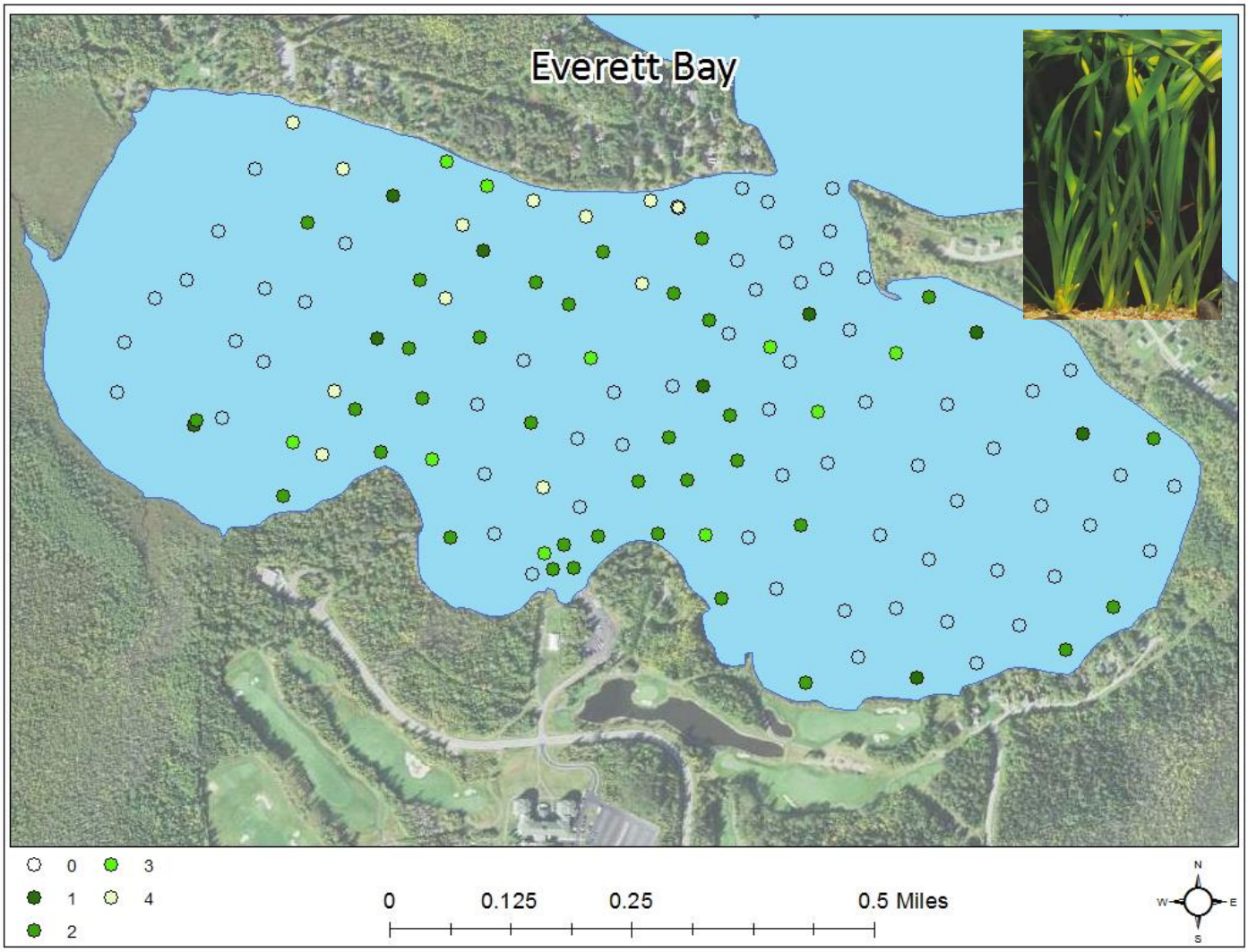


Figure 19: Abundance of water celery at Lake Vermilion sample points in Everett Bay.

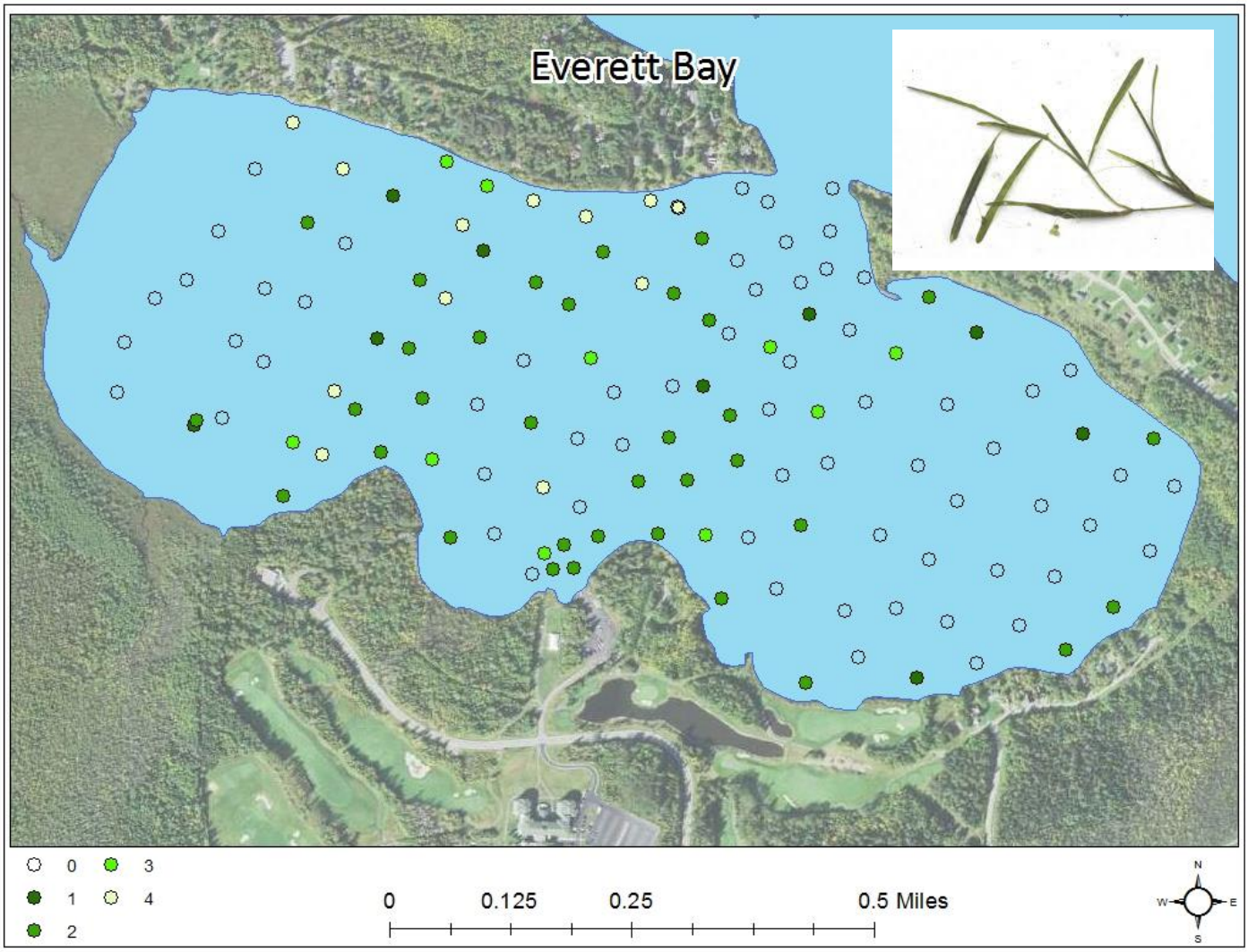


Figure 20: Abundance of flat-stem pondweed at Lake Vermilion sample points in Everett Bay.

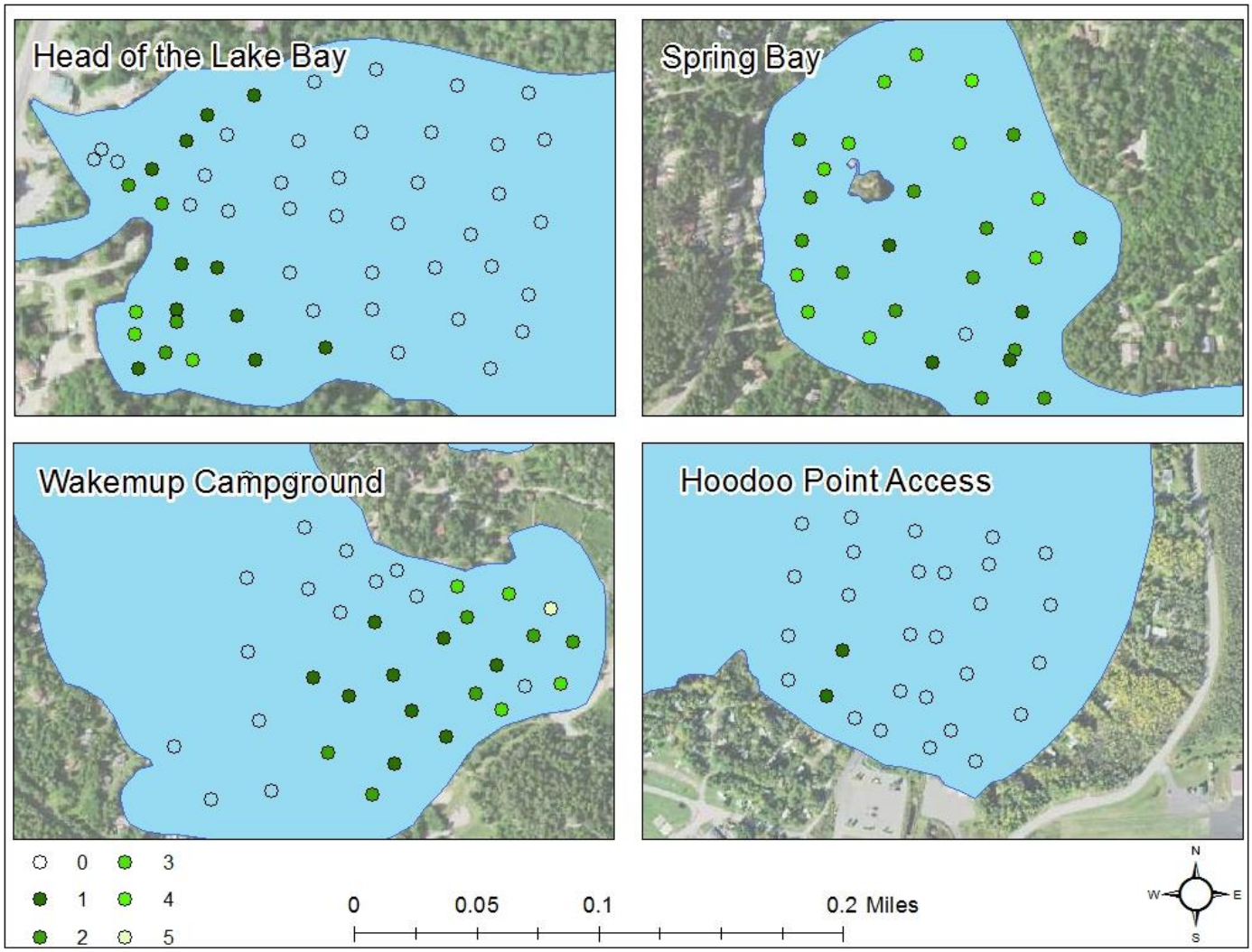


Figure 20: Plant abundance at various areas of Lake Vermilion.

Several native plants were found throughout these sampling areas. In head of the Lake Bay, the most abundant plants included water celery (13) and clasping-leaf pondweed (4). In Spring Bay, there was an abundance of vegetation. Nearly all sample points had at least one species of vegetation. A couple of the more common plants were water celery (24) and fern pondweed (16). In front of the Wakemup access and campground, there was plenty of vegetation in the southeastern portion of the bay. Fries pondweed (7) and fern pondweed (6) were two of the more common plants found in this bay. Very little vegetation was found in front of the Hoodoo Point access even though it was shallow throughout the sampling area with an average depth of around 4 feet. Only one bladderwort plant and one water celery plant were found in front of the public access. These areas remain important to check as they are popular areas with high boating traffic. Careless transport of watercraft could lead to an infestation of starry stonewort or other AIS in Lake Vermilion.

Discussion

Lake Vermilion is a moderately deep lake for northern Minnesota. The presence of plants and the depth at which one finds them is related to the water clarity. In areas where the sunlight does not reach the lake's bottom, there will not be plants present. Lake Vermilion has an average clarity of 7-10 feet depending upon the bay, and greatest numbers of plants were found between 1-8 feet of water.

The Minnesota DNR lists the littoral area of Lake Vermilion to be approximately 38% of the total surface area, and the findings of this plant survey support these findings. In general, the littoral area is approximated as the area of the lake that is 15 feet deep or less; in this plant survey, no plants were found deeper than 12 feet. Plants are also limited by the stained water of Lake Vermilion. Water is naturally darker in Lake Vermilion due to the watershed being comprised of bedrock, and it is also located in a heavy mining area.

Curly-leaf pondweed was the only invasive species found on Lake Vermilion; however, it was not wide-spread. Only one plant was sampled in Wolf Bay in 2019. Curly leaf has also historically been in the west side of Everett Bay near the public access, however none was found this year, likely due to the timing of the survey.

Aquatic plant communities are important to a body of water because of their ability to maintain water clarity and good fish habitat. Plants in all lakes lock up nutrients in their tissues which limit algae growth keeping lakes clear and healthy. Aquatic plants produce oxygen throughout the water column as a byproduct of photosynthesis, which oxygenates the water column. Plants also help to keep the sediments stable at the bottom of the lake and prevent it from mixing into the water column. Tiny invertebrates called zooplankton eat algae and use plants as a hiding place from predators such as perch, sunfish, and crappies.

Unfortunately, if a lake isn't taken care of, the water can become green and murky (switch to the turbid state). If large areas of plants are removed, the sediments can get churned up and nutrients are released. If there are fewer plants to use the nutrients, the algae will use the nutrients and multiply. Once the water is "green" with dense algae, these lakes have mostly muck on the bottom instead of plants because the sunlight can't get through the dense algae to the bottom of the lake. Algae-dominated shallow lakes are also not as high of quality habitat for fish and wildlife. If the plants are gone there is no place for aquatic animals to hide. The natural state of the littoral area in lakes is to have abundant aquatic vegetation and clear water.

What Local Residents Can Do

- Leave large plant beds alone. Only clear a small area by your dock from swimming. Removal of large areas of plants destabilizes the sediment and causes phosphorus to come up to the surface of the lake and cause algae blooms. It also leaves that area open for invasive species to establish.
- Protect the lake from additional phosphorus by installing vegetative buffers along the lakeshore to slow and filter runoff.
- Protect the lake from additional phosphorus and harmful bacteria by properly maintaining your septic system and picking up pet waste.
- Learn what aquatic invasive plants look like and check around your dock periodically throughout the summer.
- Have a couple people designated to check around the public accesses for any new invasive plants periodically throughout the summer.

Lake Learning

Aquatic Plants – Good or Bad?

If you've spent any length of time at your favorite Minnesota lake, chances are you're no stranger to aquatic plants. Maybe you've cast into lily pads looking for bass, watched minnows dart to safety in plant beds, pulled in an anchor covered with green vegetation, or waded through a few plants while swimming.

Figure 2. Native beneficial aquatic plants.

Unfortunately, most people see aquatic plants as problems. They perceive lakes or lakeshores with lots of so-called "weeds" as messy and in need of cleaning. But what a cabin owner sees as a weedy mess is an essential part of a lake's or river's ecosystem (MN DNR).

Aquatic plant communities are important to a body of water because of their ability to maintain water clarity and good fish habitat. Plants in all lakes lock up nutrients in their tissues which limit algae growth keeping lakes clear and healthy. Aquatic plants produce oxygen throughout the water column as a byproduct of photosynthesis, which oxygenates the water column. Plants also help to keep the sediments stable at the bottom of the lake and prevent it from mixing into the water column. Tiny invertebrates (zooplankton and aquatic insects) eat algae and use plants as a hiding place from predators such as perch, sunfish and crappies.

The presence of plants and the depth at which one finds them is related to the water clarity. In areas where the sunlight does not reach the lake's bottom (usually deep areas), there won't be plants present.

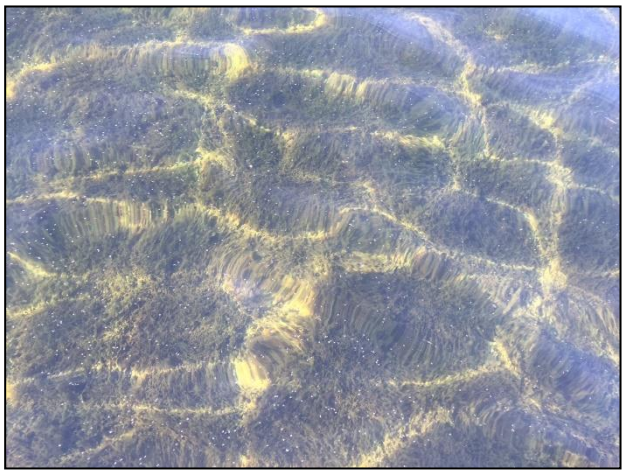


Figure 3. A Muskgrass (Chara) meadow in clear water.

Minnesota is home to about 150 species of aquatic plants, most of which are native species. Certain native plants can be water quality indicators. Muskgrass (*Chara*) is found more often in lakes with good water clarity. Though it gives off a 'musky' odor when brought to the surface, it is a great bottom stabilizer and slows the suspension of sediments; therefore, large communities of it can greatly benefit water quality and clarity. This plant is also wonderful habitat for fish and is a favorite food for waterfowl.

Bladderwort is a very interesting native aquatic plant. It is carnivorous and captures small invertebrates with its bladder-like traps. Despite their small size, the traps are extremely sophisticated. The prey brush against trigger hairs connected to the trapdoor. The bladder, when "set", is under negative pressure in relation to its environment so that when the trapdoor is mechanically triggered, the prey, along with the water surrounding it, is sucked into the bladder. Once the bladder is full of water, the door closes again, the whole process taking only ten to fifteen milliseconds

Bulrush is very important to a lake for many reasons. It provides spawning habitat for crappies, filters the water, and helps to prevent shoreline erosion by acting as a wave break. It is imperative to protect bulrush beds in lakes for these reasons. Larger leave plants, such as the pondweeds, are important spawning and hiding areas for panfish.

Figure 4. Bladderwort, a carnivorous aquatic plant that is common in Minnesota lakes.

Homeowners should be careful not to cut or remove large areas of native plants in the lake. When aquatic plants are uprooted, the lake bottom is disturbed, and the phosphorus in the water column gets used by algae instead of plants. This contributes to "greener" water and more algae blooms. Protecting native aquatic plant beds will ensure a healthy lake and healthy fishery. If a swimming area is necessary in front of people's docks, clear only a small area of plants. Clearing a whole 100 foot frontage is not necessary and can contribute to additional algae blooms. The natural, healthy state of shallow lakes and bays is to have clear water and abundant native plant growth.

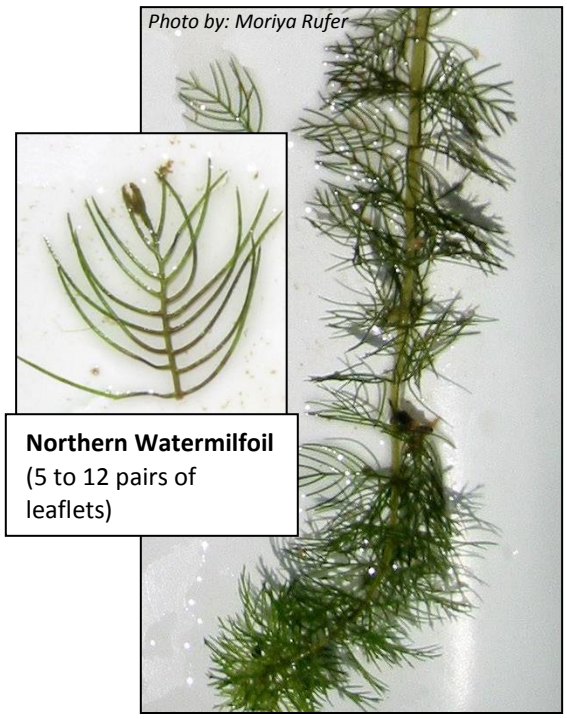
Some aquatic plants in Minnesota are not native and they may cause problems. Control of these species may be done to reduce interference with boating or swimming, to reduce the risk of spread of invasive species to un-infested water-bodies, or in some situations to attempt to produce ecological benefits such as increases in native plant communities. A DNR permit is needed for removal of aquatic plants including aquatic invasive species, and also for plant control devices such as weed rollers.

Resources
DNR Guide to Aquatic Plants: https://www.dnr.state.mn.us/shorelandmgmt/apg/index.html
Permits to control aquatic plants: https://www.dnr.state.mn.us/shorelandmgmt/apg/permits.html
DNR AIS Specialists: https://www.dnr.state.mn.us/invasives/ais/contacts.html
AIS permits: https://www.dnr.state.mn.us/invasives/training_permits.html

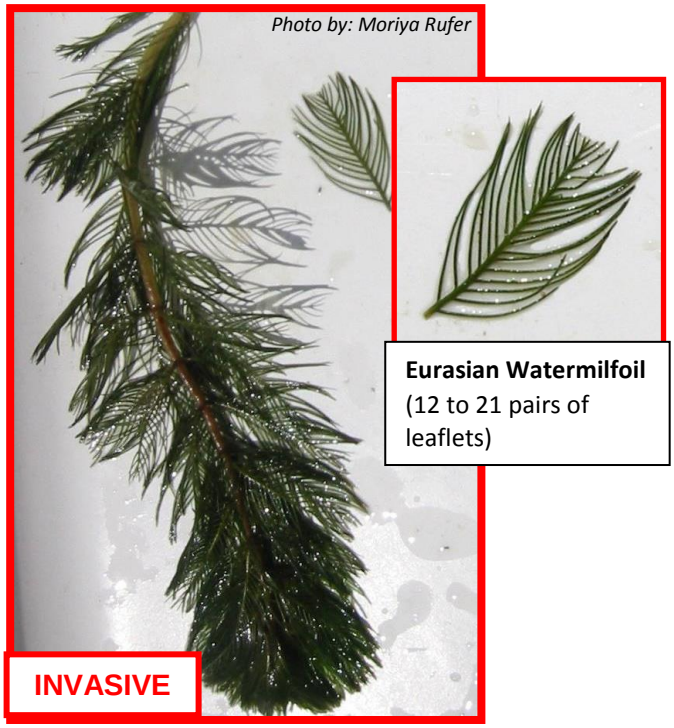
Enjoy the lakes! This article was written and shared by Moriya Rufer at RMB Environmental Laboratories as part of continuing education for their Lakes Monitoring Program (218-846-1465, lakes@rmbel.info). To learn more, visit www.rmbel.info.

Aquatic Plants In Minnesota Lakes

Compiled by Emelia Hauck Jacobs and Moriya Rufer, RMB Environmental Laboratories, Inc, 218-846-1465, rmbel.info

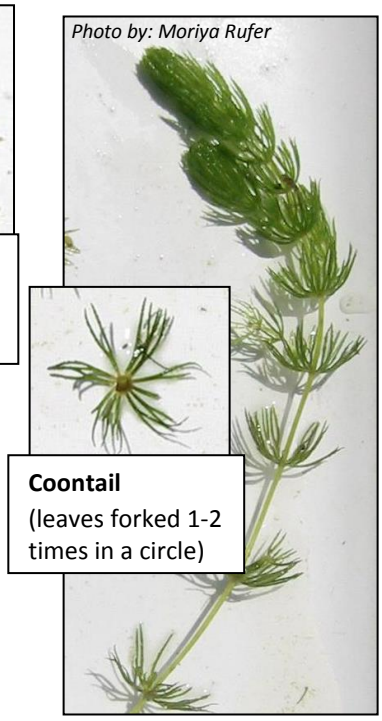


Northern Watermilfoil
(*Myriophyllum exalbescens)*

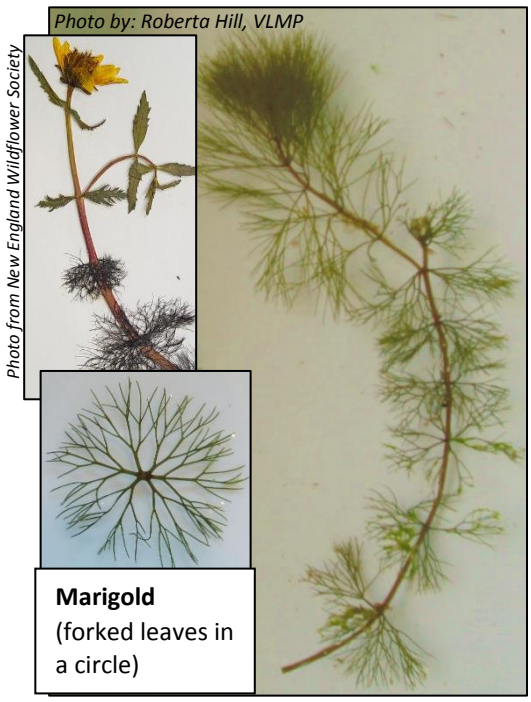


Eurasian Watermilfoil
(*Myriophyllum spicatum)*

Bladderwort
(*Utricularia vulgaris*)



Coontail
(Ceratophyllum demersum)



Water Marigold
(Bidens beckii)

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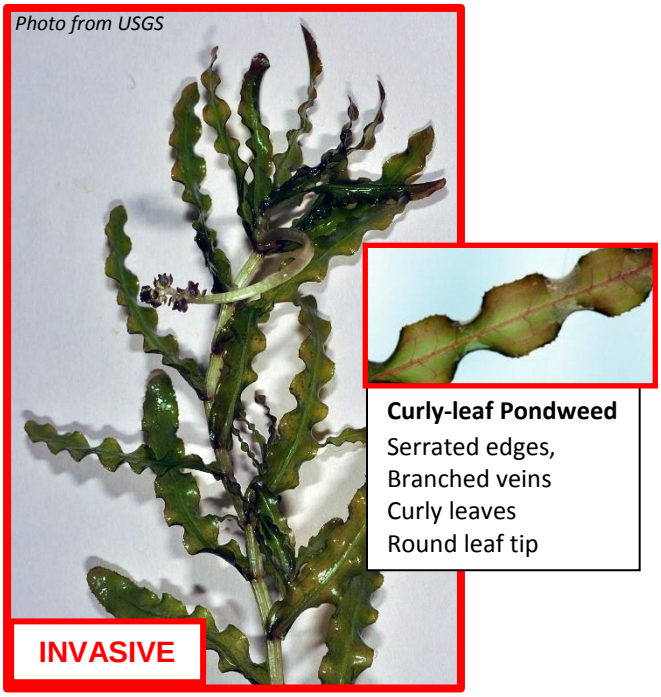
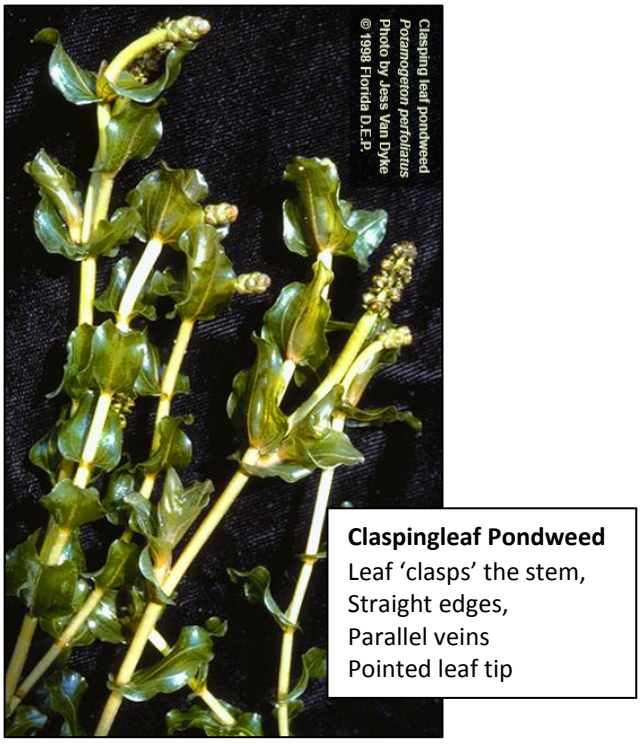


Curly-leaf Pondweed
(*Potamogeton crispus*)

Whitestem Pondweed
(*Potamogeton praelongus*)



Claspingleaf Pondweed
(*Potamogeton richardsonii*)

Robbin's Pondweed
(*Potamogeton robinsii)*

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Chara
(*Chara spp.*)

Starry Stonewort
(*Nitellopsis obtuse)*

Sago Pondweed
(*Potamogeton pectinatus)*

Brittle Naiad
(*Najas minor)*

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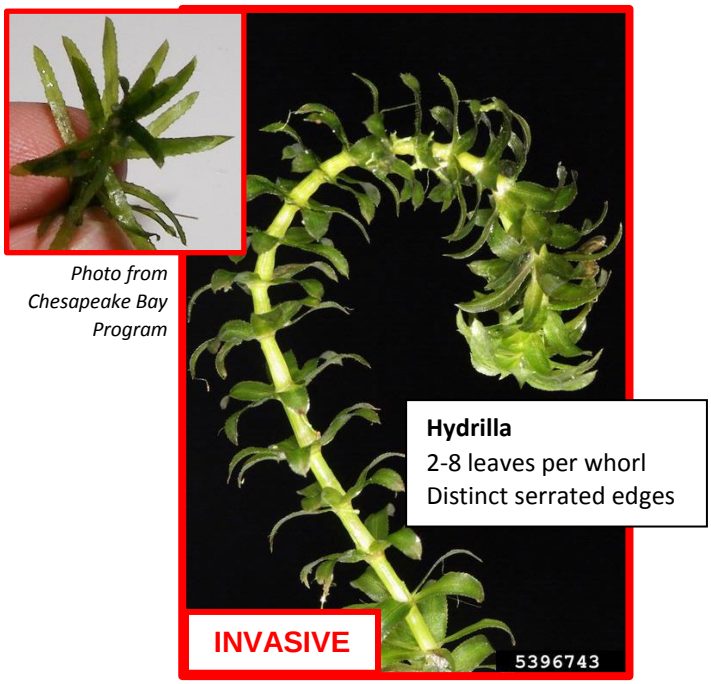
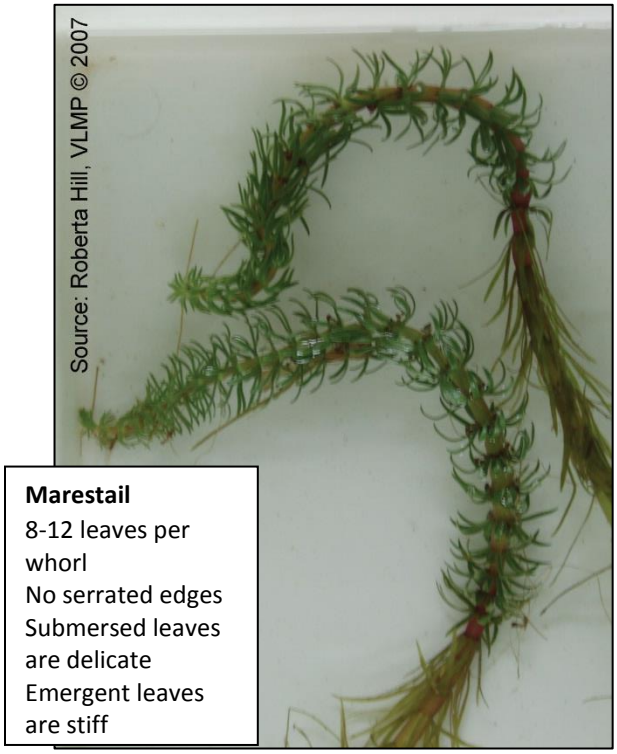
Brazilian Elodea
(Egeria densa)



Hydrilla
(*Hydrilla verticillata*)

Canada Waterweed
(Elodea canadensis)



Marestail
(*Hippuris vulgaris)*

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