RMB Environmental Laboratories, Inc.

Lake Vermilion 69-0378-00 St. Louis County

Aquatic Vegetation Point-intercept Survey

Survey Date	27 June – 28 June 2018
Observers	Phillip Oswald and Katherine Millette
Date of Report	12 July 2018
Report Author	Phillip Oswald, Moriya Rufer

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 is 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.

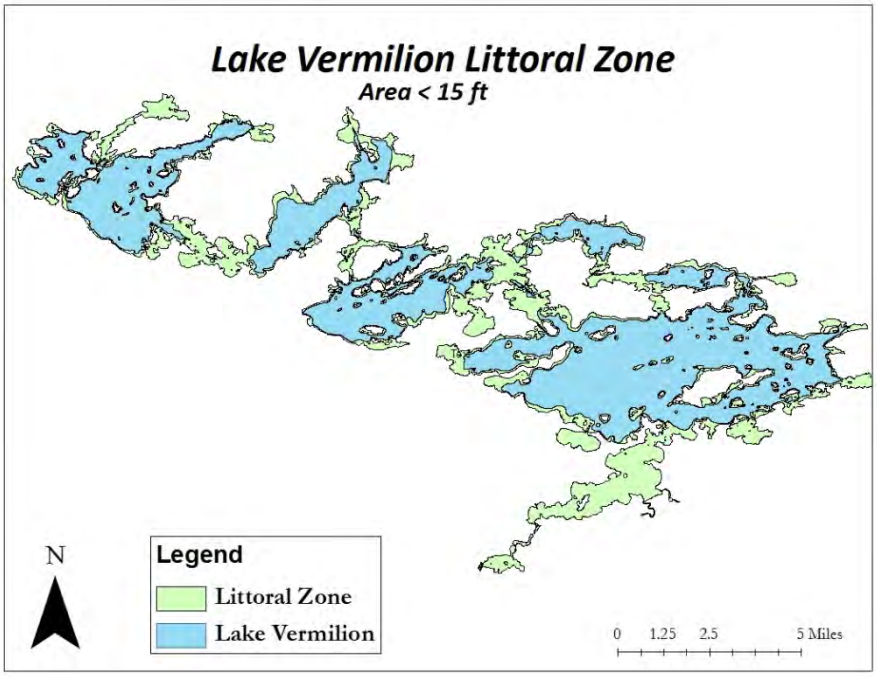
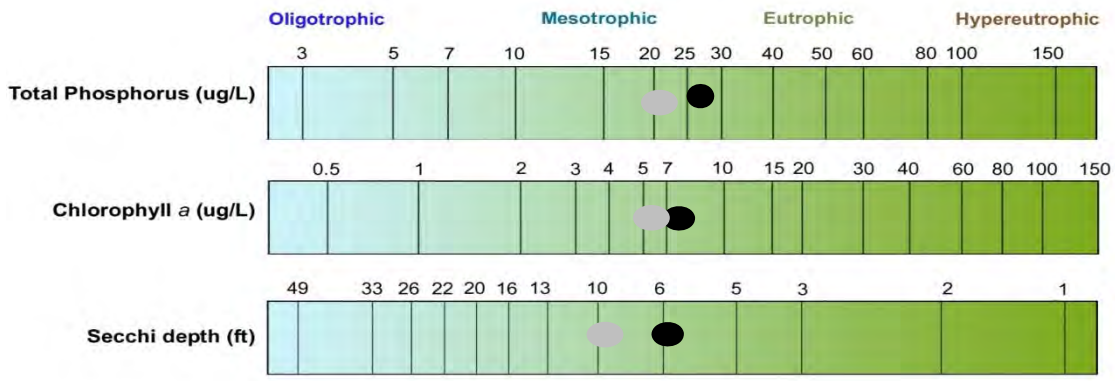


Figure 1: Vermilion Lake littoral zone.

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.

Bay	MPCA established site	Years with data	Trophic State	Mean Secchi depth (ft)	Phosphorus (ug/L)	Chlorophyll a (ug/L)
Everetts Bay	69-0378-01-118	1993	Mesotrophic/ Eutrophic	5.9	28.8	7.3
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 taxa to the level of species when possible.
3. Frequency of occurrence of each taxon found, stating the number of points used as the denominator for the calculations.
4. Frequency of all aquatic plants found.
5. Estimation of abundance of species sampled using MN DNR ranking system.
6. Distribution map for common species.
7. Determination of any invasive aquatic plants.

Methods

The point-intercept survey followed methodology described by Madsen (1999). Geographic Information Systems (GIS) software was used to generate sample points across the littoral zone surface in a 120 meter by 120-meter grid on Dago and Stuntz Bay of Lake Vermilion, resulting in a total of 147 potential survey points. Due to lack of time, a meandering survey was used in Pike Bay, Everett's Bay, and Wakemup Narrows. A rake was thrown throughout the meander and a waypoint was recorded. A Global Positioning System (GPS) unit was used to navigate the boat to each sample point. Water depths at each site were recorded in 1-foot increments using an electronic depth finder.

A double-headed, weighted garden rake attached to a rope (Figure 1 and 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).

Figure 2 and 3: Double-headed, weighted garden rake, attached to a rope used to survey aquatic vegetation.

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 >12 feet.

Survey Results

On June 27 and 28, 2018, 192 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 12 feet of water. As depths increased beyond that range, the presence of vegetation decreased and became less dense (Figure 4).

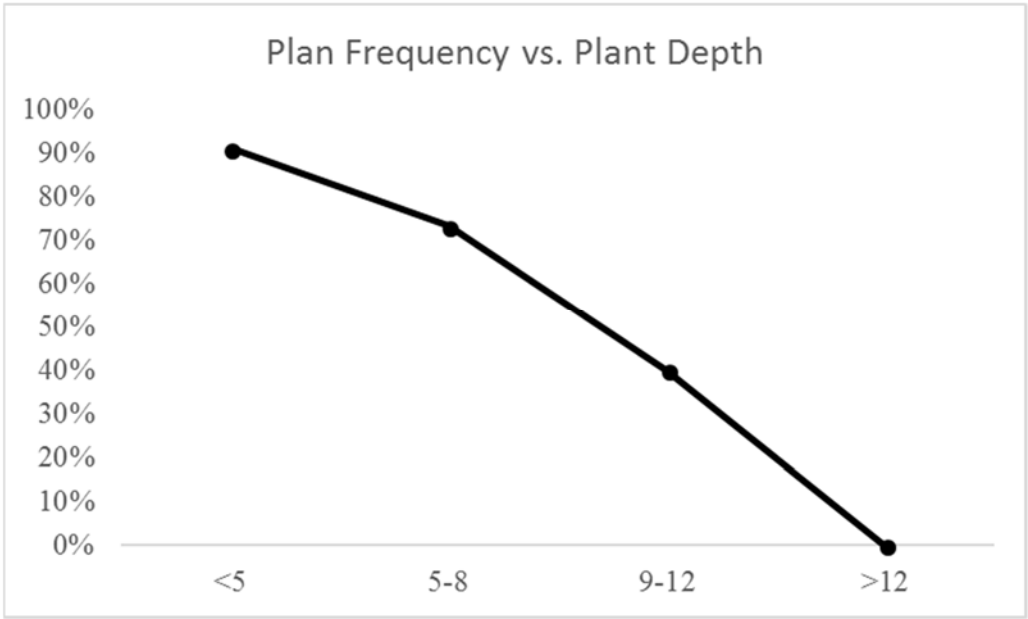


Figure 4: Plant frequency for each depth zone in Lake Vermilion, 27 June 2018.

Of the 192 sampled locations in Lake Vermillion, 54 sites had no vegetation present. The average number of plants per rake sample on Lake Vermilion was 3.6 for all sampled depths and 4.1 for points with depth less than 12 feet. Plant abundance was greatest between one and six feet of water.

Flat-stem pondweed, water celery, Robbin's pondweed, coontail, and bushy pondweed were among the most common native plants present in sampled areas (Figure 5).

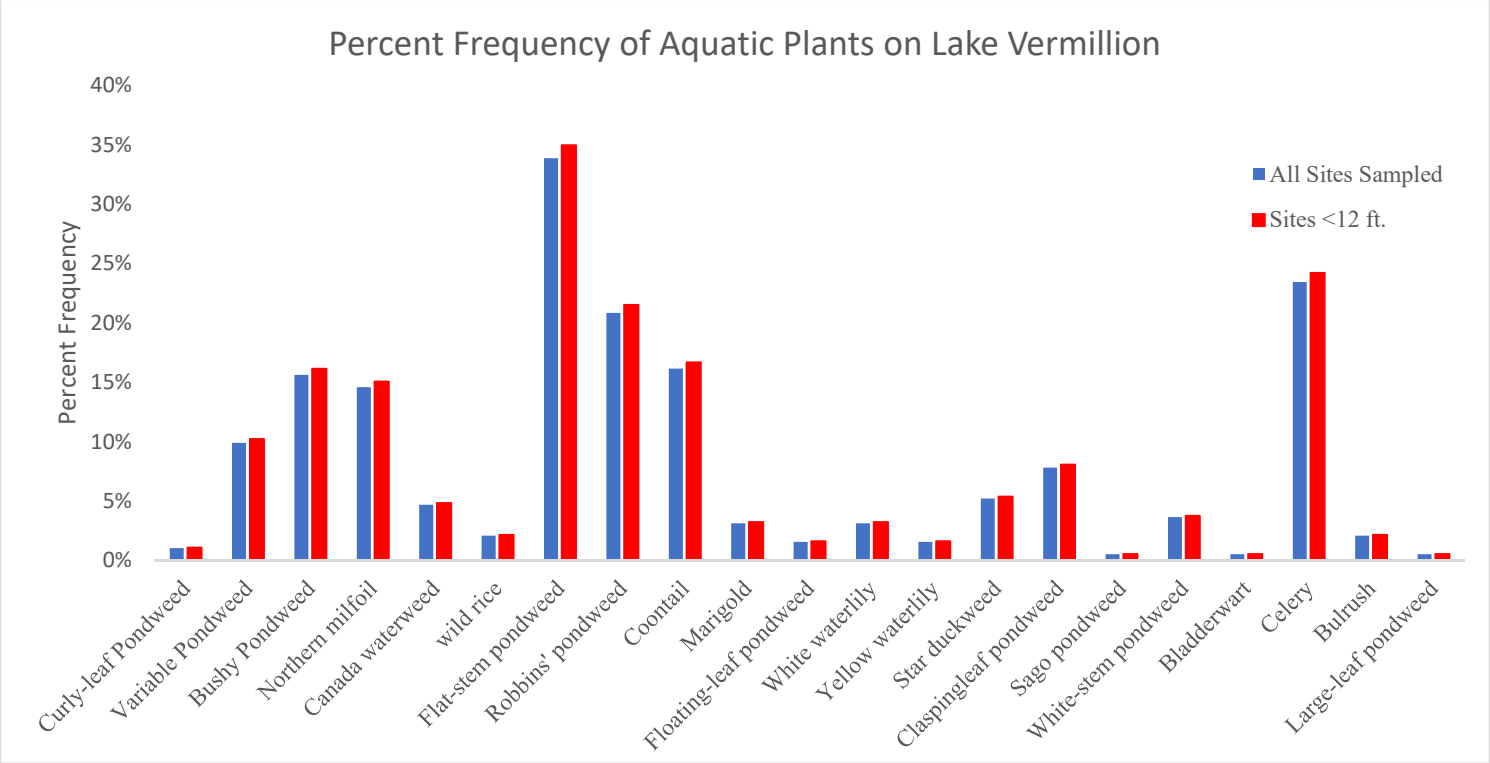


Figure 5: Frequency of aquatic plant species in Lake Vermillion, including curly-leaf pondweed and native plants, June 27-28, 2018.

Table 2. Aquatic plants surveyed from Lake Vermilion, St. Louis County, MN: June 27 and 28, 2018.

Lake Vermilion				All sampled sites	Sites <12 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.	Curly-leaf Pondweed	*Potamogeton crispus*	2	1%	1%
	Variable Pondweed	*Potamogeton gramineus*	19	10%	10%
	Bushy Pondweed	*Najas flexilus*	30	16%	16%
	Northern milfoil	*Myriophyllum sibiricum*	28	15%	15%
	Canada waterweed	*Elodea canadensis*	9	5%	5%
	Flat-stem pondweed	*Potamogeton zosteriformis*	65	34%	35%
	Robbins' pondweed	*Potamogeton robbinsii*	40	21%	22%
	Coontail	*Ceratophyllum demersum*	31	16%	17%
	Marigold	*Bidens beckii*	6	3%	3%
	Star duckweed	*Lemna trisulca*	10	5%	5%
	Claspingleaf pondweed	*Potamogeton perfoliatus*	15	8%	8%
	Sago pondweed	*Stuckenia pectinate*	1	1%	1%
	White-stem pondweed	*Potamogeton praelongus*	7	4%	4%
	Bladderwart	*Utricularia vulgaris*	1	1%	1%
	Celery	*Vallisneria Americana*	45	23%	24%
	Large-leaf pondweed	*Potamogeton ampifolius*	1	1%	1%
FLOATING – LEAF – These plant leaves float on water and are anchored to the bottom of the lake.	Floating-leaf pondweed	*Potamogeton natans*	3	2%	2%
	White waterlily	*Nymphaea alba*	6	3%	3%
	Yellow waterlily	*Nuphar lutea*	3	2%	2%
EMERGENT – These plants extend above the water surface and are found in shallow water.	Wild rice	*Zazania palustrus*	4	2%	2%
	Bulrush	*Scirpus acutus*	4	2%	2%
Total number of plants (species diversity for the lake)			21		
Total number of plant occurrences			330		
Total number of sites			192		
Total number of sites <12			186		

Dago Bay

Dago Bay is located on the northwestern side of Lake Vermilion (Figure 6). It is a smaller bay within Wolf Bay, north of Knotts' Island. Dago Bay was sampled on 27 June 2018. 63 points were sampled with 120 meters in between each point (Figure 8). Two points had no data because they were inaccessible due to hazards. Only one plant of curly-leaf pondweed was sampled, and it was near the mouth of the bay (Figure 9). No large stands of curly-leaf appeared to be present as points surrounding the curly-leaf all had native plants present, as well as the same point as the curly-leaf. Native plants found in Dago bay include bushy pondweed and flat-stem pondweed (Figure 10 and 11).

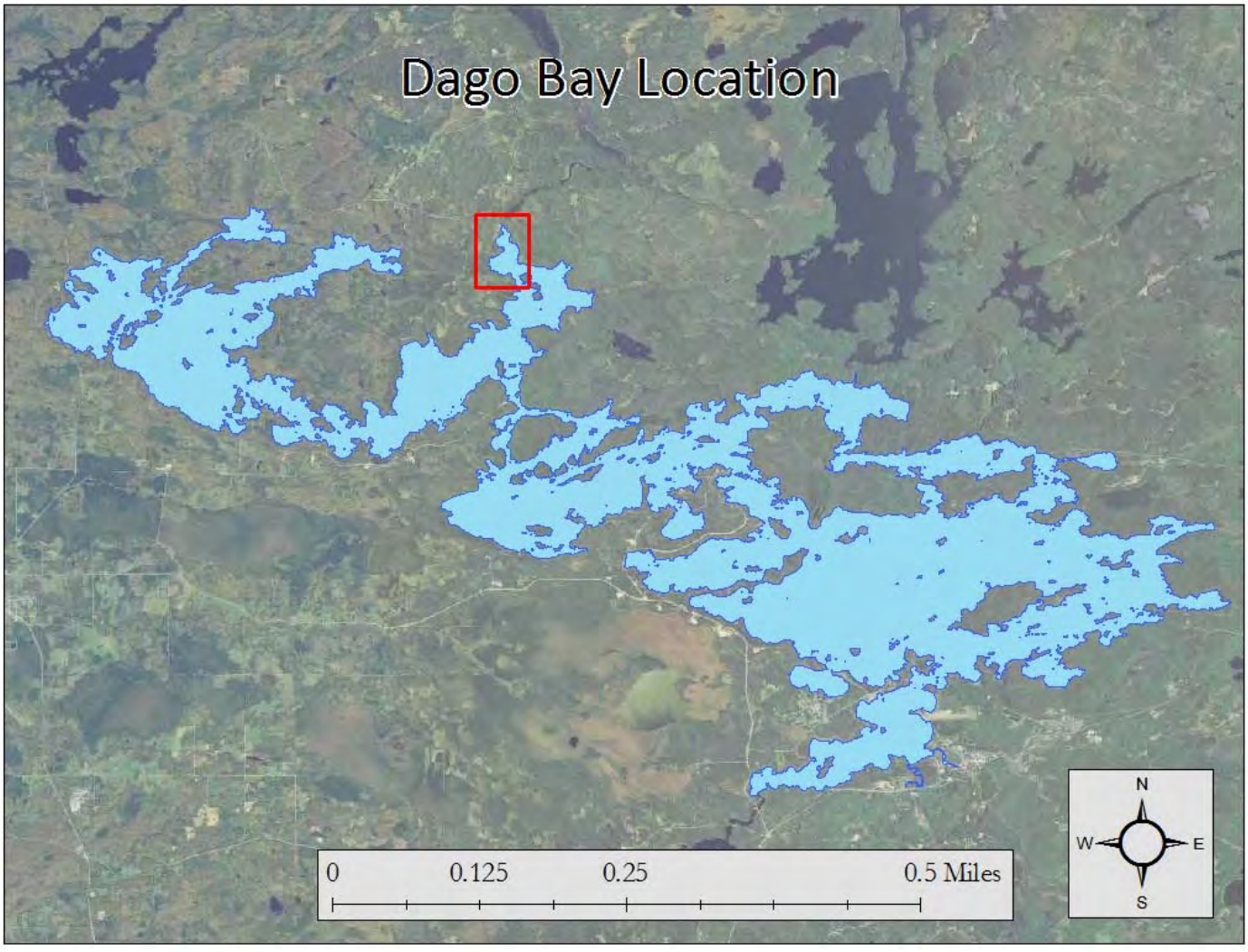


Figure 6: Location of Dago Bay on Lake Vermilion in St. Louis County, MN.

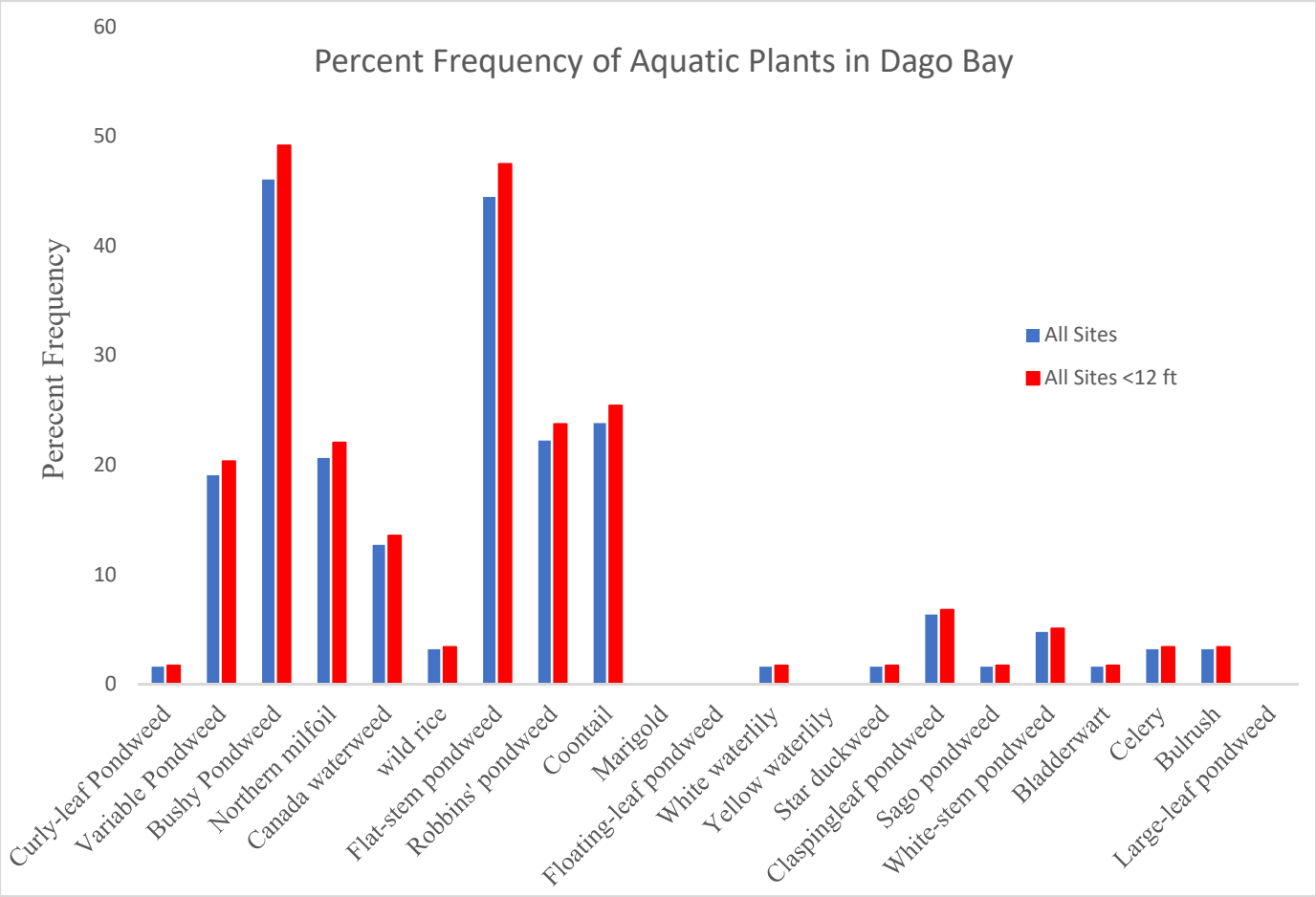


Figure 7: Frequency of plant species found in Dago Bay on Lake Vermilion on June 27, 2018.

Table 3. Aquatic plants surveyed in Dago Bay on Lake Vermilion, St. Louis County, MN: June 27, 2018.

Lake Vermilion				All sampled sites	Sites <12 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.	Curly-leaf Pondweed	*Potamogeton crispus*	2	2%	2%
	Variable Pondweed	*Potamogeton gramineus*	12	19%	20%
	Bushy Pondweed	*Najas flexilus*	29	46%	49%
	Northern milfoil	*Myriophyllum sibiricum*	13	21%	22%
	Canada waterweed	*Elodea canadensis*	8	13%	14%
	Flat-stem pondweed	*Potamogeton zosteriformis*	28	44%	47%
	Robbins' pondweed	*Potamogeton robbinsii*	14	22%	24%
	Coontail	*Ceratophyllum demersum*	15	24%	25%
	Star duckweed	*Lemna trisulca*	1	2%	2%
	Claspingleaf pondweed	*Potamogeton perfoliatus*	4	6%	7%
	Sago pondweed	*Stuckenia pectinate*	1	2%	2%
	White-stem pondweed	*Potamogeton praelongus*	3	5%	5%
	Bladderwart	*Utricularia vulgaris*	1	2%	2%
	Celery	*Vallisneria Americana*	2	3%	3%
	Large-leaf pondweed	*Potamogeton ampifolius*	1	%	%
FLOATING – LEAF – These plant leaves float on water and are anchored to the bottom of the lake.	White waterlily	*Nymphaea alba*	1	2%	2%
EMERGENT – These plants extend above the water surface and are found in shallow water.	Wild rice	*Zazania palustrus*	2	3%	3%
	Bulrush	*Scirpus acutus*	2	3%	3%
Total number of plants (species diversity for the lake)			18		
Total number of plant occurrences			137		
Total number of sites			63		
Total number of sites <12			59		

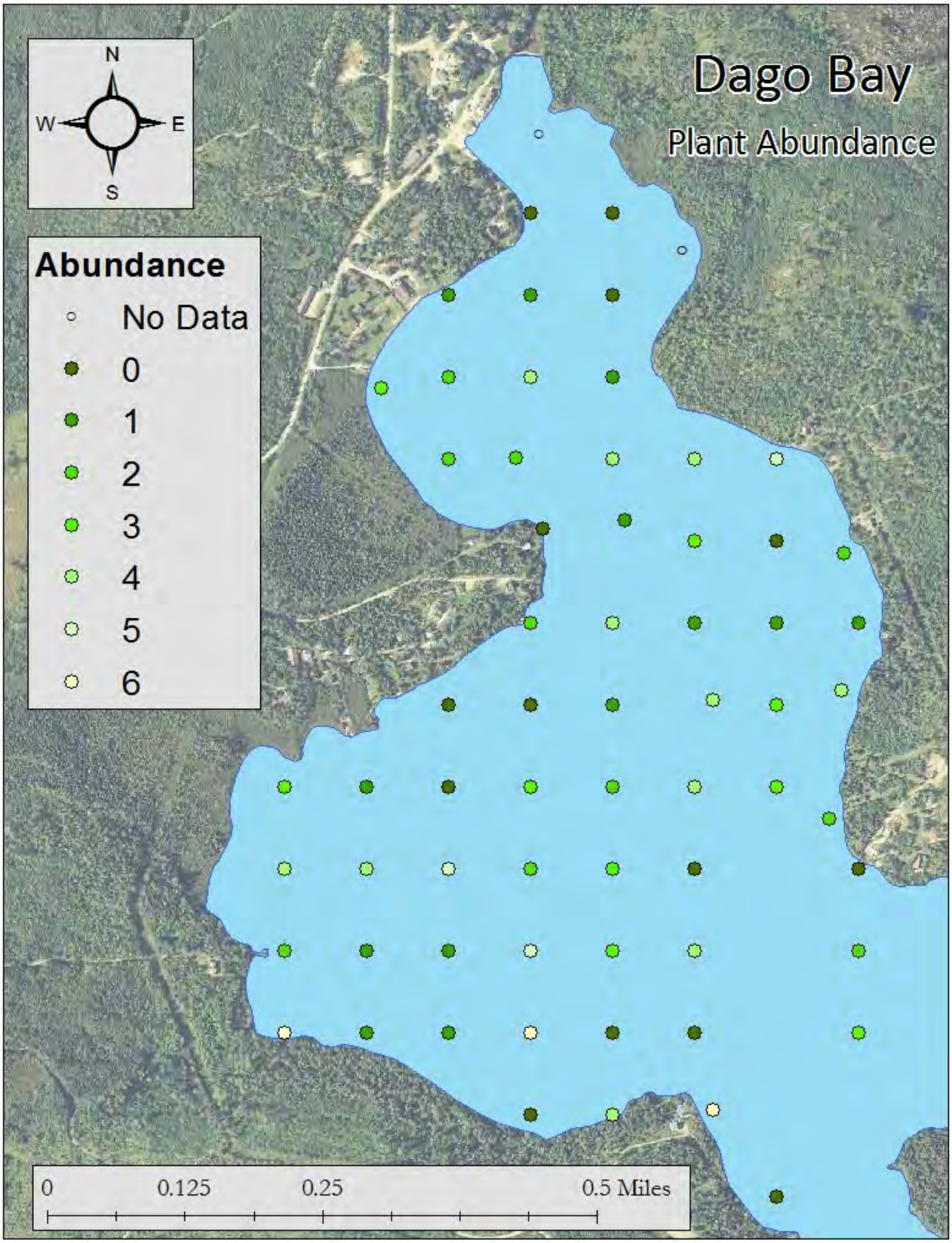


Figure 8: Number of plant species found at Lake Vermilion sample points, St. Louis County, MN, June 27, 2018.

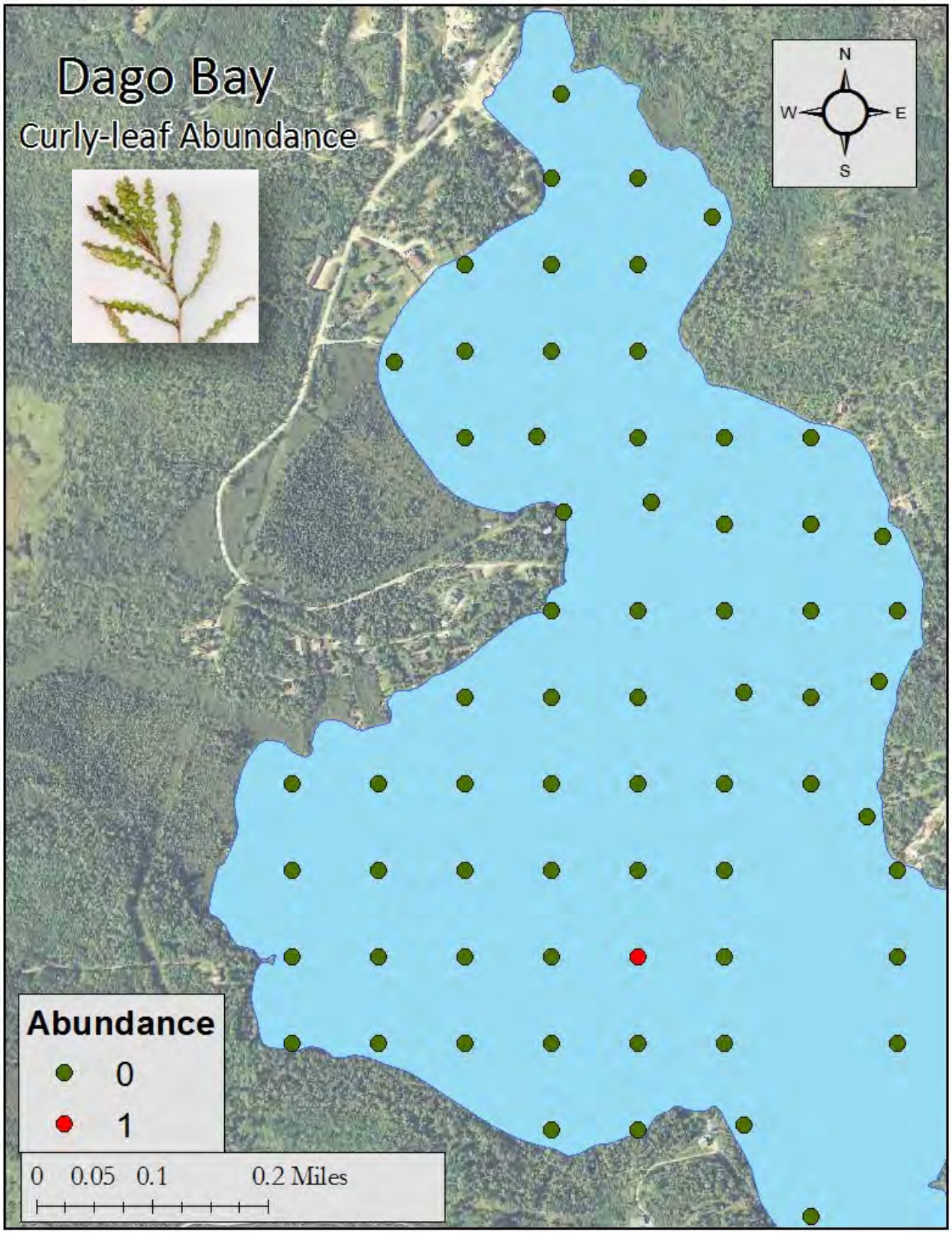


Figure 9: Curly-leaf pondweed found at Lake Vermilion, Dago Bay, sample points, St. Louis County, MN, June 27, 2018.

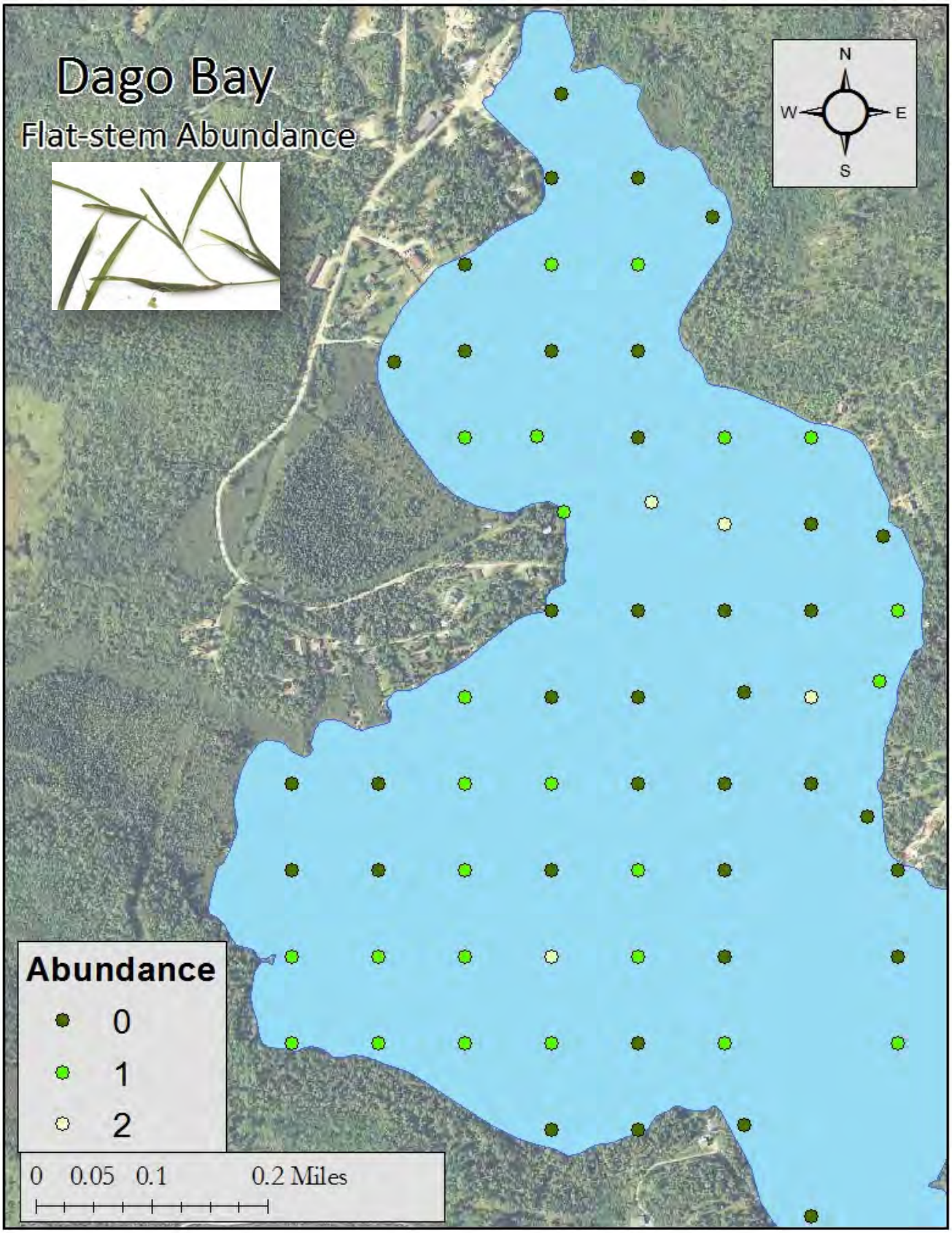


Figure 10: Density of Flat-stem pondweed (Potamogeton zosteriformus) in Dago Bay, *Lake Vermilion sample points, St. Louis County, MN, June 27, 2018.*

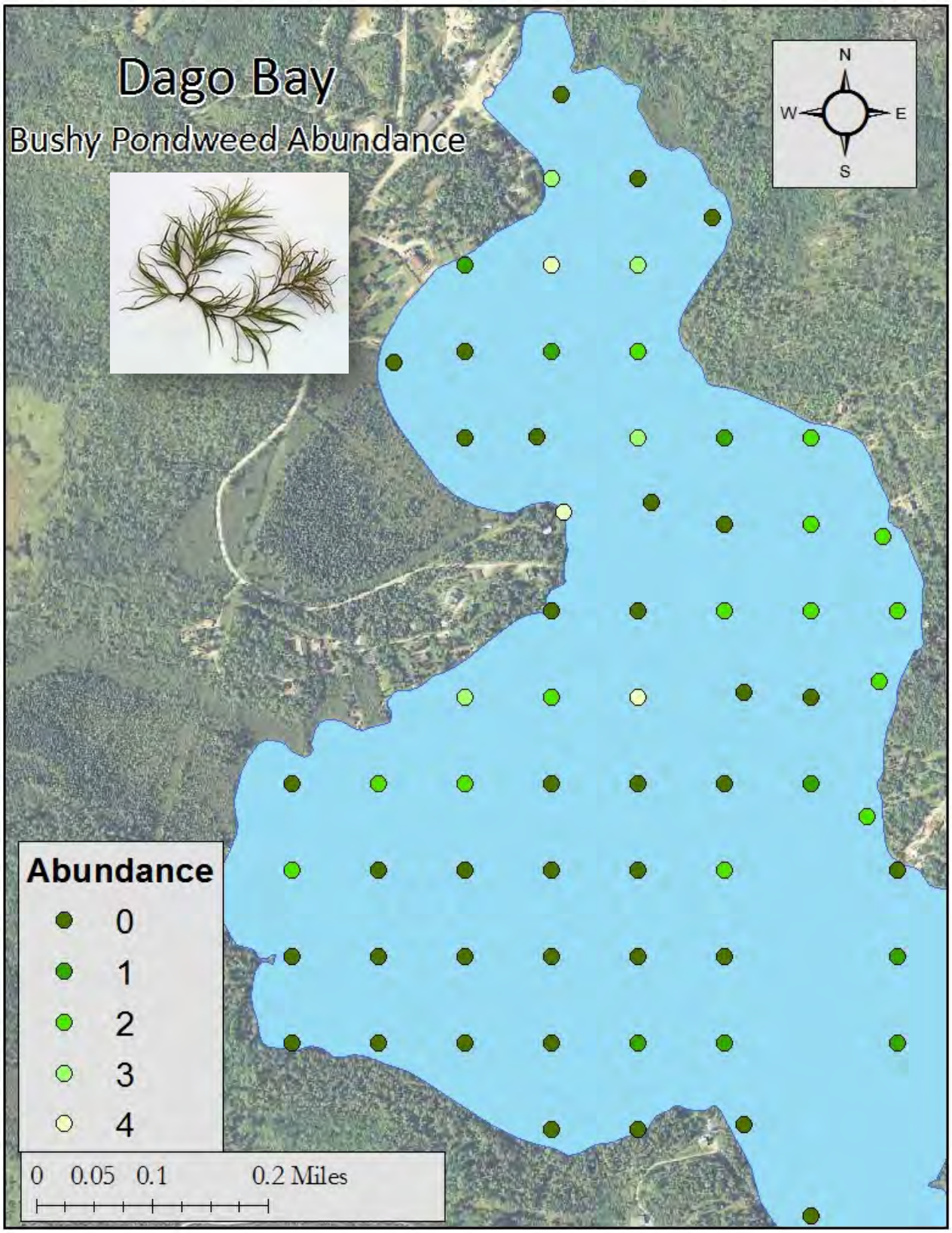


Figure 11: Density of bushy pondweed (Najas flexilus) at sample points in Lake Vermilion, Dago Bay, St. Louis County, MN, June 27, 2018

Stuntz Bay

Stuntz Bay is located on the southeast portion of Lake Vermilion (Figure 12) and was sampled on 28 June 2018. A total of 85 points were sampled with 120 meters in between each point (Figure 14). Curly-leaf pondweed was only found one time in the east portion of the bay (Figure 15). Flat-stem pondweed and water celery were among the common native plants found in Stuntz Bay (Figures 16 & 17). All sample points were less than 12 feet in depth, but some points did not have vegetation due to the rocky substrate. There were native plants all around providing evidence to suggest that it was not widespread or dense.

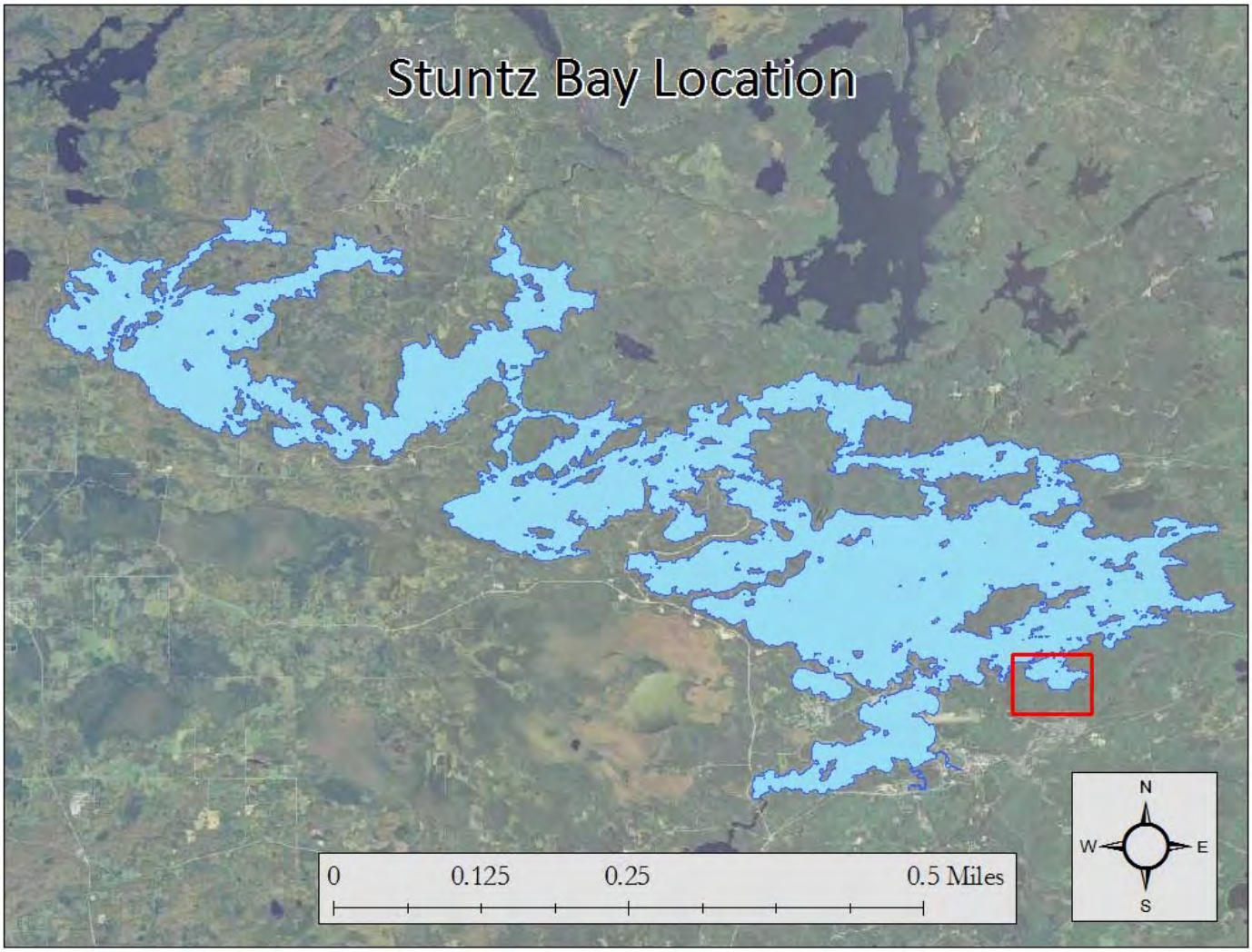


Figure 12: Location of Stuntz Bay, Lake Vermilion in, St. Louis County, MN.

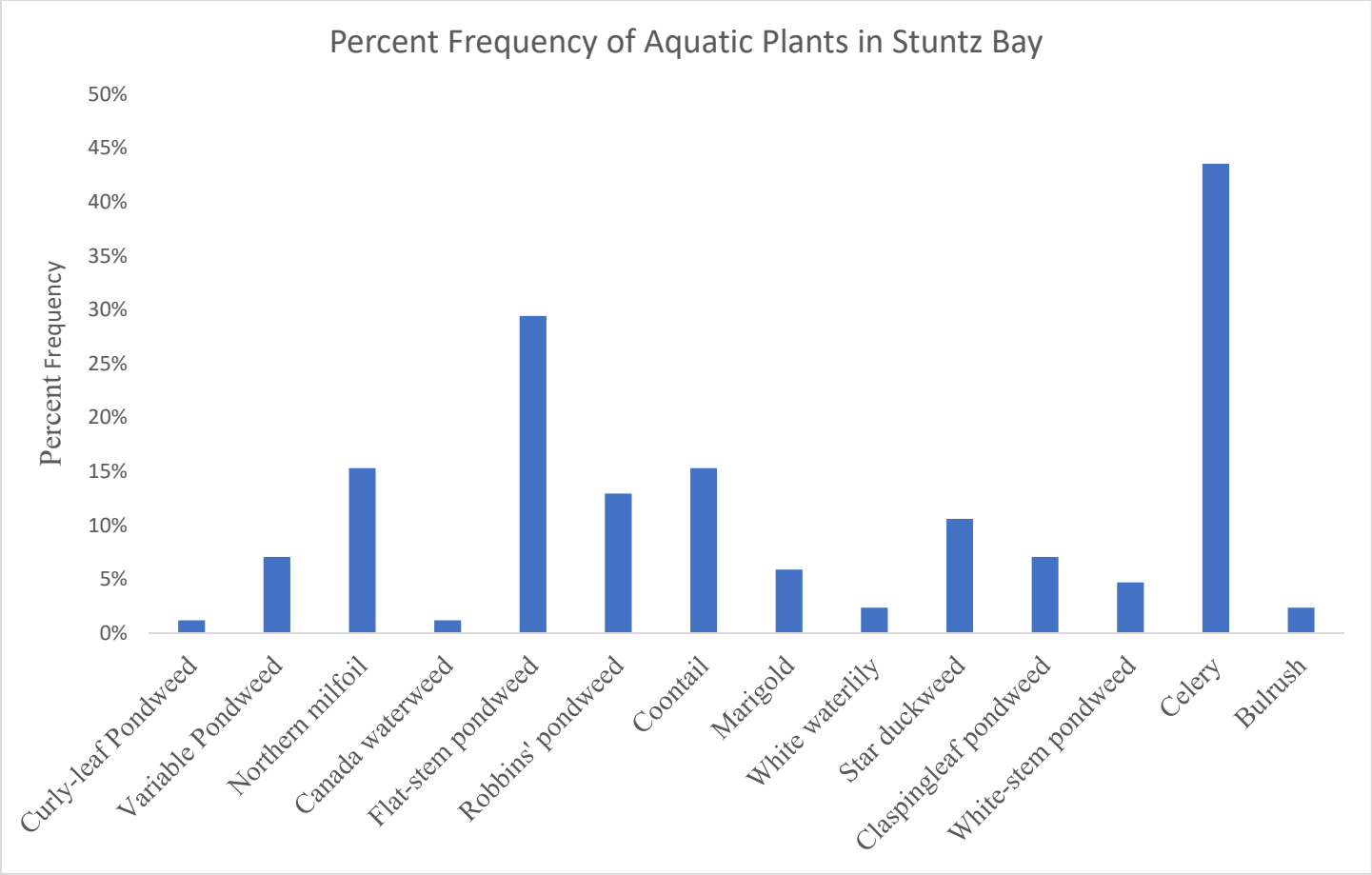


Figure 13: Percent frequency of aquatic plants in Stuntz Bay, Lake Vermilion in, St. Louis County, MN.

Table 3. Aquatic plants surveyed from Stuntz Bay, Lake Vermilion, St. Louis County, MN: June 27 and 28, 2018.

Lake Vermilion				All sampled sites	Sites <12 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.	Curly-leaf Pondweed	*Potamogeton crispus*	1	1%	1%
	Variable Pondweed	*Potamogeton gramineus*	6	7%	7%
	Northern milfoil	*Myriophyllum sibiricum*	13	15%	15%
	Canada waterweed	*Elodea canadensis*	1	1%	1%
	Flat-stem pondweed	*Potamogeton zosteriformis*	25	29%	29%
	Robbins' pondweed	*Potamogeton robbinsii*	11	13%	13%
	Coontail	*Ceratophyllum demersum*	13	15%	15%
	Marigold	*Bidens beckii*	5	6%	6%
	Star duckweed	*Lemna trisulca*	9	11%	11%
	Claspingleaf pondweed	*Potamogeton perfoliatus*	6	7%	7%
	White-stem pondweed	*Potamogeton praelongus*	4	5%	5%
	Celery	*Vallisneria Americana*	37	44%	44%
FLOATING – LEAF – These plant leaves float on water and are anchored to the bottom of the lake.	White waterlily	*Nymphaea alba*	2	2%	2%
EMERGENT – These plants extend above the water surface and are found in shallow water.	Bulrush	*Scirpus acutus*	2	2%	2%
Total number of plants (species diversity for the lake)			14		
Total number of plant occurrences			135		
Total number of sites			85		
Total number of sites <12			85		

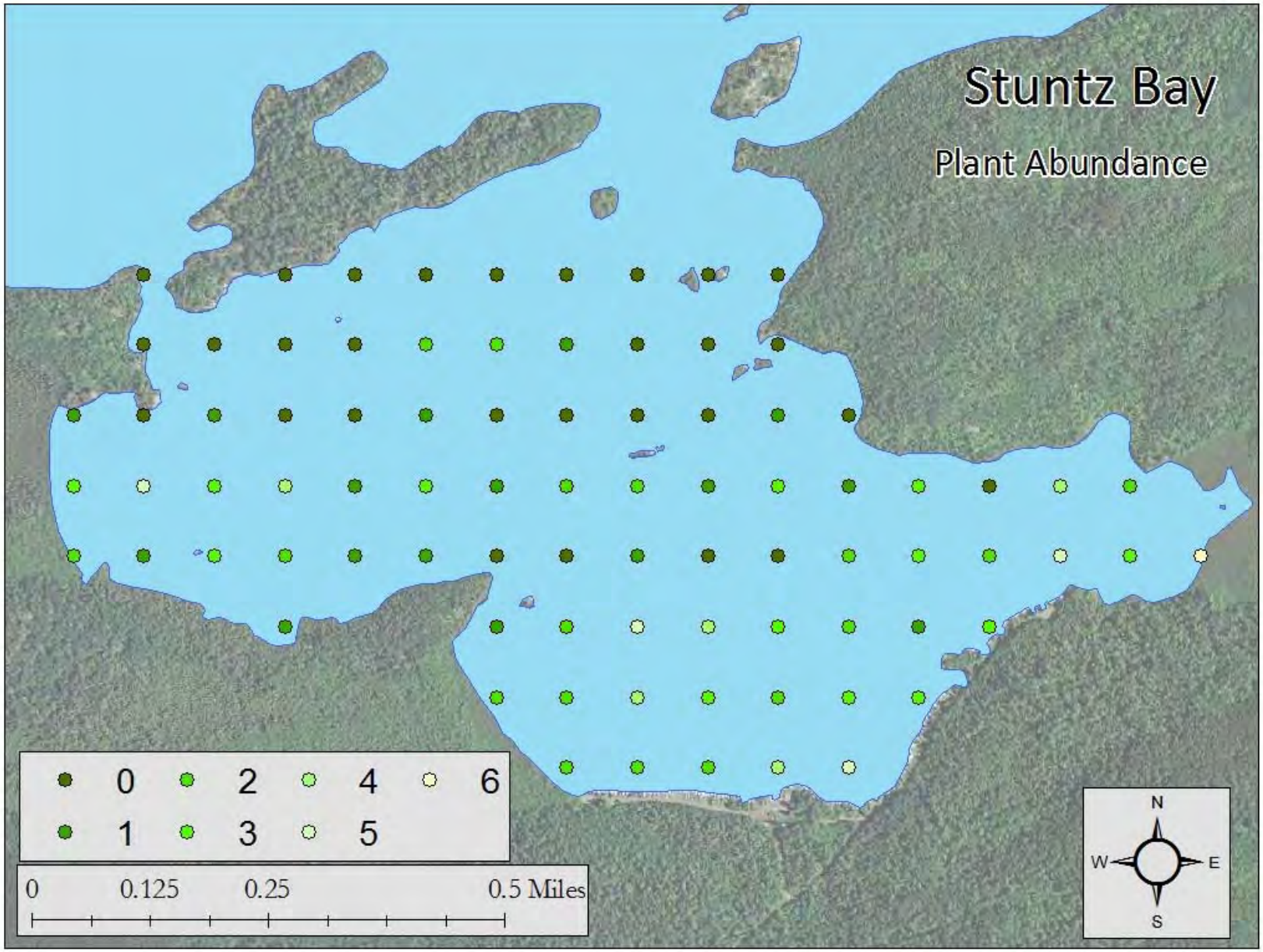


Figure 14: Abundance of aquatic plants in Stuntz Bay, Lake Vermilion in, St. Louis County, MN.

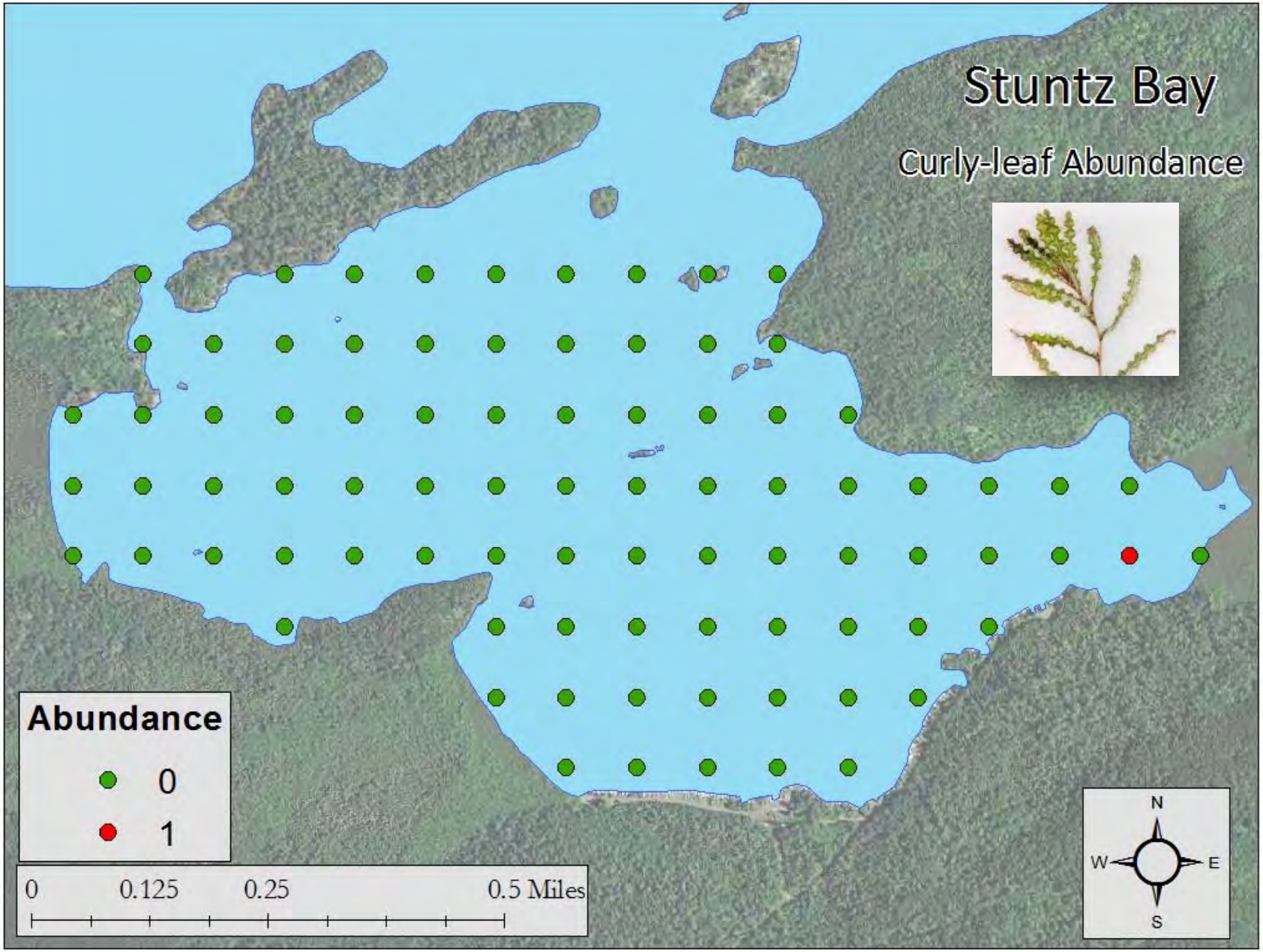


Figure 15: Density of curly-leaf pondweed (Potamogeton crispus) at sample points in Lake Vermilion, Stuntz Bay, St. Louis County, MN, June 28, 2018.

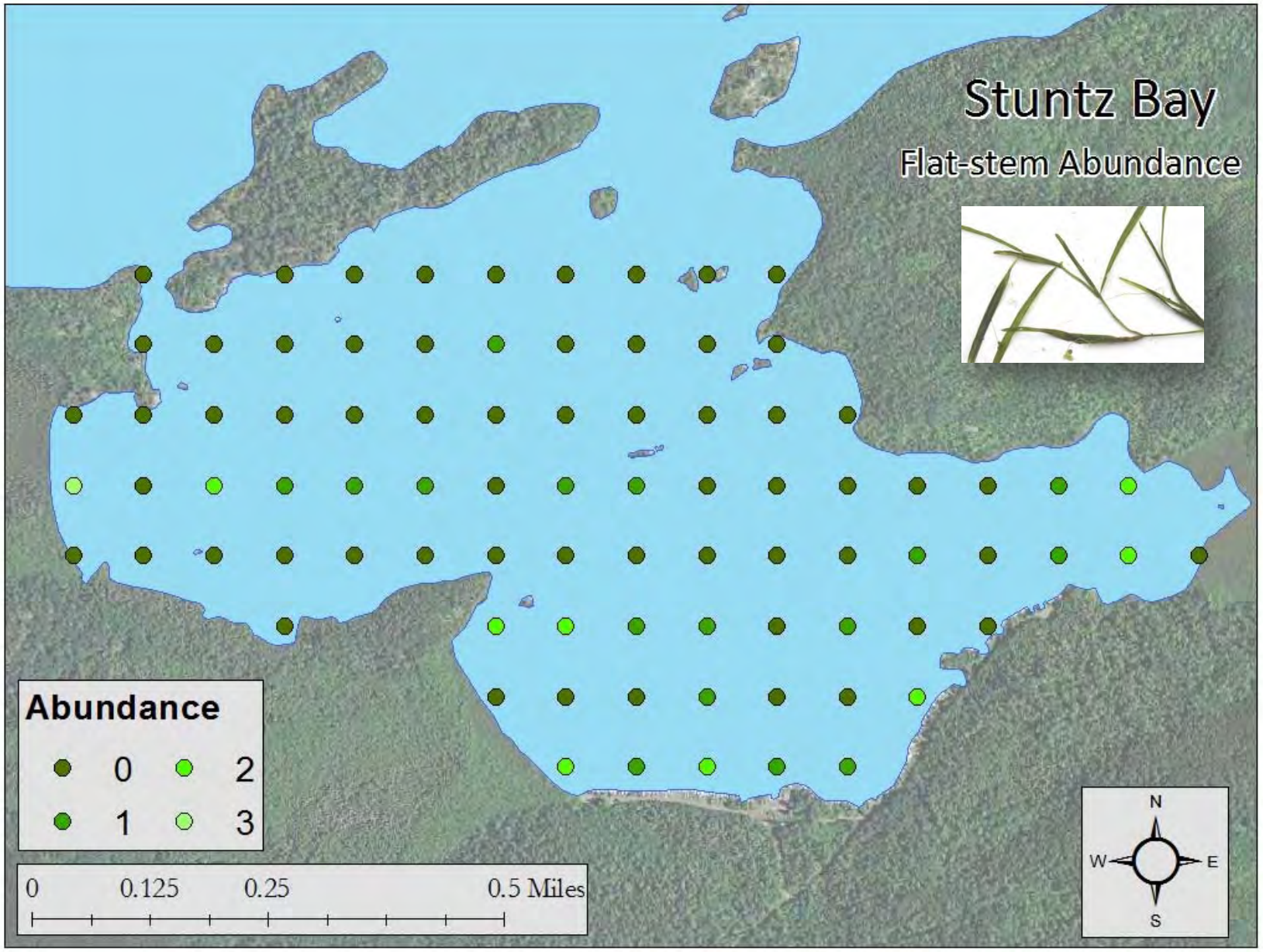


Figure 16: Density of Flat-stem pondweed (Potamogeon zosteriformis) at sample points in Lake Vermilion, Stuntz Bay, St. Louis County, MN, June 28, 2018

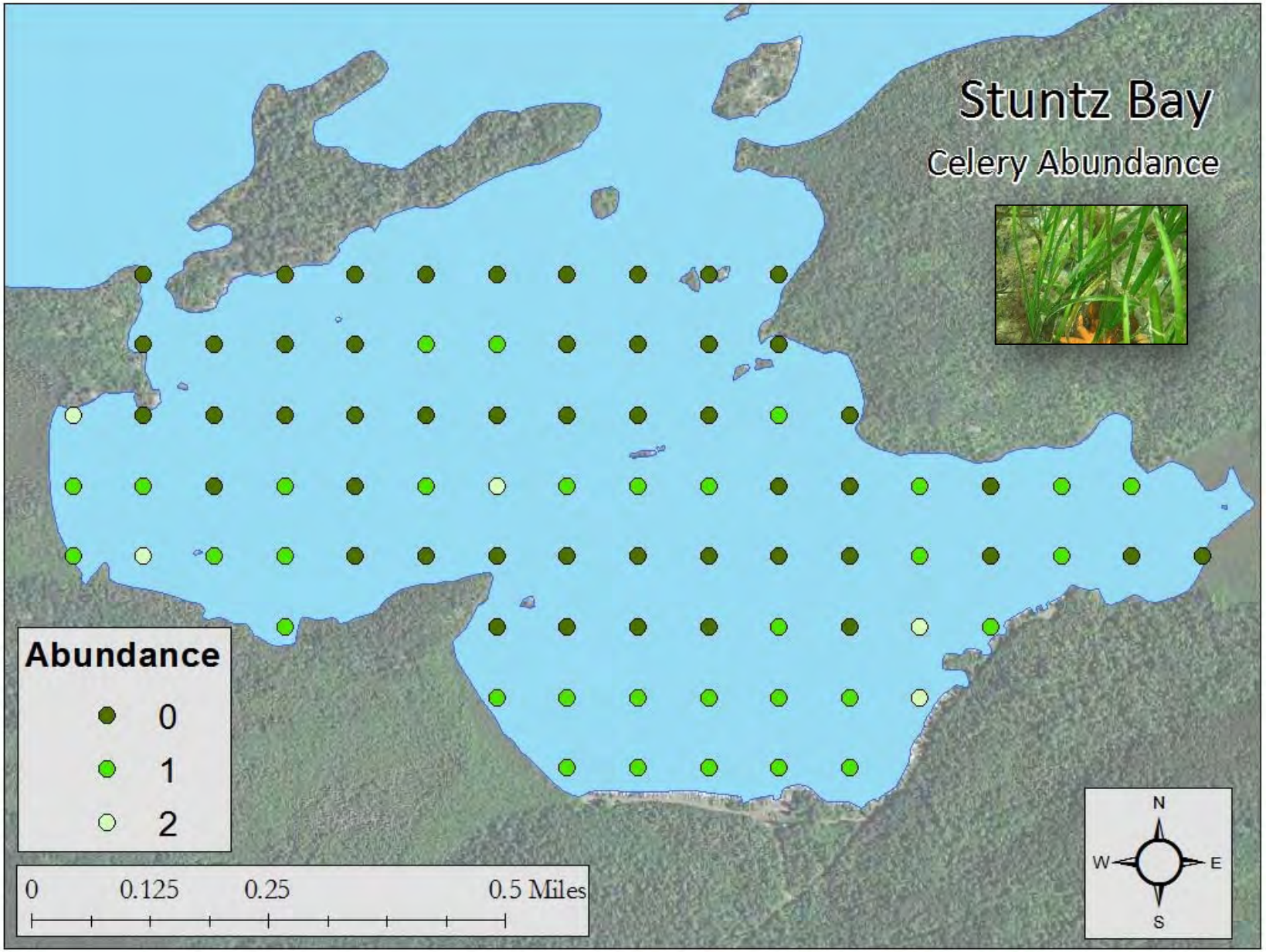


Figure 17: Density of wild water celery (Vallisneria Americana) at sample points in Lake Vermilion, Stuntz Bay, St. Louis County, MN, June 28, 2018

Pike Bay, Everett Bay, and Wakemup Narrows

Due to time constraints, Pike Bay, Everett Bay, and Wakemup Narrows were meandered and no point intercept surveys were done in these locations (Figure 18). Rakes were thrown occasionally and waypoints were recorded where a rake was thrown (Figure 19). Visual observations were recorded as well. No curly-leaf pondweed was found in any area.

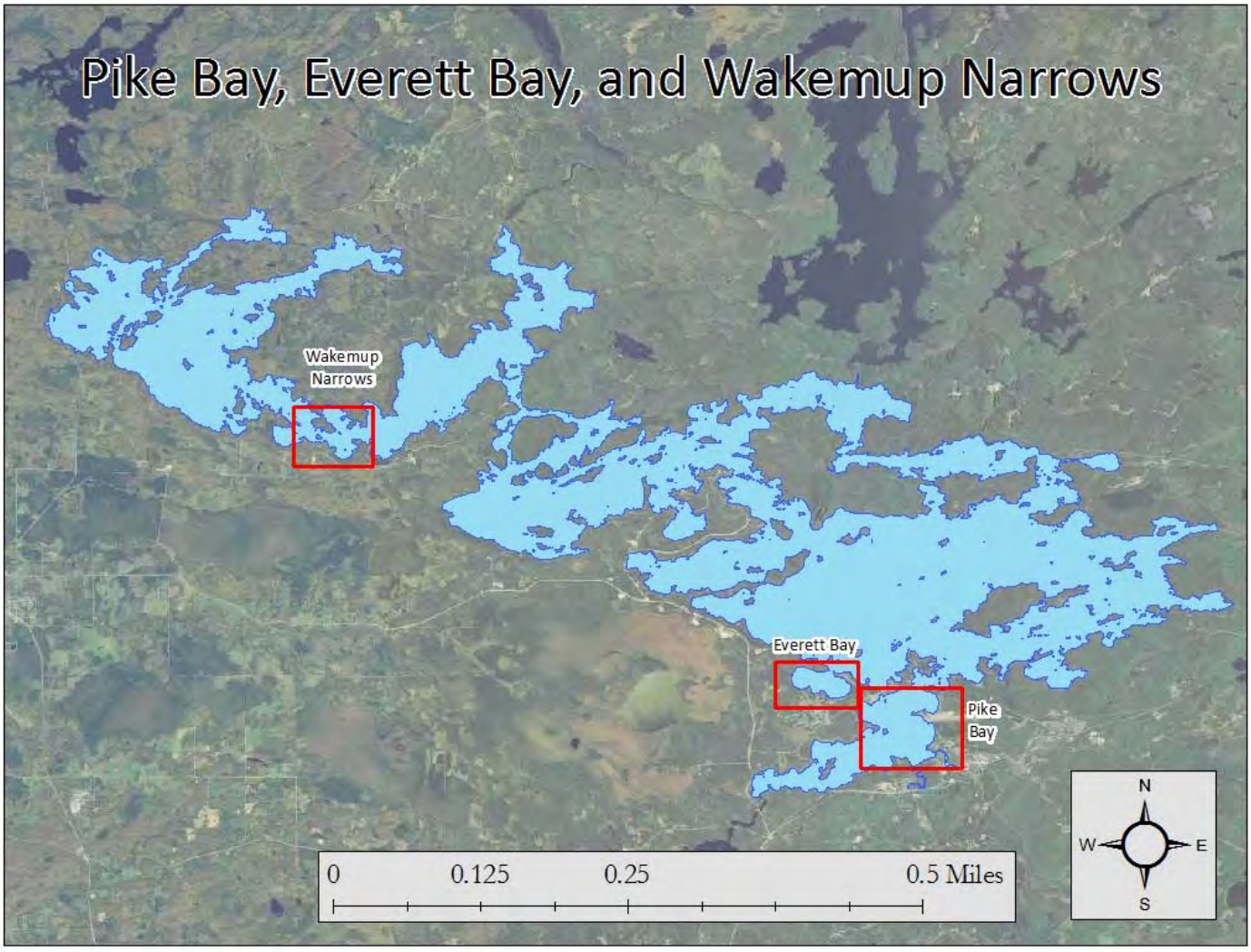


Figure 18: Other sampling areas surveyed for aquatic vegetation on Lake Vermilion, St. Louis County, MN, June 28, 2018

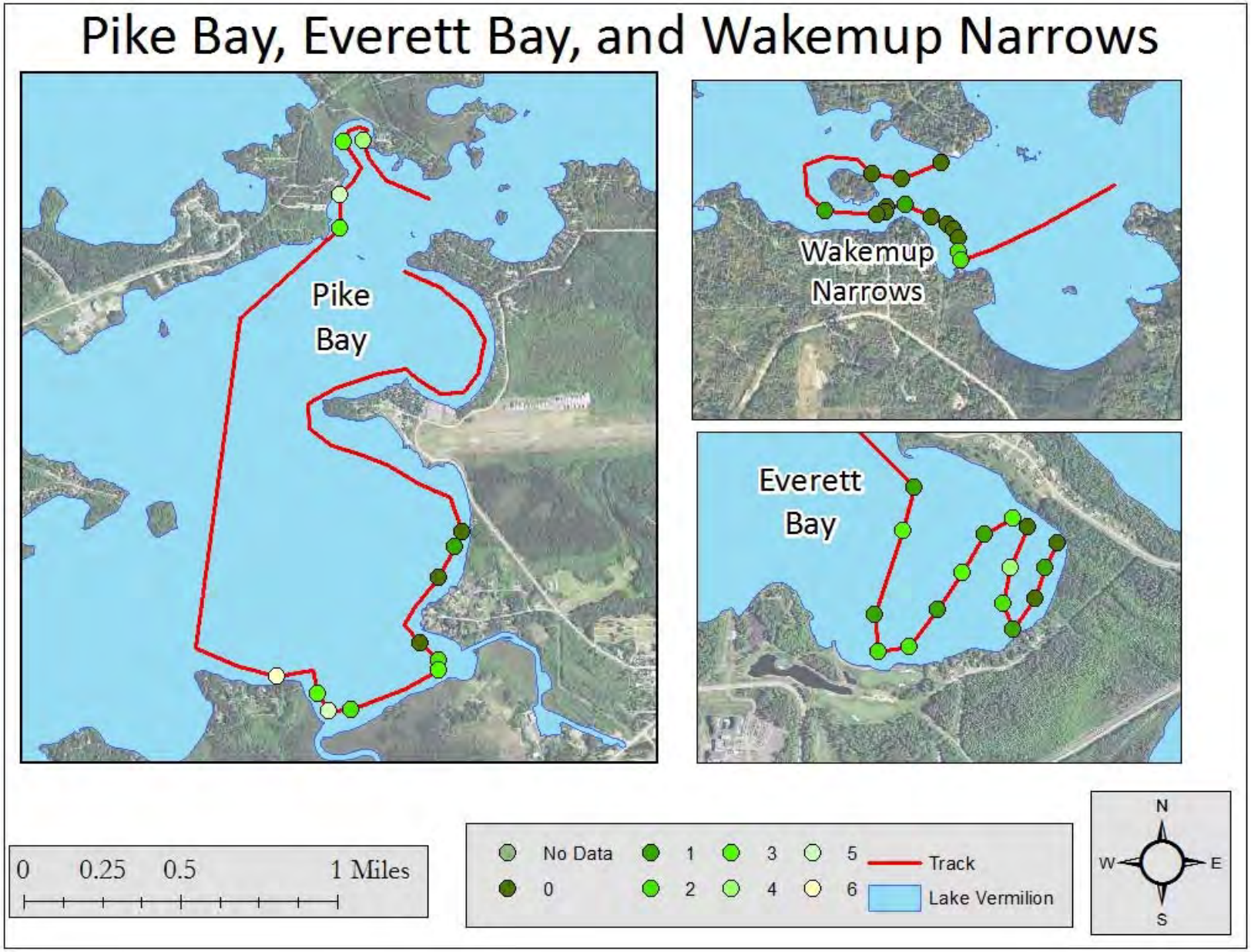


Figure 19: Abundance of aquatic vegetation at sample points in different areas of Lake Vermilion, St. Louis County, MN, June 28, 2018

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 Dago and Stuntz bay in 2018. Curly-leaf is also located in the west side of Everett Bay near the public access. No curly-leaf was found in Wakemup narrows where it has been documented before

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.

Survey Photos

Figure 3. Curly-leaf pondweed found in Lake Vermilion, June 28, 2018.

Figure 4. Northern milfoil (native), found in Lake Vermilion on June 28, 2018.

Literature Cited

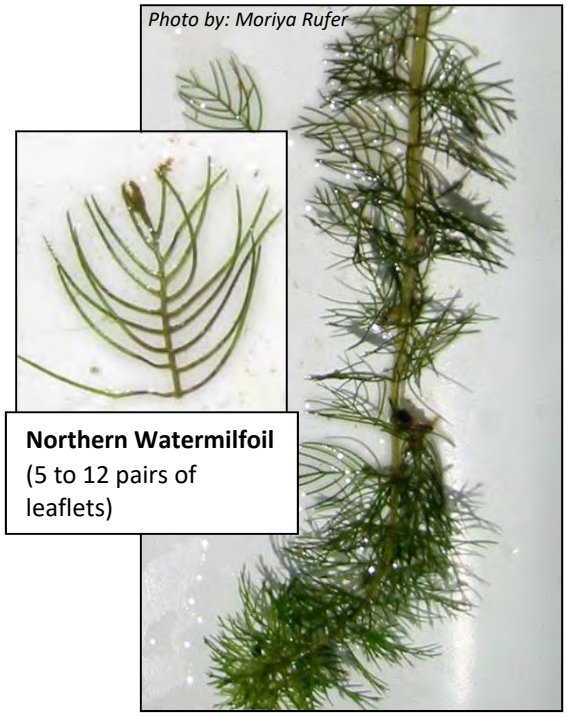
Blickenderfer, Mary. 2007. A Field Guide to Identification of Minnesota Aquatic Plants. University of Minnesota Extension.

Borman, Susan et. al. 1997. Through the Looking Glass…a Field Guide to Aquatic Plants. University of Wisconsin Estension.

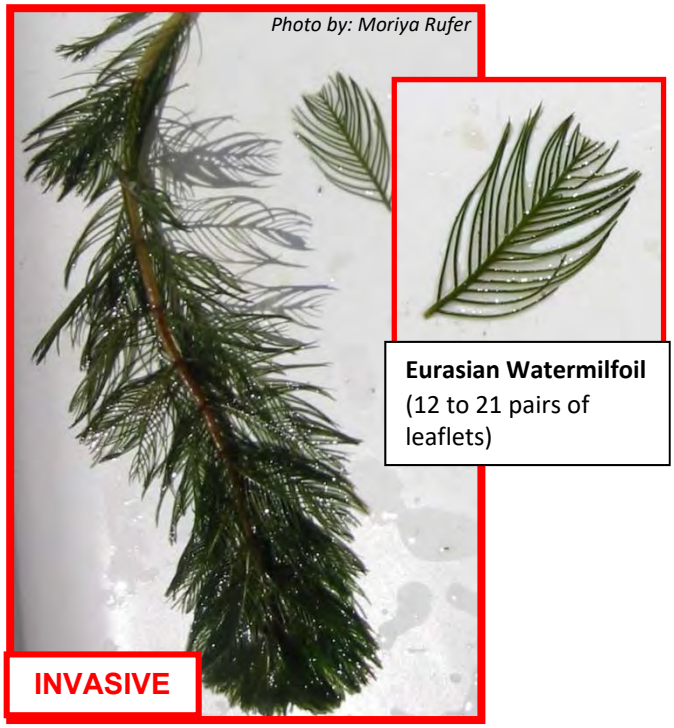
Madsen, J. D. 1999. Point intercept and line intercept methods for aquatic plant management. *APCRP Technical Notes Collection* (TN APCRP-M1-02). U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/aqua

Aquatic Plants In Minnesota Lakes

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

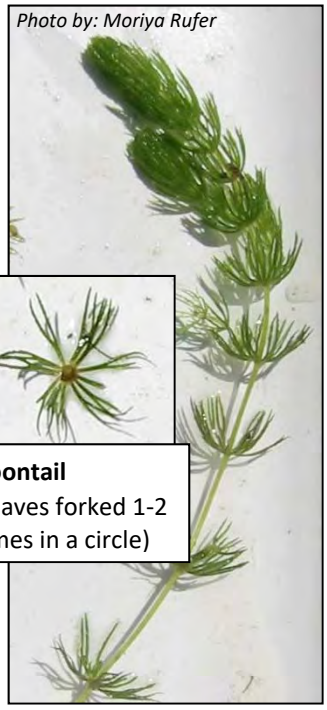


Northern Watermilfoil
(*Myriophyllum exalbescens)*

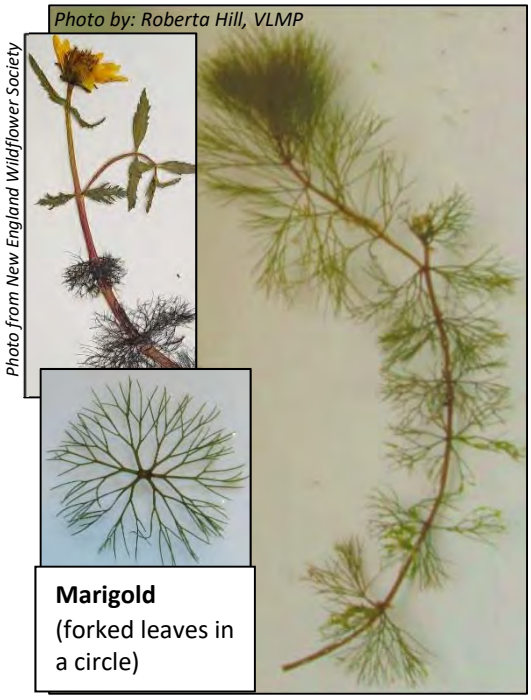


Eurasian Watermilfoil
(*Myriophyllum spicatum)*

Bladderwort
(*Utricularia vulgaris*)



Coontail
(Ceratophyllum demersum)



Water Marigold
(Bidens beckii)

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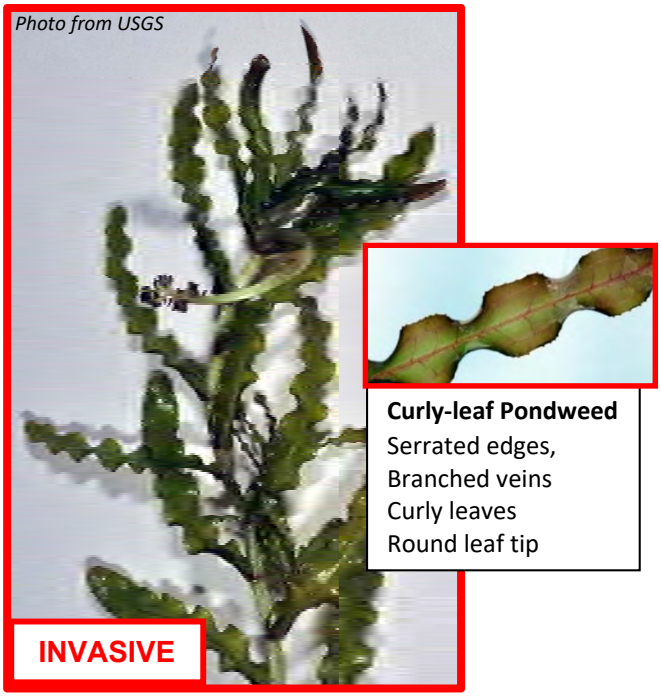

Curly-leaf Pondweed
Serrated edges,
Branched veins
Curly leaves
Round leaf tip

Curly-leaf Pondweed
(*Potamogeton crispus*)

Whitestem Pondweed
Leaf 'clasps' the stem,
Straight edges,
Parallel veins
'Bowled' leaf tip

Whitestem Pondweed
(*Potamogeton praelongus*)

Claspingleaf Pondweed
Leaf 'clasps' the stem,
Straight edges,
Parallel veins
Pointed leaf tip

Claspingleaf Pondweed
(*Potamogeton richardsonii*)

Robbin's Pondweed
Finely serrated edges,
Pointed leaf tip,
Leaf 'clasps' the stem

Robbin's Pondweed
(*Potamogeton robinsii)*

Aquatic Plants In Minnesota Lakes

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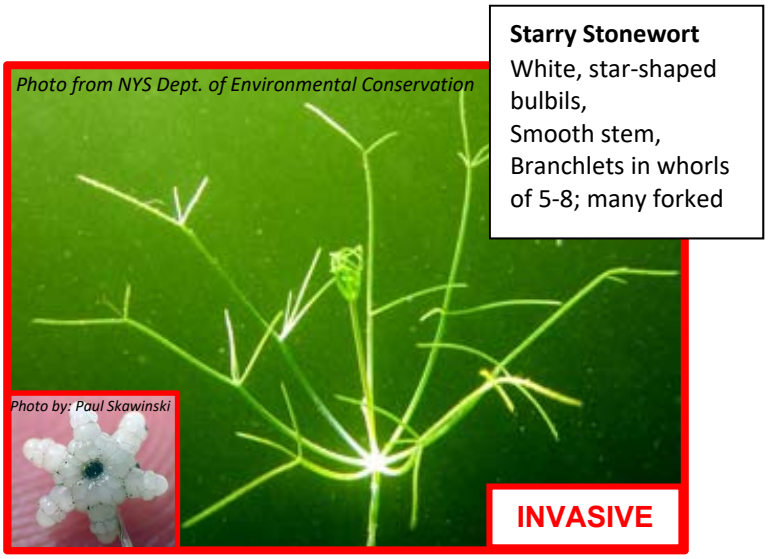
Chara
(*Chara spp.*)



Starry Stonewort
(*Nitellopsis obtuse)*

Sago Pondweed
(*Potamogeton pectinatus)*

Brittle Naiad
(*Najas minor)*

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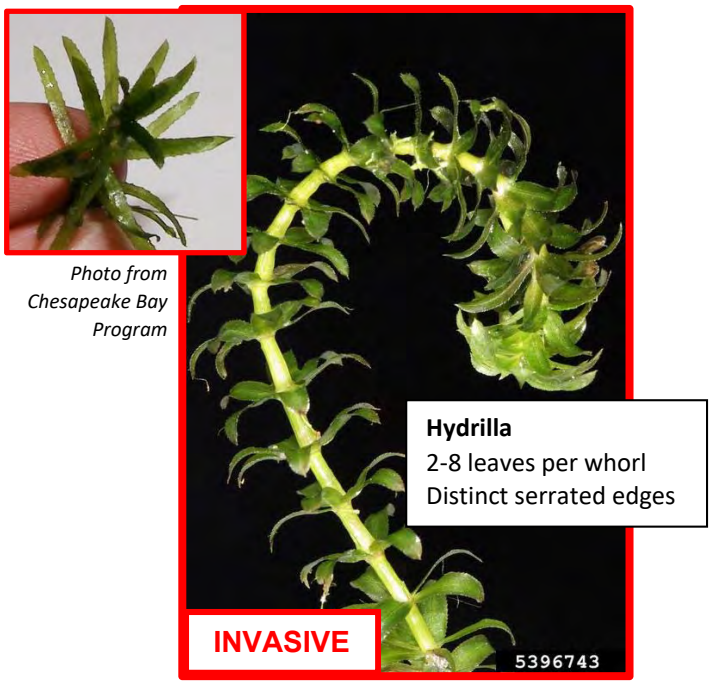
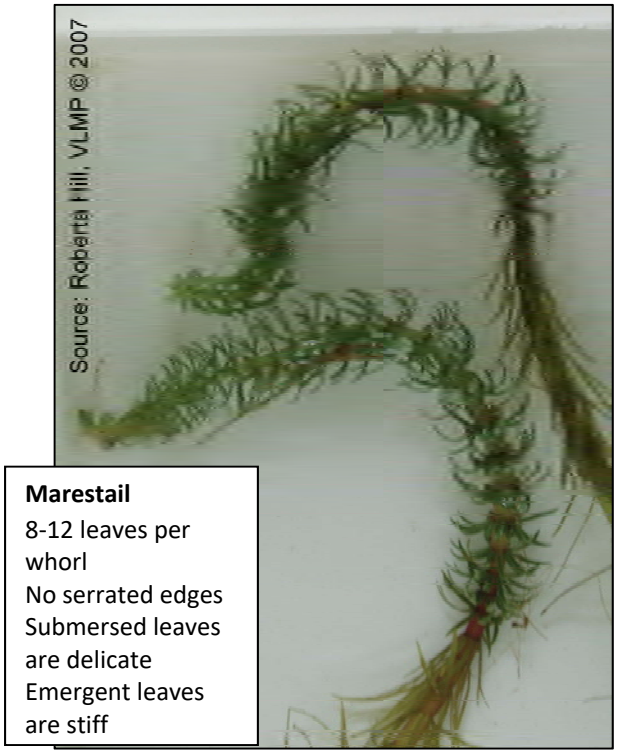
Brazilian Elodea
(Egeria densa)



Hydrilla
(*Hydrilla verticillata*)

Canada Waterweed
(Elodea canadensis)



Marestail
(*Hippuris vulgaris)*