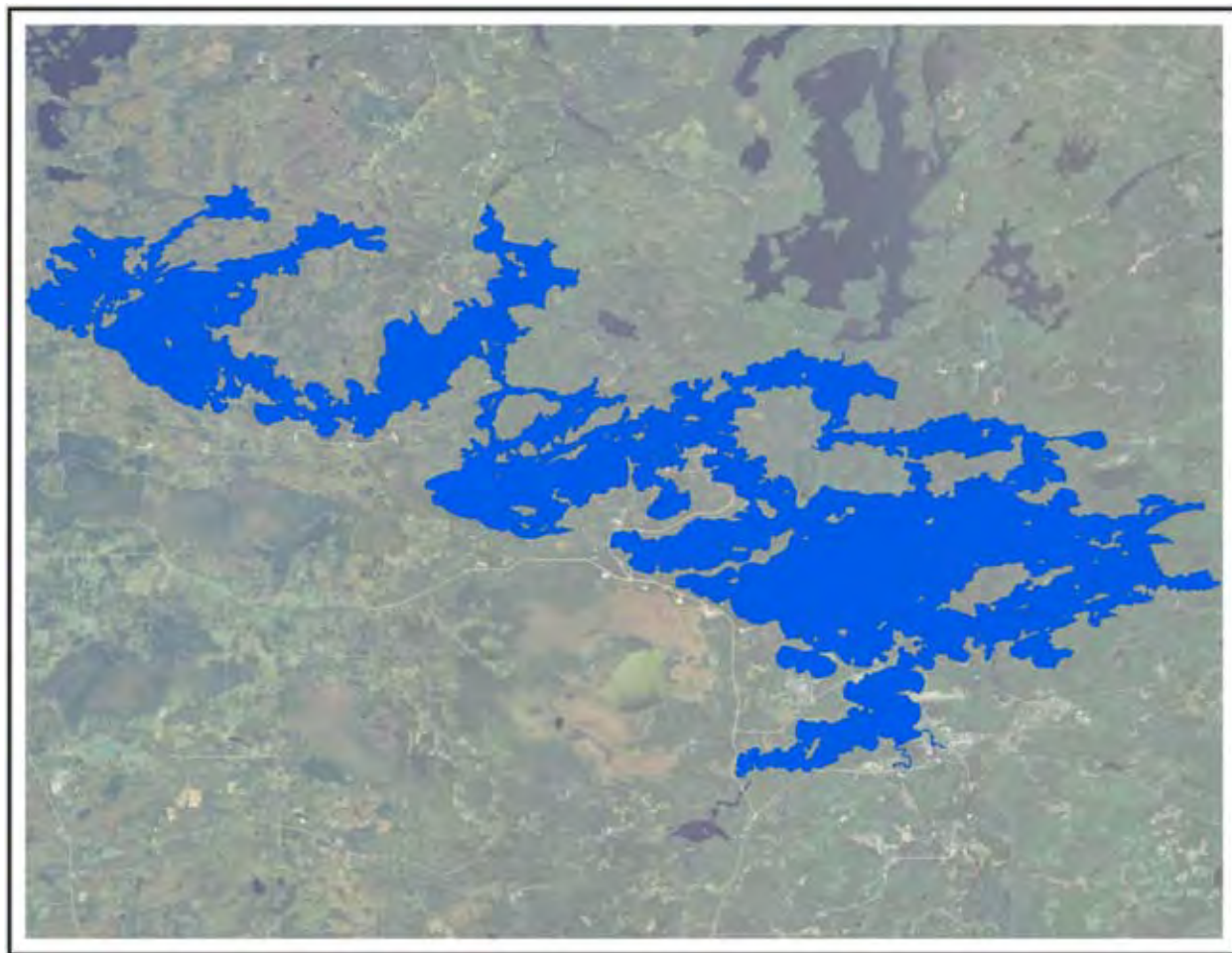


Lake Vermilion (69 - 0378 - 00)



Aquatic Vegetation Survey

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Lake: Lake Vermilion

DOW Number: 69-0378-00

Date of inspection: June 6-10, 2016

County: St. Louis

Observers: Emelia Hauck, Anna Johnson

Author of report: Emelia Hauck

Date of report: July 11, 2016

Introduction

Lake Vermilion (DOW 69-0378-00) is a large 28,181 acre lake located one mile northwest of Tower MN, in St. Louis County. Lake Vermilion has a maximum depth of 70 feet and contains a littoral area of about 33 percent which permits light penetration and allows plant growth.

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.

Table 1. Water quality means over the last 10 years for Lake Vermilion.

Bay	MPCA established site	Years with data	Trophic State	Mean Secchi depth (ft)	Phosphorus (ug/L)	Chlorophyll a (ug/L)
Armstrong Bay	69-0378-01-134	2008	Mesotrophic /Eutrophic	6.9	26.4	7.6
Black Duck Bay	No site available	NA	NA	NA	NA	NA
Cable Bay	No site available	NA	NA	NA	NA	NA
Everetts Bay	69-0378-01-118	1993	Mesotrophic /Eutrophic	5.9	28.8	7.3
Greenwood Bay	69-0378-01-111	NA	NA	NA	NA	NA
Mattson Bay	No site available	NA	NA	NA	NA	NA
Pike Bay	69-0378-03-201	NA	NA	NA	NA	NA
Stuntz Bay	69-0378-01-123	NA	NA	NA	NA	NA
Swedetown Bay	69-0378-01-122	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 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 System (GIS) software was used to generate sample points across the littoral zone surface in a 160 meter by 160 meter grid in Pike Bay and a 120 meter by 120 meter grid in all other surveyed bays, resulting in a total of 1,261 potential survey points on Lake Vermilion. Points were added in areas with curly leaf for better delineation. In the field, all points except those in the southwest corner of Pike Bay (as discussed at a meeting upon arrival) were sampled and vegetation was not found beyond 11 feet in depth. 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 1 and 4; 1 being rare ($\leq 1/3$ of the rake head covered), 2 being scattered ($>1/3$ but $\leq 2/3$ 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).



Figures 1 and 2. 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, 4 to 7 feet, 8 to 11 feet, 12 to 16 feet, and over 17 feet.

Armstrong Bay

On June 8, 2016, 55 locations, plus 13 additional points around plant-abundant areas were observed and sampled for aquatic vegetation (Figure 3). The weather was good for the survey with clear skies, temperatures reaching 69 degrees and little wind.

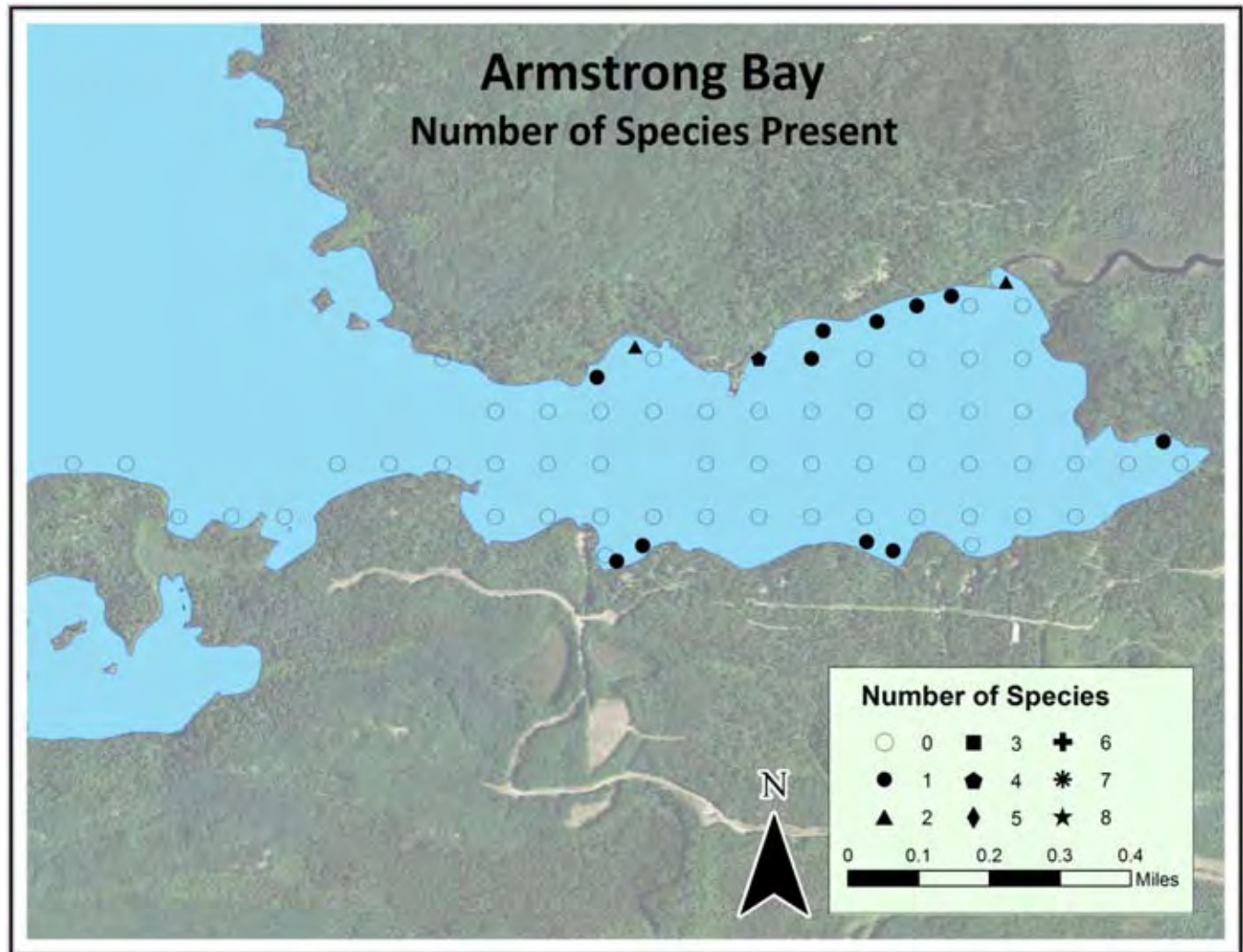


Figure 3. Armstrong Bay, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 8, 2016.

The average number of plants per rake sample in Armstrong Bay was 0.3. One was the maximum number of species sampled at one location in Armstrong Bay while two and four species were sampled occasionally (Figure 3).

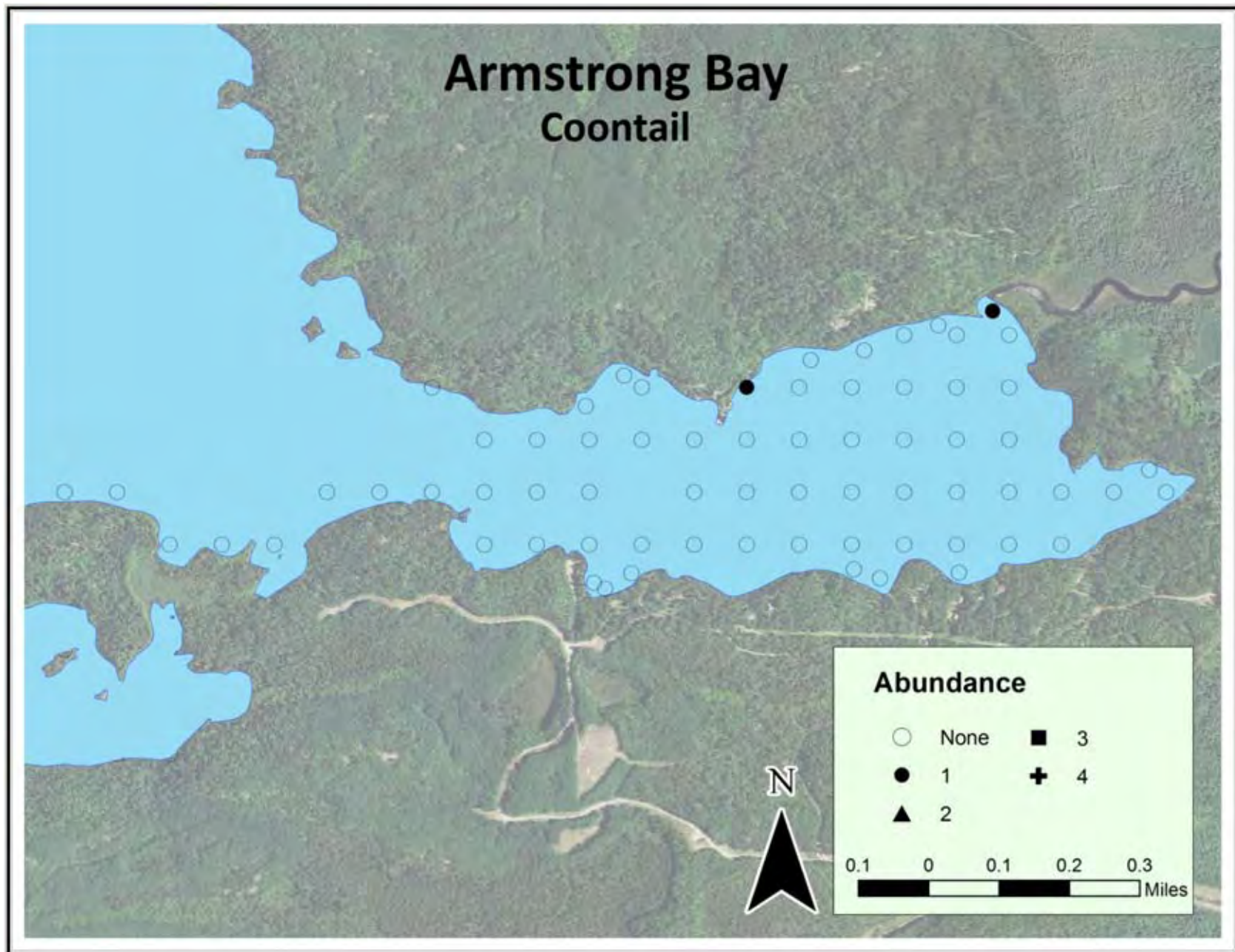


Figure 4. Coontail areas in Armstrong Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

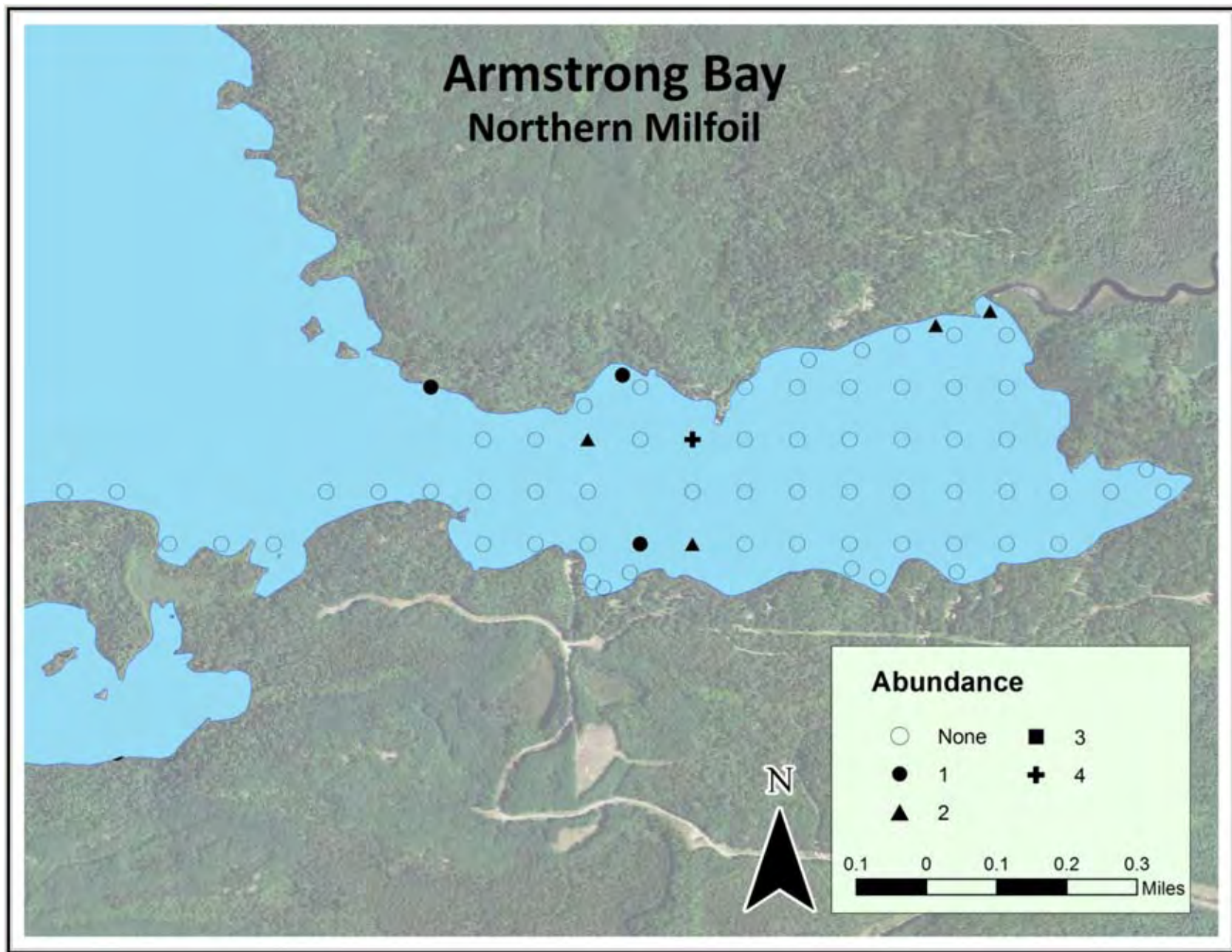


Figure 5. Northern Milfoil in Armstrong Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

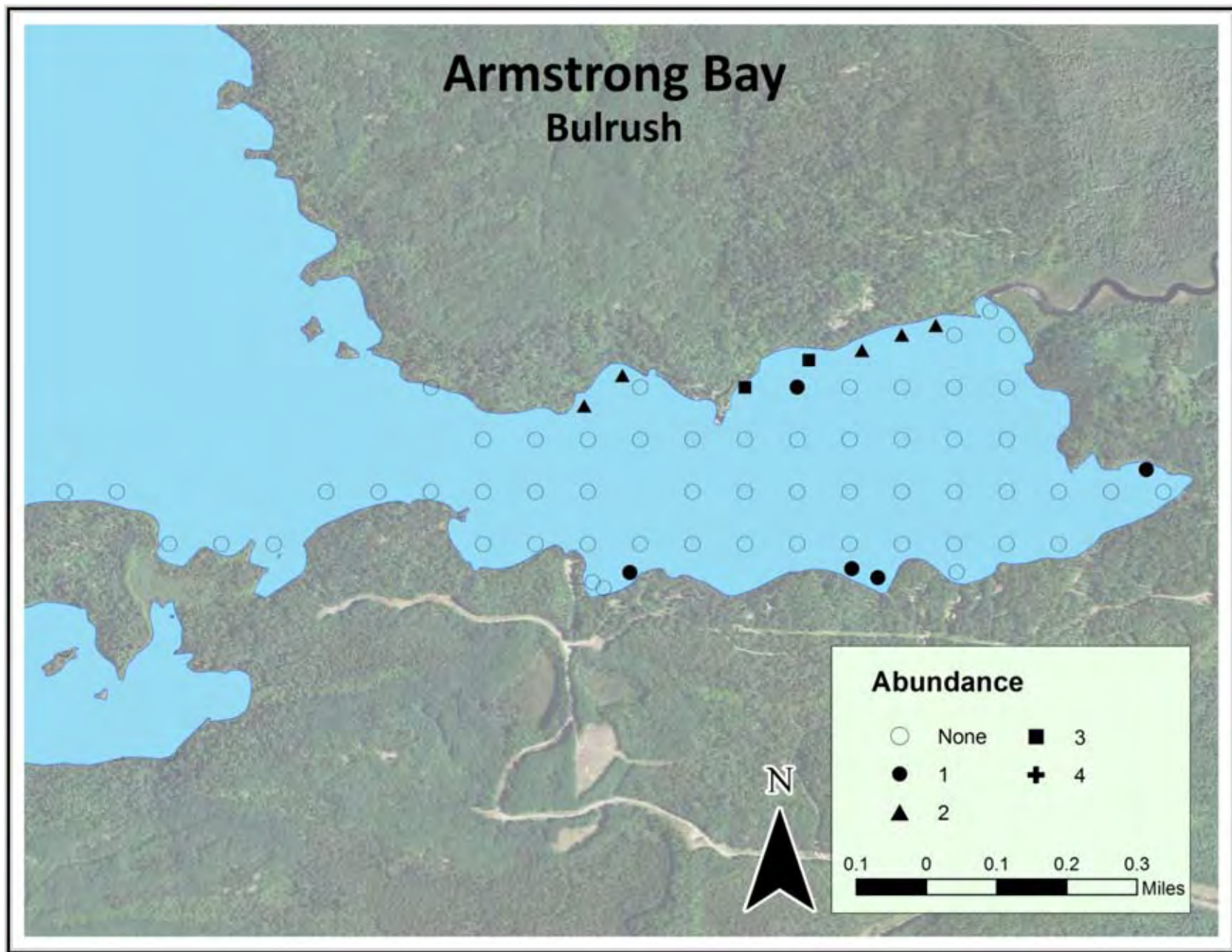


Figure 6. Bulrush in Armstrong Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

Table 2. Aquatic plants surveyed in Armstrong Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

Armstrong Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	Coontail	<i>Ceratophyllum demersum</i>	2	2.9%
	Northern water milfoil	<i>Myriophyllum sibiricum</i>	1	1.5%
FLOATING - LEAF - These plant leaves float on water and are anchored to the bottom of the lake.	Yellow Waterlily	<i>Nuphar variegata</i>	3	4.4%
	White Waterlily	<i>Nymphaea odorata</i>	1	1.5%
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	Bulrush	<i>Scirpus acutus</i>	12	17.6%
Total number of plants (species diversity for the bay)			5	
Total number of plant occurrences			19	
Total number of sites			68	

Sampling occurred to a maximum depth of 25 feet; however, no plants were found to be growing beyond 7 feet of water. Plant abundance was greatest between 4-7 feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 8).

Of the 68 sampled locations in Armstrong Bay, 54 sites had no vegetation present.

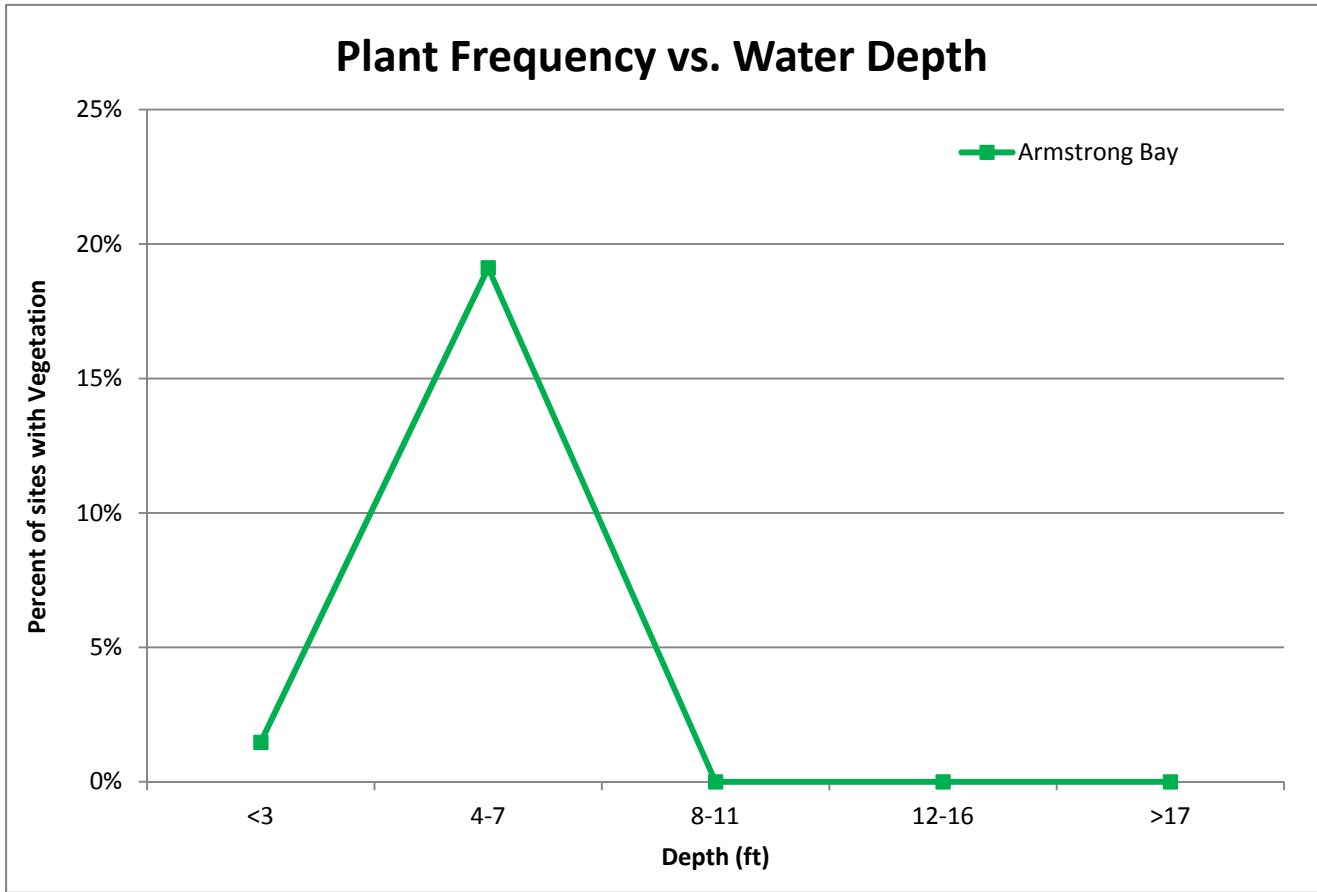


Figure 8. Frequency of vegetation vs. water depth, Armstrong Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

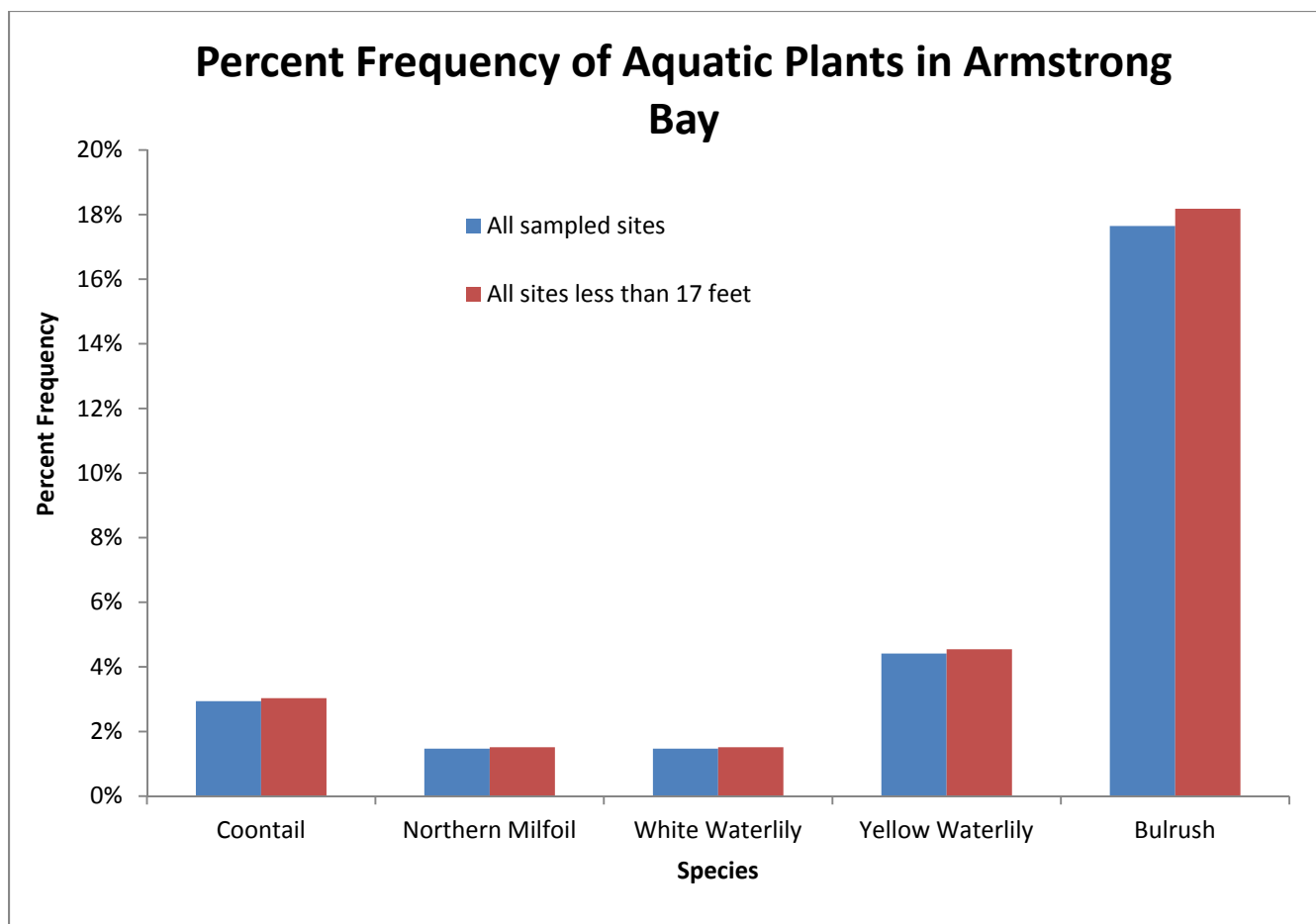


Figure 9. Frequency of occurrence for aquatic plant species in Armstrong Bay, Lake Vermilion, June 8, 2016.

Cable Bay

On June 8, 2016, 22 locations, plus 3 additional points around plant-abundant areas were observed and sampled for aquatic vegetation (Figure 10). The weather was good for the survey with clear skies, temperatures reaching 69 degrees and little wind.

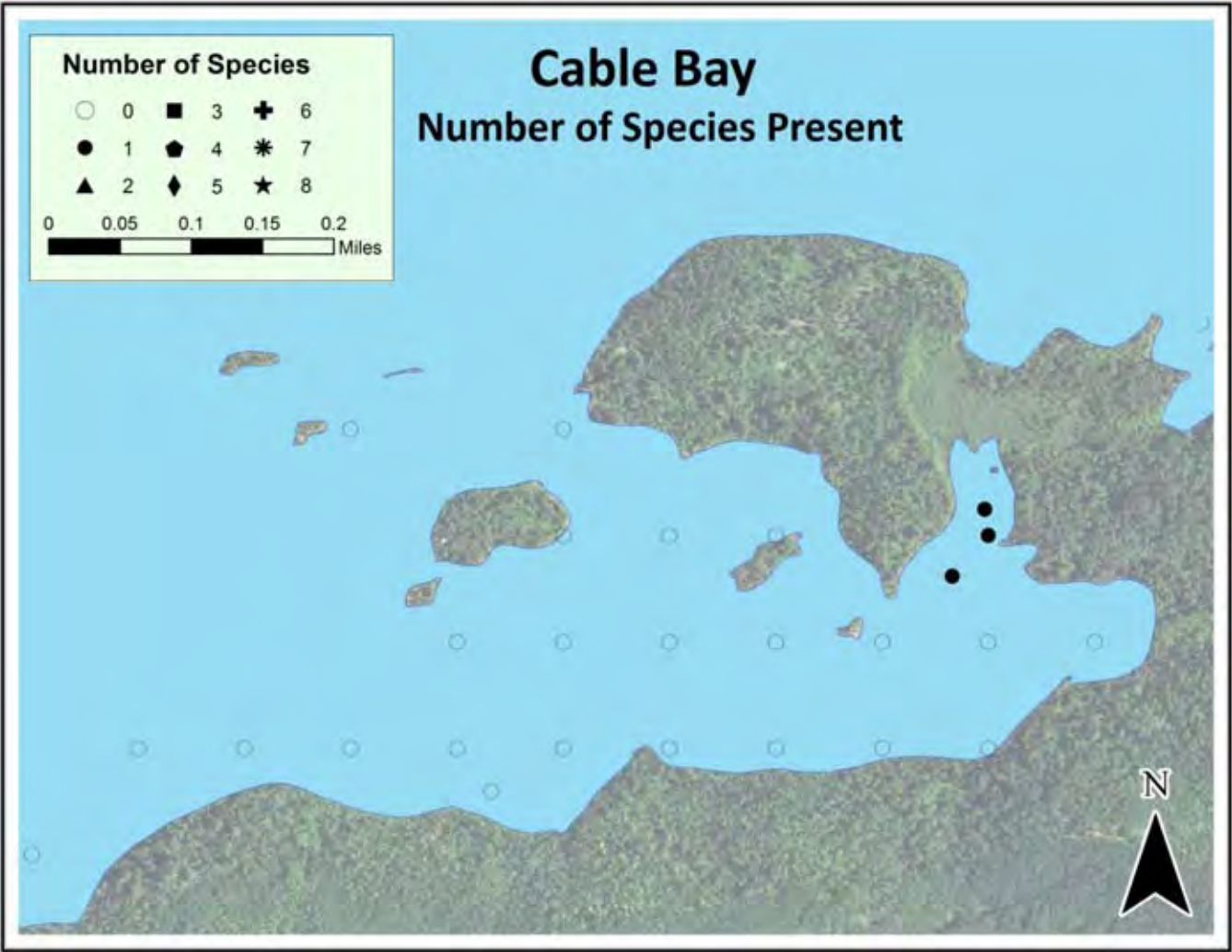


Figure 10. Cable Bay, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 8, 2016.

The average number of plants per rake sample in Cable Bay was 0.08. One was the maximum number of species sampled at one location in Lake Vermilion (Figure 10).

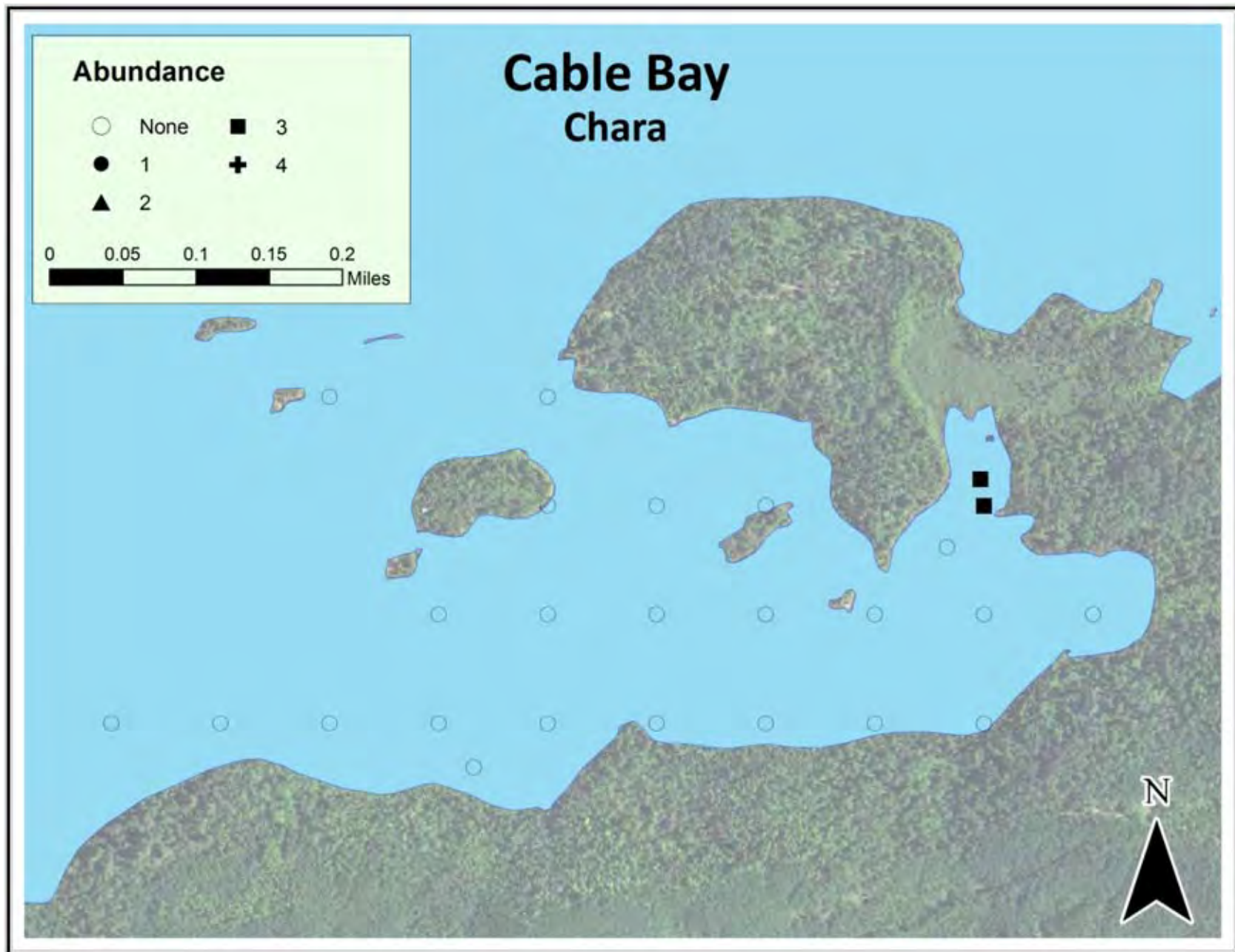


Figure 11. Chara areas in Cable Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

Table 3. Aquatic plants surveyed in Cable Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

Cable Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	Chara	<i>Chara sp.</i>	2	8.0%
FLOATING - LEAF -These plant leaves float on water and are anchored to the bottom of the lake.	NA			
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	NA			
Total number of plants (species diversity for the bay)			1	
Total number of plant occurrences			2	
Total number of sites			25	

Sampling occurred to a maximum depth of 26 feet; however, no plants were found to be growing beyond 7 feet of water. Plant abundance was greatest between one and eleven feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 12).

Of the 25 sampled locations in Cable Bay, 22 sites had no vegetation present.

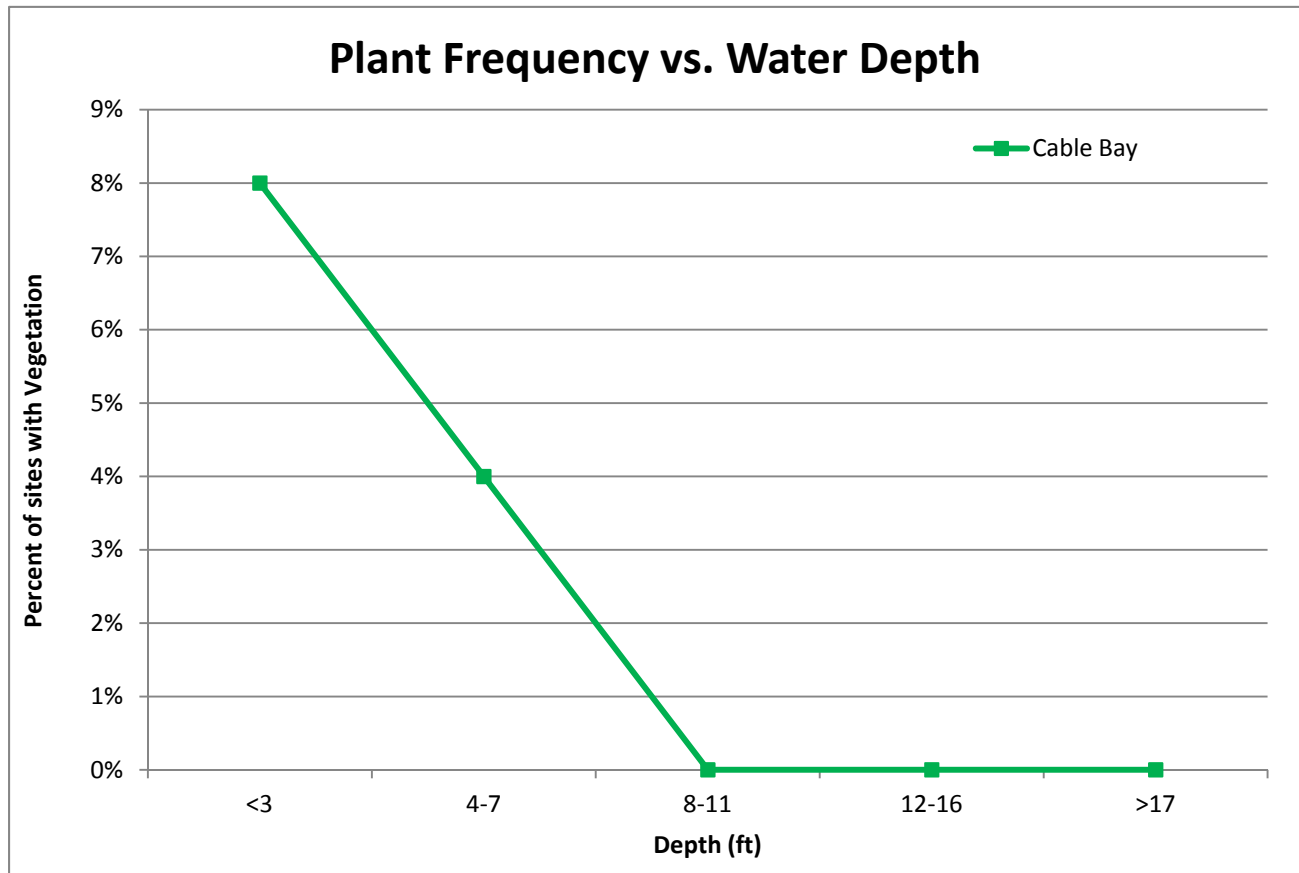


Figure 12. Frequency of vegetation vs. water depth, Cable Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

Mattson Bay

On June 8, 2016, 36 locations, plus 2 additional points around plant-abundant areas were observed and sampled for aquatic vegetation (Figure 13). The weather was good for the survey with clear skies, temperatures reaching 69 degrees and little wind.

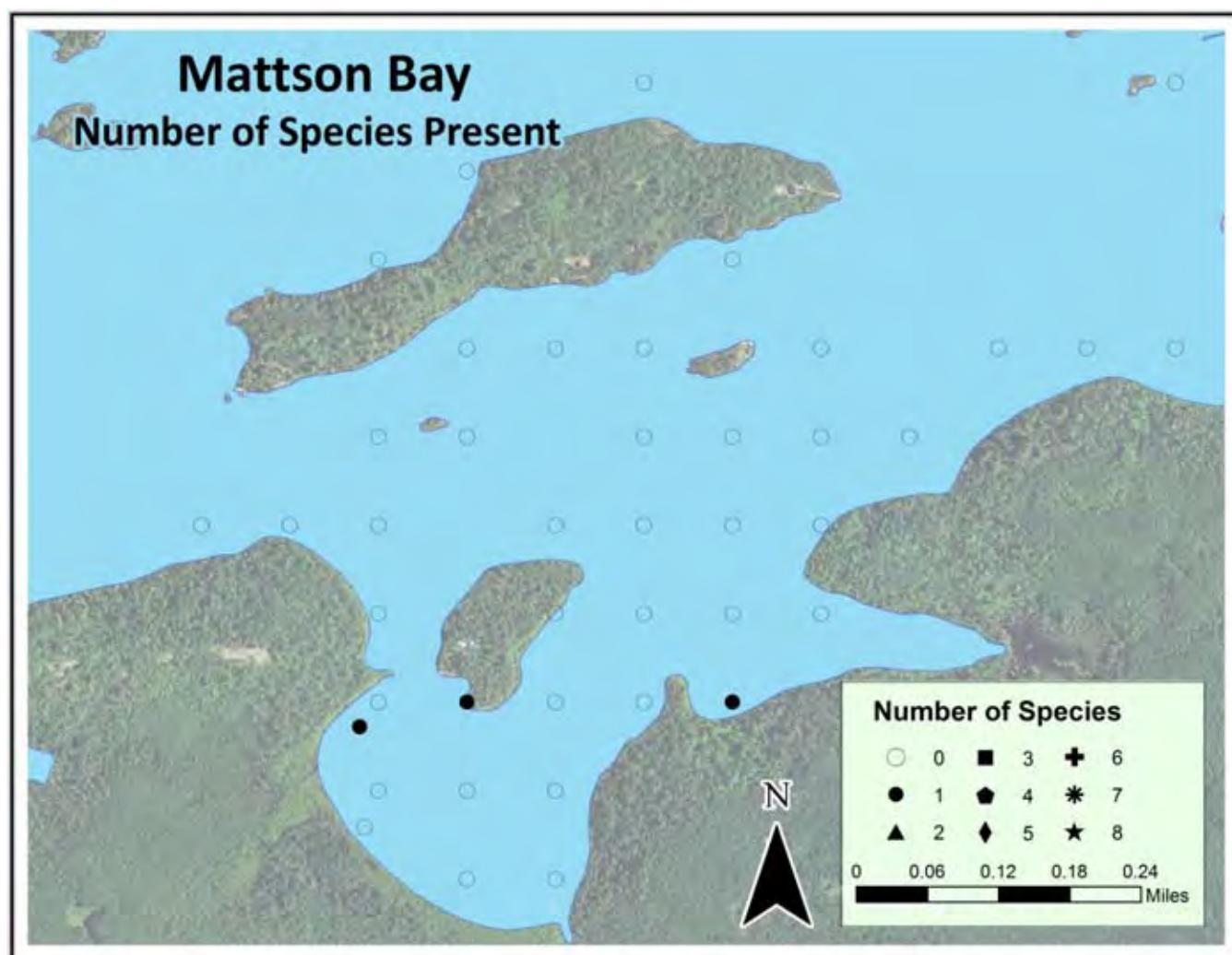


Figure 13. Mattson Bay, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 8, 2016.

The average number of plants per rake sample in Mattson Bay was 0.08. One was the maximum number of species sampled at one location in Mattson Bay.

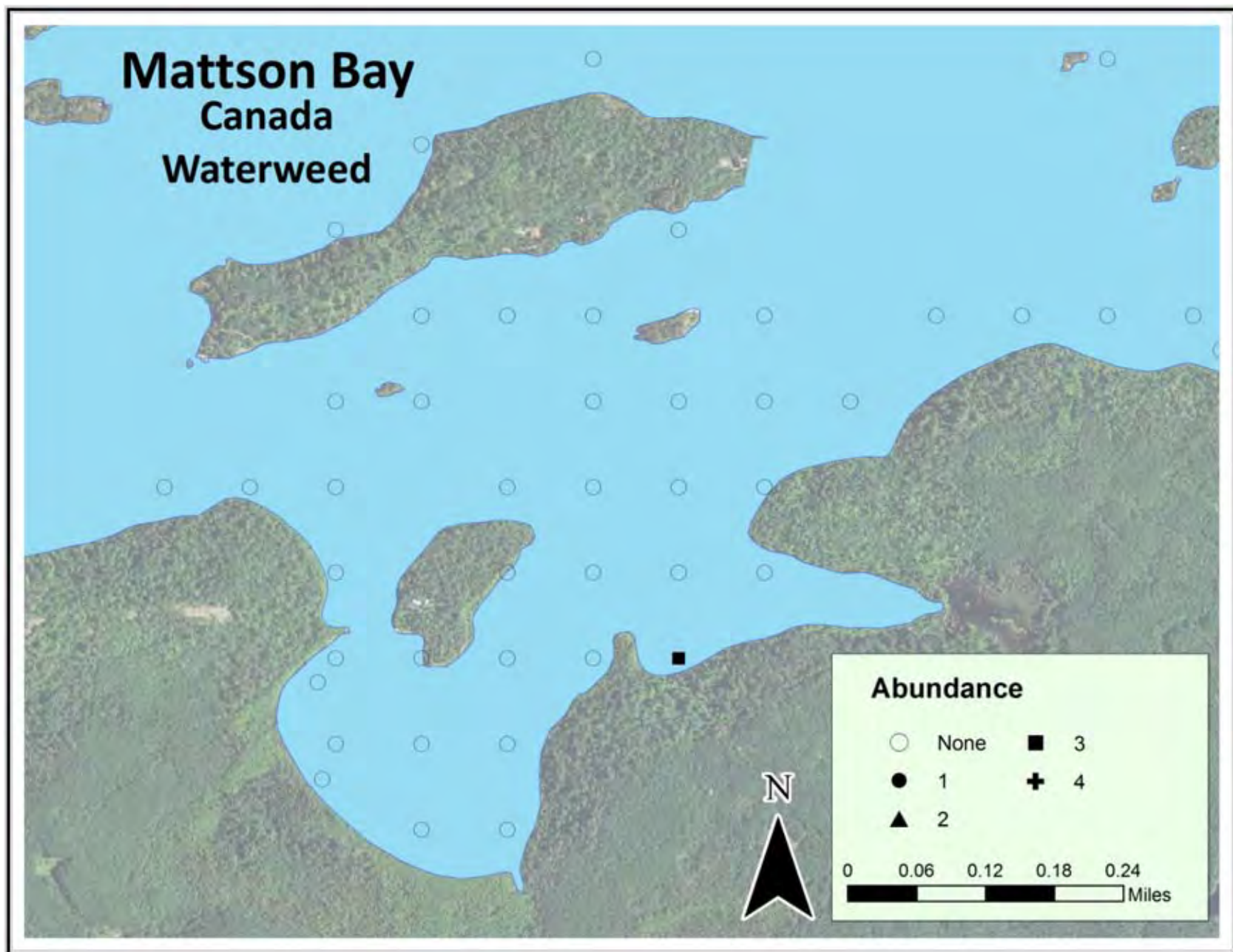


Figure 14. Canada Waterweed areas in Mattson Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

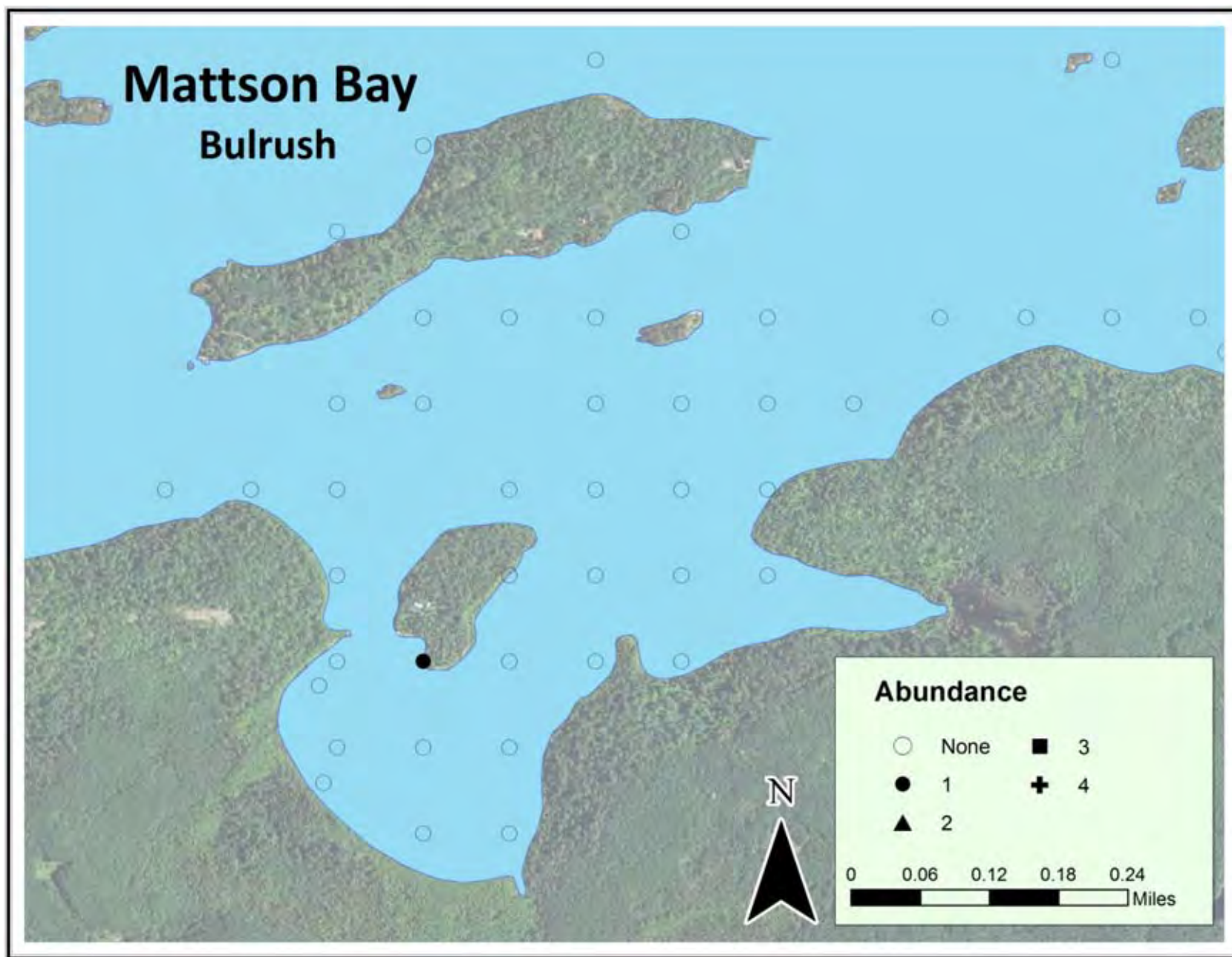


Figure 15. Bulrush in Mattson Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

Table 4. Aquatic plants surveyed in Mattson Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

Mattson Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	Canada Waterweed	<i>Elodea canadensis</i>	1	2.6%
	Chara	<i>Chara sp.</i>	1	2.6%
FLOATING - LEAF - These plant leaves float on water and are anchored to the bottom of the lake.	NA			
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	Bulrush	<i>Scirpus acutus</i>	1	2.6%
Total number of plants (species diversity for the bay)			3	
Total number of plant occurrences			3	
Total number of sites			38	

Sampling occurred to a maximum depth of 26 feet; however, no plants were found to be growing beyond 7 feet of water. Plant abundance was greatest between four and seven feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 16).

Of the 38 sampled locations in Mattson Bay, 35 sites had no vegetation present.

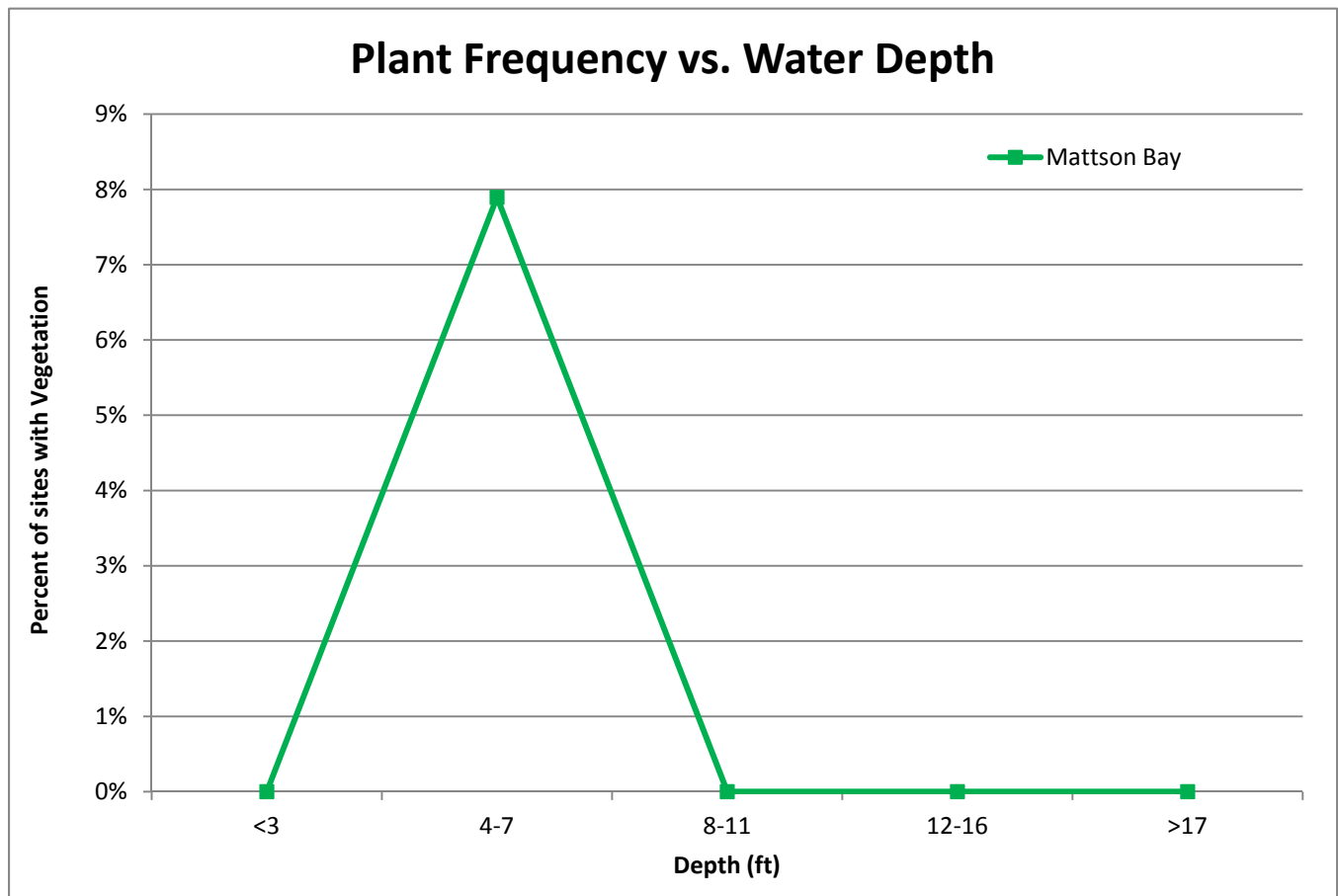


Figure 16. Frequency of vegetation vs. water depth, Mattson Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

Stuntz Bay

On June 9, 2016, 106 locations, plus 47 additional points around plant-abundant areas were observed and sampled for aquatic vegetation (Figure 17). The weather was good for the survey with partially cloudy skies, temperatures reaching 78 degrees and little wind.

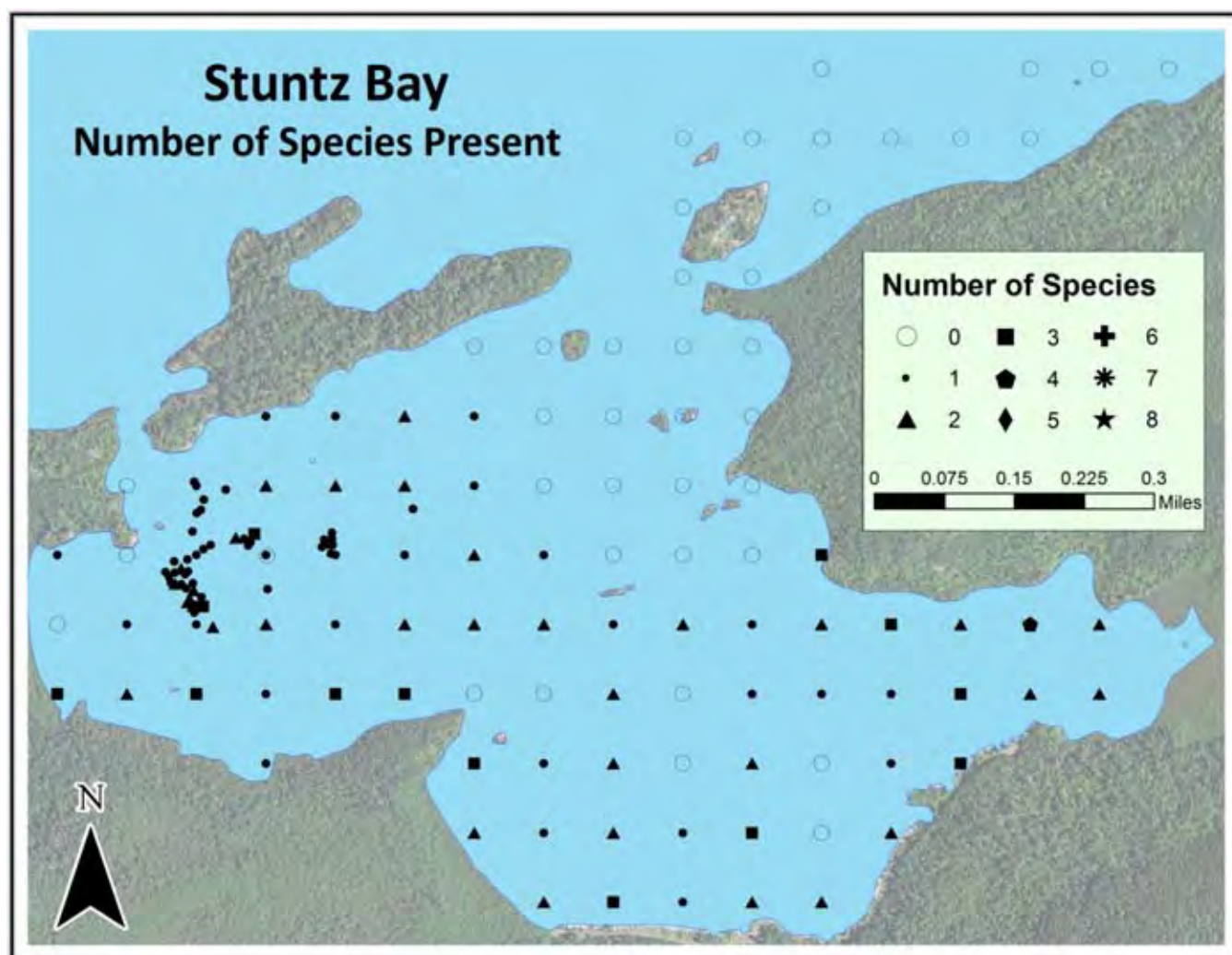


Figure 17. Stuntz Bay, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 9, 2016.

The average number of plants per rake sample on Stuntz Bay was 1.2. Four was the maximum number of species sampled at one location in Stuntz Bay while One and two species were sampled regularly (Figure 17).

The invasive Curly-leaf Pondweed was found in the northwest portion of Stuntz Bay at high densities (Figure 18 and 19).

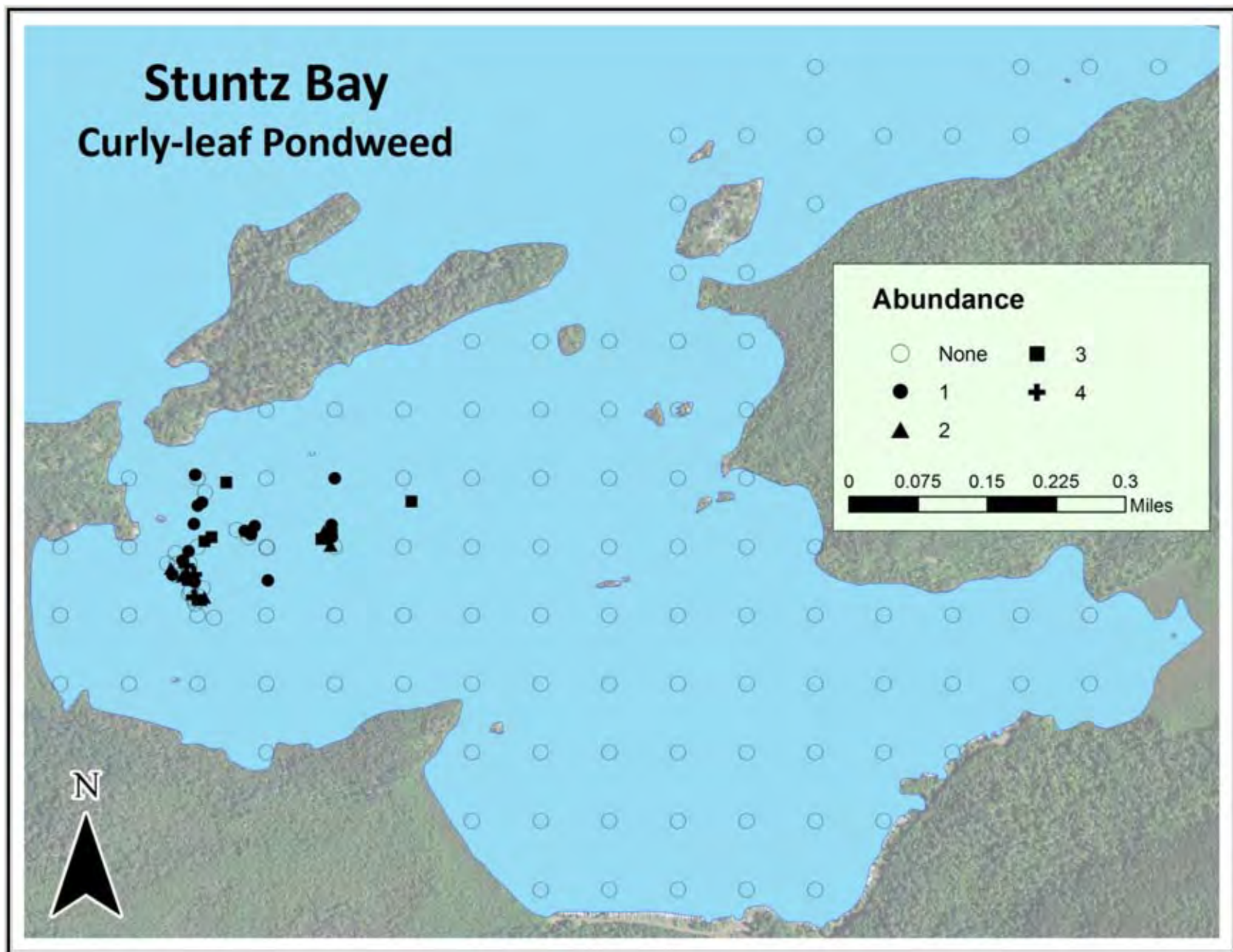


Figure 18. Curly-leaf areas in Stuntz Bay, Lake Vermilion Point-Intercept Survey, June 9, 2016.

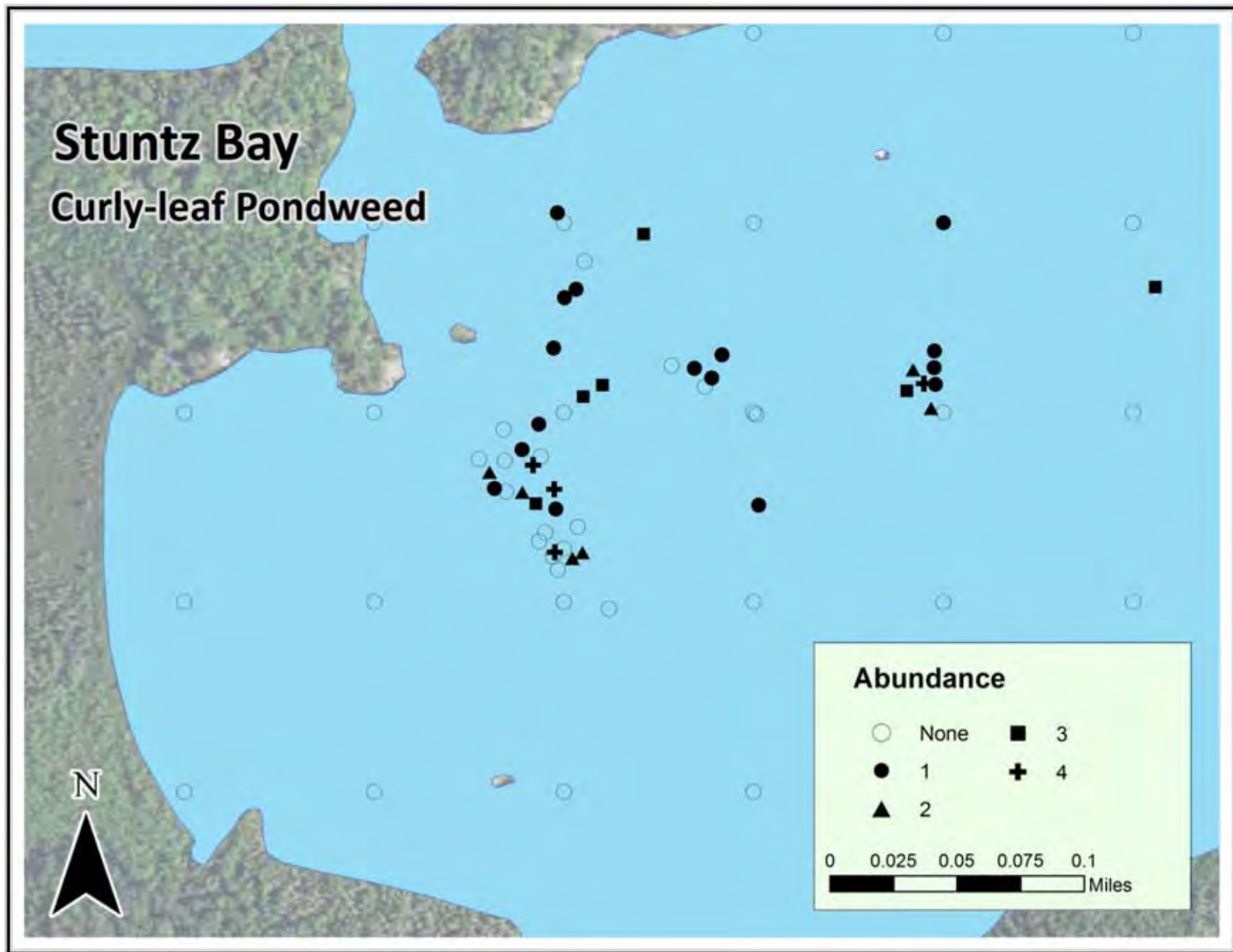


Figure 19. Magnified area with curly-leaf in Stuntz Bay, Lake Vermilion Point-Intercept Survey, June 9, 2016.

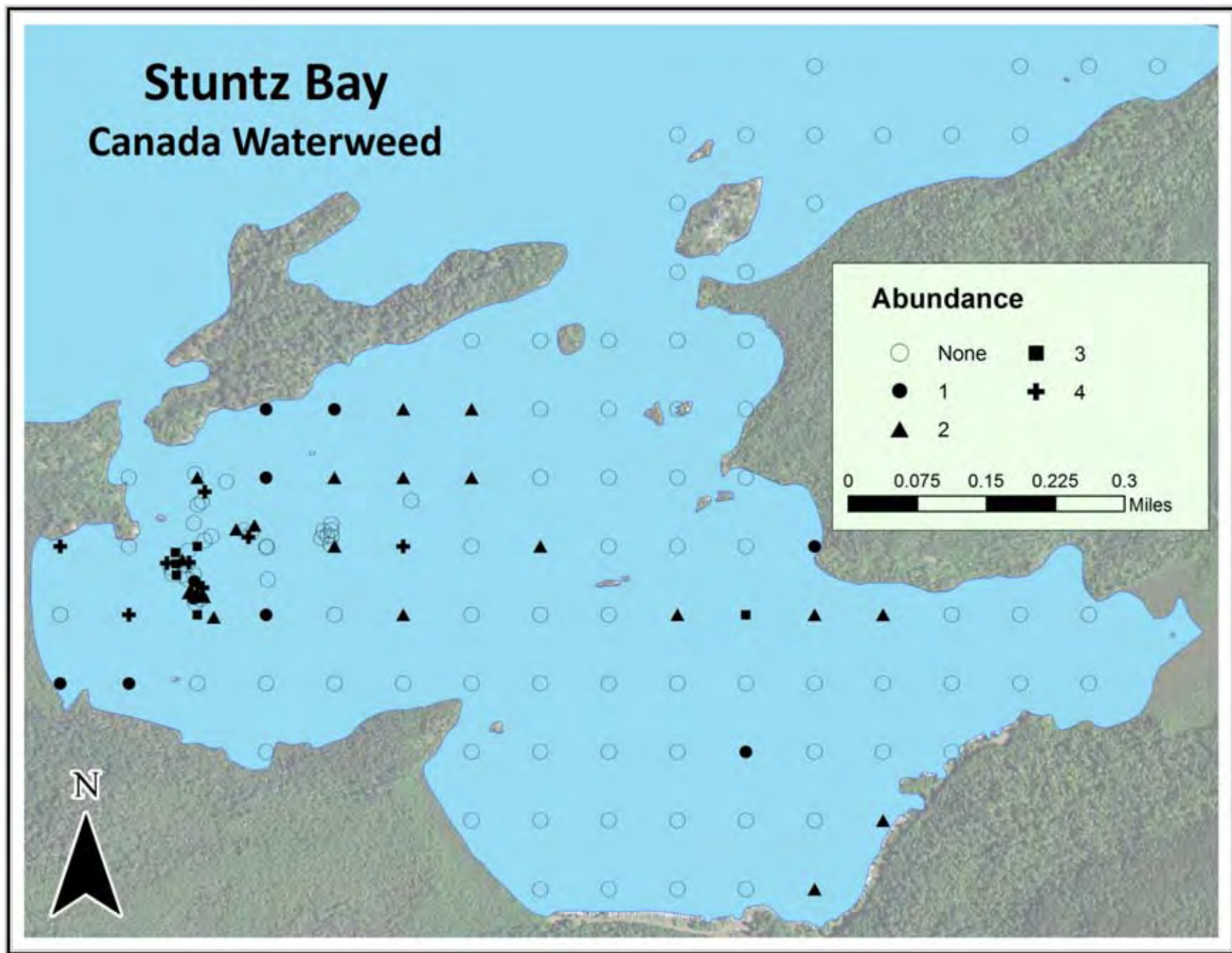


Figure 20. Canada Waterweed in Stuntz Bay, Lake Vermilion Point-Intercept Survey, June 9, 2016.

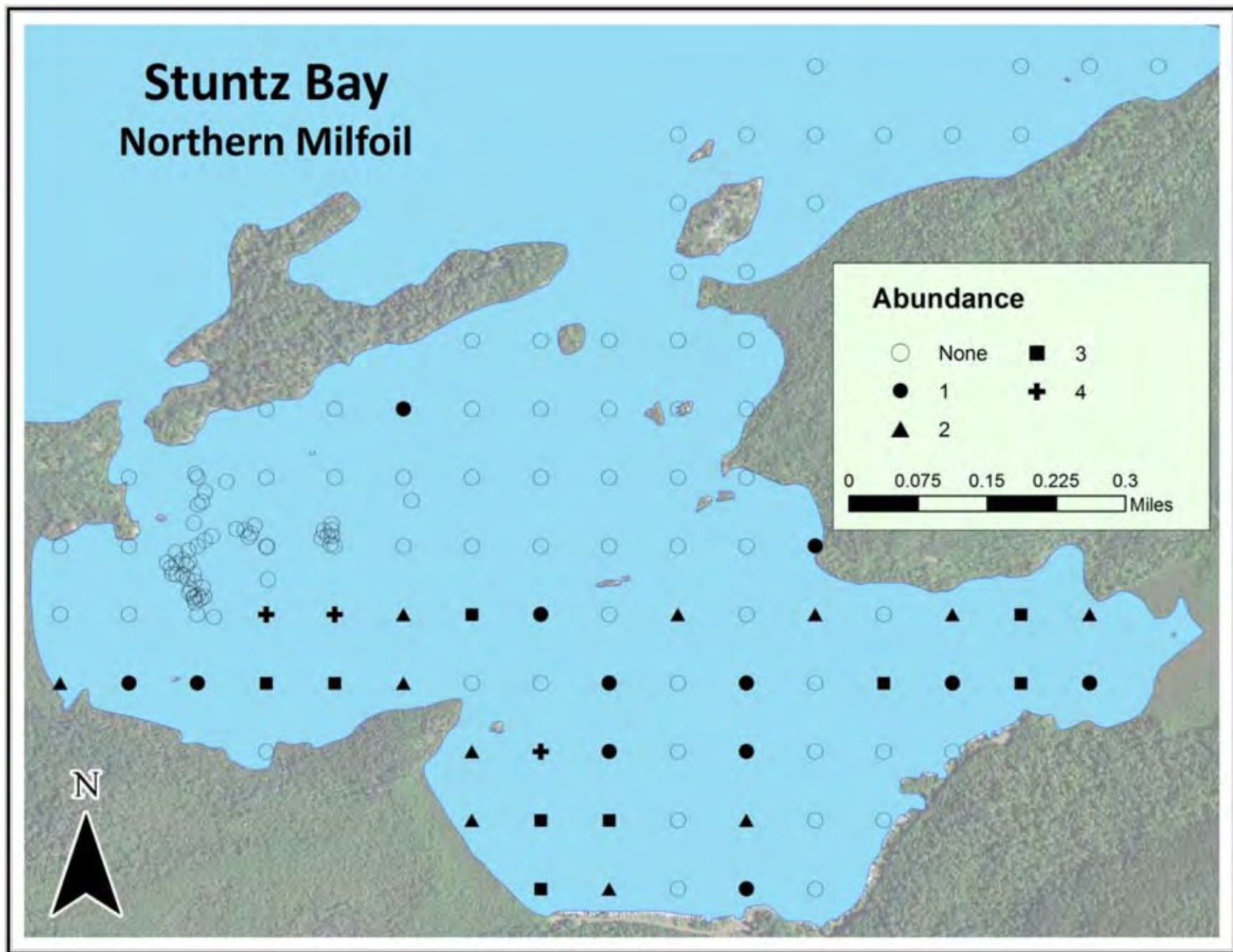


Figure 21. Northern Milfoil in Stuntz Bay, Lake Vermilion Point-Intercept Survey, June 9, 2016.

Table 5. Aquatic plants surveyed in Stuntz Bay, Lake Vermilion, St. Louis County, MN: June 9, 2016.

Stuntz Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	Buttercup	<i>Ranunculus sp.</i>	1	0.7%
	Canada Waterweed	<i>Elodea canadensis</i>	46	30.1%
	Chara	<i>Chara sp.</i>	10	6.5%
	Claspingleaf Pondweed	<i>Potamogeton richardsonii</i>	1	0.7%
	Coontail	<i>Ceratophyllum demersum</i>	18	11.8%
	Curly-leaf Pondweed	<i>Potamogeton crispus</i>	32	20.9%
	Flatstem Pondweed	<i>Potamogeton zosteriformis</i>	19	12.4%
	Marigold	<i>Bidens beckii</i>	1	0.7%
	Northern Milfoil	<i>Myrophyllum sibiricum</i>	35	22.9%
	Robbin's Pondweed	<i>Potamogeton robbinsii</i>	1	0.7%
	Star Grass	<i>Zosterella dubia</i>	5	3.3%
	White-stem Pondweed	<i>Potamogeton praelongus</i>	10	6.5%
FLOATING - LEAF -These plant leaves float on water and are anchored to the bottom of the lake.	NA			
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	Bulrush	<i>Scirpus acutus</i>	1	0.7%
Total number of plants (species diversity for the bay)			13	
Total number of plant occurrences			180	
Total number of sites			153	

Sampling occurred to a maximum depth of 17 feet; however, no plants were found to be growing beyond 15 feet of water. Plant abundance was greatest between four and seven feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 22).

Of the 153 sampled locations in Stuntz Bay, 44 sites had no vegetation present.

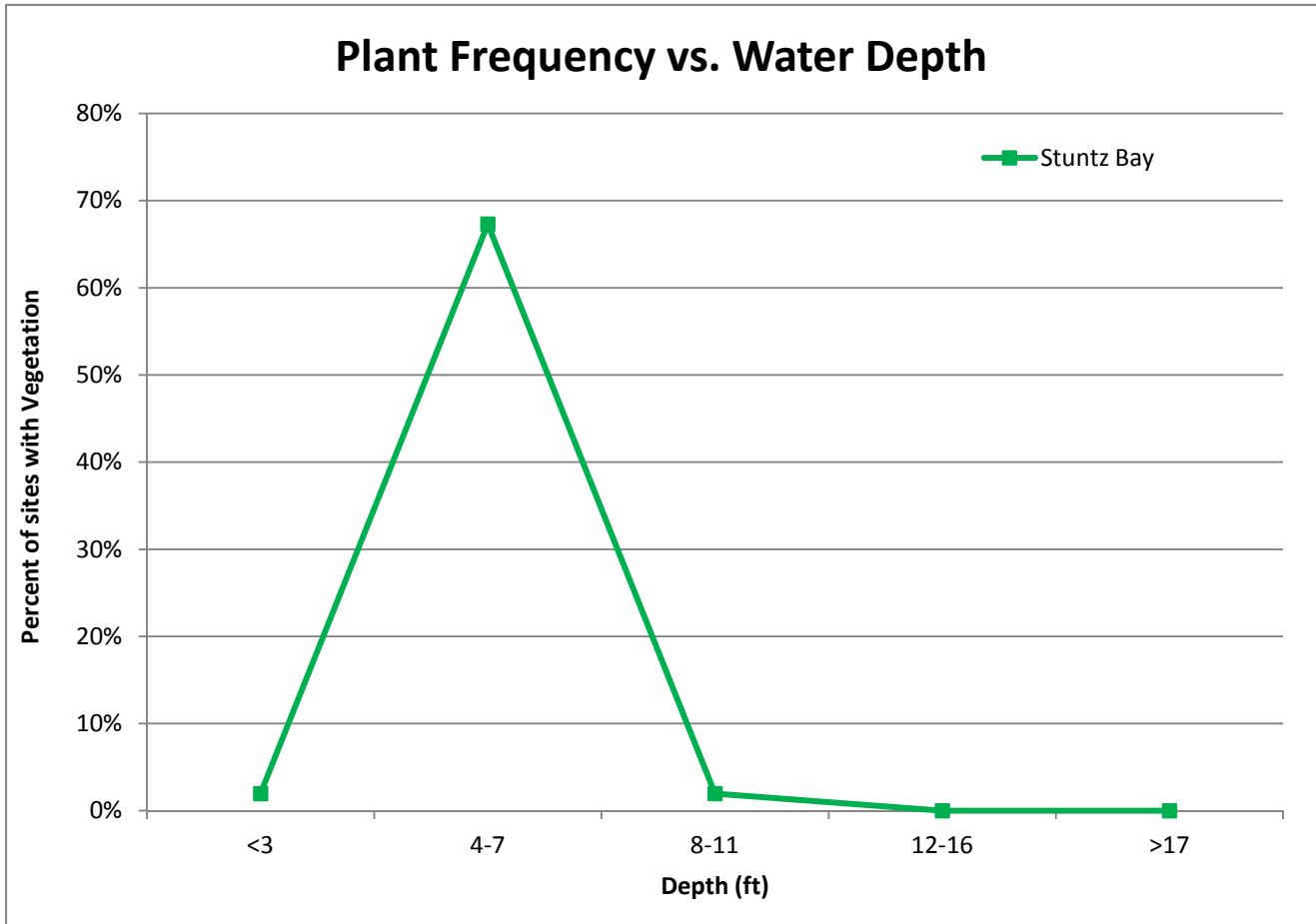


Figure 22. Frequency of vegetation vs. water depth, Stuntz Bay, Lake Vermilion, St. Louis County, MN: June 9, 2016.

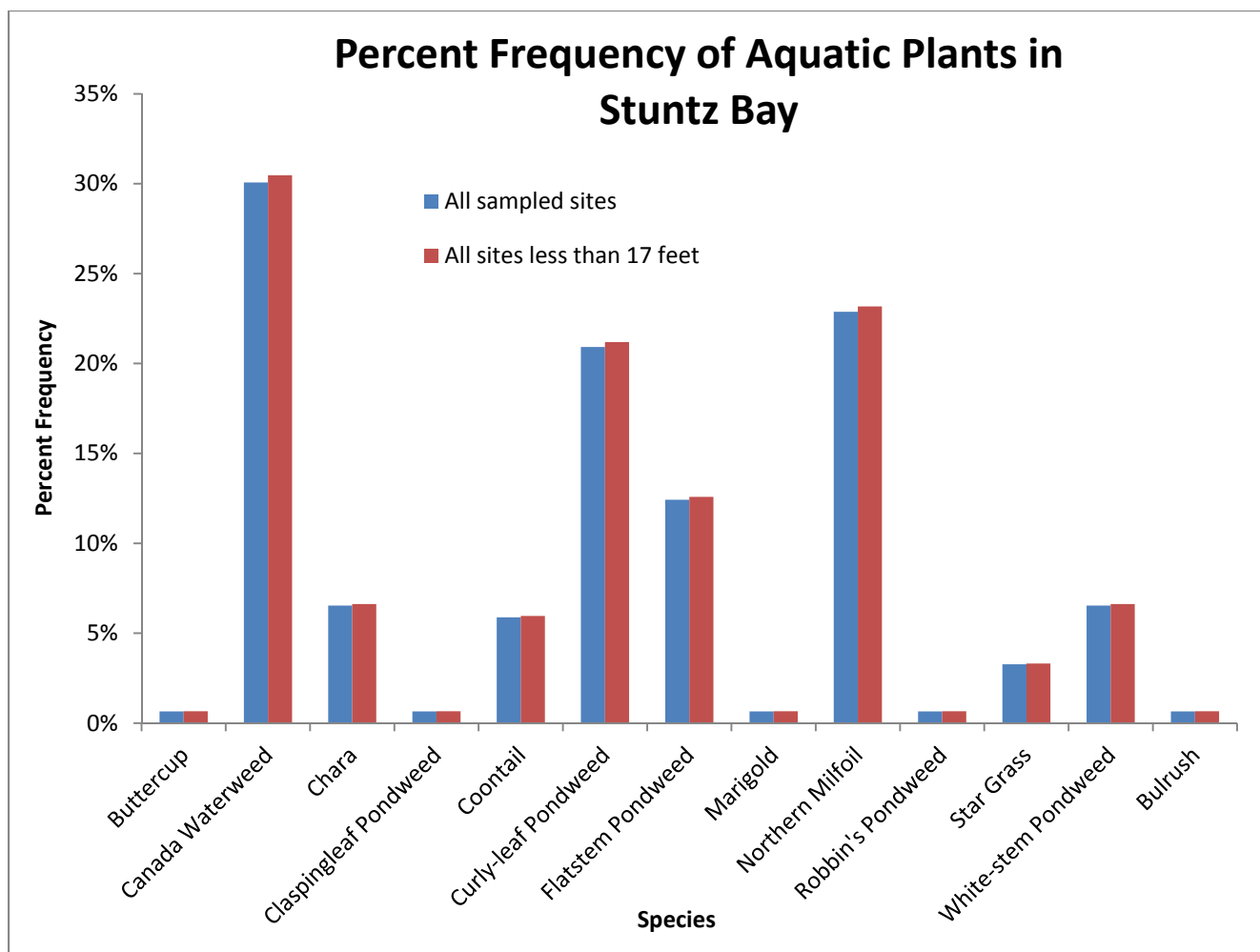


Figure 23. Frequency of occurrence for aquatic plant species in Stuntz Bay, Lake Vermilion, June 9, 2016.

Swedetown Bay

On June 8, 2016, 29 locations were observed and sampled for aquatic vegetation (Figure 24). The weather was good for the survey with clear skies, temperatures reaching 69 degrees and little wind.

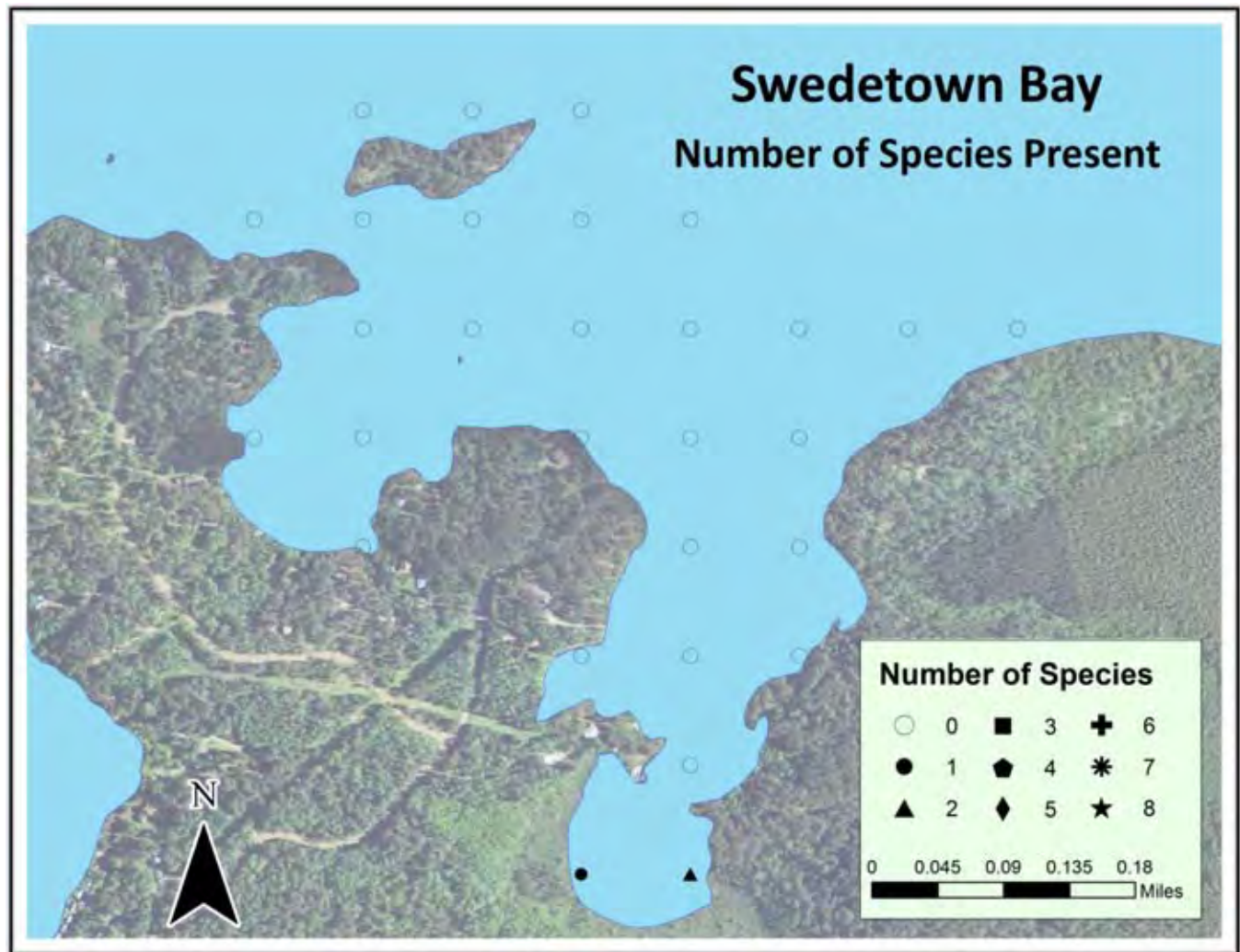


Figure 24. Swedetown Bay, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 8, 2016.

The average number of plants per rake sample on Swedetown Bay was 0.1. Two was the maximum number of species sampled at one location in Swedetown Bay (Figure 24).

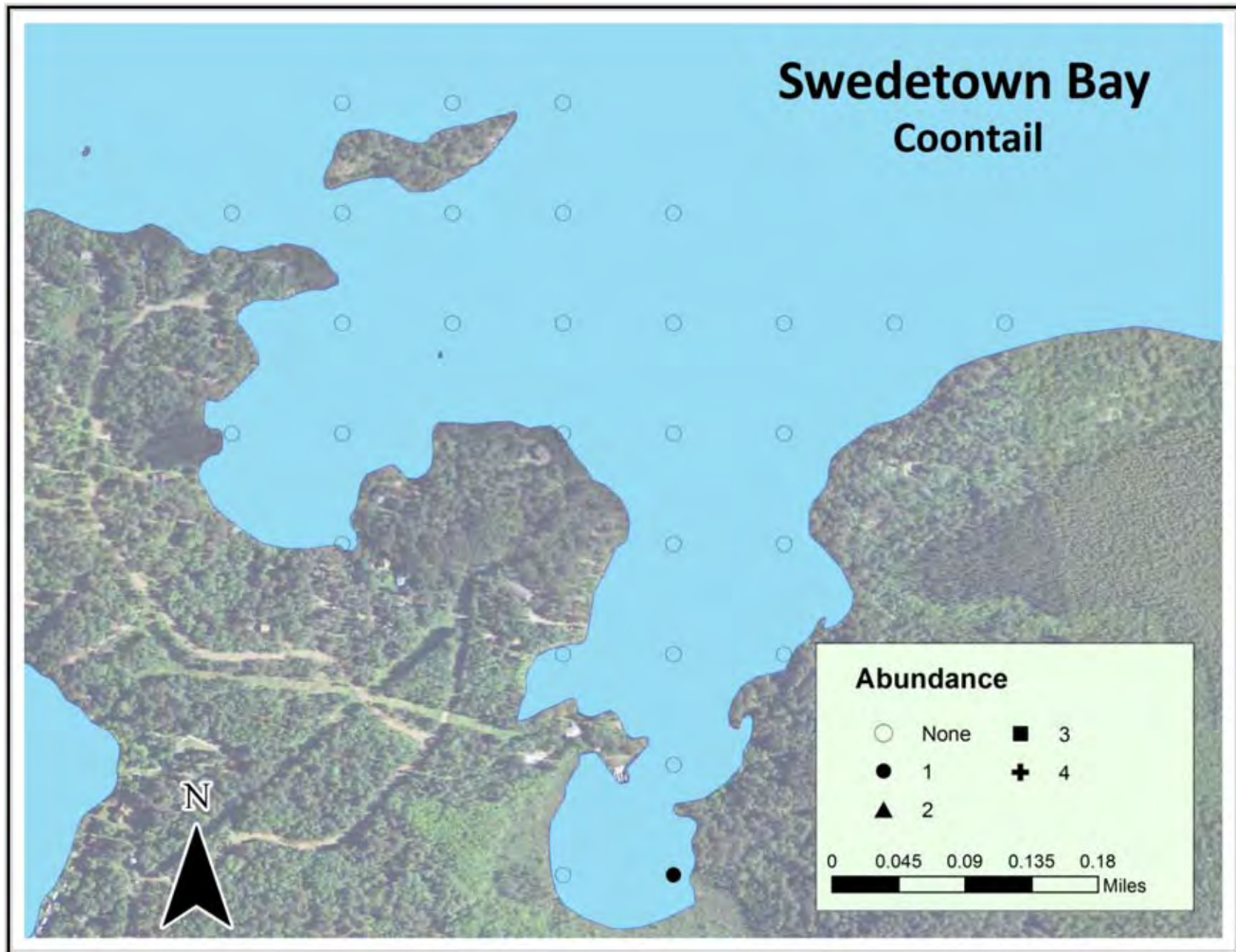


Figure 25. Coontail areas in Swedetown Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

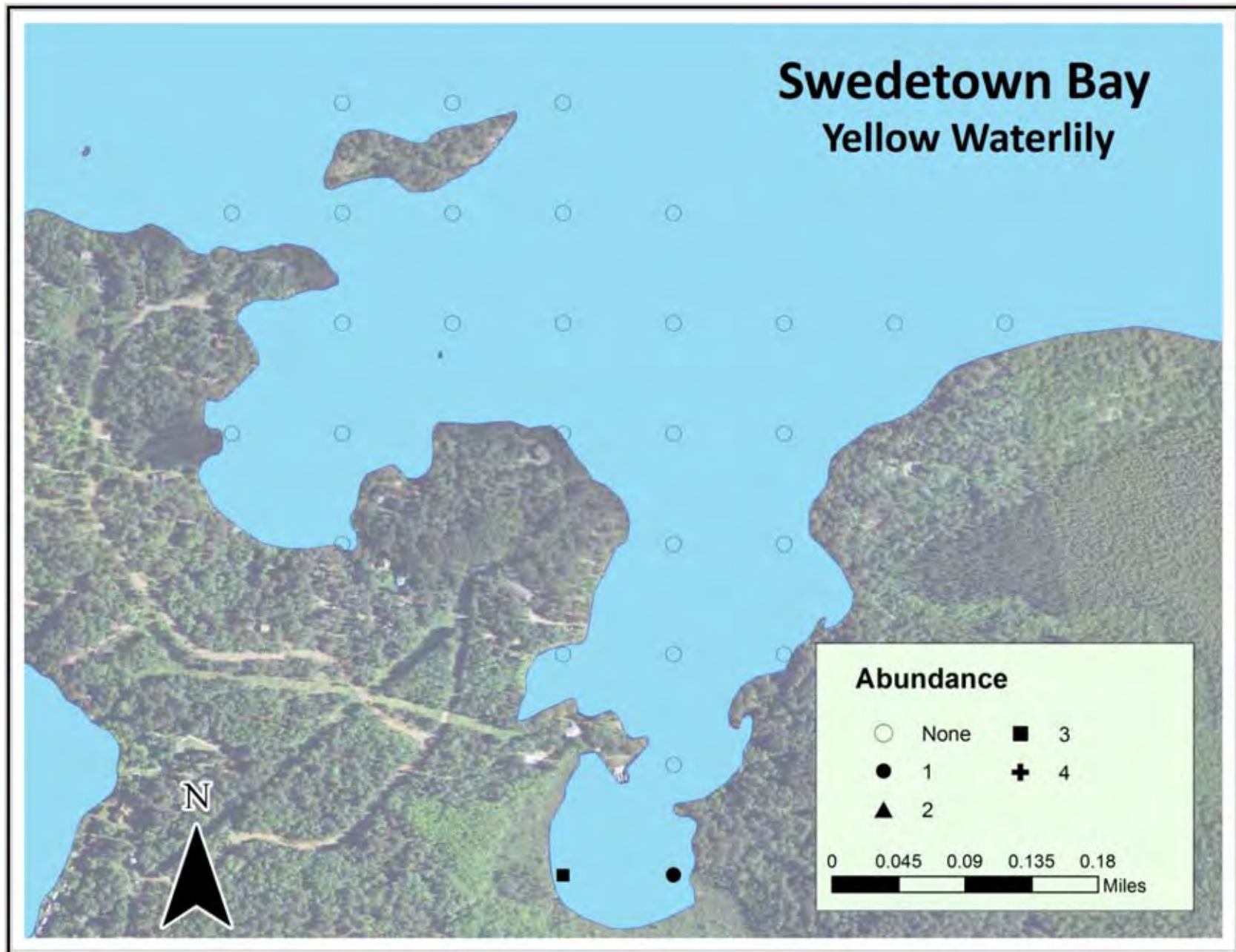


Figure 26. Yellow Waterlily areas in Swedetown Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

Table 6. Aquatic plants surveyed in Swedetown Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

Swedetown Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	Coontail	<i>Ceratophyllum demersum</i>	1	3.4%
FLOATING - LEAF - These plant leaves float on water and are anchored to the bottom of the lake.	Yellow Waterlily	<i>Nuphar variegata</i>	2	6.9%
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	NA			
Total number of plants (species diversity for the bay)			2	
Total number of plant occurrences			3	
Total number of sites			29	

Sampling occurred to a maximum depth of 25 feet; however, no plants were found to be growing beyond 3 feet of water. Plant abundance was greatest between one and three feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 27).

Of the 29 sampled locations in Swedetown Bay, 27 sites had no vegetation present.

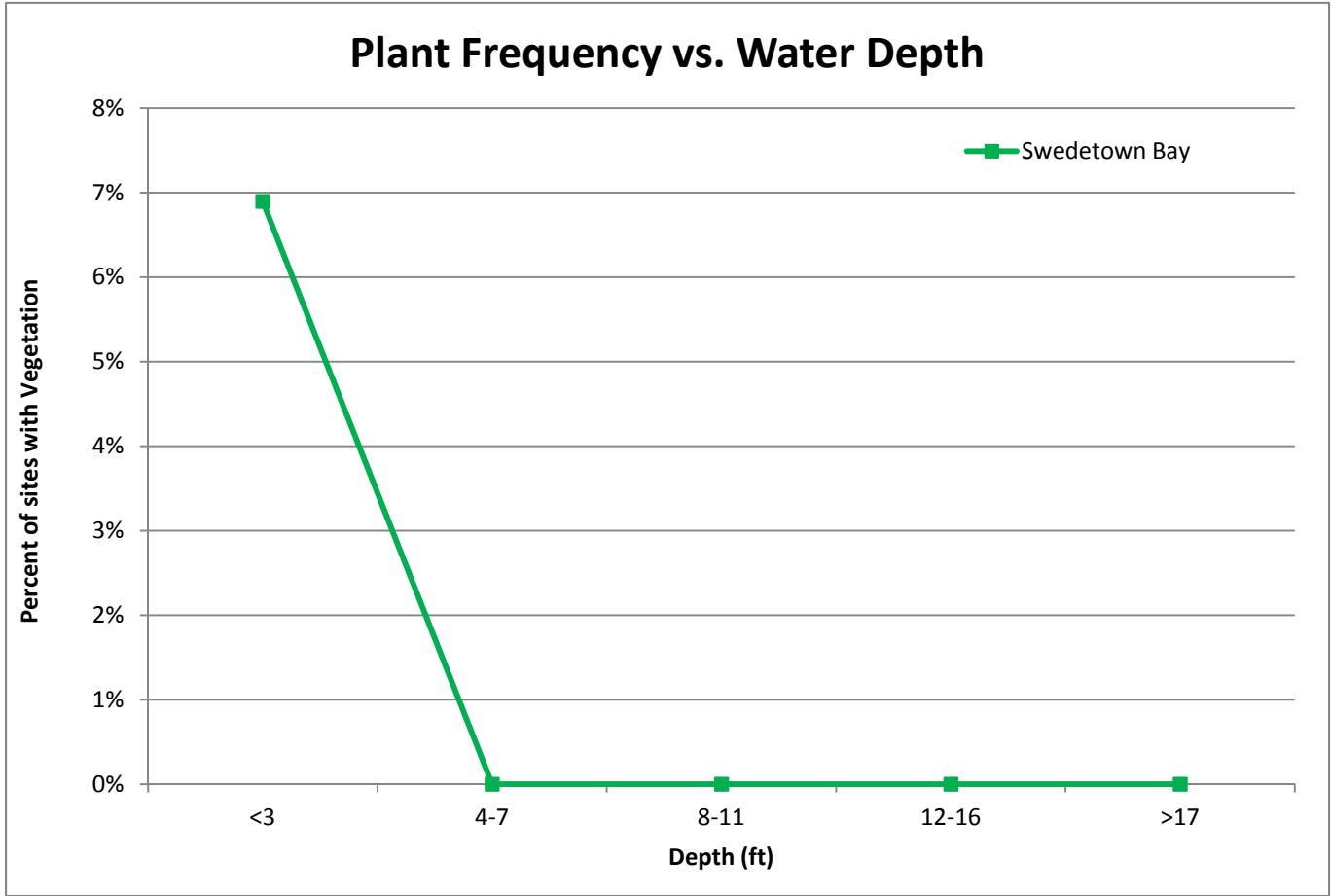


Figure 27. Frequency of vegetation vs. water depth, Swedetown Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

Pike Bay

On June 6 and 7, 2016, 291 locations, plus 16 additional points around plant-abundant areas and public accesses were observed and sampled for aquatic vegetation (Figure 28). The southwest area was proposed, but decided against at our meeting with the Lake Vermilion Sportsman's Club upon our arrival. The weather was acceptable for the survey with cloudy skies, temperatures reaching 60 degrees and winds around 15 mph.

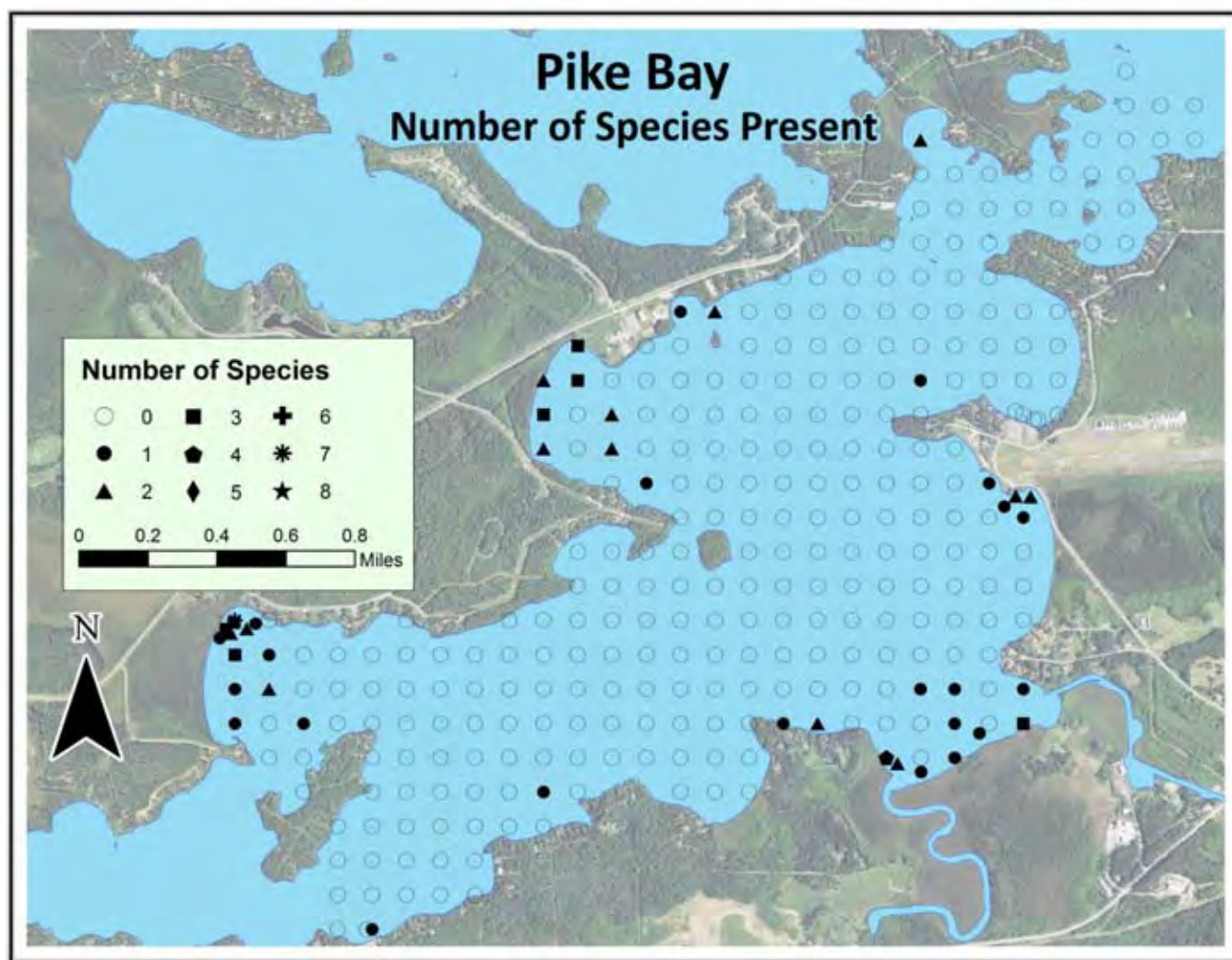


Figure 28. Pike Bay, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 6 and 7, 2016.

The average number of plants per rake sample on Pike Bay was 0.3. Seven was the maximum number of species sampled at one location in Pike Bay while one and two species were sampled occasionally (Figure 28).

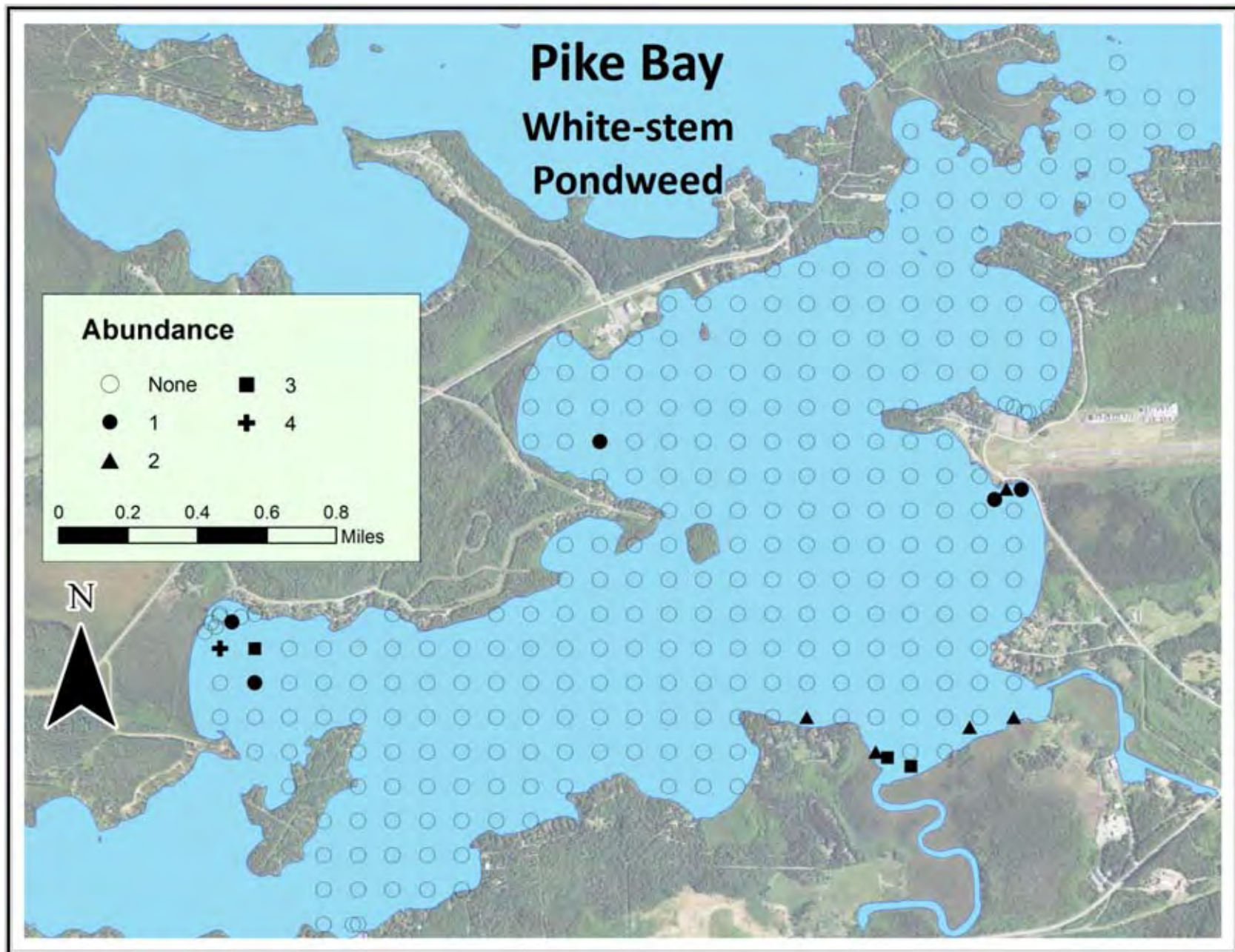


Figure 29. Whitestem Pondweed areas in Pike Bay, Lake Vermilion Point-Intercept Survey, June 6 and 7, 2016.

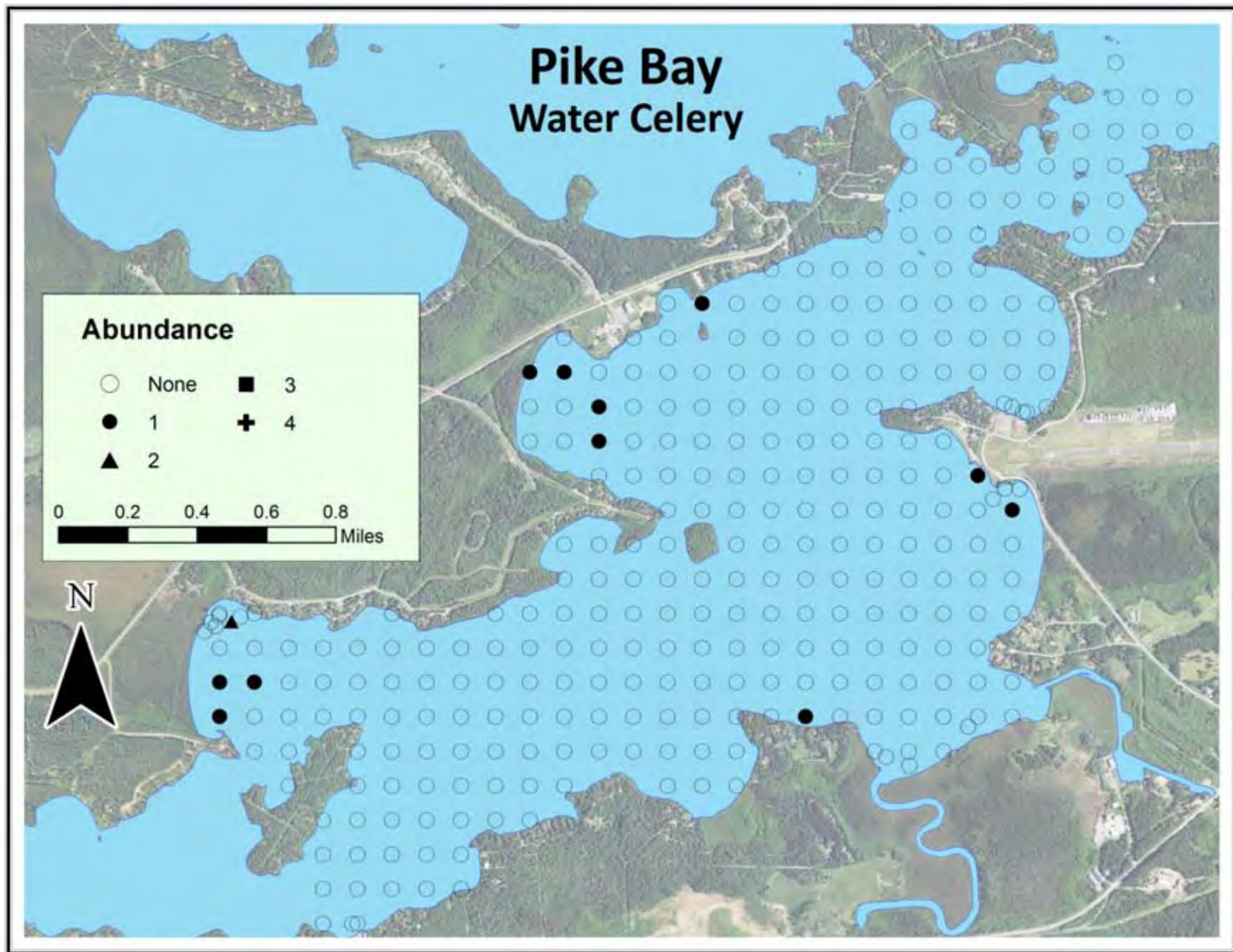


Figure 30. Water Celery in Pike Bay, Lake Vermilion Point-Intercept Survey, June 6 and 7, 2016.

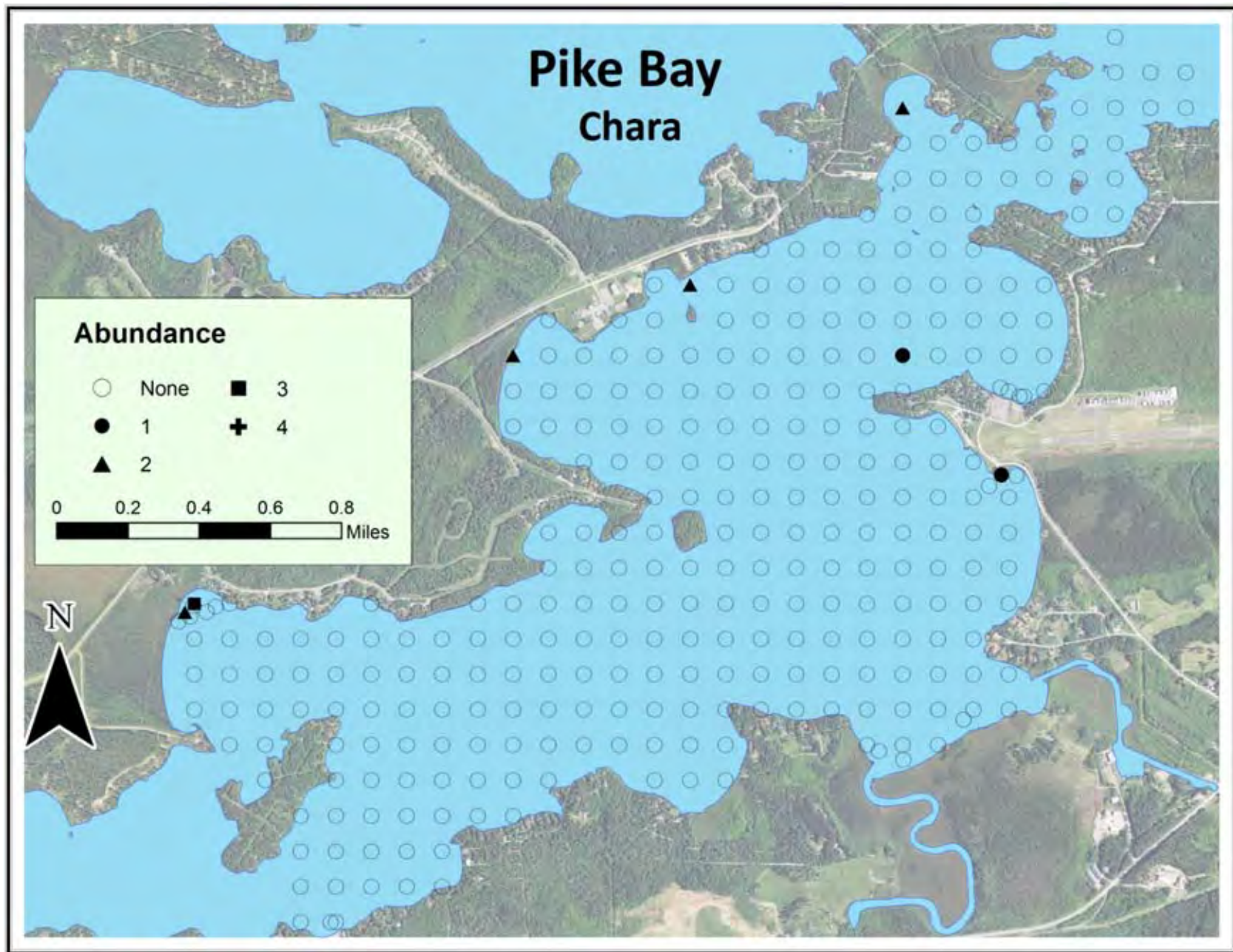


Figure 31. Chara in Pike Bay, Lake Vermilion Point-Intercept Survey, June 6 and 7, 2016.

Table 7. Aquatic plants surveyed in Pike Bay, Lake Vermilion, St. Louis County, MN: June 6 and 7, 2016.

Pike Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	Greater Bladderwort	<i>Utricularia vulgaris</i>	5	1.6%
	Bushy Pondweed	<i>Najas flexilis</i>	1	0.3%
	Water Celery	<i>Vallisneria americana</i>	12	3.9%
	Chara	<i>Chara sp.</i>	7	2.3%
	Claspingleaf Pondweed	<i>Potamogeton richardsonii</i>	1	0.3%
	Coontail	<i>Ceratophyllum demersum</i>	5	1.6%
	Illinois Pondweed	<i>Potamogeton illinoensis</i>	1	0.3%
	Northern Milfoil	<i>Myrophyllum sibiricum</i>	6	2.0%
	Robbin's Pondweed	<i>Potamogeton robbinsii</i>	5	1.6%
	White-stem Pondweed	<i>Potamogeton praelongus</i>	14	4.6%
FLOATING - LEAF -These plant leaves float on water and are anchored to the bottom of the lake.	Floatingleaf Pondweed	<i>Potamogeton natans</i>	2	0.7%
	White Waterlily	<i>Nymphaea odorata</i>	5	1.6%
	Yellow Waterlily	<i>Nuphar variegata</i>	3	1.0%
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	Wild Rice	<i>Zizania aquatica</i>	7	2.3%
	Watermoss		6	2.0%
Total number of plants (species diversity for the bay)				15
Total number of plant occurrences				80
Total number of sites				307

Sampling occurred to a maximum depth of 15 feet; however, no plants were found to be growing beyond 6 feet of water. Plant abundance was greatest between one and six feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 32).

Of the 307 sampled locations in Pike Bay, 263 sites had no vegetation present. The water was very tea-stained, which decreases the depth at which plants can grow. Although the bay is fairly shallow, no plants were found beyond the edge of the bay.

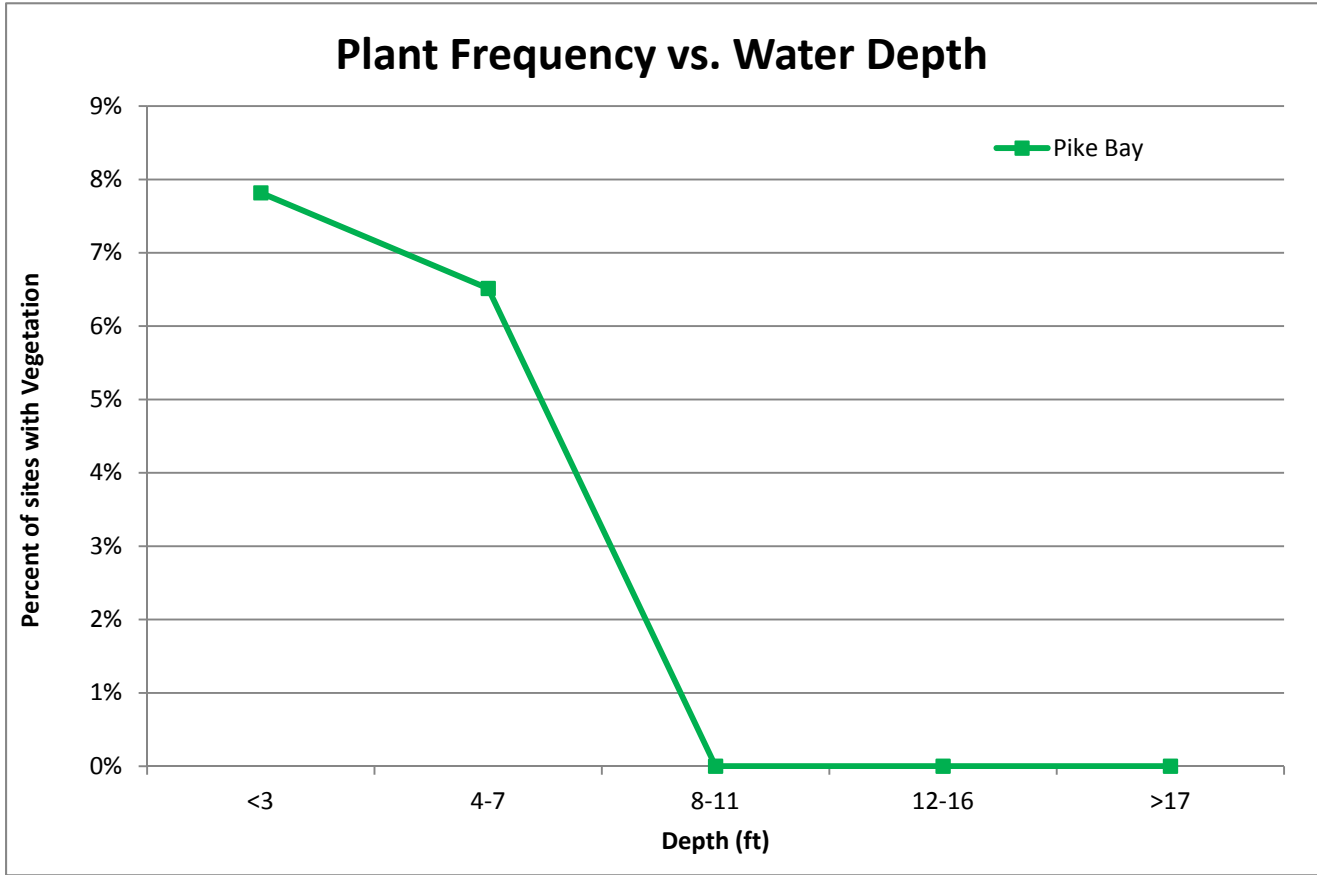


Figure 32. Frequency of vegetation vs. water depth, Pike Bay, Lake Vermilion, St. Louis County, MN: June 6 and 7, 2016.

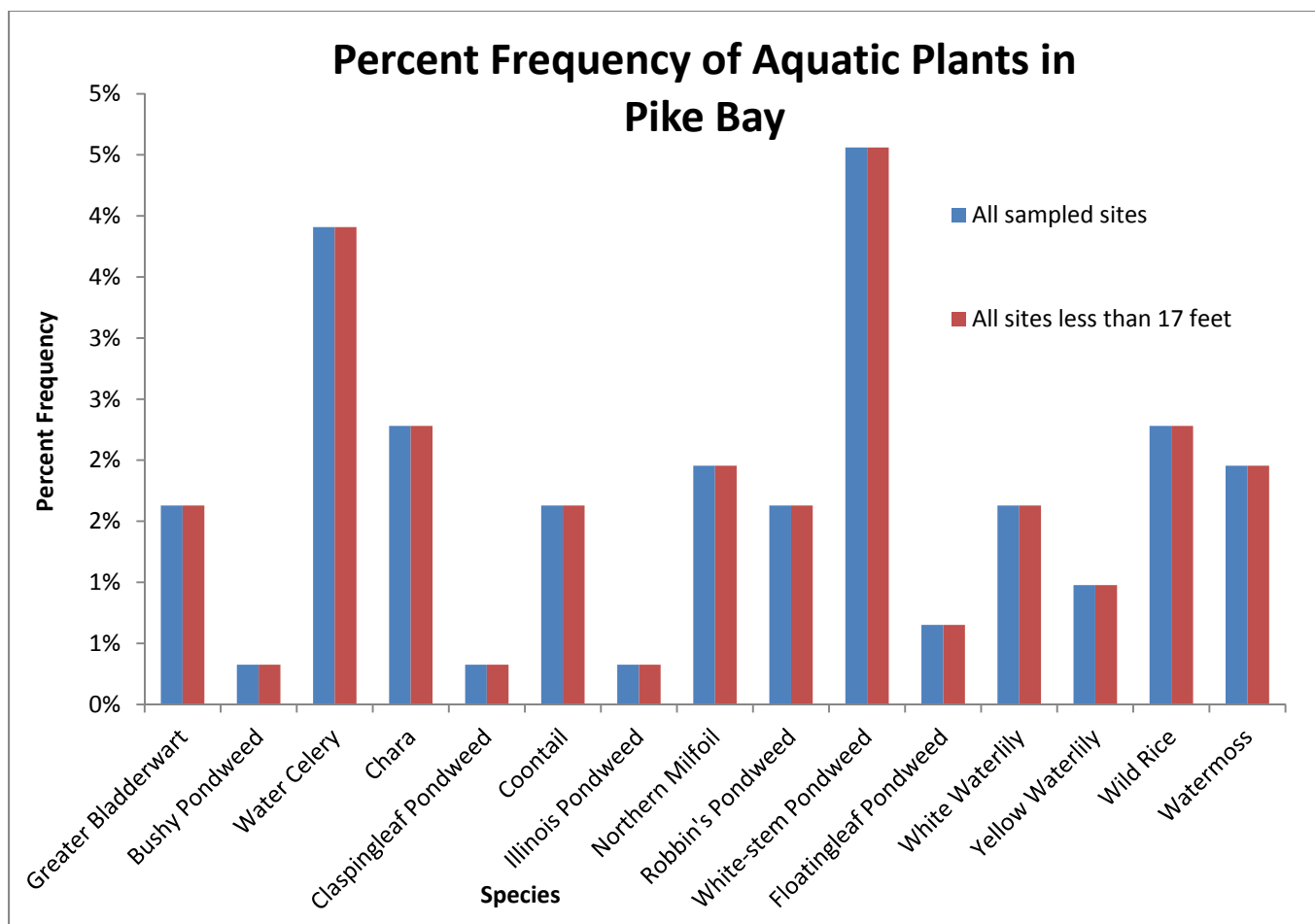


Figure 33. Frequency of occurrence for aquatic plant species in Pike Bay, Lake Vermilion, June 6 and 7, 2016.

North of Everetts Bay

On June 8, 2016, 52 locations, plus 13 additional points around plant-abundant and high traffic areas were observed and sampled for aquatic vegetation (Figure 34). The weather was good for the survey with clear skies, temperatures reaching 69 degrees and little wind.

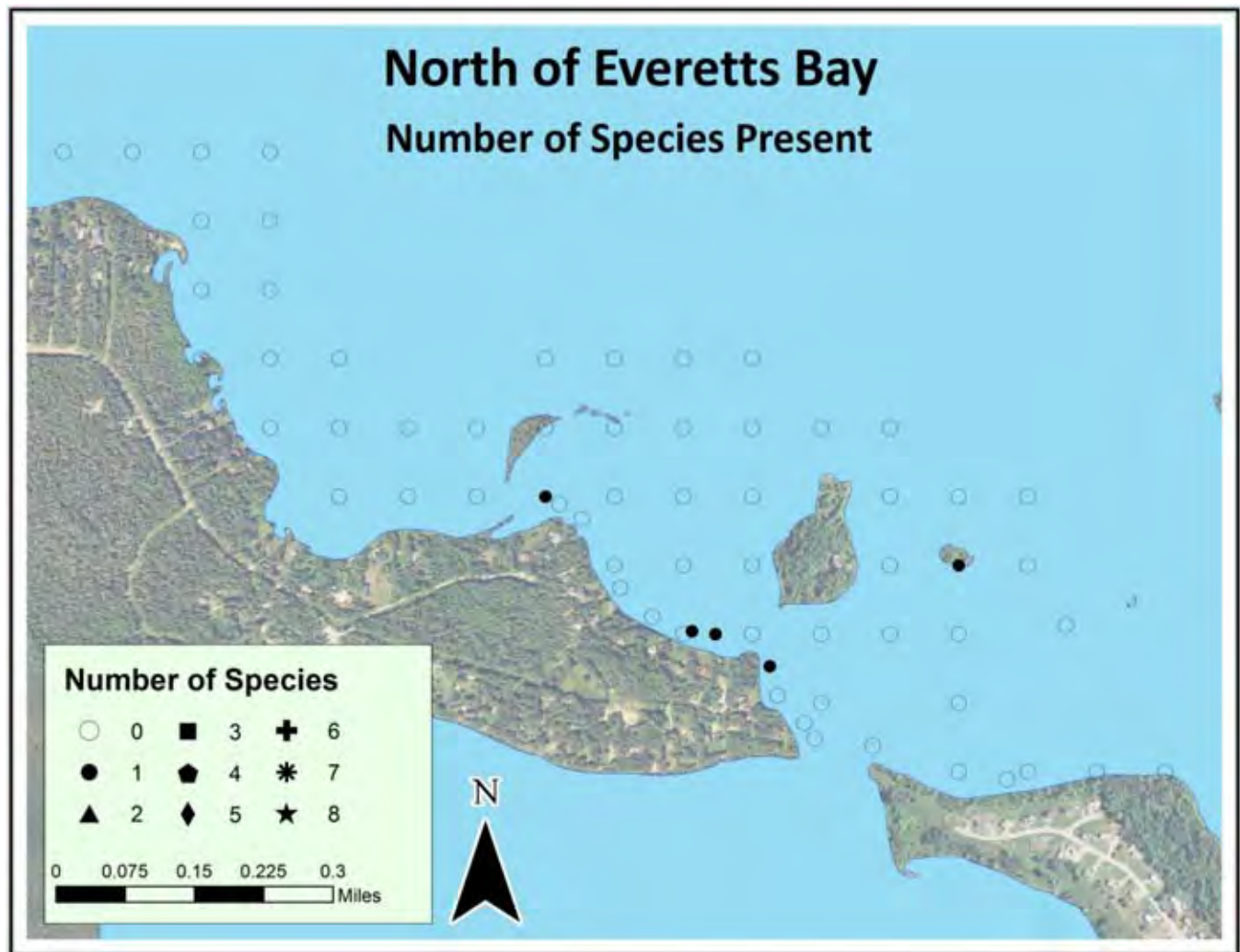


Figure 34. North of Everetts Bay, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 8, 2016.

The average number of plants per rake sample north of Everetts Bay was 0.06. One was the maximum number of species sampled at one location north of Everetts Bay (Figure 34).

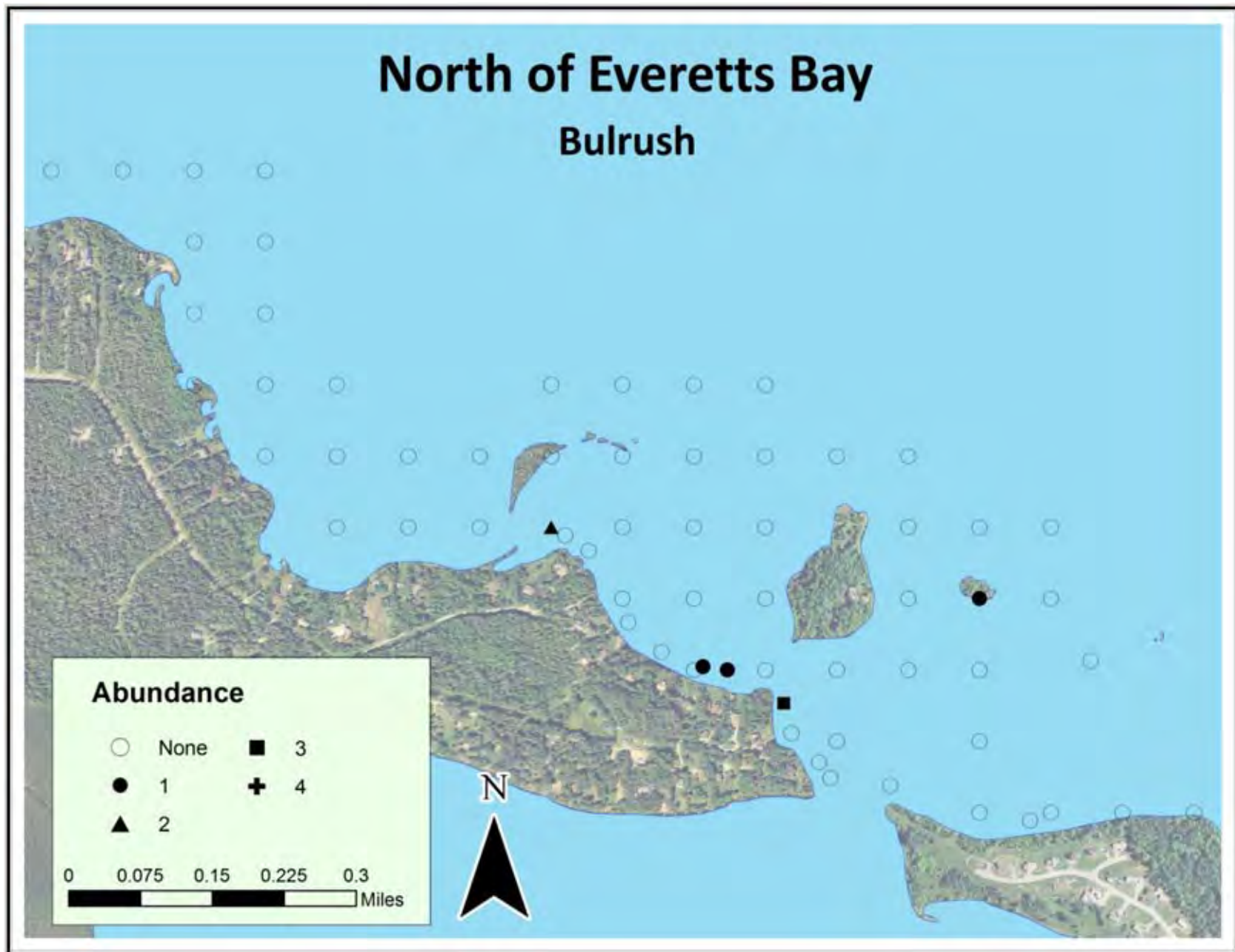


Figure 35. Bulrush areas north of Everetts Bay, Lake Vermilion Point-Intercept Survey, June 8, 2016.

Table 8. Aquatic plants surveyed north of Everetts Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

North of Everetts Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	NA			
FLOATING - LEAF -These plant leaves float on water and are anchored to the bottom of the lake.	NA			
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	Bulrush	<i>Scirpus acutus</i>	4	6.2%
Total number of plants (species diversity for the bay)			1	
Total number of plant occurrences			4	
Total number of sites			65	

Sampling occurred to a maximum depth of 23 feet; however, no plants were found to be growing beyond 5 feet of water. Plant abundance was greatest between one and five feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 36).

Of the 65 sampled locations north of Everetts Bay, 60 sites had no vegetation present.

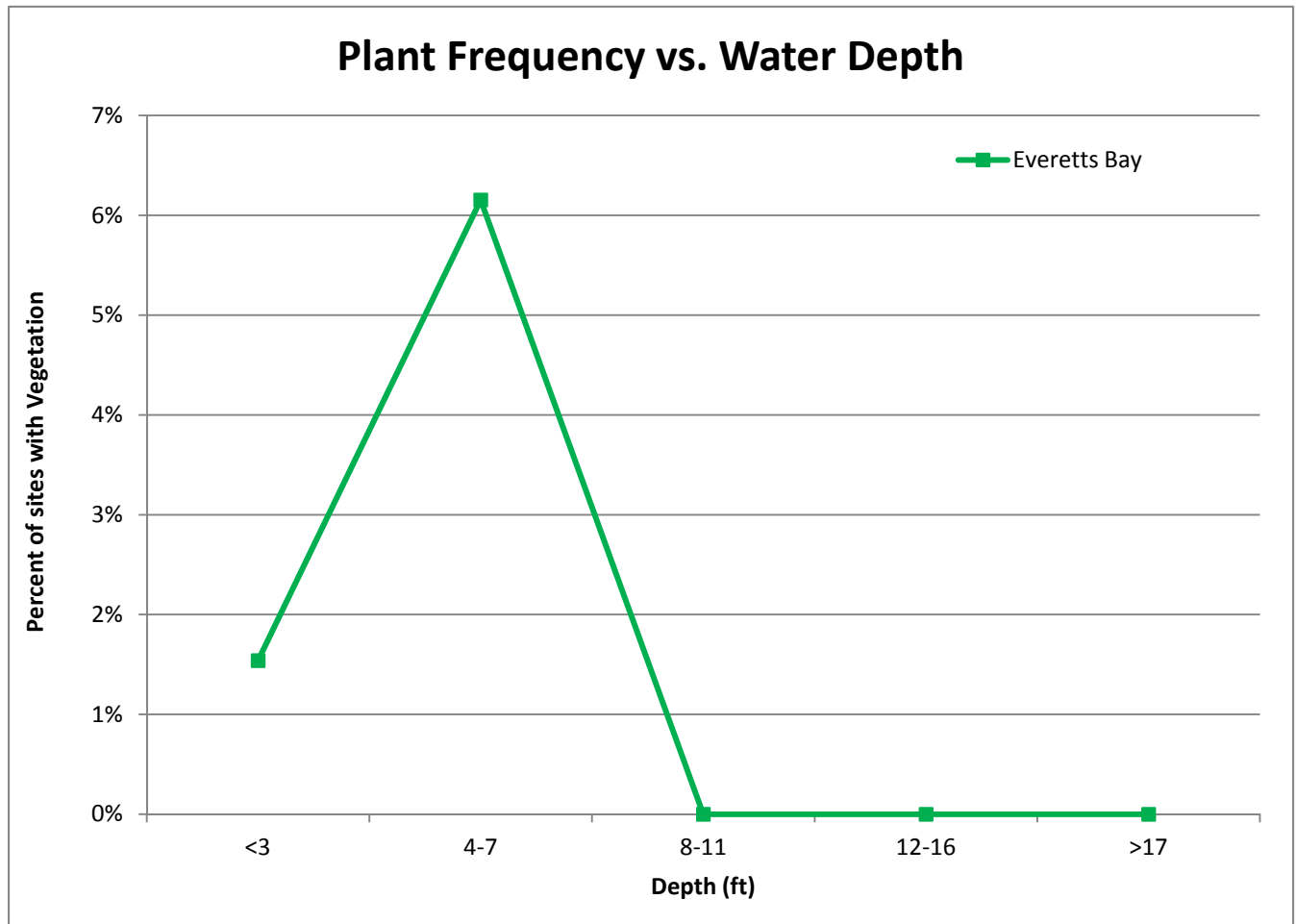


Figure 36. Frequency of vegetation vs. water depth, north of Everetts Bay, Lake Vermilion, St. Louis County, MN: June 8, 2016.

Greenwood and Black Duck Bays

On June 9, 2016, 116 locations, plus 7 additional points around plant-abundant areas and public accesses were observed and sampled for aquatic vegetation (Figure 37). The weather was good for the survey with slightly cloudy skies, temperatures reaching 78 degrees and little wind.

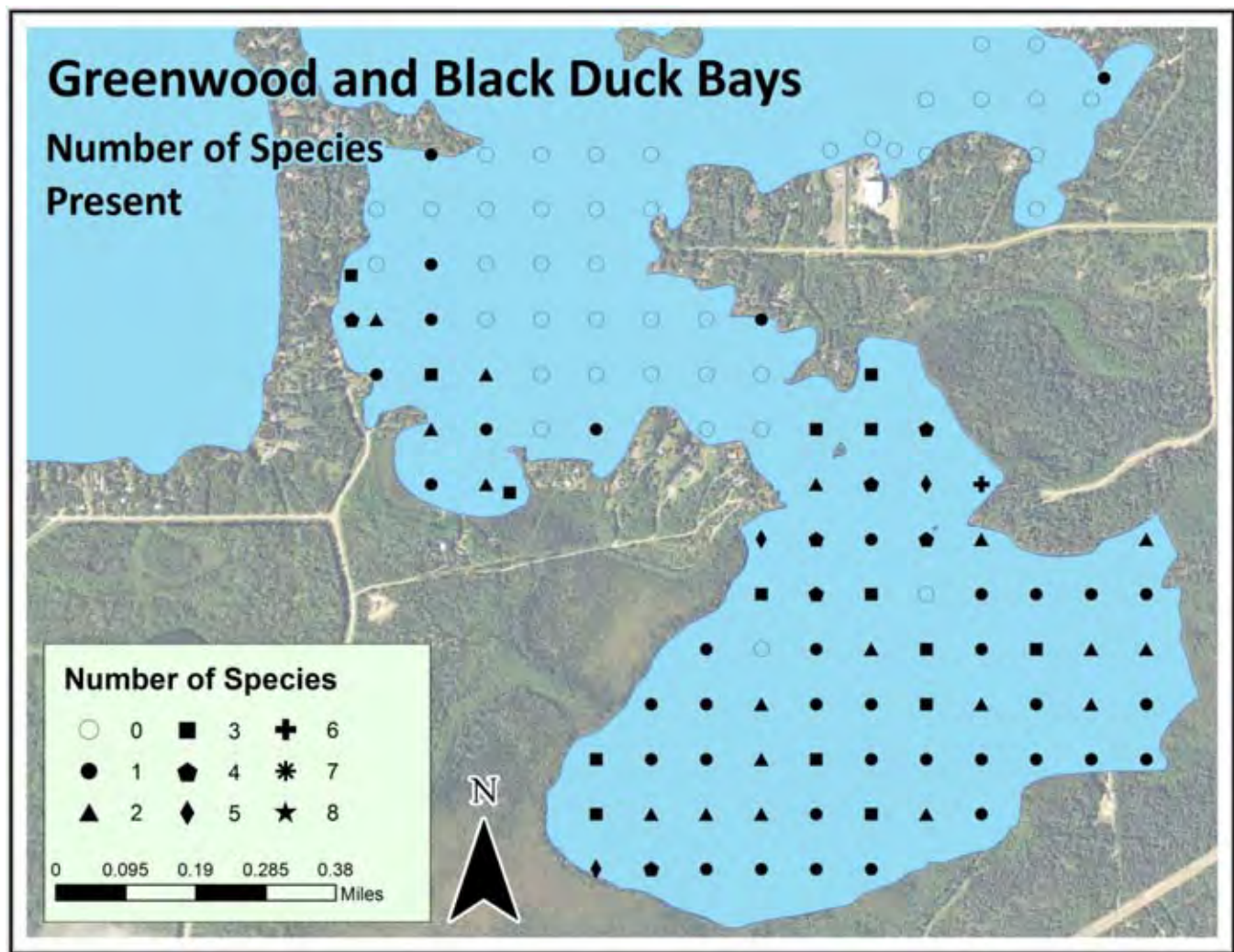


Figure 37. Greenwood and Black Duck Bays, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 9, 2016.

The average number of plants per rake sample on Greenwood Bay was 1.5 and on Black Duck Bays was 0.08. Six was the maximum number of species sampled at one location in Greenwood and Black Duck Bays while one and two species were sampled regularly (Figure 37).

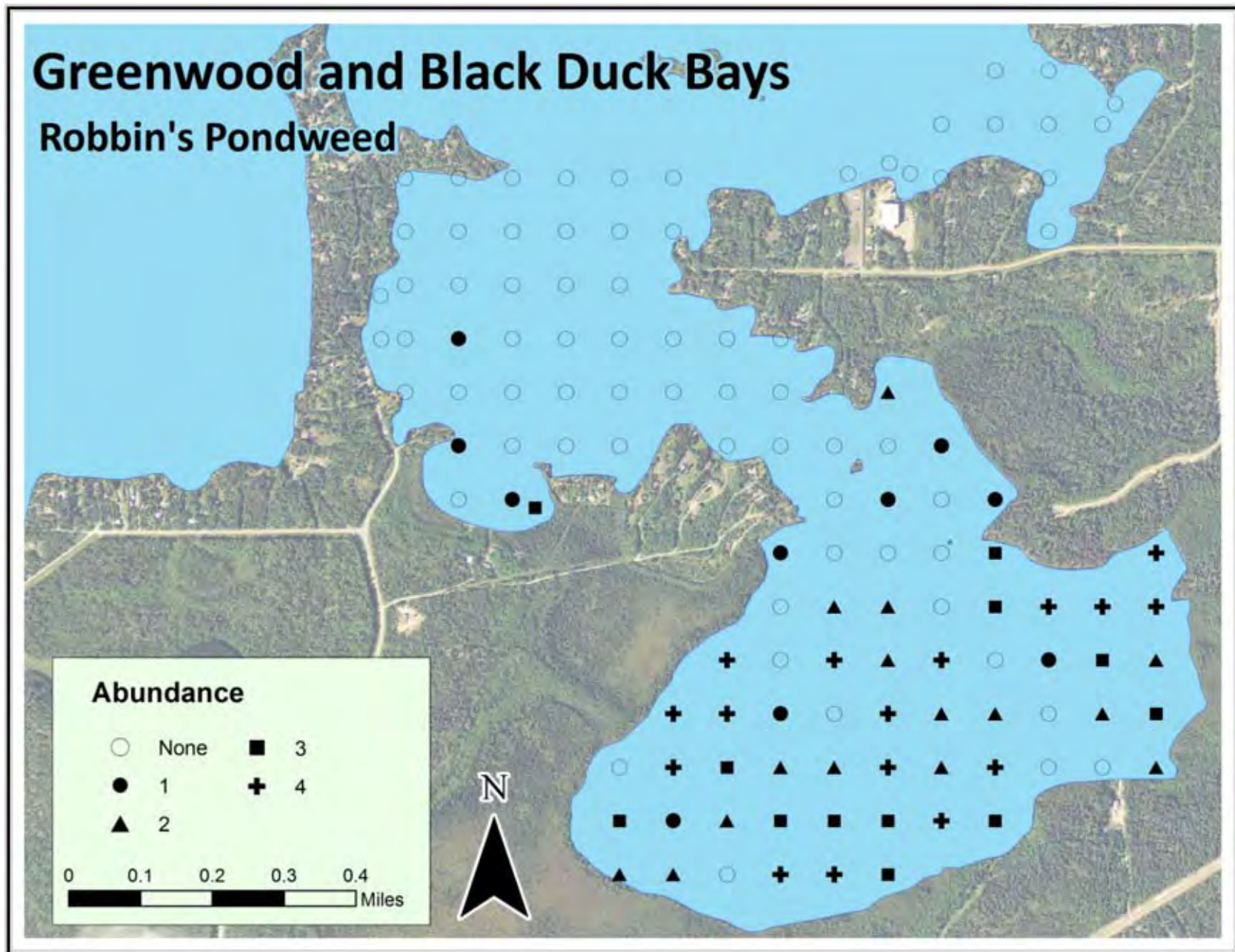


Figure 38. Robbin's Pondweed areas in Greenwood and Black Duck Bays, Lake Vermilion Point-Intercept Survey, June 9, 2016.

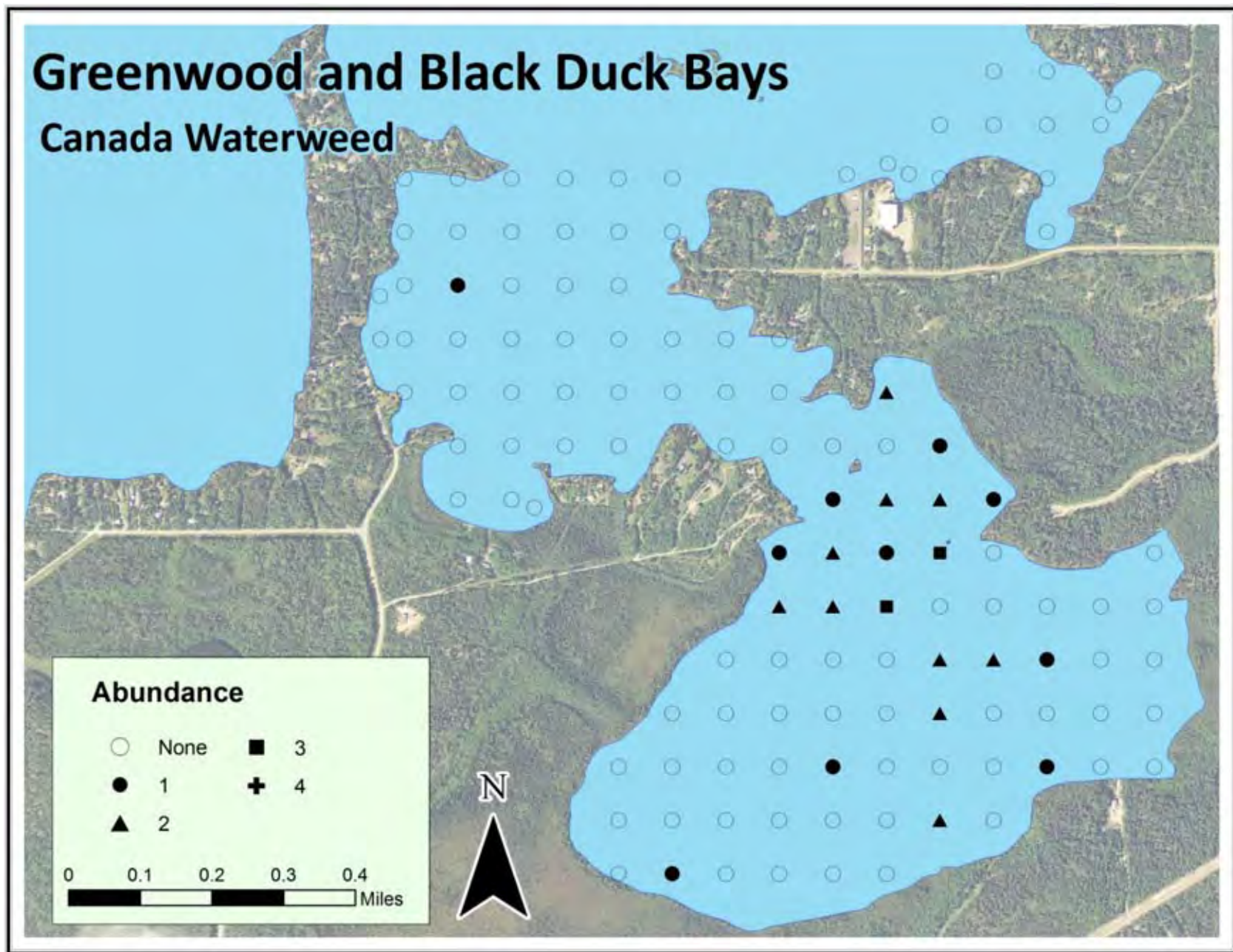


Figure 39. Canada Waterweed in Greenwood and Black Duck Bays, Lake Vermilion Point-Intercept Survey, June 9, 2016.

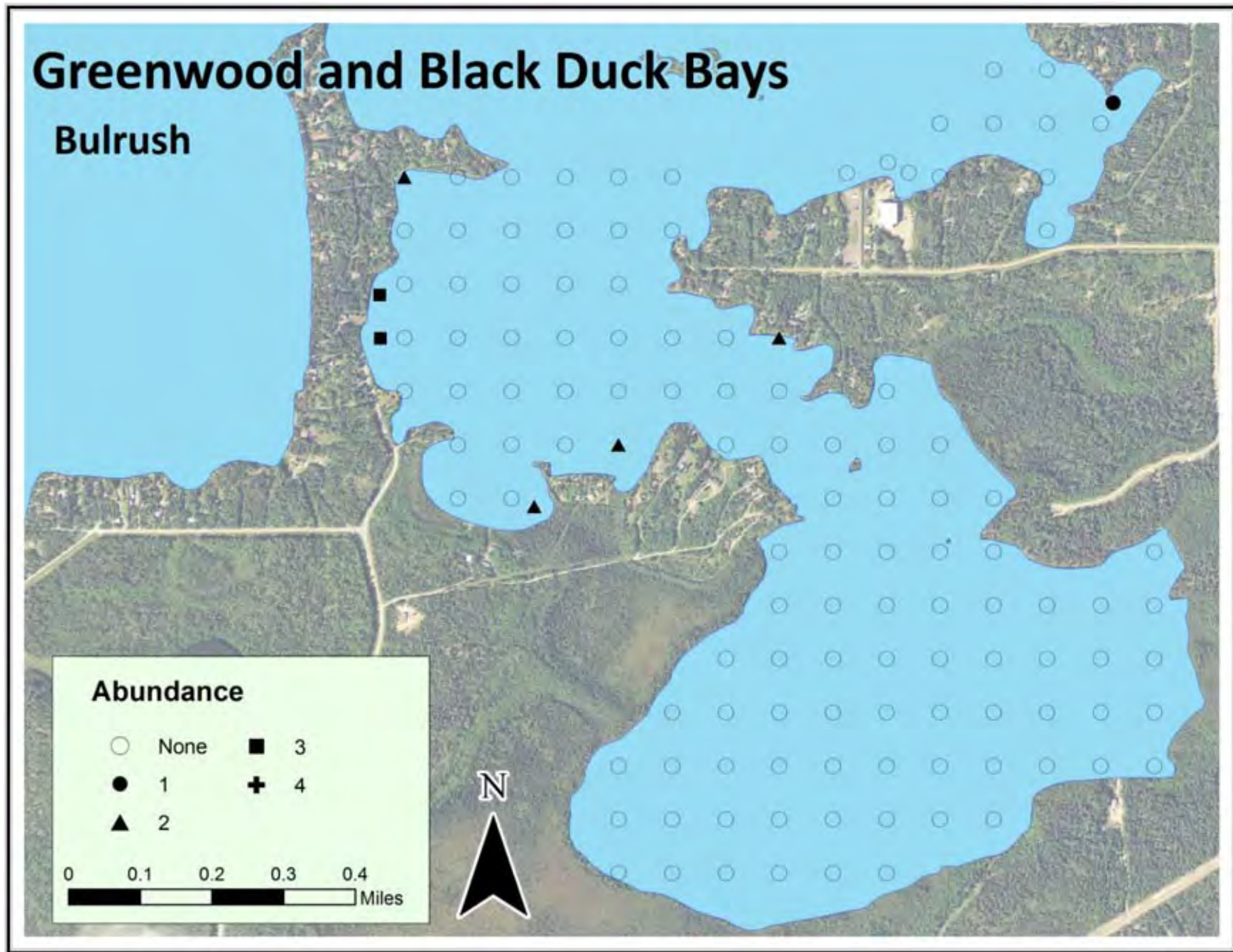


Figure 40. Bulrush in Greenwood and Black Duck Bays, Lake Vermilion Point-Intercept Survey, June 9, 2016.

Table 9. Aquatic plants surveyed in Gerenwood Bay, Lake Vermilion, St. Louis County, MN: June 9, 2016.

Gerenwood Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	Buttercup	<i>Ranunculus sp.</i>	2	1.8%
	Canada Waterweed	<i>Elodea canadensis</i>	22	20.0%
	Chara	<i>Chara sp.</i>	3	2.7%
	Claspingleaf Pondweed	<i>Potamogeton richardsonii</i>	18	16.4%
	Coontail	<i>Ceratophyllum demersum</i>	10	9.1%
	Flatstem Pondweed	<i>Potamogeton zosteriformis</i>	9	8.2%
	Large-leaf Pondweed	<i>Potamogeton amplifolius</i>	2	1.8%
	Marigold	<i>Bidens beckii</i>	3	2.7%
	Northern Milfoil	<i>Myrophyllum sibiricum</i>	20	18.2%
	Robbin's Pondweed	<i>Potamogeton robbinsii</i>	53	48.2%
	Variable Pondweed	<i>Potamogeton gramineus</i>	2	1.8%
	White-stem Pondweed	<i>Potamogeton praelongus</i>	9	8.2%
FLOATING - LEAF -These plant leaves float on water and are anchored to the bottom of the lake.	White Waterlily	<i>Nymphaea odorata</i>	5	4.5%
	Yellow Waterlily	<i>Nuphar variegata</i>	3	2.7%
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	Bulrush	<i>Scirpus acutus</i>	6	5.5%
	Watermoss		1	0.9%
Total number of plants (species diversity for the bay)			16	
Total number of plant occurrences			168	
Total number of sites			110	

Table 10. Aquatic plants surveyed in Black Duck Bay, Lake Vermilion, St. Louis County, MN: June 9, 2016.

Black Duck Bay, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	NA			
FLOATING - LEAF - These plant leaves float on water and are anchored to the bottom of the lake.				
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	Bulrush	<i>Scirpus acutus</i>	1	7.7%
Total number of plants (species diversity for the bay)			1	
Total number of plant occurrences			1	
Total number of sites			13	

In Greenwood Bay, sampling occurred to a maximum depth of 14 feet; however, no plants were found to be growing beyond 8 feet of water. Plant abundance was greatest between two and eight feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 41).

Of the 110 sampled locations in Gerenwood Bay, 29 sites had no vegetation present.

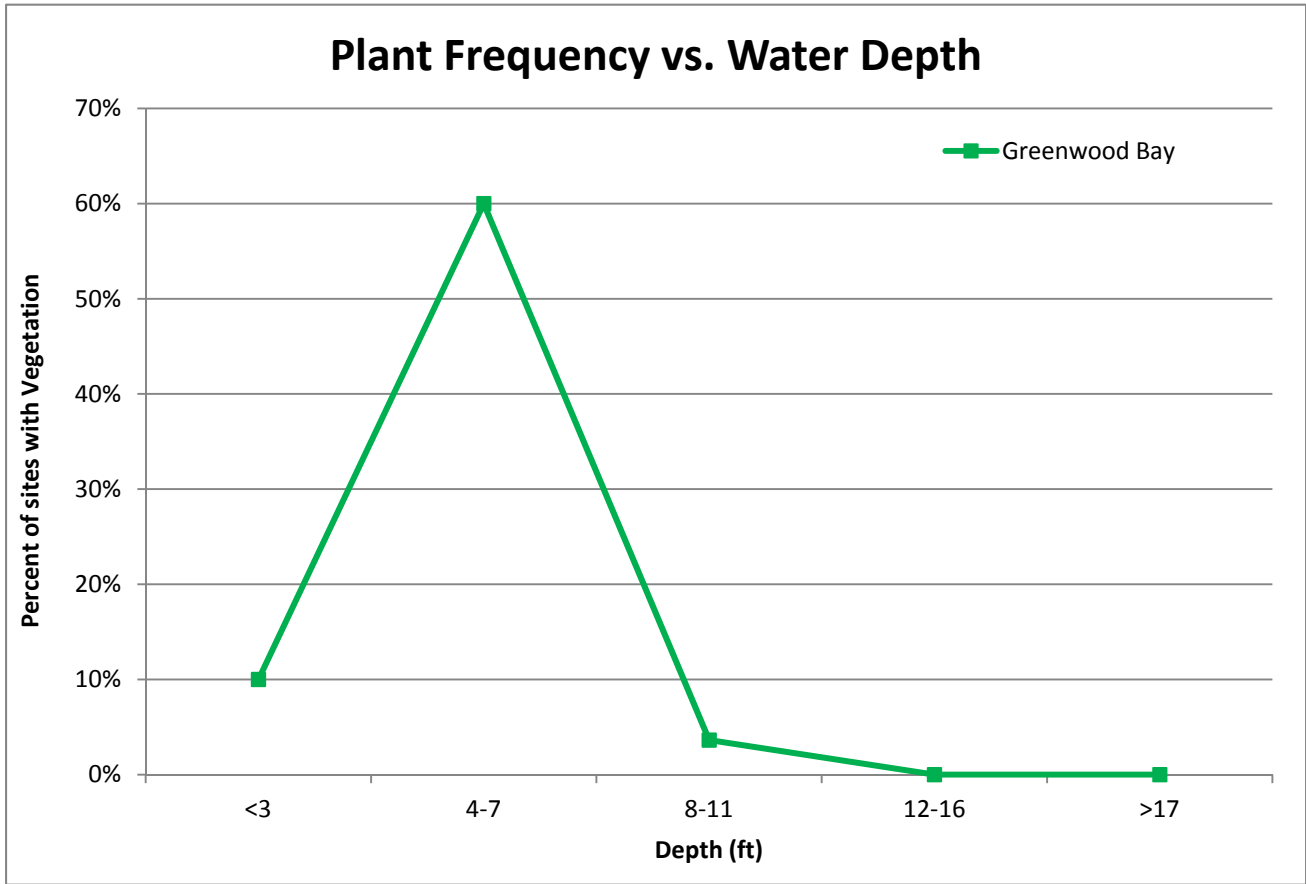


Figure 41. Frequency of vegetation vs. water depth, Gerenwood Bay, Lake Vermilion, St. Louis County, MN: June 9, 2016.

In Black Duck Bay, sampling occurred to a maximum depth of 13 feet; however, no plants were found to be growing beyond five feet of water. Only one plant was found in the bay (Figure 42).

Of the 13 sampled locations in Black Duck Bay, 12 sites had no vegetation present.

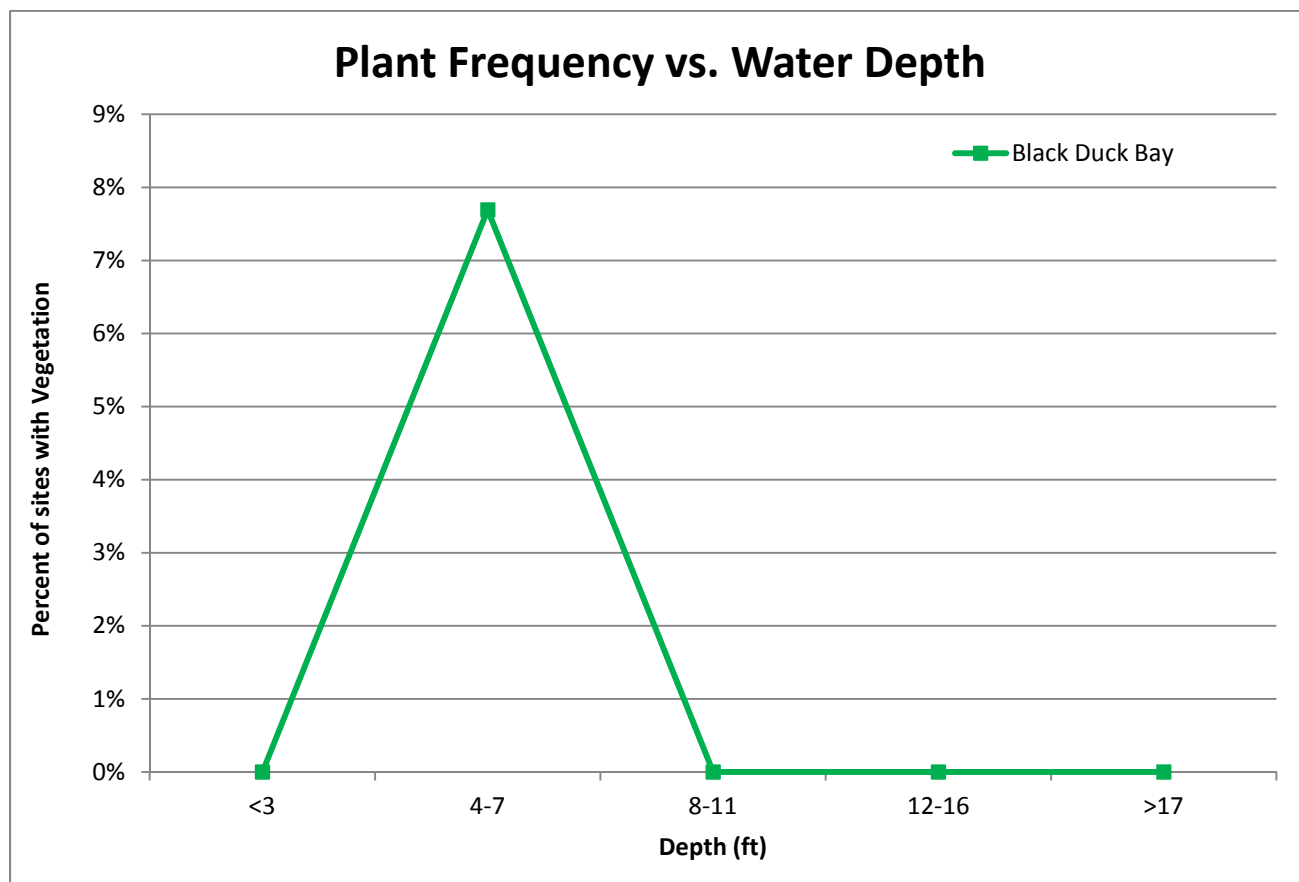


Figure 42. Frequency of vegetation vs. water depth, Black Duck Bay, Lake Vermilion, St. Louis County, MN: June 9, 2016.

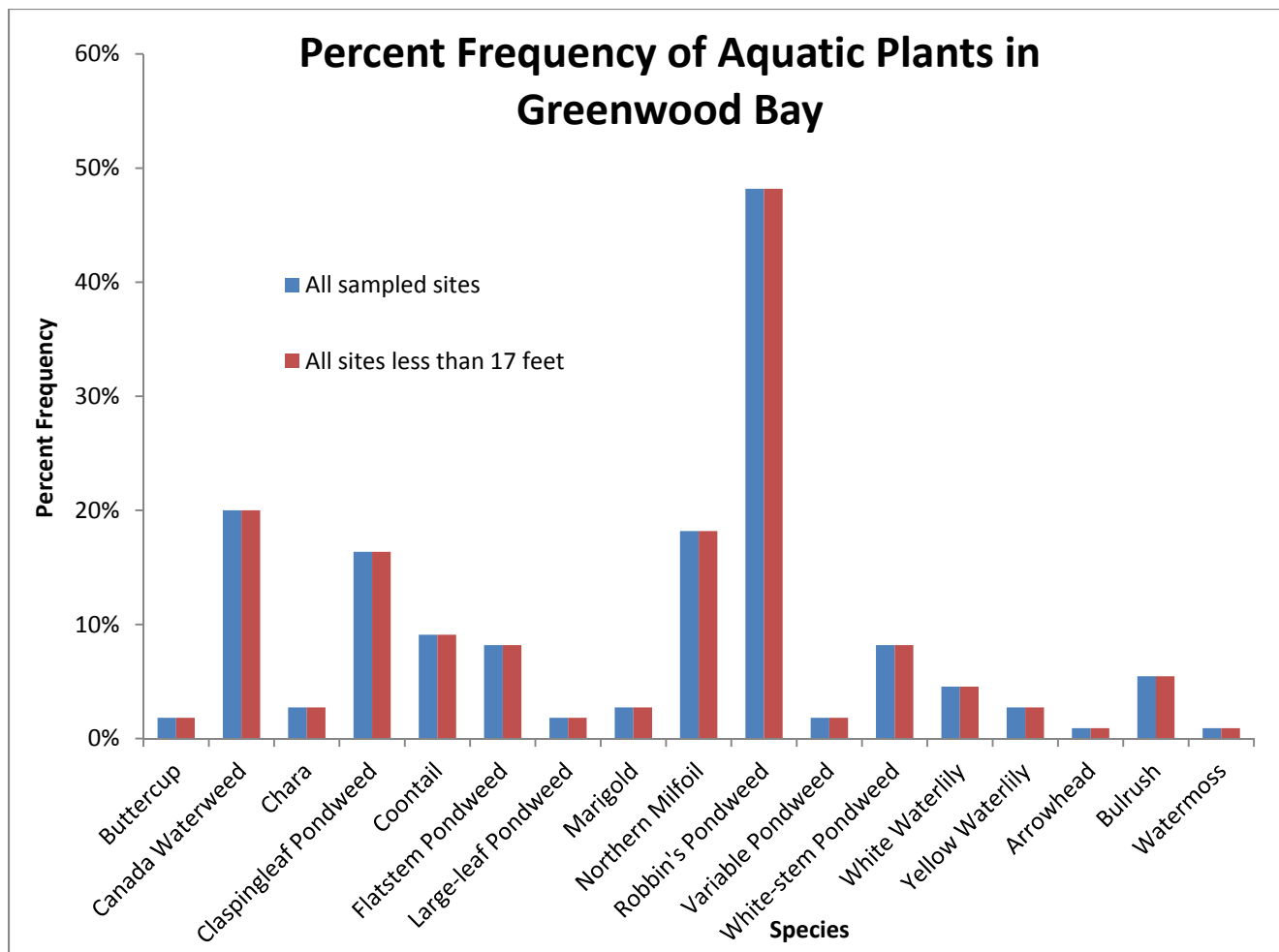


Figure 43. Frequency of occurrence for aquatic plant species in Greenwood Bay, Lake Vermilion, June 9, 2016.

Wakemup Narrows

On June 9 and 10, 2016, 289 locations, plus 15 additional points around curly-leaf areas were observed and sampled for aquatic vegetation (Figure 44). The weather was good for the survey on the 9th with slightly cloudy skies, temperatures reaching 78 degrees and little wind. Friday the 10th was cloudy with temps reaching 84 degrees, occasional precipitation, and wind reaching 13 mph.

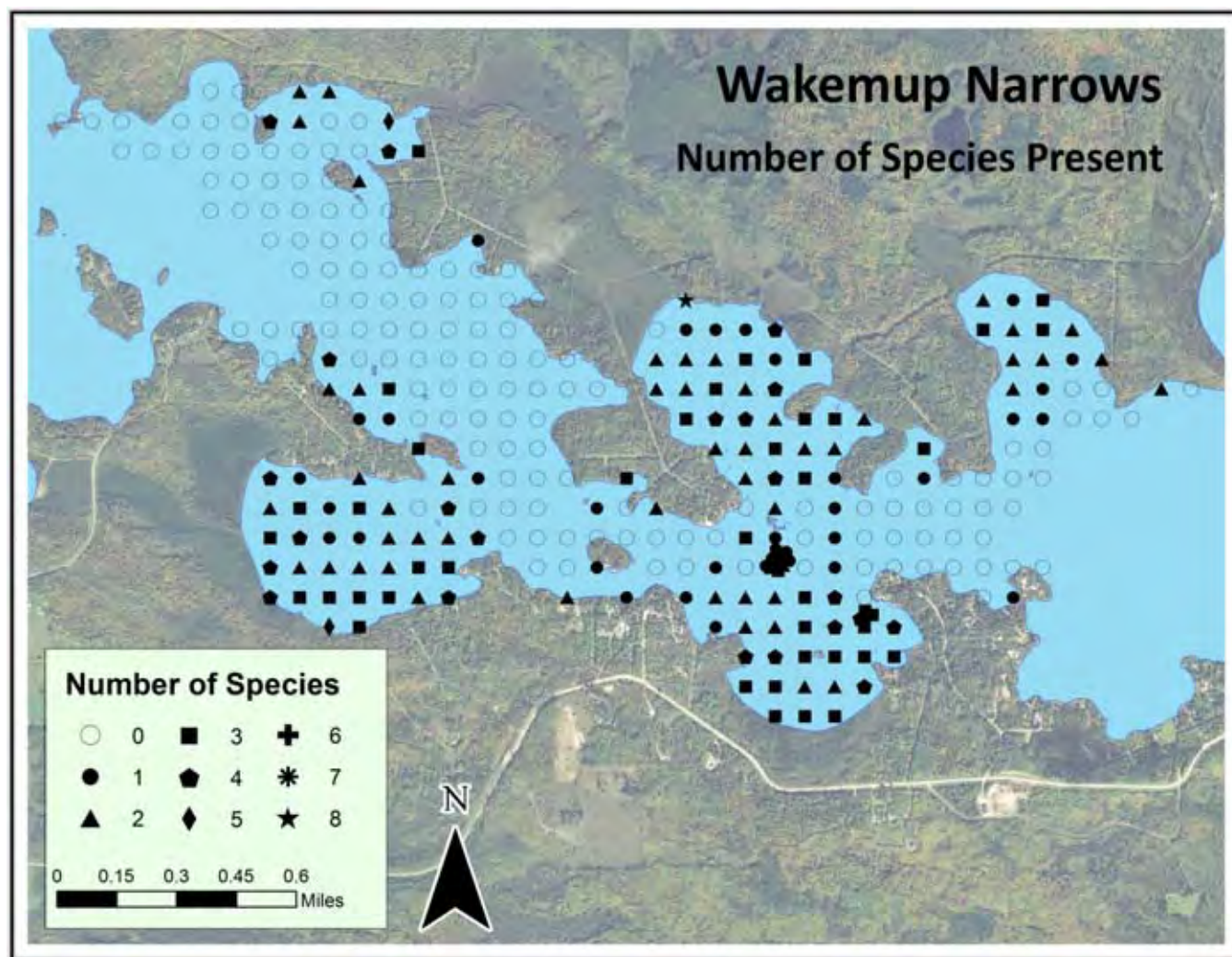


Figure 44. Wakemup Narrows, Lake Vermilion Point-Intercept Survey with the number of species present per site, June 9 and 10, 2016.

The average number of plants per rake sample in Wakemup Narrows was 1.2. Eight was the maximum number of species sampled at one location in Wakemup Narrows while two and three species were sampled occasionally (Figure 44).

The invasive Curly-leaf Pondweed was found between Indian and Laura Bays at very low densities (Figure 45).

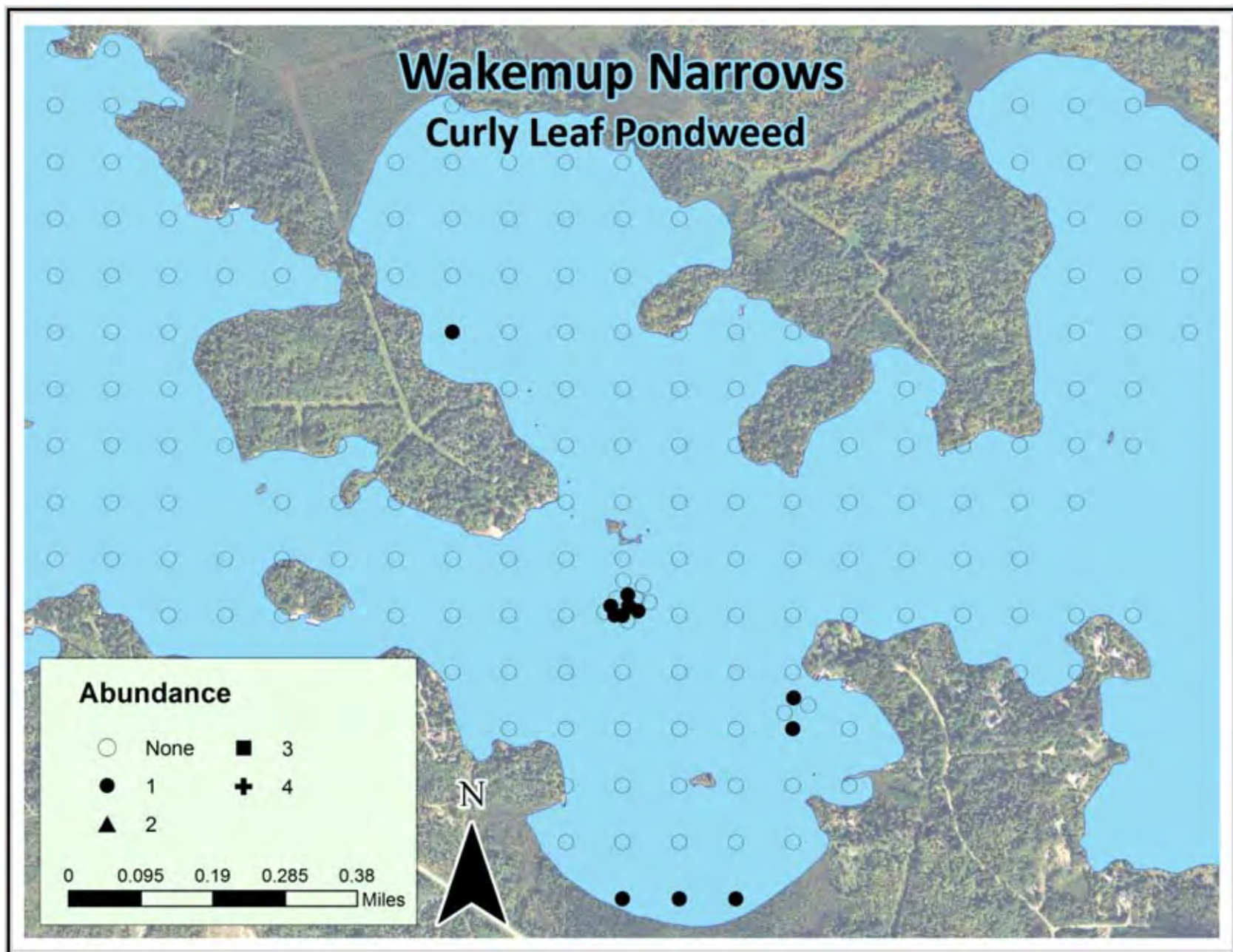


Figure 45. Curly Leaf Pondweed areas in Wakemup Narrows, Lake Vermilion Point-Intercept Survey, June 9 and 10, 2016.

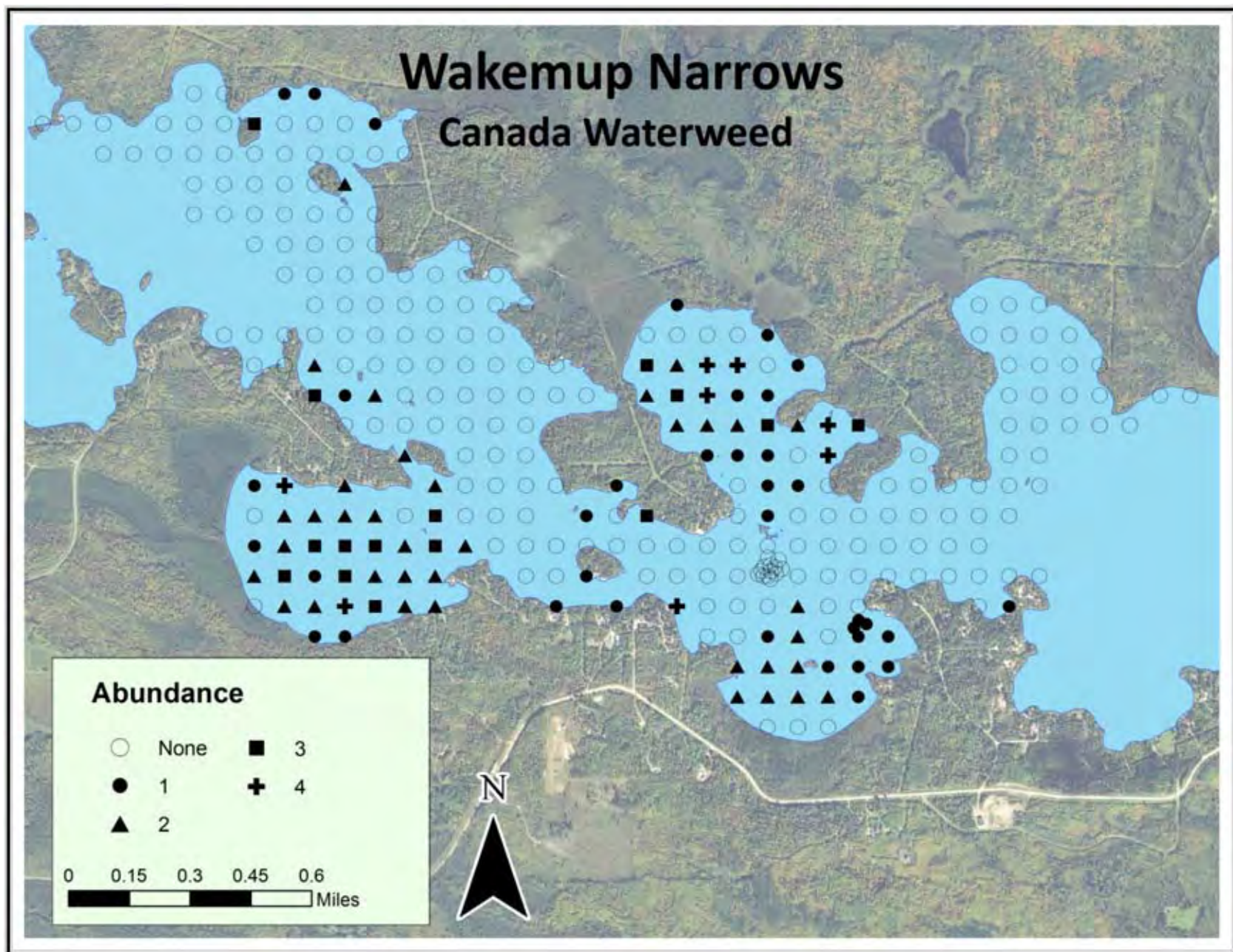


Figure 46. Canada Waterweed in Wakemup Narrows, Lake Vermilion Point-Intercept Survey, June 9 and 10, 2016.

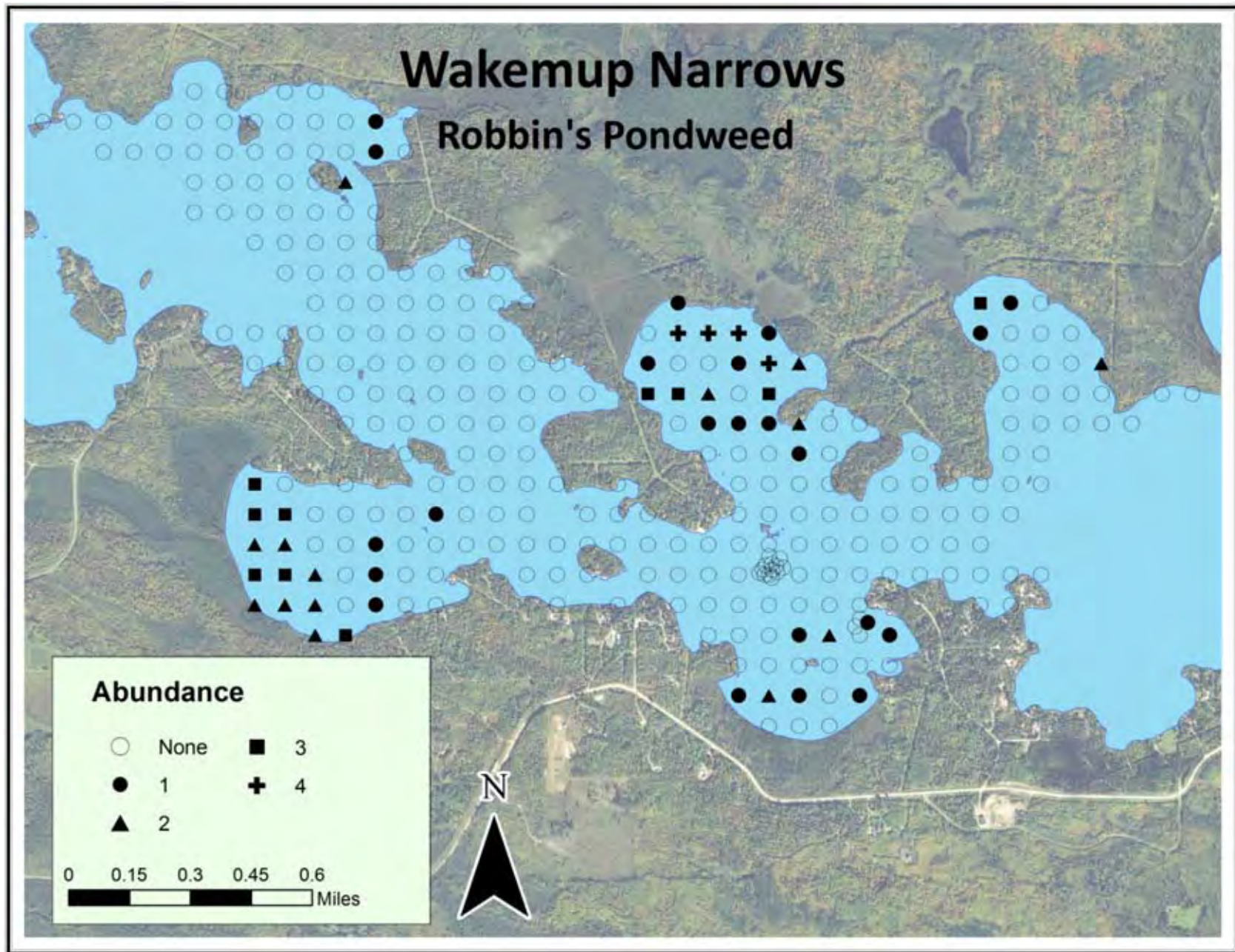


Figure 47. Robbin's Pondweed in Wakemup Narrows, Lake Vermilion Point-Intercept Survey, June 9 and 10, 2016.

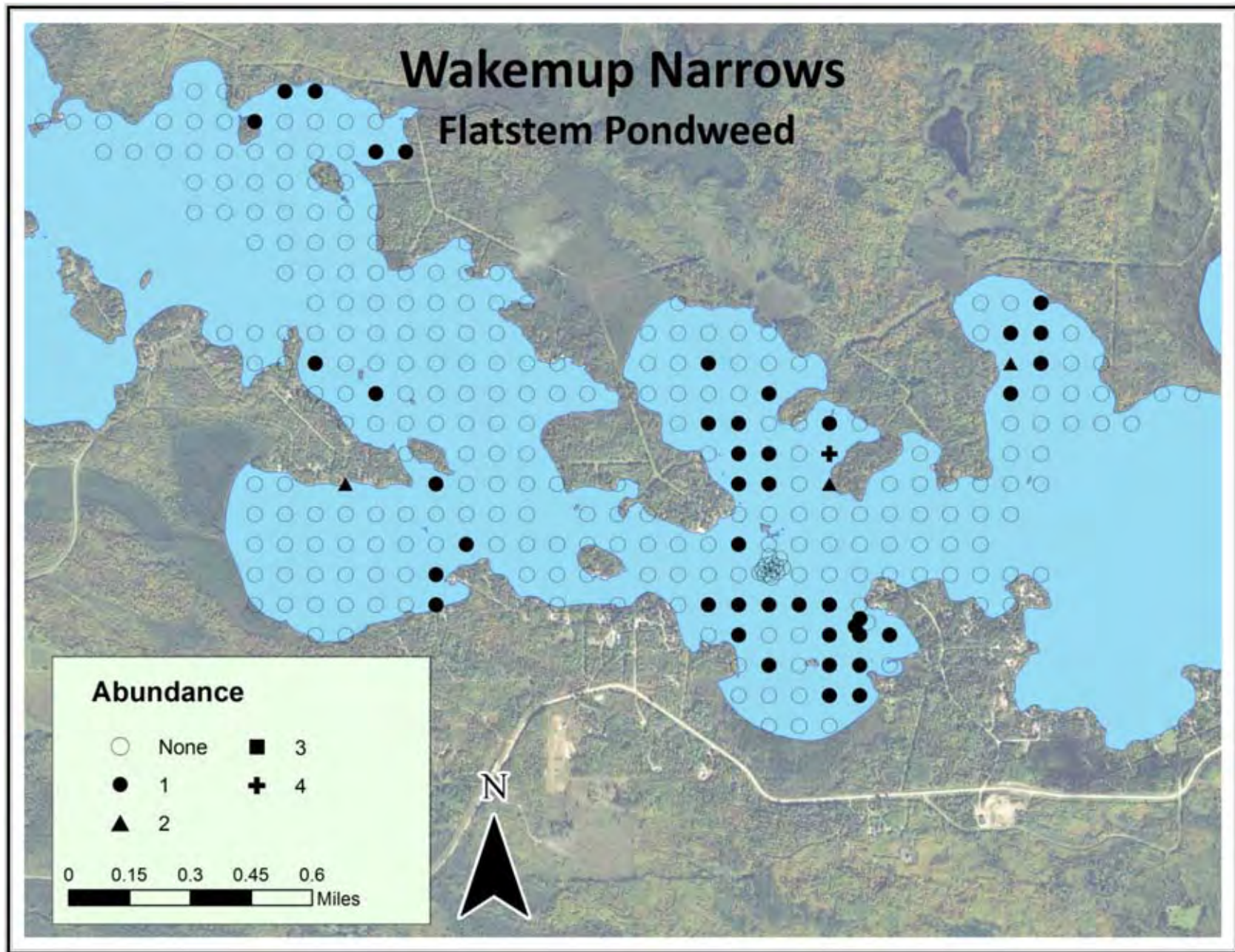


Figure 48. Flatstem Pondweed in Wakemup Narrows, Lake Vermilion Point-Intercept Survey, June 9 and 10, 2016.

Table 11. Aquatic plants surveyed in Wakemup Narrows, Lake Vermilion, St. Louis County, MN: June 9 and 10, 2016.

Wakemup Narrows, Lake Vermilion				All sampled sites
Life Form	Common Name	Scientific Name	Count	Frequency (%)
SUMBMERGED - 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.	Greater Bladderwort	<i>Utricularia vulgaris</i>	2	0.7%
	Bushy Pondweed	<i>Najas flexilis</i>	9	3.0%
	Canada Waterweed	<i>Elodea canadensis</i>	95	31.3%
	Water Celery	<i>Vallisneria americana</i>	3	1.0%
	Chara	<i>Chara sp.</i>	6	2.0%
	Claspingleaf Pondweed	<i>Potamogeton richardsonii</i>	8	2.6%
	Coontail	<i>Ceratophyllum demersum</i>	39	12.8%
	Curly-leaf Pondweed	<i>Potamogeton crispus</i>	12	3.9%
	Flatstem Pondweed	<i>Potamogeton zosteriformis</i>	46	15.1%
	Large-leaf Pondweed	<i>Potamogeton amplifolius</i>	9	3.0%
	Marigold	<i>Bidens beckii</i>	2	0.7%
	Narrowleaf Pondweed	<i>Potamogeton sp.</i>	24	7.9%
	Northern Milfoil	<i>Myrophyllum sibiricum</i>	34	11.2%
	Robbin's Pondweed	<i>Potamogeton robbinsii</i>	50	16.4%
	Star Grass	<i>Zosterella dubia</i>	3	1.0%
	White-stem Pondweed	<i>Potamogeton praelongus</i>	24	7.9%
FLOATING - LEAF - These plant leaves float on water and are anchored to the bottom of the lake.	White Waterlily	<i>Nymphaea odorata</i>	2	0.7%
	Yellow Waterlily	<i>Nuphar variegata</i>	1	0.3%
	Watershield	<i>Brasenia schreberi</i>	4	1.3%
	Star Duckweed	<i>Lemna triscula</i>	1	0.3%
EMERGENT - These plants extend well above the water surface and are usually found in shallow water, near shore.	Wild Rice	<i>Zizania aquatica</i>	1	0.3%
	Watermoss		2	0.7%
Total number of plants (species diversity for the bay)			22	
Total number of plant occurrences			377	
Total number of sites			304	

Sampling occurred to a maximum depth of 19 feet; however, no plants were found to be growing beyond 16 feet of water. Plant abundance was greatest between four and eleven feet of water. As depths increased beyond that range, the presences of vegetation decreased and became less dense (Figure 49).

Of the 289 sampled locations in Wakemup Narrows, 146 sites had no vegetation present.

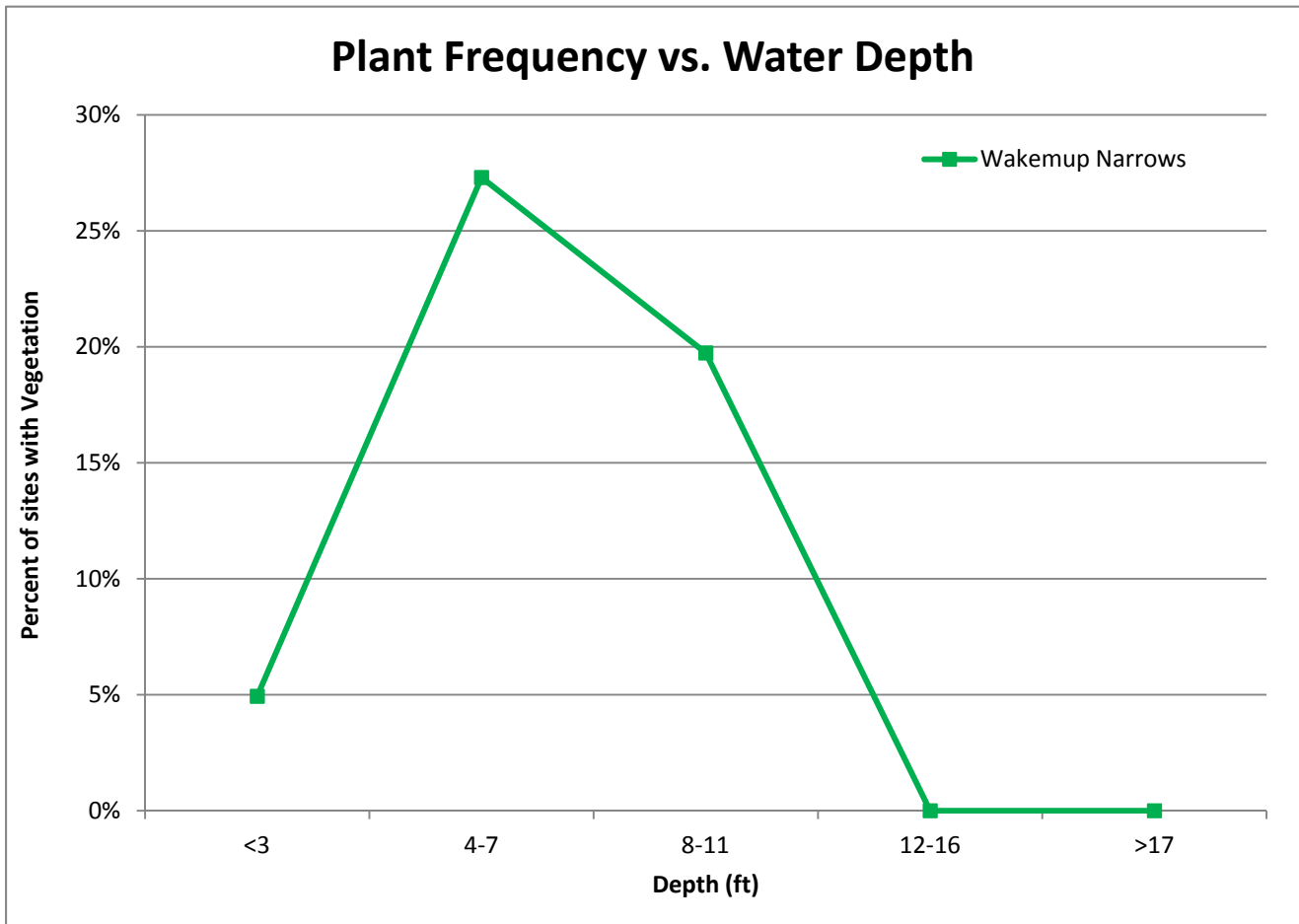


Figure 49. Frequency of vegetation vs. water depth, Wakemup Narrows, Lake Vermilion, St. Louis County, MN: June 9 and 10, 2016.

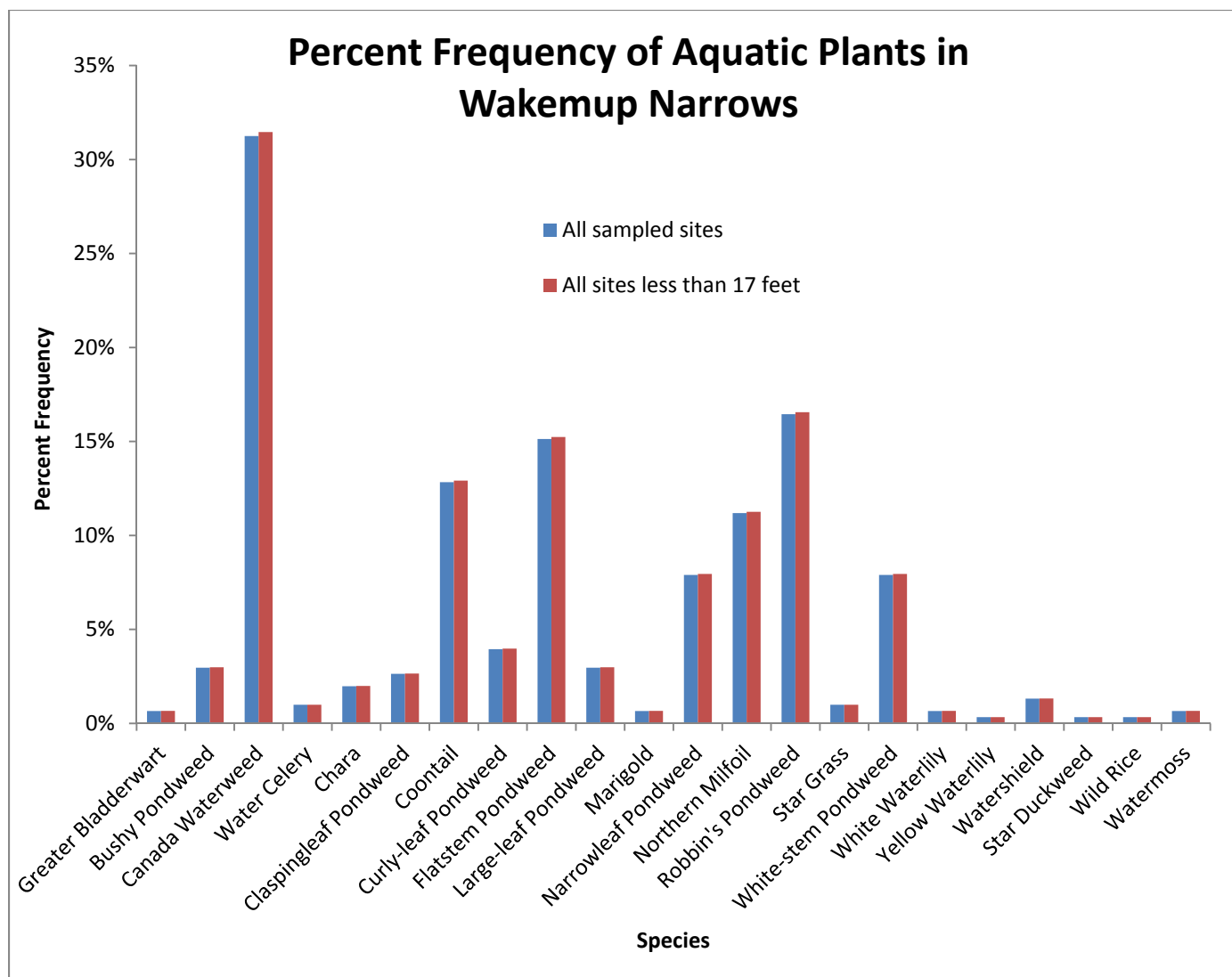


Figure 50. Frequency of occurrence for aquatic plant species in Wakemup Narrows, Lake Vermilion, June 9 and 10, 2016.

Discussion

Lake Vermilion is a moderately deep lake for central 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 won't 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 main goal of this plant survey was to document known areas of curly-leaf pondweed and discover if there were any new areas. The curly-leaf pondweed was easy to spot since we waited until later in the curly-leaf growing season to complete the survey (mid-June). It reached the surface of the water in some places in Stuntz Bay (Figure 53), which made it easy to identify between sample points. Curly-leaf pondweed was only found in Stuntz Bay and Wakemup Narrows. The curly-leaf pondweed found in Stuntz Bay was dense and in previously identified areas, while the curly-leaf in Wakemup Narrows was sparse and previously unidentified. Native plant populations in both bays looked healthy and abundant (Figures 17 and 44).

Many of the bays in the southeast portion of Lake Vermilion, with the exception of Stuntz, Pike, and Armstrong Bays, are very rocky and have few plants. This is also true for the area north of Everetts Bay. These rocky bottoms are very poor substrate for vegetation in general and are unlikely to contain curly-leaf pondweed.

Armstrong bay was very tea-stained, which decreases the area at which plants can grow. No plants were found in the central portion of the bay although the bay is fairly shallow.

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. Aquatic plants should be protected to maintain water quality and habitat.

Some plants are found more often in lakes with good water clarity, such as Muskgrass (*Chara*). Muskgrass was found in most of the bays sampled. 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.

Coontail is also a great native plant and is common in Lake Vermilion. It has a unique ability to draw a great abundance of nutrients from the water, which increases water clarity. It also has a tolerance for cold weather and low oxygen levels, which allows it to remain alive longer into the winter and provides great habitat for many critters.

Bulrush, an emergent plant, is very common in Lake Vermilion. It 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 leaf plants, such as the pondweeds, are important spawning and hiding areas for panfish.

Wild Rice, a very ecologically significant plant, was found in Pike Bay. Wild Rice is protected by the State of Minnesota. It is an excellent food for waterfowl.

RMB Lake Vermilion 2016 Survey Photos:



Figure 51. Sampling rake with many native aquatic plants in Lake Vermilion on June 6-10, 2016. White-stem pondweed can be seen in the background at the water's surface.



Figure 52. sampling rake with many native plants and a some curly-leaf.



Figure 53. Curly-leaf Pondweed beds under clear water in Stuntz Bay.

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