Lake Oscaleta + Lake Rippowam

2018 Aquatic Macrophyte Surveys at Three Lakes

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2018 Aquatic Macrophyte Surveys at Lake Oscaleta & Rippowam

The Three Lakes Council

Lewisboro, New York

Introduction

In 2008, the discovery of Brazilian elodea (*Egeria densa*) in Lake Waccabuc, rose concerns of potential infestations present in the other two waterbodies in the interconnected lake system (Lakes Oscaleta and Rippowam). Additional threats of other non-native aquatic growth, aquatic macrophyte surveys were performed at each lake in 2018. Aquatic macrophyte surveys have been performed at Lakes Oscaleta and Rippowam in 2008, 2016 and 2018. This report will include the following: aquatic macrophyte abundance, distribution and discussion, as well as an evaluation of the Floristic Quality Index results and discussion. Maps from the aquatic macrophyte survey are included in the appendix of this report.

Solitude Lake Management was pleased to conduct a detailed aquatic macrophyte survey at Lake Oscaleta on the following dates: July 20, 26, and 27, 2018. An aquatic macrophyte survey at Lake Rippowam was performed on July 20, 2018. The surveys were conducted utilizing the Point Intercept Method (PIM) with two biologists on site. These surveys were conducted to determine the aquatic macrophyte community at Lakes Oscaleta and Rippowam to identify changes to the community structures based on the previous data collected in 2008 and 2016.

Methodology

The Point Intercept Method (PIM) of sampling macrophytes is designed to determine the extent of submersed aquatic plant growth within an area of concern. The total number of sample locations is typically based on the total acreage of a waterbody, where one sample location per acre is surveyed at a given site. At Lake Oscaleta 88 sites were sampled on July 20, 26, and 27, 2018. At Lake Rippowam 60 sites were sampled on July 26, 2018. At each point, the real-time GPS coordinates of the sample location were recorded using a Trimble Geo 7X, a handheld GNSS system. Due to aquatic system characteristics, visual documentation was also used to augment this survey.

The Point Intercept Methodology, developed by the US Army Corps of Engineers and modified by Cornell University was used for this survey (Lord and Johnson 2006). However, the referred methodology only requires one rake toss. At Lakes Oscaleta and Rippowam **two rake tosses** were conducted at each site, as historically performed before. The tosses were conducted from opposite sides of the boat and were labeled and recorded as A and B (Table 1). The following data was collected for each rake toss: overall abundance of floating and submersed macrophyte growth, relative abundance of each species, and any other pertinent field notes regarding the sample location. The abundance scale defined by this methodology was used to categorize the observed macrophyte growth for each rake toss:

Table 1: PIM Abundance Descriptions	
Abundance	**Description**
Z: Zero	no plants on rake
T: Trace	Fingerful on rake
S: Sparse	Handful on rake
M: Medium	Rakeful of plants
D: Dense	Difficult to bring into boat

The overall and relative abundance values from the two rake tosses were translated into a numeric value before further data analysis: 0 for no plants, 1 for trace, 2 for sparse, 3 for medium, and 4 for dense plants. For example, if toss A was Dense (4) and toss B was Sparse (2) for the same macrophyte, the mean abundance would be Medium (4+2=6/2=3). Raw abundance data with mean calculations can be found in Appendix A.

Any macrophyte specimen requiring further identification was collected and placed in a Ziploc-type bag with a reference to the sampled location. Regionally appropriate taxonomic keys were used for identification.

Lake Oscaleta

Macrophyte Abundance and Discussion

Table 2 provides the presence of all species from each survey year and the percent change from 2017 to 2018 per species. Graphs displaying the abundance and distribution from year to year for each macrophyte are located in Appendix.

Three invasive macrophytes were present during the 2018 survey: brittle naiad, curly-leaf pondweed and Eurasian watermilfoil. Ranging from one to three invasive macrophytes were found throughout the three-year data set.

Comparing from 2017 to 2018, ribbon-leaf pondweed in Lake Oscaleta increased the most with a percent change of +150.0%. Other aquatic macrophytes with substantial percent changes were bassweed, creeping bladderwort, pondweed species, spatterdock, watershield, water bulrush, and white-water lily. Brittle naiad had a positive percent change of 100.0% and curly-leaf pondweed was trending in a positive direction in 2018. While Eurasian watermilfoil had a percent change negative 12.1%. Aquatic macrophytes that displayed negative percent changes were: common waterweed, creeping bladderwort, curly-leaf pondweed, Eurasian water milfoil, floating filamentous algae, quillwort, Robbin's pondweed, slender naiad, spatterdock, pondweed species and watershield.

Located in Table 2 is a summary of the species collected/observed during each survey since 2008. The Type column is a quick classification of the macrophyte. Abbreviations are as follows: **A-Algae,**

E-Emergent, S-Submersed, F-Floating leaf or Free Floating. The results of each species are discussed below. Red entries indicate invasive species and Green entries indicate algae species.

Common Name	Scientific Name	2008	2016	2018	% Change
Arrowhead (rosette)	*Sagittaria sp.*	X	X	X	0.0%
Bassweed	*Potamogeton amplifolius*	X	X	X	+9.3%
Benthic Filamentous Algae		X	X	X	-12.5%
Brittle Naiad	*Najas minor*		X	X	+100.0%
Common Waterweed	*Elodea canadensis*	X	X	X	-62.5%
Coontail	*Ceratophyllum demersum*	X	X	X	-14.6%
Creeping Bladderwort	*Utricularia gibba*	X	X	X	+6.7%
Curly-leaf Pondweed	*Potamogeton crispus*			X	+
Eurasian Water Milfoil	*Myriophyllum spicatum*	X	X	X	-12.1%
Floating Bur-reed	*Sparganium fluctuans*		X	X	0.0%
Floating Filamentous Algae			X	X	-55.6%
Leafy Pondweed	*Potamogeton foliosus*	X	X	X	-60.0%
Pondweed Species	*Potamogeton sp.*			X	+
Ribbon-leaf Pondweed	*Potamogeton epihydrus*	X	X	X	+150.0%
Robbin's Pondweed	*Potamogeton robbinsii*	X	X	X	-37.5%
Small Duckweed	*Lemna minor*		X	X	-66.7%
Southern Naiad	*Najas guadalupensis*		X		-100.0%
Spatterdock	*Nuphar variegata*	X	X	X	+12.1%
Stonewort	*Nitella sp.*	X			0.0%
Water Bulrush	*Schoenoplectus subterminalis*			X	+
Watershield	*Brasenia schreberi*	X	X	X	+18.2%
Water-thread Pondweed	*Potamogeton diversifolius*		X		-100.0%
White Water Lily	*Nymphaea odorata*	X	X	X	+4.8%
Wild Celery	*Vallisneria americana*		X	X	0.0%

At Lake Oscaleta, 88 sites were assessed to determine the abundance and distribution of submersed and floating vegetation on July 20, 26 and 27, 2018. Submersed vegetation was collected at 77 sites or at 88% abundance in the basin. Overall, 21 different aquatic plants (including benthic and filamentous algae) were observed. Three invasive aquatic macrophyte species were found in Lake Oscaleta. Dense abundance of submersed macrophytes were supported at six (or 8%) of the sites surveyed. Medium abundances were observed at 12 sites (or 16%), while sparse amounts were present at 26 sites (or 34%). Trace abundances of submersed macrophytes were accounted for at 33 sites (or 43%).

Seven floating macrophyte species were observed at Lake Oscaleta. A total of 77 sites (88%) supported floating macrophyte growth. Dense abundances of floating macrophytes were present at 25 (or 32%) sites. Medium abundances were observed at 20 sites (or 26%) and sparse abundances were observed at 20 sites (or 26%). Trace amounts of floating macrophytes were accounted for at 12 sites (or 16%). Thus, 58% of the sites contained nuisance floating aquatic plants.

The invasive submersed aquatic macrophyte species, Eurasian watermilfoil, continues to dominate in the basin, however, few sites were recorded at nuisance levels. Dense amounts of Eurasian watermilfoil were observed at one site (2%), while two sites (3%) were observed at medium abundance. Sparse amounts were present at seven sites (12%), while trace abundances were observed at 48 sites (83%). Lining the majority of the basin, lighter amounts of Eurasian watermilfoil were observed with a few heavier densities located towards the eastern end of the basin.

Bassweed was observed at 47 sites (53%) at Lake Oscaleta. One site was considered dense, while the four sites (9%) were considered medium. Sparse abundances occurred at nine sites (19%) and trace abundances were observed at 33 sites (70%). The bassweed abundance and distribution in this basin provides and continues to support fishery habitats. A mixed variety of densities were observed just outside of the launch area located in the open water. Low abundances were scattered along the shorelines leading towards the eastern end of the lake.

Coontail was present at 35 (or 40%) of the sites surveyed. Four nuisance level sites (11%), containing medium abundances, were observed. Sparse abundances accounted for four sites (11%), while trace amounts were observed at 27 sites (77%). Populations of coontail were concentrated at the opposite ends of the basin. Lighter populations were located in the canal.

Creeping bladderwort was documented at 32 sites (36%). Medium abundance supported one site (3%), while sparse abundances were observed at 13 (or 41%). Trace amounts of creeping bladderwort were observed at 18 sites (56%). Creeping bladderwort was observed floating from the launch area out to open water near the lilies towards the southwestern cove. Located at the eastern end of the lake, this species was observed throughout the lilies.

Robbin's pondweed, a desirable native, occurred at 20 sites (or 23%). Dense abundances were observed at three sites (15%), while three other sites (15%) were found at medium abundances. Trace abundances were observed at 14 sites (70%). Communities of Robbin's pondweed were observed clustered at the western end of the lake, scattered throughout the southern shoreline, leading to one dense site located at the eastern end of the lake.

Benthic filamentous algae were observed at 14 sites (or 16%). Sparse abundances were observed at four sites (29%) and trace abundances were recorded at 10 sites (71%). Benthic filamentous algae were located near the western end of the lake leading into the canal.

Arrowhead rosettes were observed at nine sites (or 10%) at trace abundances. Scattered randomly throughout the western end of the basin and along the northern and southeastern shorelines.

Brittle naiad, one of the three invasive species found in Lake Oscaleta, was observed at four sites (5%). All sites were observed at trace abundances. This species was located near the western area of the basin.

Common waterweed was observed at three sites (or 3%) at trace abundances. One site was located in the canal, another site near the launch and the last site was in the open water.

Curly-leaf pondweed, an invasive species that typically occurs early-on in the season, was observed at three sites. Trace abundances supported these sites located at the mouth of the canal in Lake Oscaleta. Due to its life cycle, curly-leaf pondweed abundance in July could be an underestimate of the true extent of this species.

Leafy pondweed, a native species, was present at two sites (2%). One site was documented at sparse abundance (50%), while the other site was accounted for at trace abundances (50%). The sparse site was located near the launch area and other site was located at the northern cove along the shoreline.

Wild celery, a highly desirable native, was observed at two sites (2%). Dense abundance was recorded at one site (50%) and the other site supported trace abundances. These populations should be encouraged as they are beneficial to aquatic biota. Wild celery populations were observed along the shoreline near the eastern end of the lake.

A thin-leaf pondweed species was observed at one site at trace abundances this year in Lake Oscaleta. It is possible that this could have come in from the neighboring lake (Lake Waccabuc). This could possibly be spiral fruited pondweed, however, it is difficult to determine this due to the lack of distinguishing characteristics, such as seeds etc. Therefore, biologists called this pondweed species, which was located in the canal.

White water lily was observed at 66 sites (or 75%) near the launch and clustered along the main shorelines. Dense abundances were observed at 19 sites (29%), while medium abundances occurred at 12 sites (18%). Sparse amounts were observed 22 sites (33%) and trace abundances were recorded at 13 sites (20%). Heavier abundances were concentrated on opposite ends of the lake. Scattered populations, of medium and sparse abundances, were located along the northern shoreline.

Watershield occurred at 39 sites (or 44%) at mixed abundances. Dense levels were observed at two sites (or 5%) and medium abundances were accounted for at six sites (15%). Sparse amounts were observed at 17 sites (44%). Trace abundances were documented at 14 sites (36%). A presence of watershield was scattered throughout the majority of the shorelines of Lake Oscaleta.

Spatterdock was present among other lilies, occurring at 37 sites (42%). Dense abundances were observed at five sites (14%) and medium amounts were assessed at nine sites (24%). Sparse abundances also were observed at nine sites (24%) and trace amounts were observed at 14 sites (38%). Spatterdock was observed throughout the canal and scattered at both the western and eastern end of the lake.

Floating filamentous algae was observed at four (5%) of the sites surveyed. Sparse abundances were recorded at two sites (50%) and the other two sites (50%) were observed at trace abundances. Located along opposite shorelines at the western end of the basin.

Water bulrush was observed at two sites (2%) at Lake Oscaleta. Both sites were recorded at sparse abundances present near the launch area.

Small duckweed occurred at two (or 2%) of the sites surveyed, all at trace abundances at the mouth of and in the canal.

Floating bur-reed was observed at one site (1%) at trace abundances in the canal.

Pennwort species were also found while performing the 2018 survey. Located near the mouth of the canal which connects between Lake Rippowam and Lake Oscaleta. However, it was not observed within the boundaries of the survey, therefore, it was not included in the results. More information regarding this species is located in the Aquatic Macrophyte Library in the Appendix.

Floristic Quality Index Results (FQI)

In order to determine the 'naturalness' of the sites examined and to evaluate the structures of plant communities, a methodology called the Floristic Quality Index (FQI) can be used to quantify this. A panel of botanists go through wetland, terrestrial and aquatic macrophytes to assign a Coefficient of Conservatism (CC) numerical value. Botanists in the Northeast recently re-evaluated and organized these values into regional scales, verses using individual state developed lists. These scales are based on the plants' ecological tolerance within their vegetative communities, which is further explained in Table 2 below. All CC values for this project were derived from FQI database, based on the location of the site (Freyman, 2016). These CC lists are generally re-evaluated and updated every 5 to 7 years. Due to the intended use of this methodology, mostly for wetland and terrestrial systems, some aquatic macrophytes are not present in the lists they developed. Therefore, numbers were assigned to them in order to complete the formulas, by making an educated guess.

Table 3: Definitions of Co-efficient of Conservatism (CC)	
Co-efficient of Conservatism	**Definitions**
0	Invasive species; low tolerance
1 – 3	Native bordering invasive level or widespread native, not a typical part of plant community
4 – 6	Native with an intermediate or narrow range of tolerances; May persist under some anthropogenic disturbances.
7 - 10	Native community with a very narrow range of tolerances, sensitive to anthropogenic disturbances

Source: (New England Water Interstate Water Pollution Control Commission, 2013)

For organizational purposes, the calculated average percent value of the CC was defined into three sections (shown in Table 3) to report the results, as well as following along with the definitions in Table 3. Total richness, being the aquatic macrophyte diversity, was accounted for per year. The number of native species, invasive species, as well as the percentages were calculated.

The following formulas listed below in Table 4 include examining more in-depth about the calculations of native and invasive species. The FQI formula calculates the native species only. The total mean C, is also known as the average for both native and invasive species. Total N represents the entire number of species in the equation. Native mean C is representative of the average coefficient value of the native species within that year. Native N is the number of native species present within that system. The total number of species was counted, along with breaking down the number (and percentage) of native species and non-native species.

Table 4: FQI Metrics Definitions:		
Metric	**Description**	**Definition**
Total Mean C	$I = \overline{C}\sqrt{n}$	Mean C value for both native and non-native species
Native Mean C	Average (C_{Native})	Mean coefficient value of native species
Total FQI	Average (C_{Native} and $C_{Non\text{-}Native}$)	Only native species
Total N	Number of Native species + Number of Non-native specie	Total number of species

Source: (Mid-Atlantic Wetland Working Group, 2019)

Below is a list of all the aquatic macrophytes present over the years with the assigned Co-efficient of Conservatism (CC) values. Those with asterisks in Table 5 indicate a Solitude Lake Management Biologist assigned a number as it was not available on the list botanists developed. Algae or macroalgae species were not included in these formulas, due to these species not being "true aquatic macrophytes", according to the FQI index. Each year based on the presence of the aquatic macrophyte CC the following values were calculated to determine the results utilizing the formulas above.

Table 5: Lake Oscaleta: Aquatic Macrophyte Co-efficient Conservatism Values			
Aquatic Macrophyte	Scientific Name	Coefficient Conservatism (CC)	Type
Arrowhead (rosette)	*Sagittaria graminea**	7	S
Bassweed	*Potamogeton amplifolius*	7	S
Benthic Filamentous Algae	-	-	A
Brittle Naiad	*Najas minor*	0	S
Common Waterweed	*Elodea canadensis*	4	S
Coontail	*Ceratophyllum demersum*	4	S
Creeping Bladderwort	*Utricularia gibba*	7	S
Curly-leaf Pondweed	*Potamogeton crispus*	0	S
Eurasian Water Milfoil	*Myriophyllum spicatum*	0	S
Floating Bur-reed	*Sparganium fluctuans*	8	S
Floating Filamentous Algae	-	-	A
Leafy Pondweed	*Potamogeton foliosus*	5	S
Pondweed Species	*Potamogeton sp.*	5*	S
Ribbon-leaf Pondweed	*Potamogeton epihydrus*	5	S
Robbin's Pondweed	*Potamogeton robbinsii*	5	S
Small Duckweed	*Lemna minor*	2	F
Southern Naiad	*Najas guadalupensis*	4	S
Spatterdock	*Nuphar variegata*	4	F
Stonewort	*Nitella sp.*	-	A
Water Bulrush	*Schoenoplectus subterminalis*	9	F
Watershield	*Brasenia schreberi*	6	F
Water-thread Pondweed	*Potamogeton diversifolius*	8	S
White Water Lily	*Nymphaea odorata*	5	F
Wild Celery	*Vallisneria americana*	6	S

– Red indicates an invasive species and green indicates an algae species.

Table 6: Lake Oscaleta – Richness Results			
Richness	**2008**	**2016**	**2018**
Total Richness	12	18	19
Native Species	11 (91.7%)	16 (88.9%)	16 (84.2%)
Invasive Species	1 (8.3%)	2 (11.1%)	3 (15.8%)

The species richness per year was similar in 2016 and 2018, with an outlier of 12 species recorded in 2008 (Table 6). Species richness over the three-years of data averages out to n=16.3. The highest percentage of native species occurred in 2008 at 91.7%, however, there were less species accounted for that year overall. In comparison to 2016 and 2018, which had similar percentages in the number of native species found greater than 84.2%. 2018 was the year with the highest number of invasive species observed at Lake Oscaleta. This is because of the presence of curly-leaf pondweed, typically an early season invasive species. In comparison to 2008, where only one invasive species was observed.

Based on the data collected, it seems there has been a gradual increase in the number of invasive species from 2008 to 2018. It's possible that an abundance of the native community could be decreasing, allowing the opportunity of invasive species populations to increase. However, due to the presence of curly-leaf pondweed present in 2018, this is impacting the FQI results. We also increased our effort in 2016 and 2018 which could account for additional species being found. The overall richness, number of native species and invasive species in the yearly plant assemblages were consistent in 2016 and 2018. The year with the least amount of diversity was observed in 2008 and the year with the most was recorded during the 2018 survey.

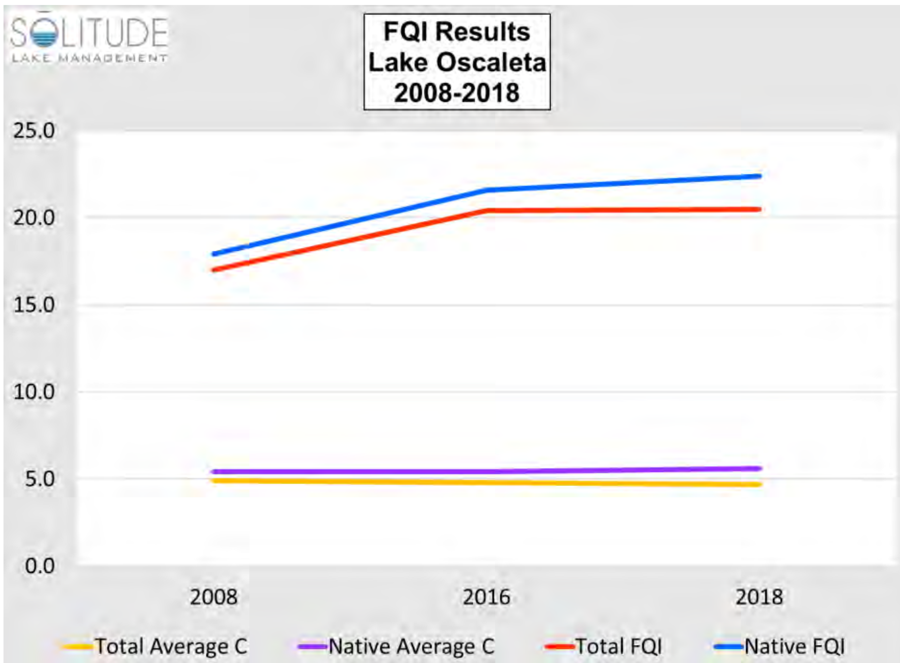

Figure 1. 2008-2018 Lake Oscaleta FQI Results

The total average FQI remained steady throughout the three-year data set. As displayed on Figure 1 there was little variation between the results in 2016 and 2018, about a 0.1-unit difference. Whereas in 2008 the results were slightly lower at 17.0. Throughout the dataset the native FQI was slightly higher by an average of n=1.3. Both native FQI and total FQI results were nearly identical, with the total FQI being slightly lower. As displayed, it continues to show minimal variation and appears to be stable.

Table 7: Lake Oscaleta - FQI Results			
FQI Results	**2008**	**2016**	**2018**
Total Average C	4.9	4.8	4.7
Native Average C	5.4	5.4	5.6
Total FQI	17.0	20.4	20.5
Native FQI	17.9	21.6	22.4
% C Value 0	8.3	11.1	15.8
% C Value 1-3	0.0	5.6	5.3
% C Value 4-6	66.7	55.6	52.6
% C Value 7-10	25.0	27.8	26.3

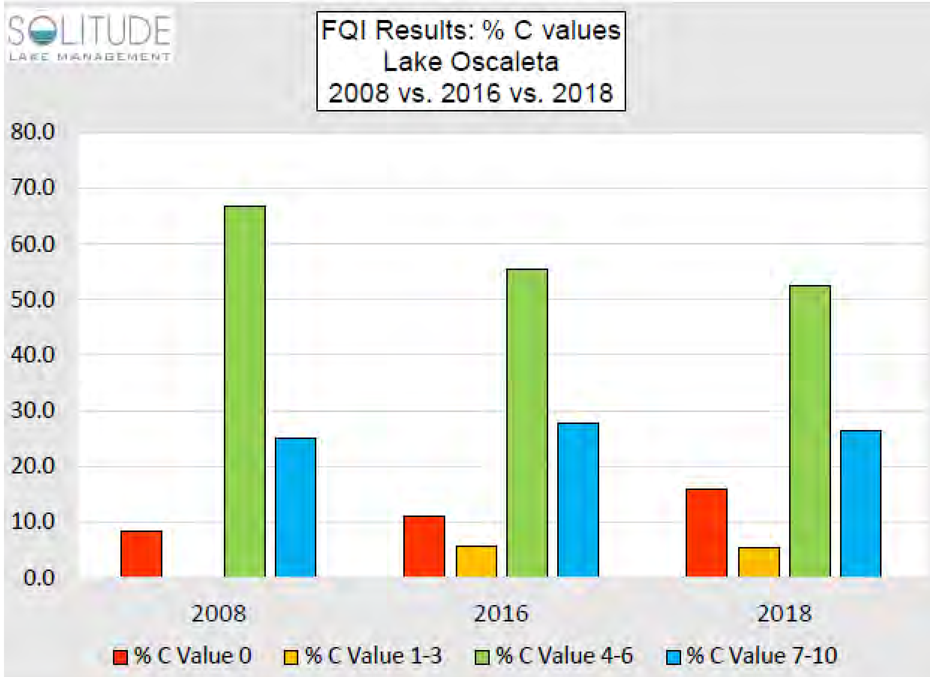

Figure 2. 2008-2018 Lake Oscaleta FQI % C Values

Based on the dataset, the percent average value for zero generated at <15.1% for invasive species. It is apparent throughout the data that the average percent value for zero increased in both 2016 and 2018, due to the number of invasive species increasing. The average percent values of 1 - 3 calculated out at <5.6% and was present for 2016 and slightly decreased in 2018. Its possible conditions were not suitable in 2008 for those specifically valued set of macrophytes. While the average percent values ranging from 4 – 6 were stable and similar in numbers within the last two years, whereas 2008 had the highest percentage of 66.7%. Most of the aquatic macrophytes in the assemblages per year was comprised of CC values ranging from 4 – 6. The average percent values of 7 – 10 was <27.8%, as shown on Figure 2, these valued species have been consistent with little variation throughout the three years of data. The results seem to have natural variation is more than likely possible, however, based on the data we currently have the trend decreased from 2008 and seems to be stabilized for 4- 6 CC valued species. However, more data is needed to confirm this. As referenced in Figure 2, 7 – 10 CC values increased in 2016 and slightly decreased in 2018. Based on this limited data, the aquatic macrophyte community appears to be stable.

Lake Rippowam

Table 8. is a summary of the species collected/observed during each survey since 2008 at Lake Rippowam. The Type column is a quick classification of the macrophyte. Abbreviations are as follows: **A-Algae, E-Emergent, S-Submersed, F-Floating leaf or Free Floating.** The results of each species are discussed below. Red entries indicate invasive species and Green entries indicate algae species.

Common Name	Scientific Name	2008	2016	2018	% Change
Arrowhead (rosette)	*Sagittaria sp.*		X	X	+66.7%
Bassweed	*Potamogeton amplifolius*		X	X	0.0%
Benthic Filamentous Algae		X	X		-100.0%
Coontail	*Ceratophyllum demersum*		X	X	-66.7%
Eurasian Water Milfoil	*Myriophyllum spicatum*	X	X	X	+20.7%
Floating Filamentous Algae		X	X	X	-55.6%
Small Duckweed	*Lemna minor*		X		-100.0%
Spatterdock	*Nuphar variegata*	X	X	X	0.0%
Watermoss	*Fontinalis sp.*		X		-100.0%
White Water Lily	*Nymphaea odorata*	X	X	X	0.0%

Over the survey years, arrowhead rosettes had the highest positive percent change (66.7%) in Lake Rippowam. The only other species that is displaying a positive percent change (20.7%) is Eurasian water milfoil, an invasive species. Aquatic macrophytes with negative percent changes were benthic filamentous algae, coontail, floating filamentous algae, small duckweed and watermoss. For bassweed, spatterdock and white-water lily were observed at 0.0% percent change.

Biologists surveyed 60 sites at Lake Rippowam to determine the abundance and distribution of submersed and floating vegetation on July 26, 2018. Submersed vegetation was collected at 35 sites or at 58% abundance in the lake. Overall, seven different aquatic plants (including floating filamentous algae) were observed. One invasive aquatic macrophyte species, Eurasian watermilfoil, was found in Lake Rippowam. No dense abundances were recorded. However, medium abundances were observed at one site (or 3%), while sparse amounts were present at eight sites (or 23%). Trace abundances of submersed macrophytes was accounted for at 26 sites (or 74%).

Three floating macrophyte species were observed at Lake Rippowam. A total of 28 sites (47%) supported floating macrophyte growth. Dense abundances of floating macrophytes were present at ten sites (or 36%). Medium abundances were observed at five sites (or 18%) and sparse abundances were observed at four sites (or 14%). Trace amounts were accounted for at nine (or 32%) of the sites surveyed.

Eurasian watermilfoil, a submersed invasive aquatic macrophyte, was the dominate species of the plant assemblage, occurring at 35 sites (or 58%). Medium abundance was recorded at one site (3%) and sparse abundances were observed at seven sites (or 20%). Trace amounts were observed at 27 sites (77%). Scattered along the shorelines, the Eurasian watermilfoil was observed in light abundances located at each end of the lake.

Arrowhead rosettes were present at three of the sites (5%) surveyed. All sites were assessed at trace abundances. The locations containing these rosettes were observed along the southern shoreline.

Bassweed was observed at two sites (3%) at trace abundances. One site was located at the western end of the basin among the lilies along the shoreline, while the other site was observed at the opposite end basin.

Coontail was observed at one site (2%) at trace abundance along the southeastern shoreline.

White water lilies were observed at 21 sites (or 35%) throughout Lake Rippowam. Dense abundances were recorded at eight sites (38%). Medium abundances were observed at four sites (19%). Sparse amounts were also observed at four sites (19%) and trace abundances were observed at five sites (24%). Heavier concentrations of white-water lilies were located at the western end of Lake Rippowam and lighter amounts were observed scattered along the southern shoreline towards the eastern end where abundances increased again.

Spatterdock was observed at eight sites (13%) at Lake Rippowam. Dense sites were present at two sites (25%) and medium abundances were observed at one site (13%). Sparse abundances were also present at one site (13%) and trace abundances were found at four sites (50%). Low abundances were located along the western shoreline and heavier amounts were concentrated along the eastern shoreline.

Floating filamentous algae was observed at five sites (8%) and was assessed at trace abundances. At fairly low abundances, filamentous algae was observed scattered along the central region of the southern shoreline.

Lake Rippowam: Floristic Quality Index (FQI) Results and Discussion:

Table 9: Lake Rippowam: Aquatic Macrophyte Co-efficient Conservatism Values

Aquatic Macrophyte	Scientific Name	Coefficient Conservatism (CC)	Type
Arrowhead (rosette)	*Sagittaria graminea**	7	S
Bassweed	*Potamogeton amplifolius*	7	S
Benthic Filamentous Algae	-	-	A
Coontail	*Ceratophyllum demersum*	4	S
Eurasian Water Milfoil	*Myriophyllum spicatum*	0	S
Floating Filamentous Algae	-	-	A
Small Duckweed	*Lemna minor*	2	F
Spatterdock	*Nuphar variegata*	4	F
Watermoss	*Fontinalis sp.*	5*	S
White Water Lily	*Nymphaea odorata*	5	F

– Those with asterisks next to the scientific name indicates the species name utilized for the purpose of these calculations. An asterisk next to the CC indicates the supplement value provided by an SLM Biologist. Red indicates an invasive species and green indicates an algae species.

As explained earlier in the Lake Oscaleta FQI section, located in Table 9 CC values are listed above. Other tables and descriptions explaining more in depth about FQI can be referenced in the Lake Oscaleta: Floristic Quality Index (FQI) section.

The species richness varied year to year from 2008 through 2018. Species richness over the three years of data averaged out to n=5.6. The percentage of native species were similar in 2016 and 2018, in comparison to 2008 where results were lower (66.7%). There was only one invasive species consistently present every year, being Eurasian watermilfoil, which varied in percentages based on the number of species found at Lake Rippowam.

The overall richness, number of native species and invasive species in the yearly plant assemblages are fairly consistent. A significant increase was observed in 2016 with a record of eight aquatic macrophytes observed out of the data set. The number of species slightly decreased in 2018 to six aquatic macrophytes. The year with the least amount of diversity was observed in 2008.

Table 10: Lake Rippowam– Richness Results

Richness	2008	2016	2018
Total Richness	3	8	6
Native Species	2 (66.7%)	7 (87.5%)	5 (83.3%)
Invasive Species	1 (33.3%)	1 (12.5%)	1 (16.7%)

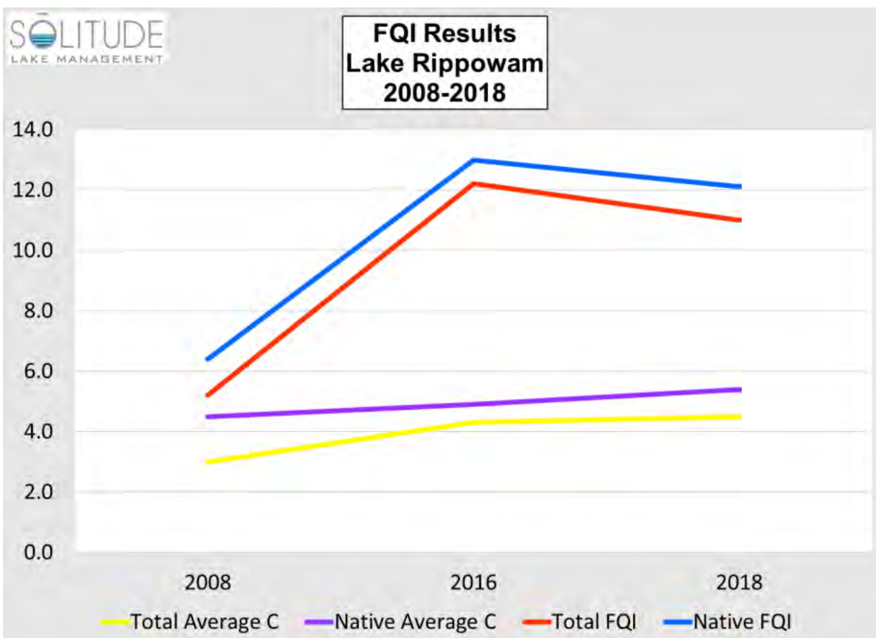

Figure 3. 2008-2018 Lake Rippowam FQI Results

The total average FQI and native average results remained steady throughout the dataset. As displayed on Figure 3 there was little variation between the results. Total FQI is considered low for this basin, an increased presence of native species would influence these results. Both native FQI and total FQI results were nearly identical, with the total FQI being slightly lower. As displayed, it continues to show minimal variation.

Table 11: 2008 – 2018 Lake Rippowam FQI Results			
FQI Results	**2008**	**2016**	**2018**
Total Average C	3.0	4.3	4.5
Native Average C	4.5	4.9	5.4
Total FQI	5.2	12.2	11.0
Native FQI	6.4	13.0	12.1
% C Value 0	33.3	12.5	16.7
% C Value 1-3	0.0	12.5	0.0
% C Value 4-6	66.7	50.0	50.0
% C Value 7-10	0.0	25.0	33.3

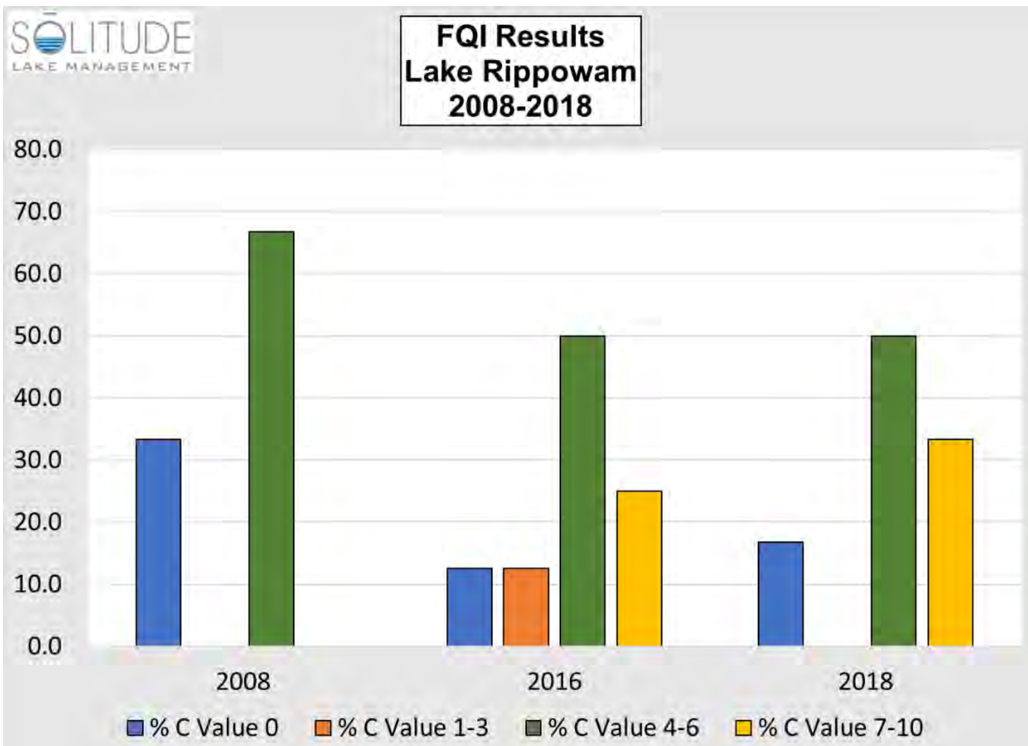

Figure 4. 2008-2018 Lake Rippowam FQI % C Values

Based on the dataset, the percent average value for zero generated at less than 33.3% for invasive species. The average percent values of 1 - 3 calculated out at less than 12.5% and was present for 2012 only. Its possible conditions were not suitable for 2008 and 2018 for that valued set of macrophytes. While the average percent values of 4 – 6 were less than 66.7%, both 2016 and 2018 had equal values (50.0%) Most of the aquatic macrophytes in the assemblages per year were comprised of CC values ranging from 4 – 6. The average percent values of 7 – 10 were less than 33.3%, as shown on Figure 4, these valued species have been fairly consistent throughout the last two years. Whereas in 2008 none of these valued macrophytes were observed. Based on these results it seems that natural variation more than likely is occurring throughout the data, with fluctuations from year to year, however, gathering more data would confirm this.

Summary of Findings:

Lake Oscaleta:

- Eurasian watermilfoil continues to be the most dominant macrophyte within Lake Oscaleta.
- **No Brazilian elodea and water chestnut were found in 2018.**
- Two other non-native macrophytes were documented during the 2018 survey: brittle naiad and curly-leaf pondweed.
- White waterlily continues to be the dominant floating-leaf macrophyte within Lake Oscaleta.
- Macrophyte diversity increased after 2008, and has remained relatively consistent.
- Overall, FQI values are considered to be suitable and displayed steady variation based on the 2016 and 2018 data.
- Based on the available data, the overall plant assemblages comprised of 4 – 6 valued aquatic macrophytes (66.7% or less).
- The year with the least amount of diversity was 2008 and the year with the most was recorded during the 2018 survey (19 species).
- 2016 and 2018 were the years with the highest native species observed.
- The survey performed in 2018 was the year three invasive species were recorded, being the highest number of invasive macrophytes observed at Lake Oscaleta.

Lake Rippowam:

- Eurasian watermilfoil continues to be the most dominant macrophyte within Lake Rippowam.
- **No Brazilian elodea and water chestnut were found in 2018.**
- White waterlily continues to be the dominant floating-leaf macrophyte within Lake Rippowam.
- Macrophyte diversity increased after 2008, and has remained relatively consistent.
- Overall, FQI values are considered to be low and stayed fairly consistent based off of 2016 and 2018 data.
- Based on the available data, the overall plant assemblages comprised of 4 – 6 valued aquatic macrophytes (66.7% or less).
- The year with the least amount of diversity was 2008 (3 species) and the year with the most was recorded during the 2016 survey (8 species).
- 2016 was the year with the highest native species observed.
- Throughout the data, Eurasian watermilfoil was the only invasive species consistently found each survey year.

Recommendations:

We highly recommend a repetition of the SAV mapping in 2020. Monitoring is important for examining and understanding the abundance and distribution of non-native and native macrophytes throughout the aquatic systems. As shown in the FQI results, we can interpret this growing data set through other potential avenues of analysis.

The point-intercept methodology continues to work well in monitoring and quantifying the growth of aquatic macrophytes in Lake Oscaleta and Rippowam. If Brazilian elodea or water chestnut should re-infest Lake Waccabuc, this will pose a threat to the other two systems for infestation, and create a need for more intensive effort for surveys. The point-intercept survey will direct the point-intercept survey is ideal to direct short- or long-term management efforts in a cost-effective manner. We should increase the frequency of surveying yearly, if this situation occurs. Based off of 2018 SAV mapping, 2 days of vegetation monitoring is recommended at Lake Oscaleta and Rippowam in 2020.

However, it's possible that other infestations (like hydrilla, as it becomes more established in the region) could appear or may not be within the boundaries of the survey and non-native growth can be overlooked, especially when an infestation is small or intermittent. While not a priority, the growth of Eurasian watermilfoil is concerning as it continues to be dominate in all three systems. The Eurasian water milfoil population of both lake systems appears to be stable and local management via hand-pulling is likely enough to reduce impacts to recreational activity.

As always, Solitude Lake Management would like to take this opportunity to thank you for allowing us to be of service to the 3LC. We look forward to working with you in the 2019 season.

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Appendix: Lake Oscaleta

Aquatic macrophyte Library (includes all macrophyte species from each lake)

2008 – 2018 Percent Abundance Graphs

2018 Survey Maps

FQI Figures

THE THREE LAKES COUNCIL:
AQUATIC MACROPHYTE PICTURE LIBRARY

Table of Contents

Arrowhead – submersed rosette (*Sagittaria* sp.)

Arrowhead Native (Submersed Rosette): This is the submersed rosette of a species of arrowhead. The submersed rosette lacks both flowers and seeds, so further identification is not possible. Arrowhead has emergent leaves, and usually inhabits shallow waters at pond or lake edges, or along sluggish streams. It can tolerate a wide variety of sediment types and pH ranges. Arrowhead is very suitable for constructed wetland development due to its tolerance of habitats, and ability to act as a nutrient sink for phosphorous. Typical arrowhead reproduction is via rhizomes and tubers although seed production is possible if conditions are ideal. Arrowhead has high wildlife value, providing high-energy food sources for waterfowl, muskrats and beavers. Arrowhead beds provide suitable shelter and forage opportunities for juvenile fish as well.

Bassweed (*Potamogeton amplifolius*)

Large-leaf pondweed, Musky weed

Bass Weed Native: Bass weed has robust stems that originate from black-scaled rhizomes. The submersed leaves of bass weed are among the broadest in the region. The submersed leaves are arched and slightly folded, attached to stems via stalks, and possess many (25-37 veins). Floating leaves are produced on long stalks (8-30 cm). Stipules are large, free and taper to a sharp point. Flowers, and later in the season fruit are densely packed onto a spike. Bass weed prefers soft sediments in water one to 4 meters deep. This plant is sensitive to increased turbidity and also has difficulty recovering from top-cutting, from such devices as boat propellers and aquatic plant harvesters. As its name implies the broad leaves of this submersed plant provides abundant shade, shelter and foraging opportunities for fish. The high number of nutlets produced per plant make it an excellent waterfowl food source.

Brazilian Elodea (*Egeria densa*)

Egeria, Anacharis, Brazilian waterweed

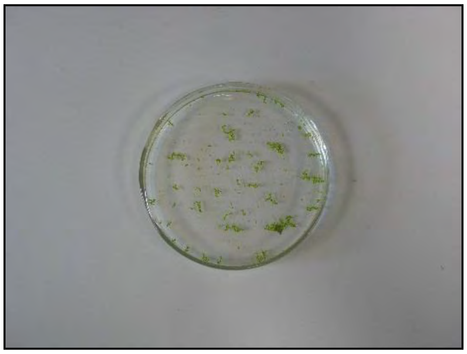
Brazilian Elodea Invasive: Brazilian elodea is an aggressive exotic invasive submersed plant that originated from South America. It was introduced via the aquarium hobby trade, and is a top selling plant used as an oxygenator. The stems can be several meters long, and the strap-like leaves are situated in whorls of three to six, but usually four. The leaves are finely serrated, and are tightly packed together near the end of the stem. Brazilian elodea can be rooted or free floating, and due to its highly branching nature, can quickly reach nuisance densities and crowd out or block light penetration for desirable native submersed plants. Although it can be confused with *Hydrilla*, another invasive submersed plant, its lack of tuber production and leaf structure differentiates it. Although it can produce white flowers, it reproduces vegetatively in the United States. Waterfowl consume Brazilian elodea, and fish and invertebrates use the stems for refuge and habitat.

Brittle Naiad (*Najas minor*)

Brittle water nymph, European naiad

Brittle Naiad Invasive: Brittle naiad is a submersed annual that flowers in August to October. It resembles other naiads, except its leaves are highly toothed with 6-15 spinules on each side of the leaf, visible without the aid of magnification. The leaves are opposite, simple, thread-like, and usually lime-green in color, often with a “brittle” feel to them. Brittle naiad fruit are narrow, slightly curved, and marked with 10-18 longitudinal ribs, resembling a ladder. Brittle Naiad has been introduced from Europe in the early 1900’s, and can be found in most of the northeastern states. Brittle naiad prefers sandy and gravel substrates, but can tolerate a wide range of bottom types. It’s tolerant of turbid and eutrophic conditions. Waterfowl graze on the fruit.

Common Watermeal (*Wolffia columbiana*)



Common Watermeal Native: Common watermeal appears as pale green globes of vegetative matter without roots, stems or true leaves. Its one of the world's smallest flowering plants, but flowers are rarely found and require magnification to see. Watermeal usually reproduces by budding. Watermeal is typically found on the surface, intermingled with duckweeds. Its drifts with the water's current or wind, and therefore it grows independent of water depth, clarity or sediment type. In the fall it produces winter buds that sink to the bottom. In the spring, the buds become buoyant and float to the surface. Waterfowl, fish, and muskrats all include watermeal in their diets.

Common Waterweed (*Elodea canadensis*)

Elodea

Common Waterweed Native: Common waterweed has slender stems that can reach a meter in length, and a shallow root system. The stem is adorned with lance-like leaves that are attached directly to the stalk that tend to congregate near the stem tip. The leaves are populated by a variety of aquatic invertebrates. Male and female flowers occur on separate plants, but it can also reproduce via stem fragmentation. Since common waterweed is disease resistant, and tolerant to low-light conditions, it can reach nuisance levels, creating dense mats that can obstruct fish movement, and the operation of boat motors.

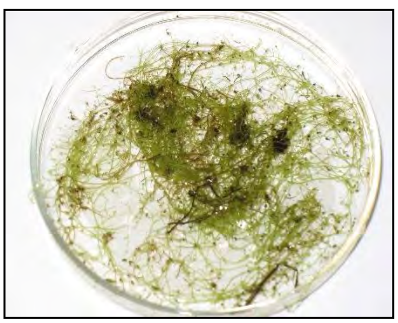
Coontail (*Ceratophyllum demersum*)

Hornwort

Coontail Native: Coontail has long trailing stems that lack true roots, although it can become loosely anchored to sediment by modified leaves. The leaves are stiff, and arranged in whorls of 5-12 at each node. Each leaf is forked once or twice, and has teeth along the margins. The whorls of leaves are spaced closer at the end of the stem, creating a raccoon tail appearance. Coontail is tolerant of low light conditions, and since it is not rooted, it can drift into different depth zones. Coontail can also tolerate cool water and can over winter as a green plant under the ice. Typically, it reproduces via fragmentation. Bushy stems of coontail provide valuable habitat for invertebrates and fish (especially during winter), and the leaves are grazed on by waterfowl.

Creeping Bladderwort (*Utricularia gibba*)

Humped bladderwort, cone-spur bladderwort



Creeping Bladderwort Native**:** Creeping bladderwort is a small (usually less than 10 cm long), delicate, free-floating stem. It often forms tangled mats in quiet shallow waters, often associated with bogs, or stranded on soil. It is sometimes mistaken for algae. It has short side braches that fork once or twice, a defining characteristic. Small bladders, used to capture live prey, are situated on these side branches. Small yellow snap-dragon-like flowers are produce on a short stalk. Mats of creeping bladderwort offer limited cover and foraging opportunities for fish.

Curly-leaf Pondweed (*Potamogeton crispus*)

Curly-leaf Pondweed Invasive: Curly-leaf pondweed has spaghetti-like stems that often reach the surface by mid-June. Its submersed leaves are oblong, and attached directly to the stem in an alternate pattern. The margins of the leaves are wavy and finely serrated, hence its name. No floating leaves are produced. Curly-leaf pondweed can tolerate turbid water conditions better than most other macrophytes. In late summer, Curly-leaf pondweed enters its summer dormancy stage. It naturally dies off (often creating a sudden loss of habitat and releasing nutrients into the water to fuel algae growth) and produces vegetative buds called turions. These turions germinate when the water gets cooler in the autumn and give way to a winter growth form that allows it to thrive under ice and snow cover, providing habitat for fish and invertebrates.

Dwarf Water Milfoil (*Myriophyllum tenellum*)

Dwarf Water Milfoil Native: Dwarf milfoil, which does not look anything like other milfoil species, has slender unbranched stems ranging from 2 cm to 15 cm in height. The leaves are reduced to scales or "bumps". If the tips rise out of the water, they are capable of producing pale flowers and nut-like fruits. The toothpick-like stems arise from rhizomes in a chain. Dwarf milfoil is often small and overlooked, preferring sandy bottoms in waters up to four meters deep. Dwarf water milfoil provides suitable spawning habitat for panfish and adequate shelter for small invertebrates. The rhizome networks also help stabilize bottom sediments.

Eurasian Watermilfoil (*Myriophyllum spicatum*)

Asian Water Milfoil

Eurasian Watermilfoil Invasive: Eurasian water milfoil has long (2 meters or more) spaghetti-like stems that grow from submerged rhizomes. The stems often branch repeatedly at the water's surface creating a canopy that can crowd out other vegetation, and obstruct recreation and navigation. The leaves are arranged in whorls of 4 to 5, and spread out along the stem. The leaves are divided like a feather, resembling the bones on a fish spine. Eurasian watermilfoil is an exotic originating in Europe and Asia, but its range now includes most of the United States. It's ability to grow in cool water and at low light conditions gives it an early season advantage over other native submersed plants. In addition to reproducing via fruit production, it can also reproduce via fragmentation. Waterfowl graze on Eurasian watermilfoil, and its vegetation provides habitat for invertebrates. However, studies have determined mixed beds of pondweeds and wild celery can support more diverse invertebrate populations.

Filamentous Algae

Floating Filamentous Algae, Benthic Filamentous Algae

Filamentous Algae: Filamentous algae is a chain or series of similar algae cells arranged in an end to end manner. Benthic filamentous algae is attached to a hard substrate, such as logs, rocks, a lake bottom, or even other aquatic plants. When growing in heavy densities, benthic filamentous algae can appear as brown or green mats of vegetation that can reach the surface. When large pieces break off the bottom substrate they become floating filamentous algae patches. Benthic filamentous algae can comprise an entire range of morphologies, but flagellated taxa are far less common.

Flat-stem Pondweed (*Potamogeton zosteriformis*)

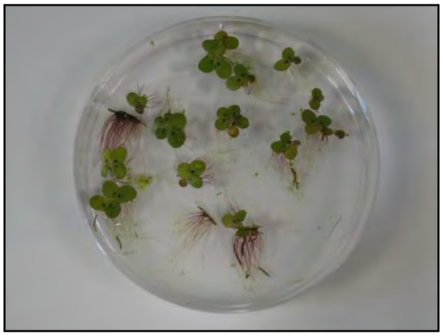
Flat-stem Pondweed Native: Flat-stem pondweed is freely branched, emerging from a delicate rhizome system. The stems are strongly flattened with an angled appearance. The long leaves are stiff and linear with a prominent midvein, and numerous fine parallel veins. This prominent midvein distinguishes this pondweed from water stargrass. The stipules are firm and free situated in the leaf axils. Flat-stem pondweed lacks floating leaves. Flat-stem pondweed inhabits a variety of water depths from shallow water to water several meters deep. It prefers soft sediment types. Although it produces nut-like fruits, it over winters primarily by rhizomes and winter buds. It can be a locally important food source to fauna, such as waterfowl, muskrat, deer, beaver, and moose. It also provides suitable habitat and food for fish and aquatic invertebrates.

Floating Bur-reed (*Sparganium fluctuans*)

Floating Bur-reed Native: Floating bur-reed is an aquatic perennial that grows along rhizomes in static or slow-moving water. The leaves are limp, strap-shaped, float on the water's surface, often growing in the direction of any flow. At maturity (July-September), the floating bur-reed produce an emergent flowering spike that supports few white flowers with an appearance of small, fluffy cotton balls. From the flowers, floating bur-reed produces spiky fruits (seed heads) that are primarily dispersed by water. The fruits are water-repellent and can remain floating for several months. Various species of bur-reed display the floating leaves.

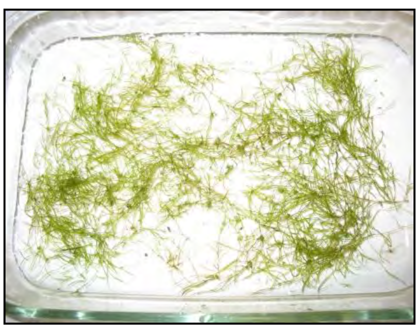
Great Duckweed (*Spirodela polyrhiza)*

Large Duckweed



Great Duckweed Native: Great duckweed is the largest of the duckweeds, but it is still very small compared to other aquatic macrophytes. It has simple flattened fronds with irregular oval shapes, often up to 1 cm in length and 2.5 to 8.0 mm long. The frond surface is usually green with a conspicuous purple dot. The underside of the frond is magenta with a cluster of 5-12 roots that dangle into the water. Indeed, peering at great duckweed from under the water grants it the appearance a tiny jellyfish. Although great duckweed produces flowers, it usually reproduces via budding, and like other duckweeds, it is capable of rapid growth. It often occurs with other duckweeds, and since it is free floating, it can be moved via the wind or water currents. It derives its nutrients from the water column and often occurs in eutrophic systems. It's an excellent food source for waterfowl, and is also used by muskrat and fish. The dense mats offer shade and cover for fish.

Leafy Pondweed (*Potamogeton foliosus*)



Leafy Pondweed Native: Leafy pondweed has freely branched stems that hold slender submersed leaves that become slightly narrower as they approach the stem. The leaf contains 3-5 veins and often tapers to a point. No floating leaves are produced. It produces early season fruits in tight clusters on short stalks in the leaf axils. These early season fruits are often the first grazed upon by waterfowl during the season. Muskrat, beaver, deer and even moose also graze on the fruit. It inhabits a wide range of habitats, but usually prefers shallow water. It has a high tolerance for eutrophic conditions, allowing it to even colonize secondary water treatment ponds.

Quillwort (*Isoetes sp.*)

Quillwort Native: Quillwort is a low-growing, submersed aquatic plant with many leaves forming from a basal structure called a corm. The size of the hollow leaves is dependent on the species. Quillwort is actually a lycopod, and does not have 'true' rhizomes or seeds. Instead, quillwort has pseudo-rhizomes and megaspores. The megaspores act like seeds, and are found in the expanded bases of each leaf; the megaspores are the primary method for species identification of quillwort genus.

Ribbon-leaf Pondweed (*Potamogeton epihydrus*)

Ribbon-leaf Pondweed Native: Ribbon-leaf pondweed has flattened stems and two types of leaves. The submersed leaves are alternate on the stem, lack a leaf stalk, and are long tape-like in shape. Each leaf, which can reach lengths up to 2 meters long, has a prominent stripe of pale green hollow cells flanking the midvein, and 5 to 13 other veins. Stipules are not fused to the leaf. Floating leaves are egg or ellipse-shaped, and supported by a leaf stalk about as long as the leaf itself. Fruiting stalks are located at the top of the stem and packed with flattened disk-shaped fruits. It is typically found growing in low alkalinity environments, and in a variety of substrates. Seeds are highly sought after by all manner of waterfowl.

Robbins Pondweed (*Potamogeton robbinsii*)

Fern Pondweed

Robbins Pondweed Native: Robbins pondweed has robust stems that emerge from spreading rhizomes. The leaves are strongly ranked creating a fern-like appearance most clearly seen while still submerged. Its distinct closely-spaced fern-like leaves give it a unique appearance among the pondweeds of our region. Each leaf is firm and linear, with a base that wraps around the stem. At the stem it has ear-like lobes fused with a fibrous stipule. No floating leaves are produced. Robbins pondweed thrives in deeper water, and under some circumstances, it can over winter green. Robbins pondweed creates suitable invertebrate habitat, and cover for lie-in-wait predaceous fish, such as pickerel and pike.

Slender Naiad (*Najas flexilis*)

Bushy Pondweed

Slender Naiad Native: Slender naiad has fine-branched stems that can taper to lengths of one meter, originating from delicate rootstalks. Plant shape varies; sometimes compact and bushy, other times long and slender, depending on growing conditions. The leaves are short (1-4 cm long) and finely serrated, tapering to a point. It is found in a variety of habitats, and can colonize sandy or gravelly substrates. If conditions are ideal, it can reach nuisance densities. It is a true annual, and dies off in the fall, relying on seed dispersal to return the next year. It is an important food source for waterfowl.

Small Duckweed (*Lemna minor*)

Water Lentil, Lesser Duckweed

Small Duckweed Native: Small duckweed is a free floating plant, with round to oval-shaped leaf bodies typically referred to as fronds. The fronds are small (typically less than 0.5 cm in diameter), and it can occur in large densities that can create a dense mat on the water's surface. Each frond contains three faint nerves, a single root (a characteristic used to distinguish it from other duckweeds), and no stem. Although it can produce flowers, it usually reproduces via budding at a tremendous rate. Its population can double in three to five days. Since it is free floating, it drifts with the wind or water current, and is often found intermixed with other duckweeds. Since it's not attached to the sediment, it derives nutrients directly from the water, and is often associated with eutrophic conditions. It over winters by producing turions late in the season. Small duckweed is extremely nutritious and can provide up to 90% of the dietary needs for waterfowl. It's also consumed by muskrat, beaver and fish, and dense mats of duckweed can actually inhibit mosquito breeding.

Southern Naiad (*Najas guadalupensis*)

Southern Water Nymph, Bushy Pondweed

Southern Naiad **Native** (*Najas guadalupensis*. Common Names: Southern water nymph, bushy pondweed.): Southern naiad is an annual aquatic plant that can form dense stands of rooted vegetation. Its ribbon-like leaves are dark-green to greenish-purple, and are wider and less pointed than slender naiad. Flowers occur at the base of the leaves, but are so small, they usually require magnification to detect. Southern naiad is widely distributed, but is less common than slender naiad in northern zones. Southern naiad reproduces by seeds and fragmentation.

Spatterdock (*Nuphar variegata*)

Yellow Pond Lily, Bullhead Pond Lily

Spatterdock Native: Spatterdock leaf stalks emerge directly from a submerged fleshy rhizome. Spatterdock has heart-shaped leaves with a prominent notch. Depending on the habitat, these leaves can be held aloft via erect stems. A distinguishing characteristic of spatterdock is the leaf stalk, which bears a winged margin. Flowering occurs in the summer and, the flowers open during the day and close at night. Spatterdock typically inhabits quiet water less than two meters deep with a soft substrate, such as ponds, shallow lakes and slow-moving streams. The leaves offer shade and protection for fish, and the leaves, stems, and flowers are grazed upon by muskrats, beaver, and sometimes, even deer.

Spiral-fruited Pondweed (*Potamogeton spirillus*)

Spiral-fruited Pondweed Native: Spiral-fruited pondweed has slender stems that originate from a delicate, spreading rhizome. The stems tend to be compact and have numerous branches. Submersed leaves are linear with a curved appearance. Floating leaves are delicate, ellipse-shaped and range from 7 to 35 mm long and two to 13 mm wide. Stipules are fused to the leaf blade for more than half of their length. Nut-like fruits are produced on stalks of varies lengths. Shorter stalks tend to be on lower axils with fruit arranged in a compact head, while longer stalks tend to appear on upper axils, with fruit arranged in a cylindrical head. The fruit itself is a flatten disc with a sharply-toothed margin. Its smooth sides appear like a tightly coiled embryo, a distinguishing characteristic. Spiral-fruited pondweed prefers shallow water with sandy substrate, but can inhabit a wide range of bottom substrates. It serves as an important stabilizer and cover for fish fry and invertebrates.

Water Bulrush (*Scirpus subterminalis, Schoenoplectus subterminalis)*

Bulrush

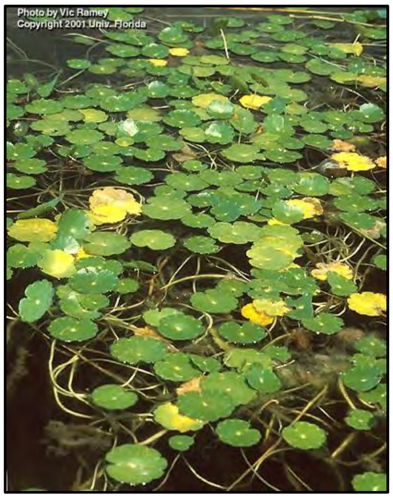
Water bulrush Native (*Scirpus subterminalis*; = *Schoenoplectus subterminalis*). Common names: water bulrush, bulrush. Water bulrush is a truly aquatic bulrush, with only the tips of fertile stems poking above the water's surface, if any. The slender, limp stems originate from a delicate rhizome, typically less than 2.0 mm diameter. The hair-like stems can reach lengths up to 1.0 meter, and occur in flowing or still-water environments. The leaves are sheathed at the base, and become crescent-shaped above the sheath. This basal sheathing is a distinct characteristic that sets water bulrush apart from spikerush species. The leaves have one to five length-wise veins and scattered cross-veins. The leaves are often covered with a fine coating of algae in nutrient-poor environments. Researchers believe the bulrush plants are a phosphorus source for the algae. When nutlets are produced, they are three-angled with a slender beak. Water bulrush prefers shallow water, but can become established in depths exceeding 1.0 meter. Water bulrush stands produce grass-like meadows which provide suitable habitat for invertebrates and juvenile fish.

Water Chestnut (*Trapa natans*)

Water nut

Water Chestnut Invasive: Water chestnut is native to Europe and Asia, and was first observed in the United States in the late 1800's in Massachusetts. Water chestnut has two types of leaves, submerged and floating rosettes. The submersed leaves are delicate, opposite and contain numerous adventitious roots. Floating leaves are strongly toothed triangular leaves displayed in a rosette fashion, supported by long petioles with spongy inflated bladders for buoyancy. These petioles can reach lengths of up to 16 feet. Water chestnut prefers to inhabit nutrient-rich slow moving waters in lakes, ponds or streams. Although water chestnut can reproduce via fragmented rosettes, the plant produces numerous single-seeded horned nuts armed with sharp ½" barbs. After maturation, these nuts fall off the plant and over winter, producing 10-15 new rosettes the following season. These nuts can inflict painful wounds to swimmers if stepped on. Studies have shown a water chestnut can lie dormant on a lake bottom for up to 12 years, and still germinate. Water chestnut is a poor source of food for waterfowl. High densities of water chestnut can inhibit boating and fishing.

Water Pennywort (*Hydrocotyle sp.*)



Water Pennywort: Water pennywort varies in appearance depending on the species, but most possess the same general characteristics. The leaves are circular, umbrella-shaped, and about the size of a half-dollar coin. The leaves are shiny green and leathery in texture with long leaf stalks attached to the center. The color of pennywort flowers can be white, green, or yellow. Fruit are typically egg-shaped with a flattened appearance. Pennywort can become a nuisance as they can form dense mats in lakes, pond, rivers, or marshes. The seeds of pennywort provide food for some waterfowl and the plants themselves provide habitat for aquatic biota. Several species of water pennywort, including native and invasive, are common throughout the United States, especially in Florida.

Water Stargrass (*Zosterella dubia*)

Water Stargrass Native: Water stargrass has slender free-branched stems that originate from rhizomes. The leaves are narrow and alternate, attaching directly to the stem. Leaves can be up to 15 cm long, and lack a prominent midvein, a distinguishing characteristic. Water stargrass can inhabit a wide range of water depths and sediment types, and can tolerate reduced clarity environments. Yellow star-shaped flowers are produced by midsummer, but reproduction is usually via over wintering rhizomes. Water stargrass is a locally important waterfowl food source, and provides suitable cover and foraging for fish.

Water-thread Pondweed (*Potamogeton diversifolius*)

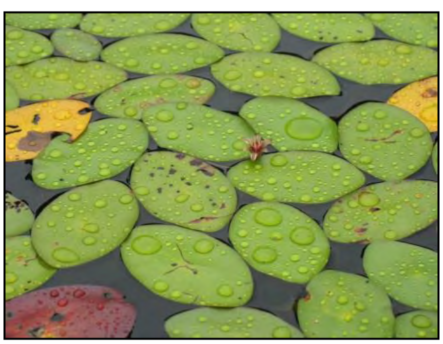
Variable-leaf Pondweed, Snailseed Pondweed

Water-thread Pondweed **Native** (*Potamogeton diversifolius*. Common Names: Water-thread pondweed, variable-leaf pondweed, snailseed pondweed.): Variable-leaf pondweed have freely-branched stems emerging from slender rhizomes. The submersed leaves are narrow and linear with one obvious midvein bordered by a row of hollow cells. The floating leaves are shaped like an ellipse, but are usually less than 4 cm long, Variable-leaf pondweed fruit spikes are produced in two distinct forms. It occurs in lakes, ponds, rivers and streams and prefers soft sediment and water less than 2 meters deep. Waterfowl graze on the fruit, and local fauna often graze on the stems and leaves.

Water Moss (*Fontinalis* sp.)

Water Moss Native: Water mosses are submerged mosses that are attached to rocks, trees, logs, and other hard substrates by false rootlets located at the base of their stems. The stems are dark-green to brown, and about one foot long. The leaves share a similar color as the stems, and are usually ovate with fine-toothed margins. Water moss is utilized by aquatic invertebrates, and as a breeding site for small fish. Water moss rarely reaches nuisance levels.

Watershield (*Brasenia schreberi*)



Watershield Native: Watershield is a floating-leaf aquatic plant similar to water lilies. Its stem and leaves are elastic, and are attached to a rooted rhizome that acts as an anchor and source of stored nutrients. The leaf stalks are attached to the middle of the leaf, creating a bull's eye effect, hence its name water target. The leaves are green on the upper surface, and purple underneath. Maroon to purple flowers peak above the water's surface on short, stout stalks. Watershield is usually coated with a clear gelatinous slime on the stem and underside of the leaves. Watershield prefers soft-water lakes and ponds in sediments containing decomposing organic matter. The whole plant is consumed by waterfowl, and the floating leaves provide shade and cover for fish.

White Water Lily (*Nymphaea* odorata)

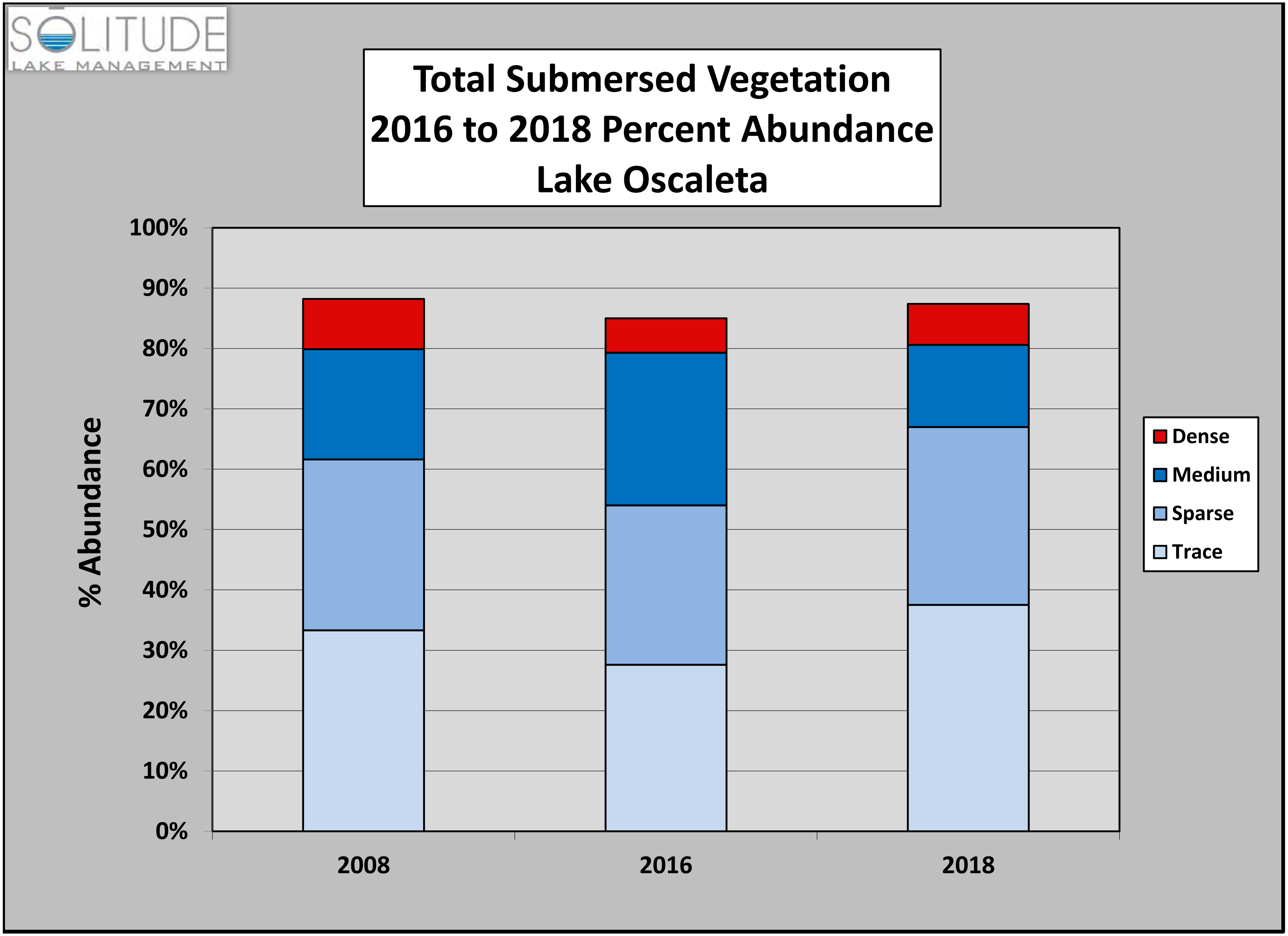
Fragrant Water Lily

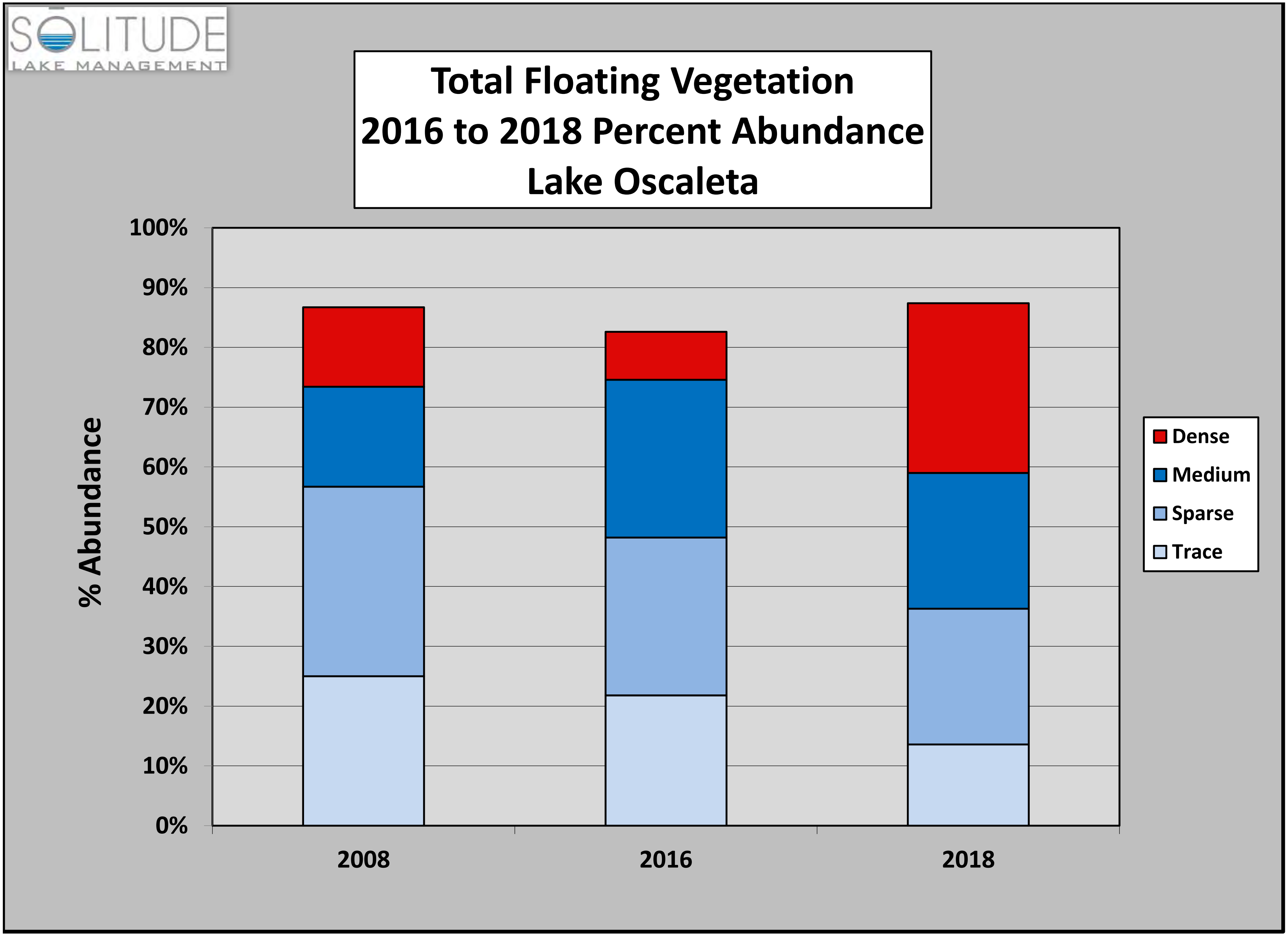
White Water Lily Native: White water lily leaf stalks emerge directly from a submerged fleshy rhizome. White water lilies have round floating leaves. Flowering occurs during the summer, and the flowers open during the day, and close during the night. Water lilies typically inhabit quiet water less than two meters deep, such as ponds, shallow lakes and slow-moving streams. The leaves offer shade and protection for fish, and the leaves, stems, and flowers are grazed upon by muskrats, beaver, and sometimes even deer.

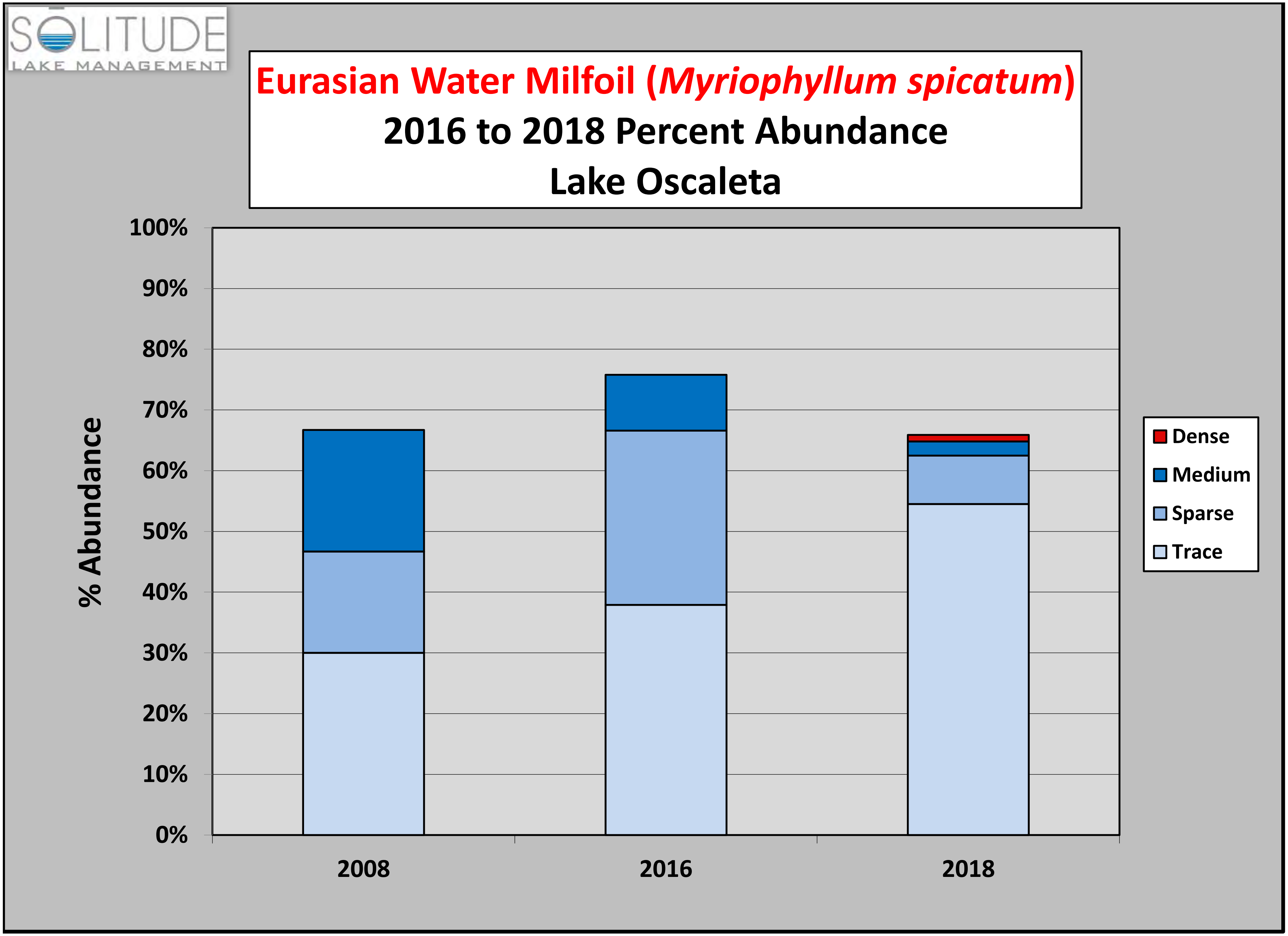
Wild celery (*Vallisneria Americana*)

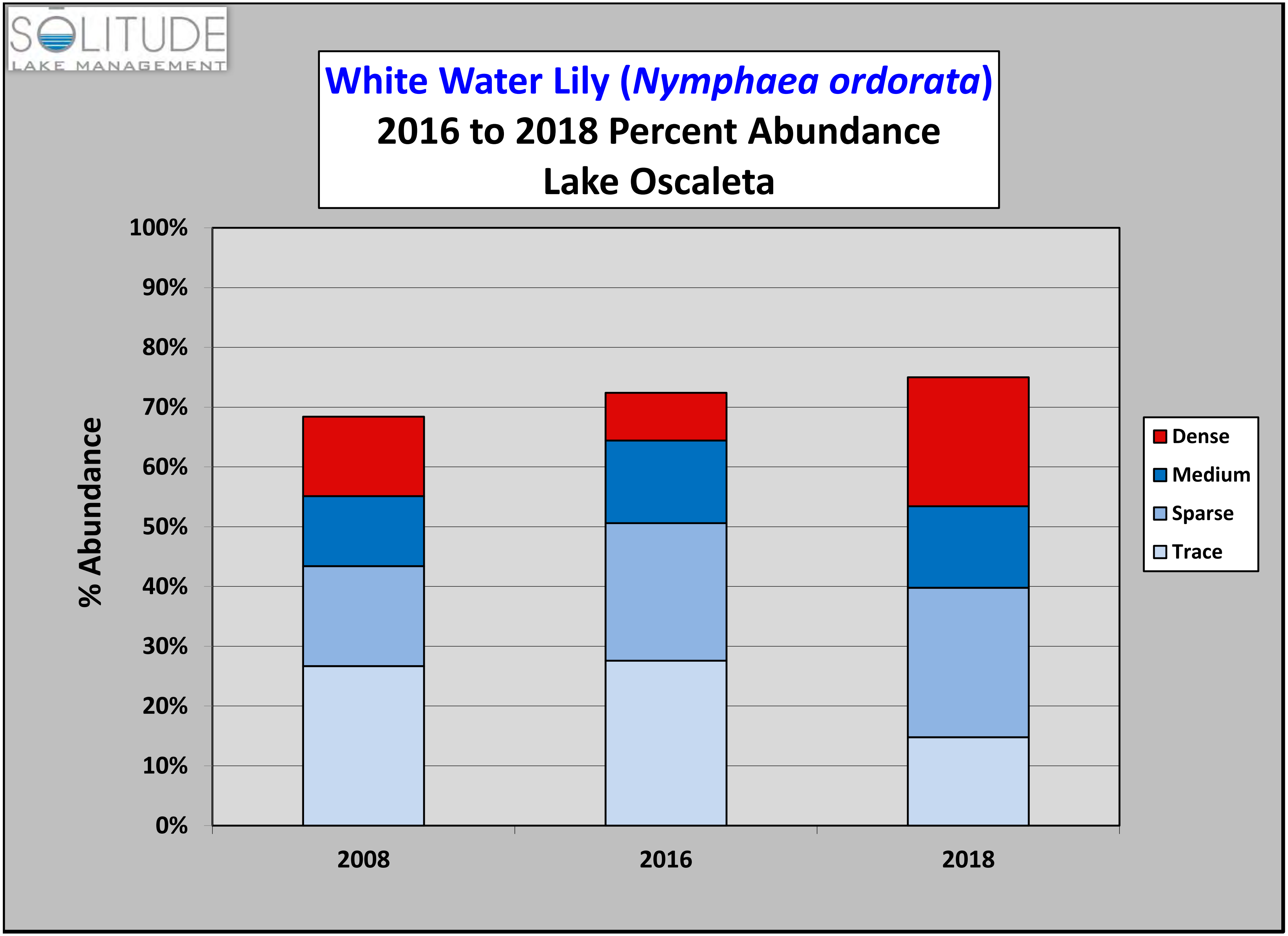
Eel-grass, Tape-grass

Tape-grass (*Vallisneria americana*. Common Names: Wild celery, eel-grass, tape-grass. **Native**.): Tape-grass has long flowing ribbon-like leaves that have a basal arrangement from a creeping rhizome. The leaves can be up to two meters long, have a cellophane-like texture, with a prominent center stripe and finely serrated edges. The leaves are mostly submersed, although they can reach the surface allowing the tips to trail. Male and female flowers are produced on separate plants, but reproduction is usually via over wintering rhizomes and tubers. Tape-grass usually inhabits hard substrate bottoms in shallow to deep water. It can tolerate a wide variety of water chemistries. Tape-grass is the premiere food source for waterfowl, which greedily consume all parts of the plant. Canvasback ducks (*Aythya valisneria*) enjoy a strong relationship with tape-grass, going so far to alter their migration routes based on tape-grass abundance. Extensive beds of tape-grass are considered good shade, habitat and feeding opportunities for fish.

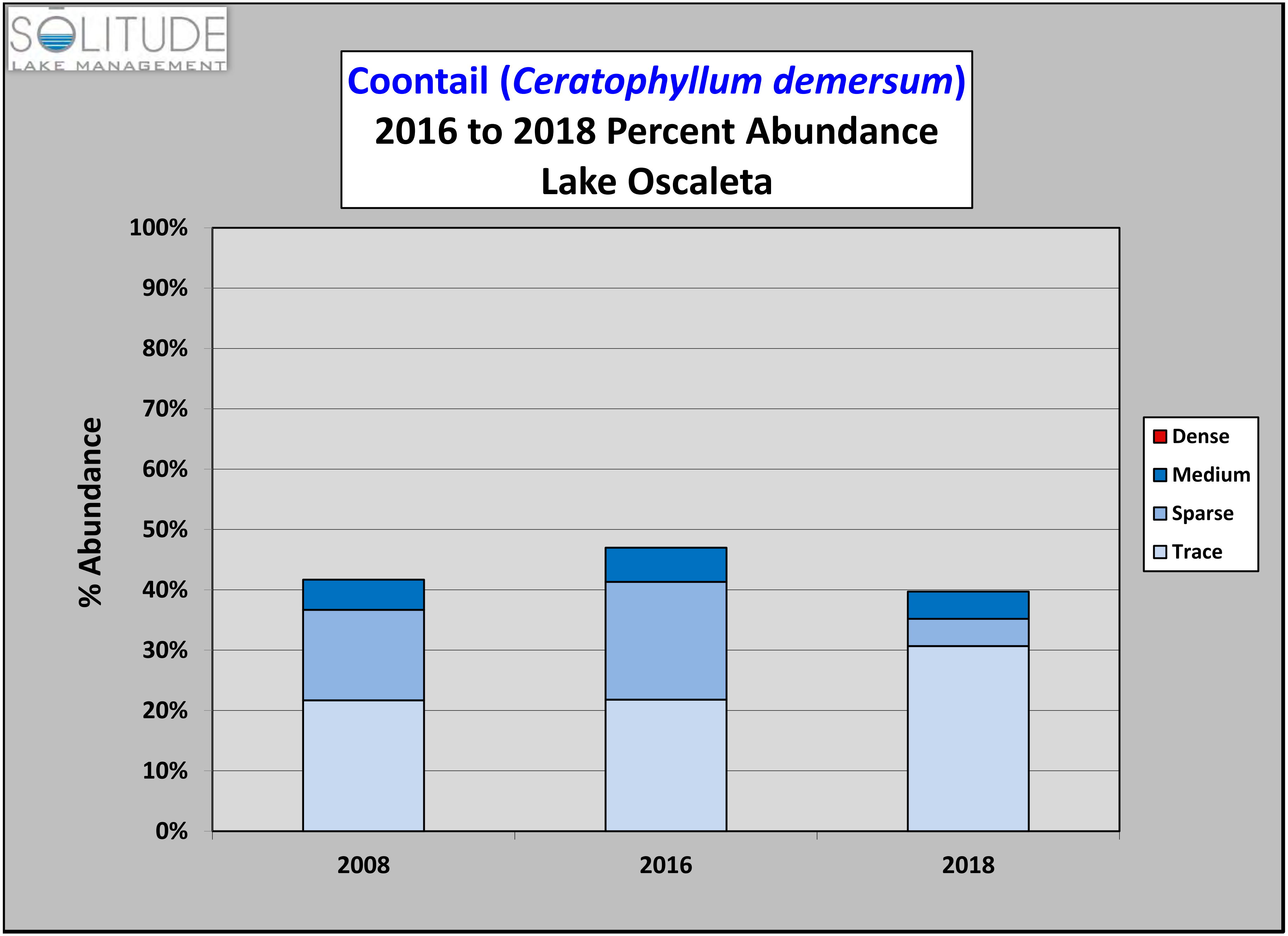

SOLITUDE
LAKE MANAGEMENT
Total Submersed Vegetation
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


SOLITUDE
LAKE MANAGEMENT
Total Floating Vegetation
2016 to 2018 Percent Abundance
Lake Oscaleta
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Abundance
2008
2016
2018
Dense
Medium
Sparse
Trace

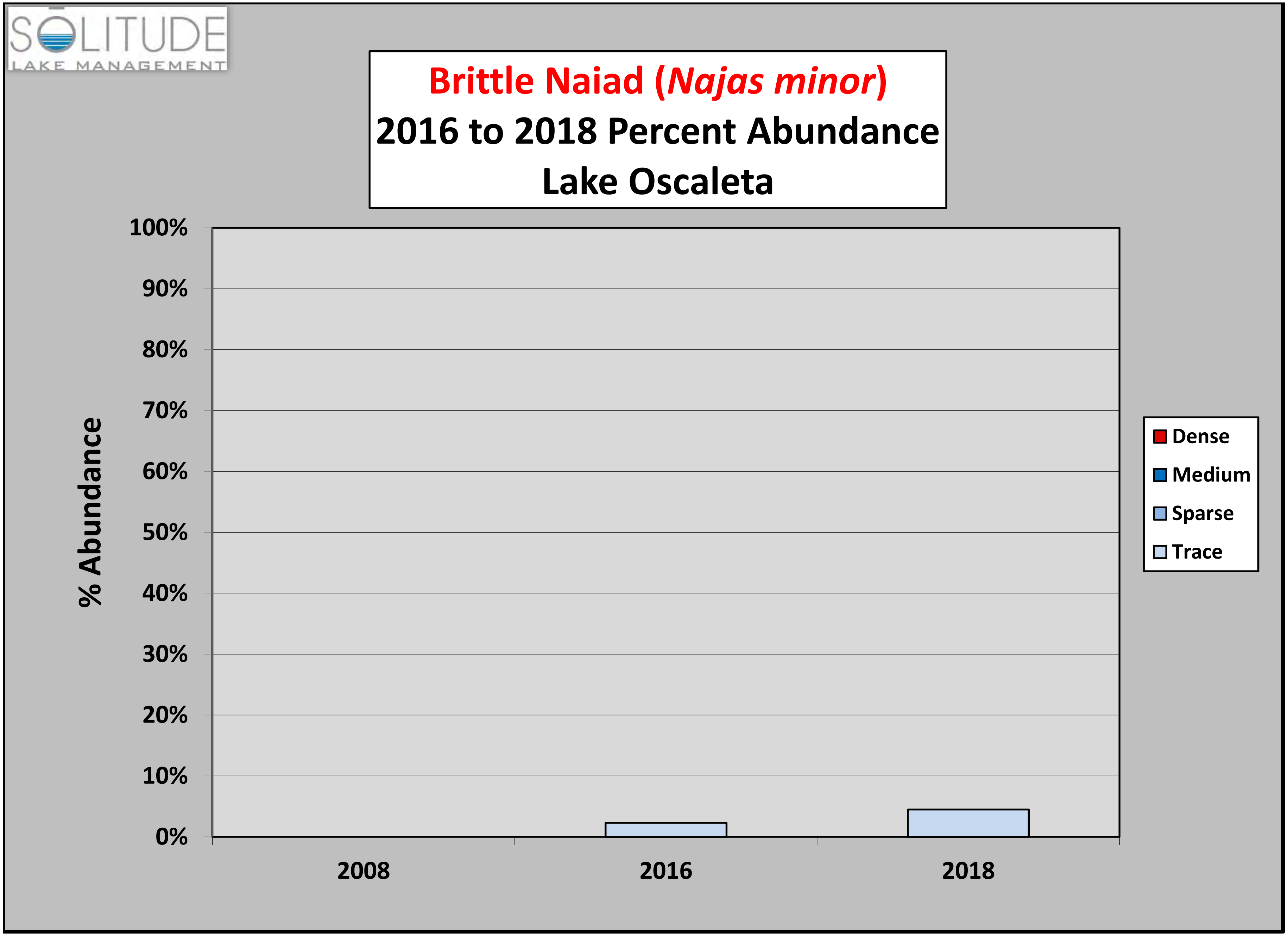

SOLITUDE
LAKE MANAGEMENT
Eurasian Water Milfoil (Myriophyllum spicatum)
2016 to 2018 Percent Abundance
Lake Oscaleta
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Abundance
2008
2016
2018
Dense
Medium
Sparse
Trace



SOLITUDE
LAKE MANAGEMENT
White Water Lily (Nymphaea ordorata)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

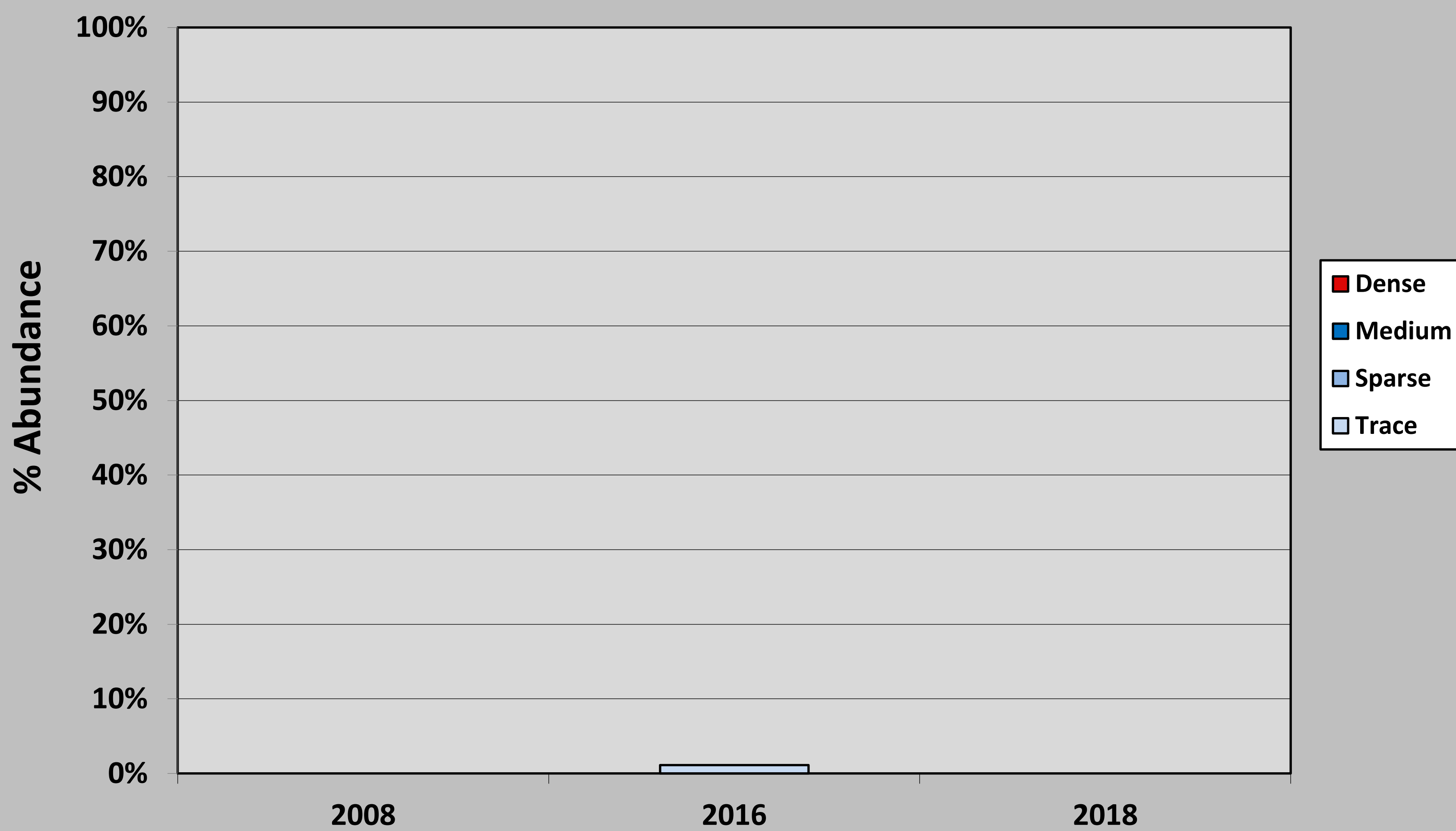


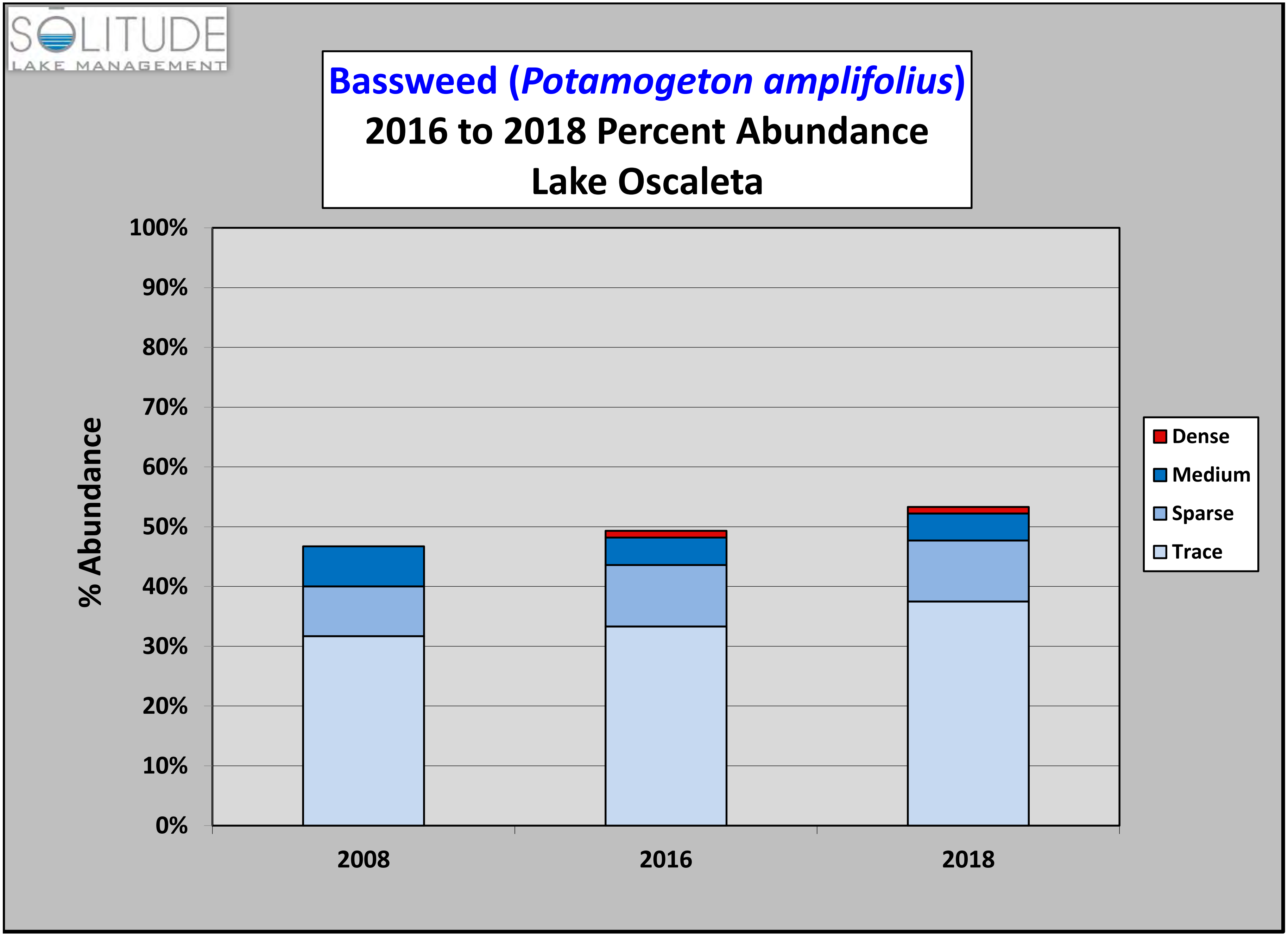
SOLITUDE
LAKE MANAGEMENT
Coontail (Ceratophyllum demersum)
2016 to 2018 Percent Abundance
Lake Oscaleta
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Abundance
2008
2016
2018
Dense
Medium
Sparse
Trace

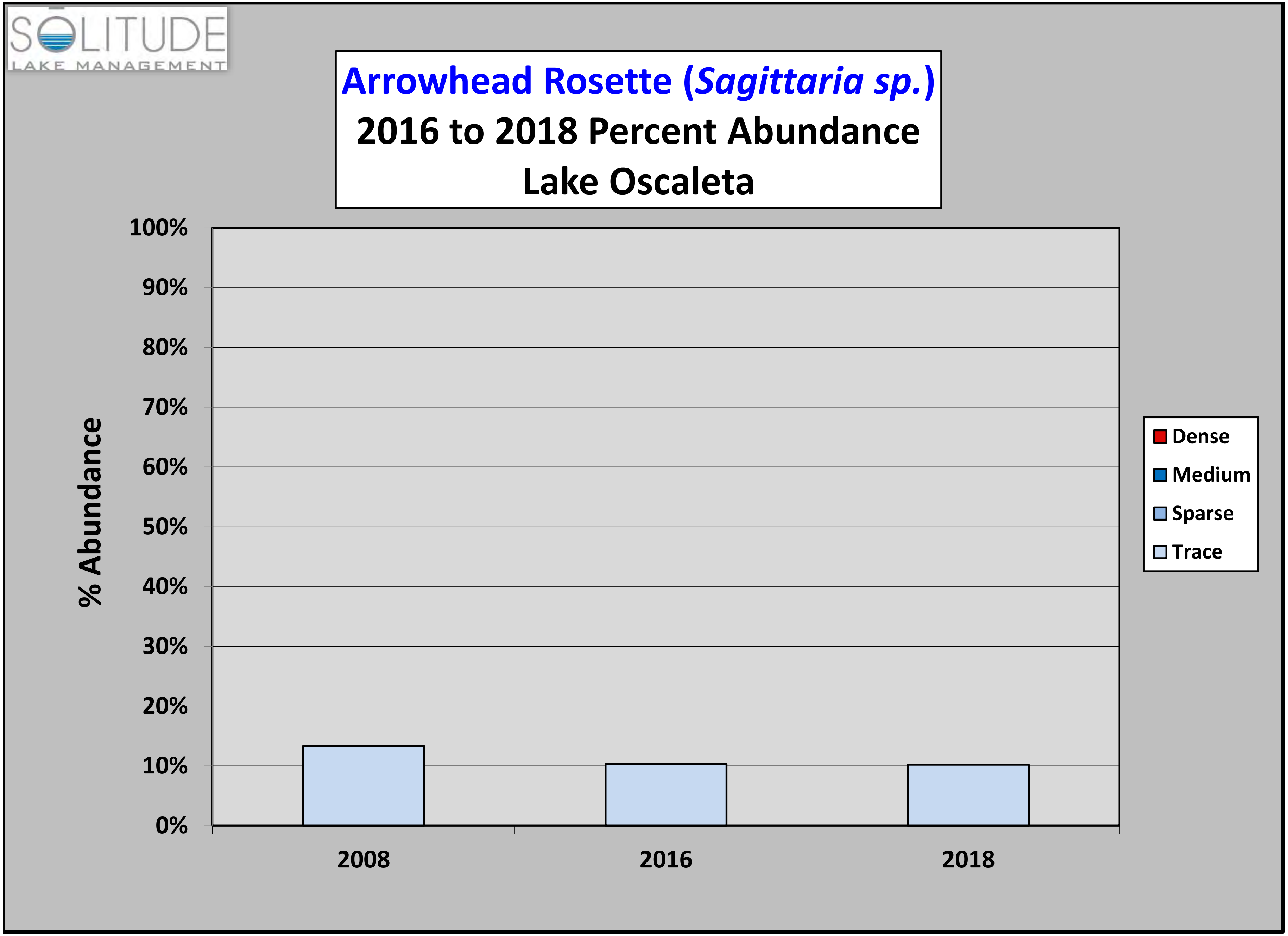


Brittle Naiad (*Najas minor*)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

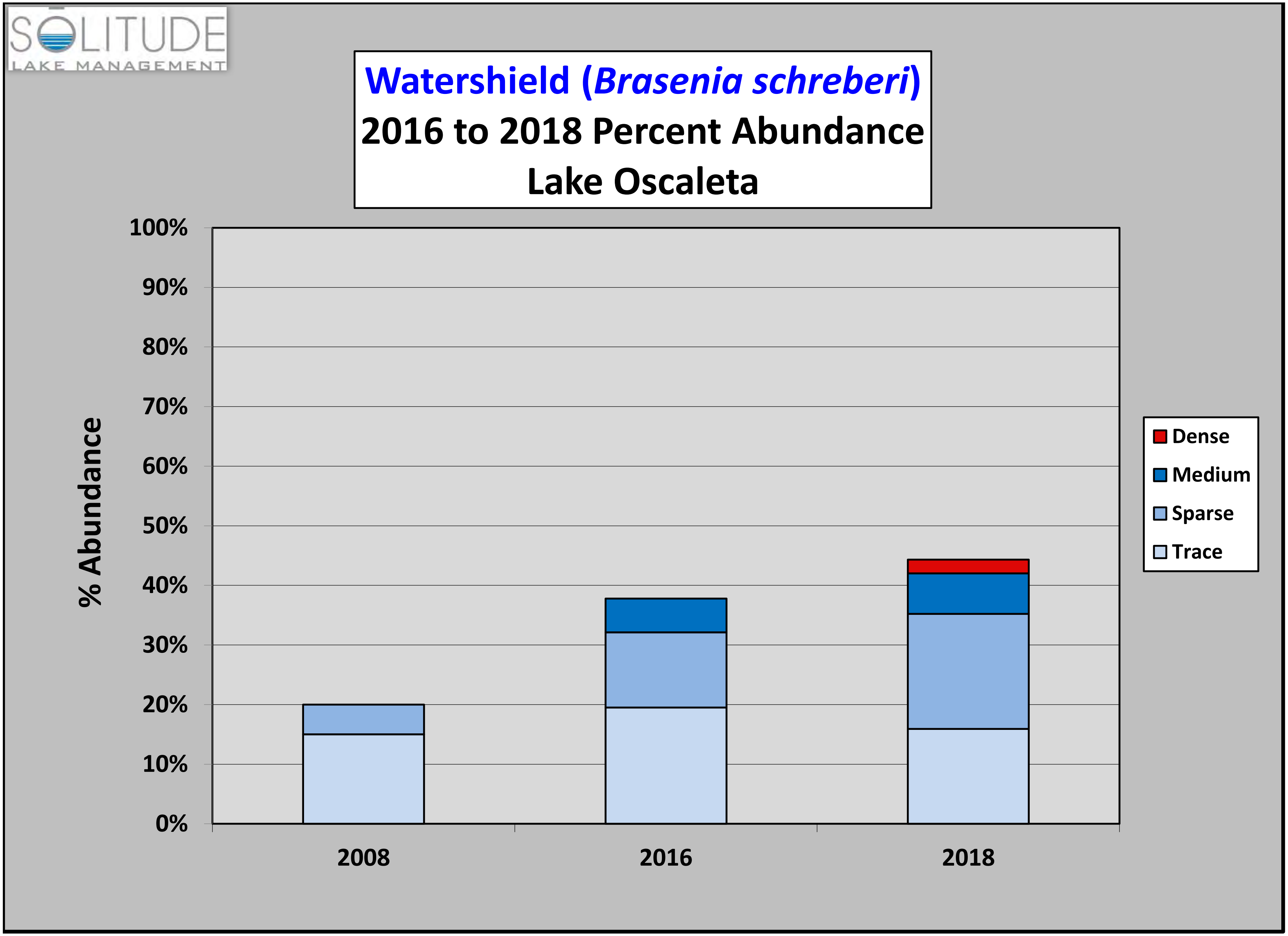
Water-thread Pondweed (*Potamogeton diversifolius*)
2016 to 2018 Percent Abundance
Lake Oscaleta

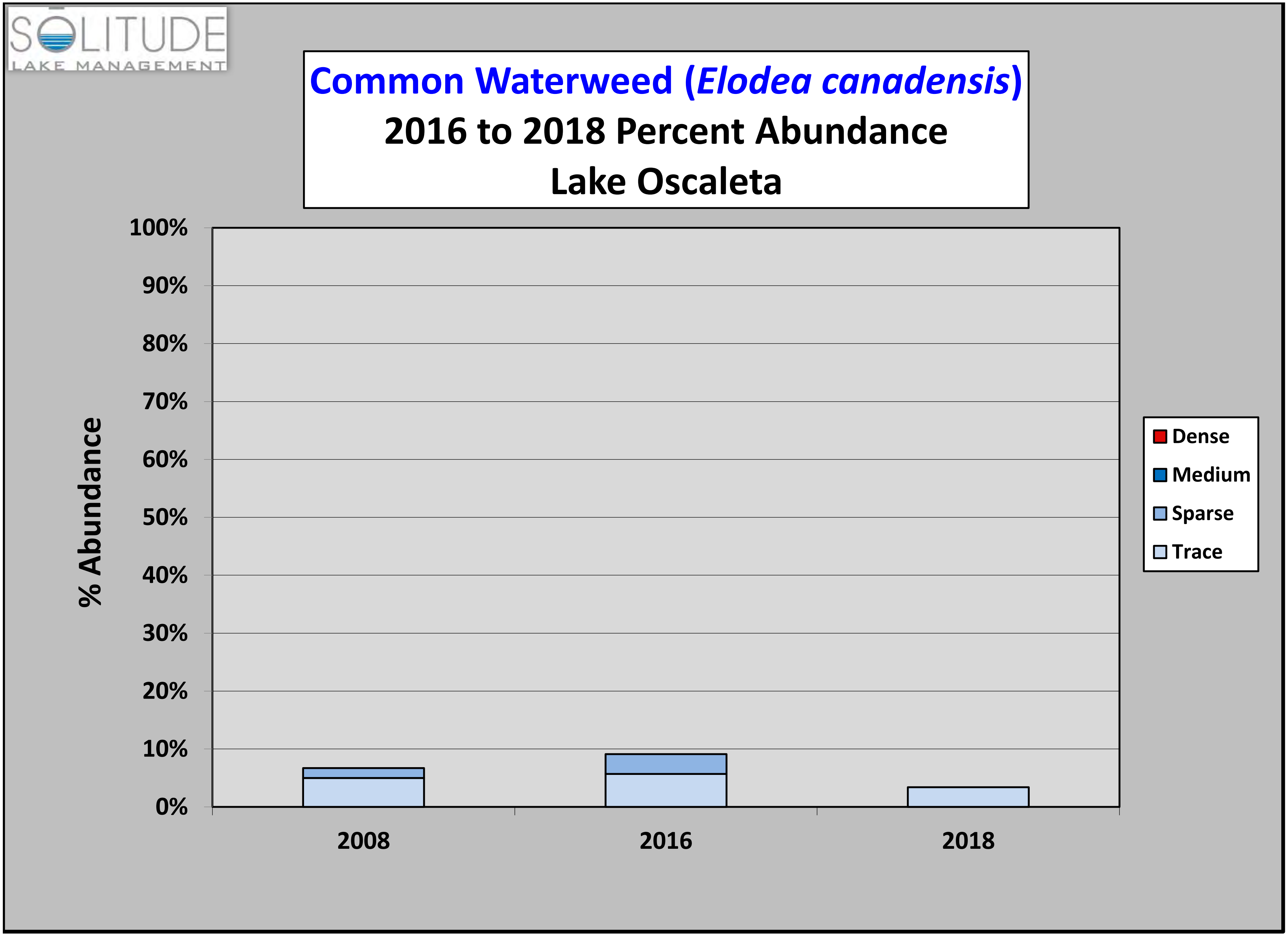



SOLITUDE
LAKE MANAGEMENT
Bassweed (Potamogeton amplifolius)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

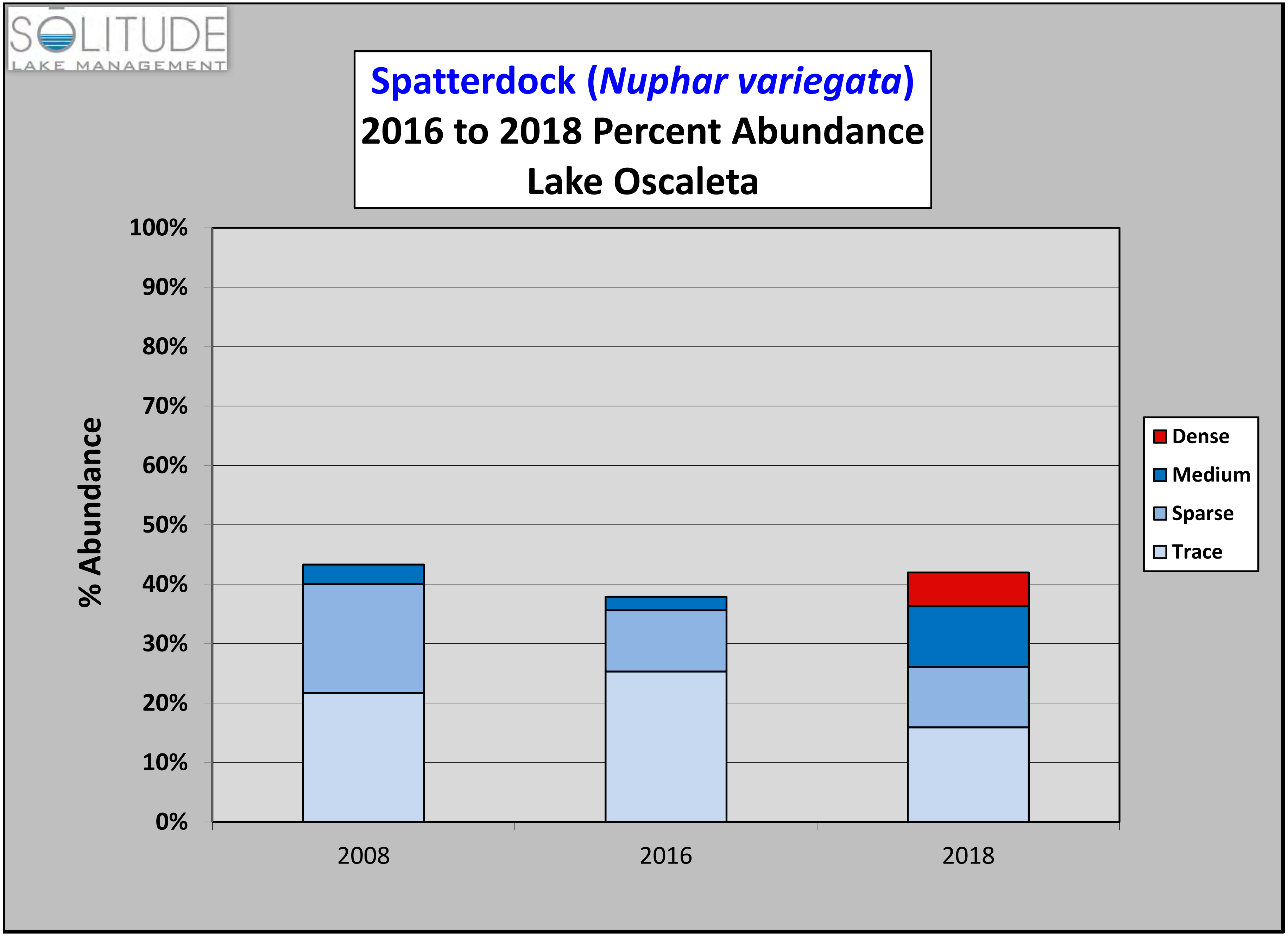


SOLITUDE
LAKE MANAGEMENT
Arrowhead Rosette (Sagittaria sp.)
2016 to 2018 Percent Abundance
Lake Oscaleta
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Abundance
2008
2016
2018
Dense
Medium
Sparse
Trace

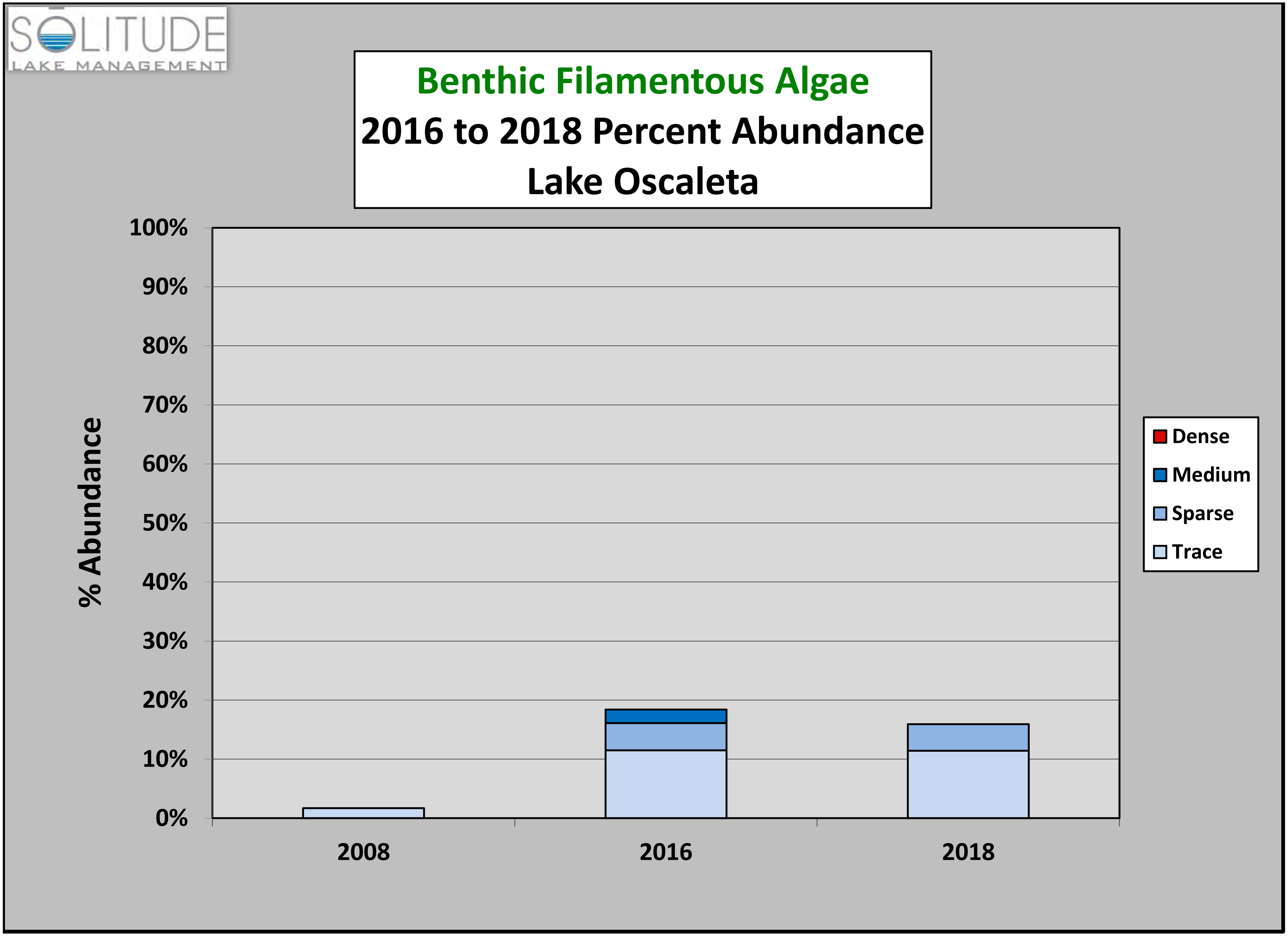

SOLITUDE
LAKE MANAGEMENT
Watershield (Brasenia schreberi)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace



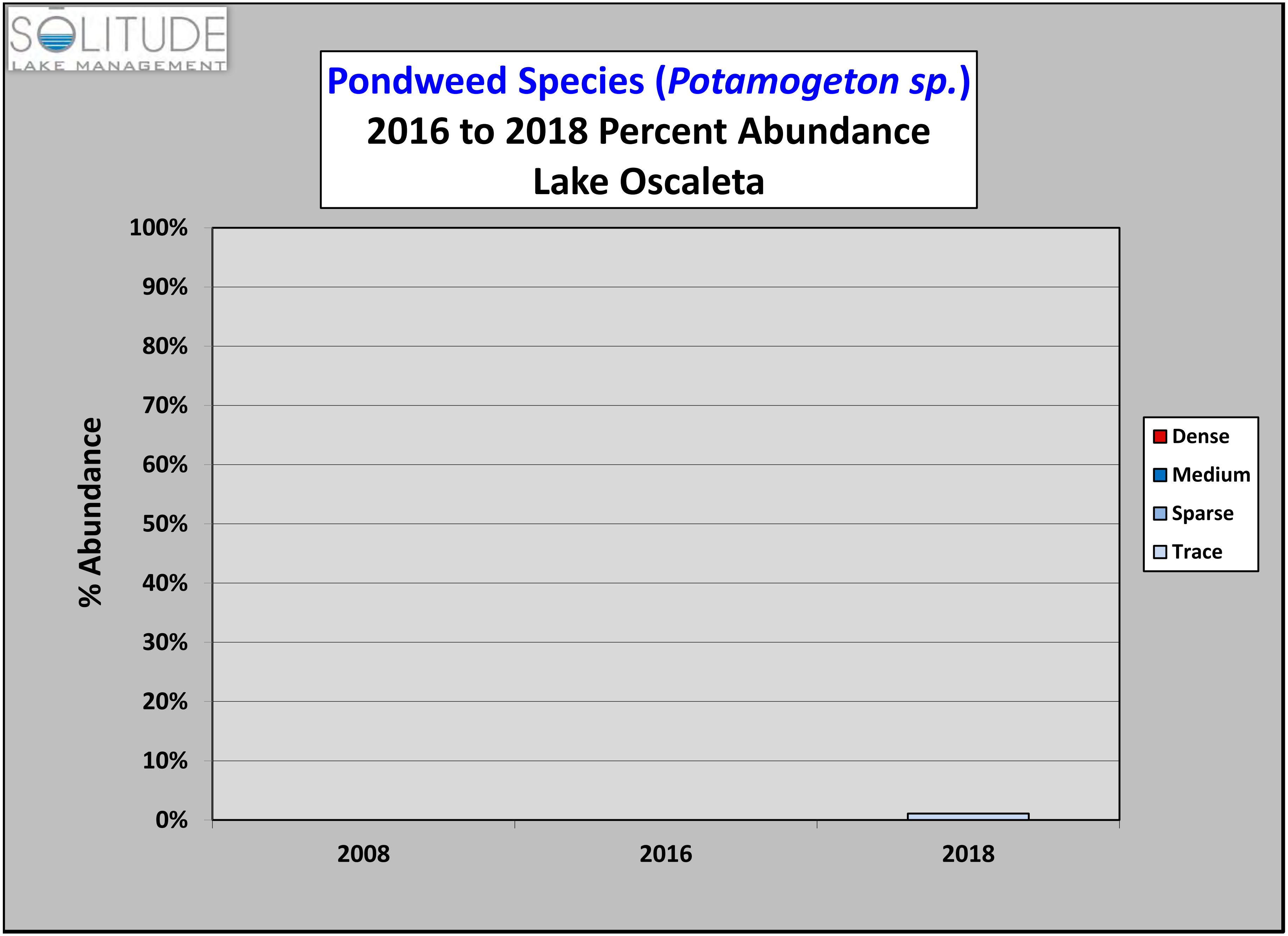
Common Waterweed (*Elodea canadensis*)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace



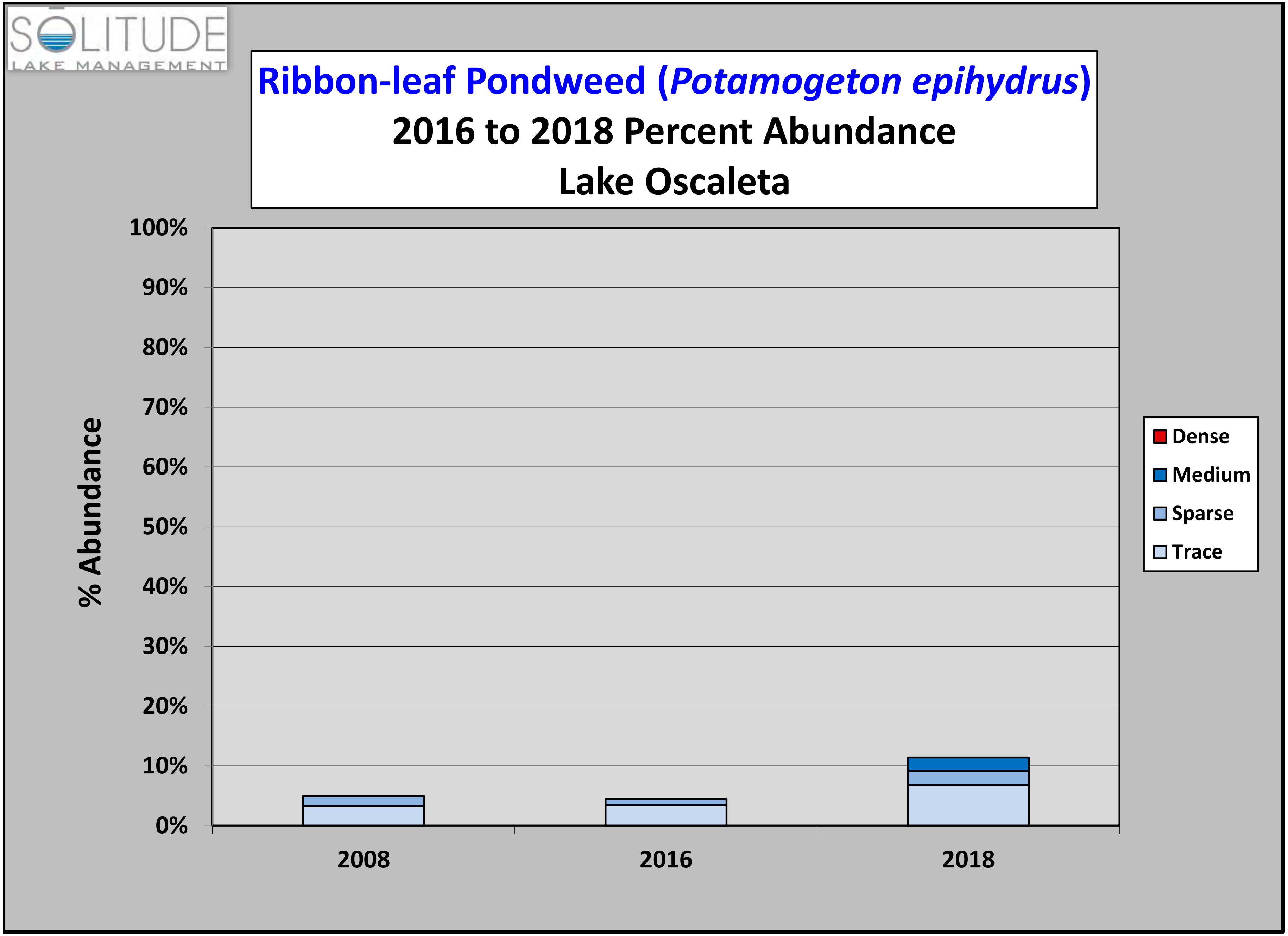
SOLITUDE
LAKE MANAGEMENT
Spatterdock (Nuphar variegata)
2016 to 2018 Percent Abundance
Lake Oscaleta
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Abundance
2008
2016
2018
Dense
Medium
Sparse
Trace

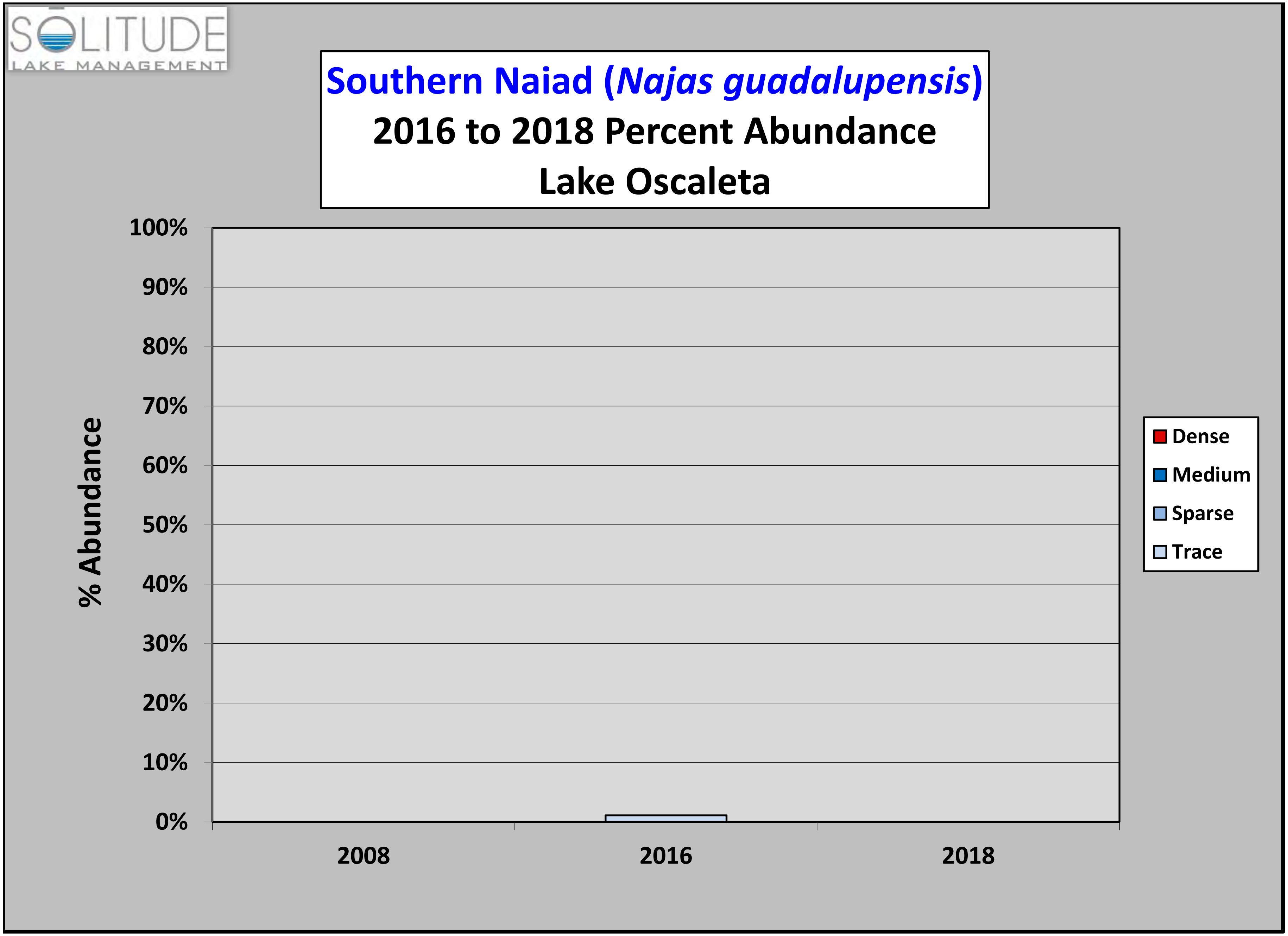


SOLITUDE
LAKE MANAGEMENT
Benthic Filamentous Algae
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

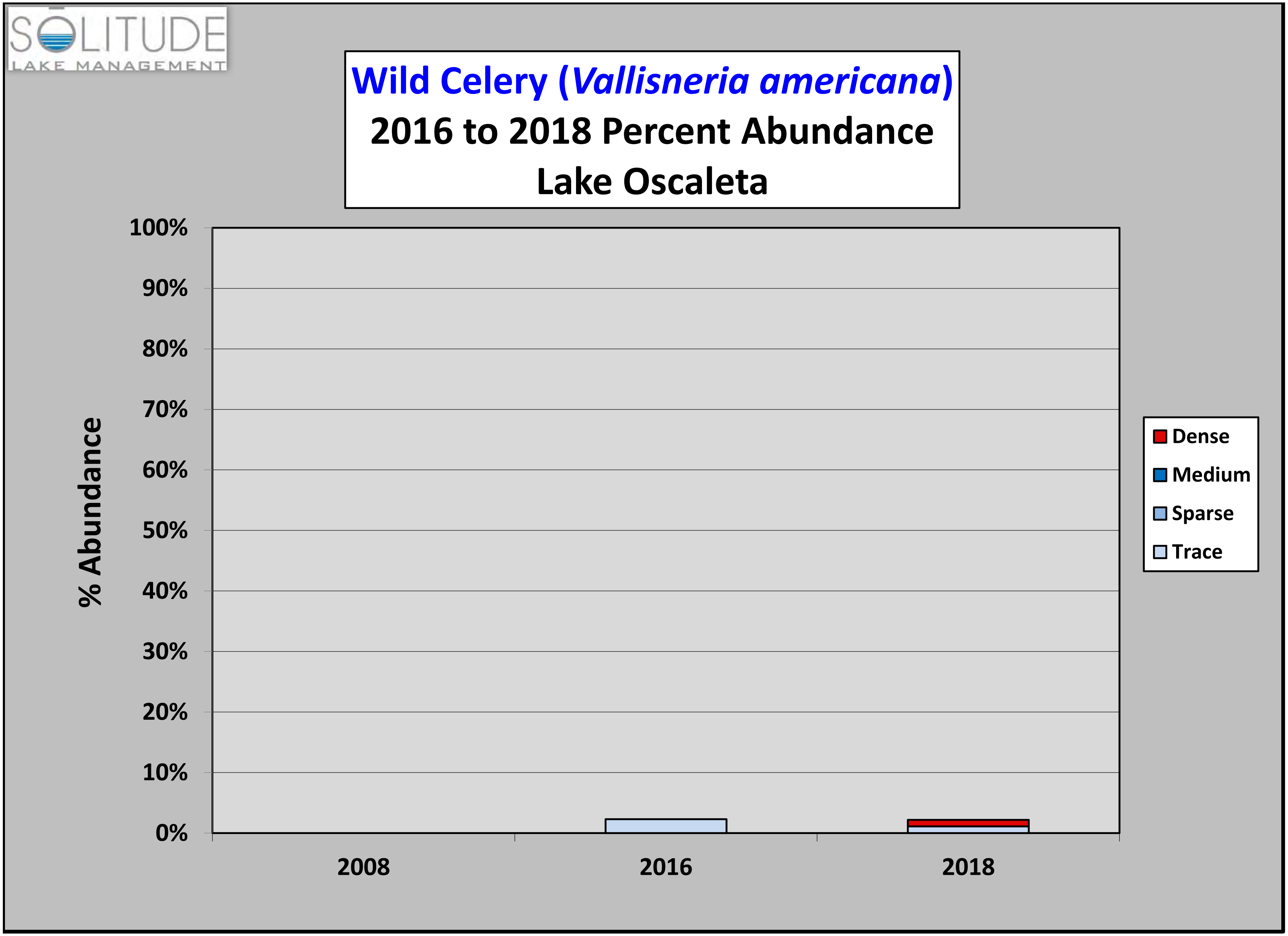


Pondweed Species (Potamogeton sp.)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

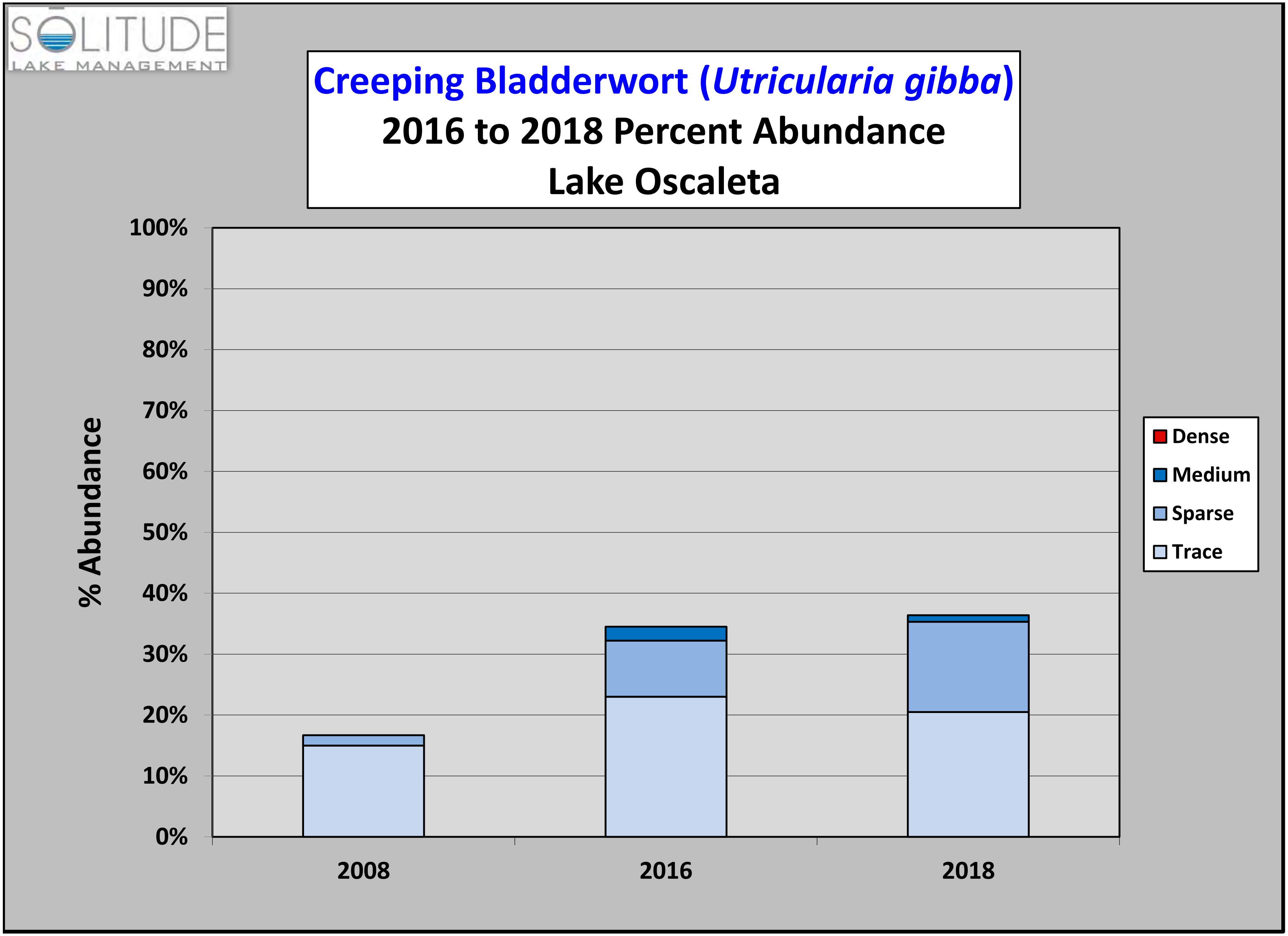

SOLITUDE
LAKE MANAGEMENT
Ribbon-leaf Pondweed (Potamogeton epihydrus)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

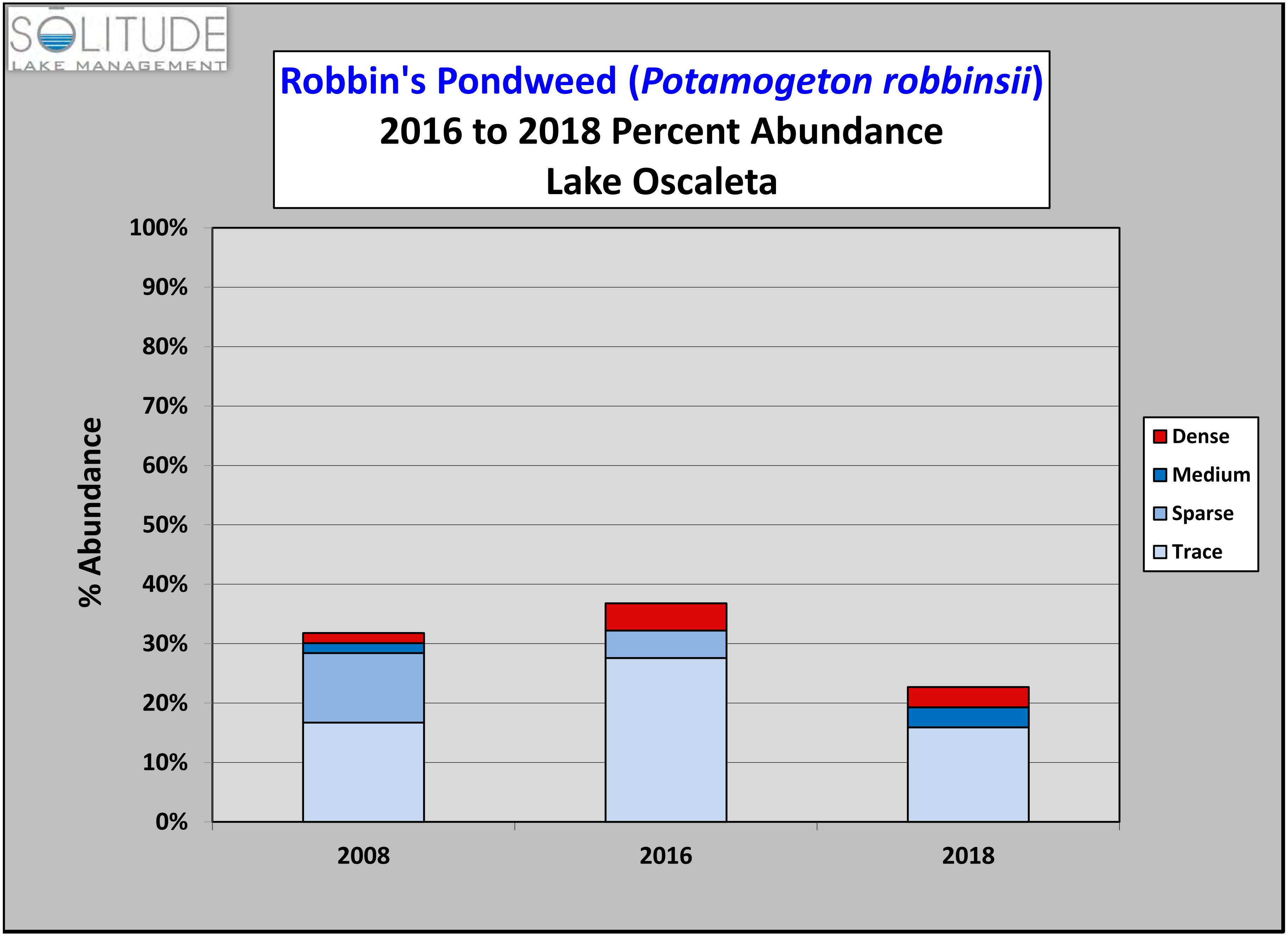


SOLITUDE
LAKE MANAGEMENT
Southern Naiad (Najas guadalupensis)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

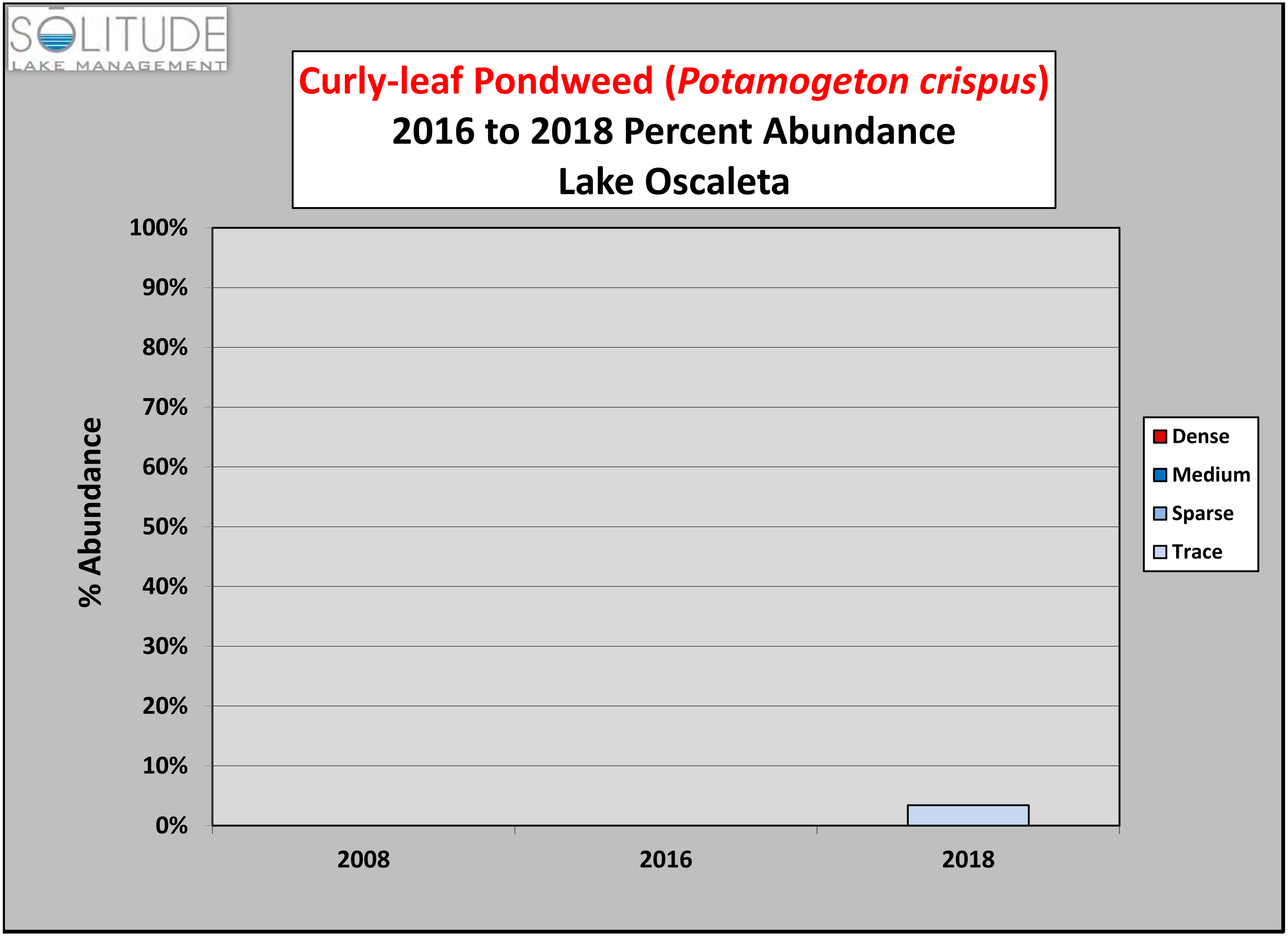


SOLITUDE
LAKE MANAGEMENT
Wild Celery (*Vallisneria americana*)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

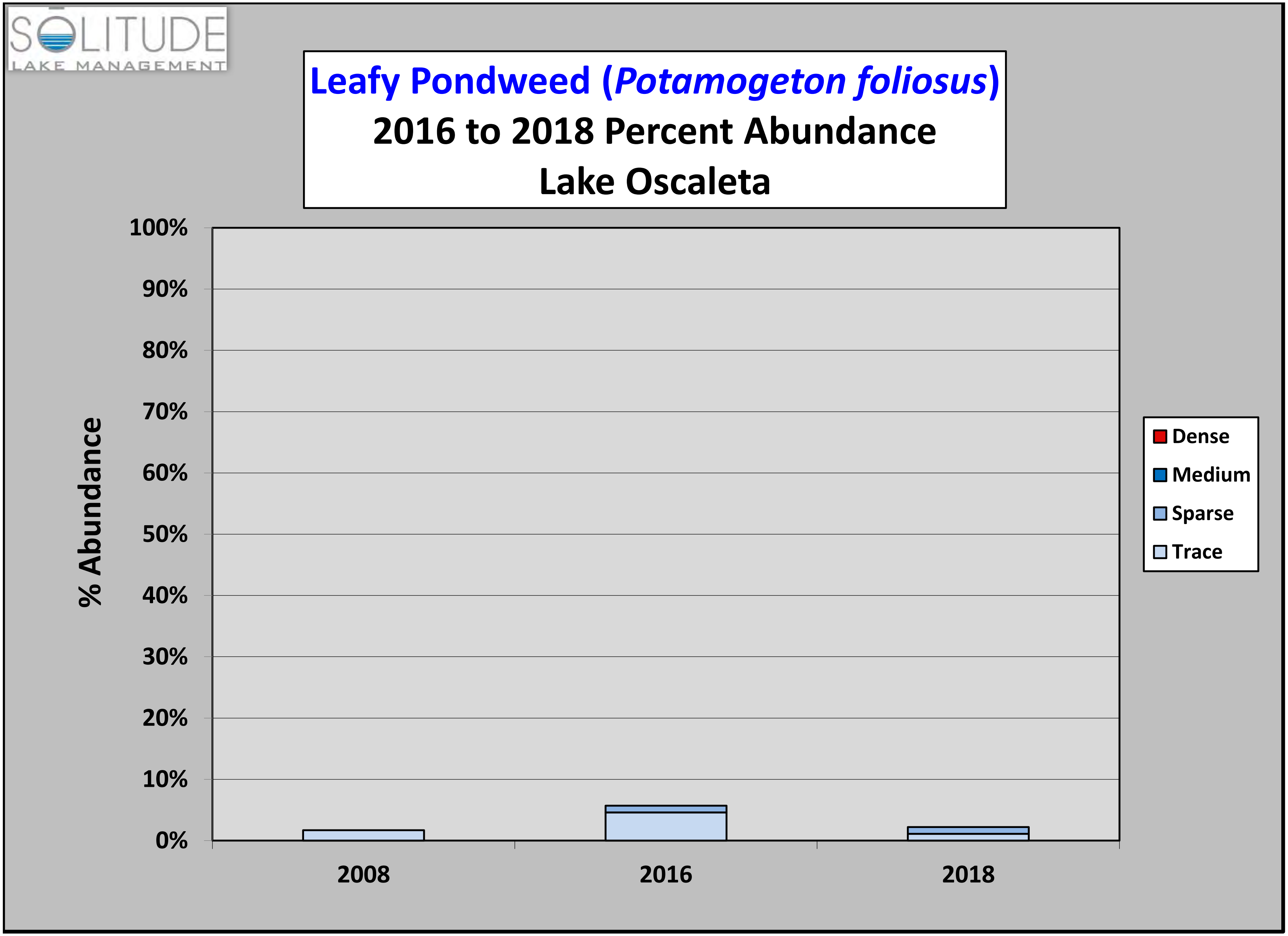

SOLITUDE
LAKE MANAGEMENT
Creeping Bladderwort (Utricularia gibba)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace



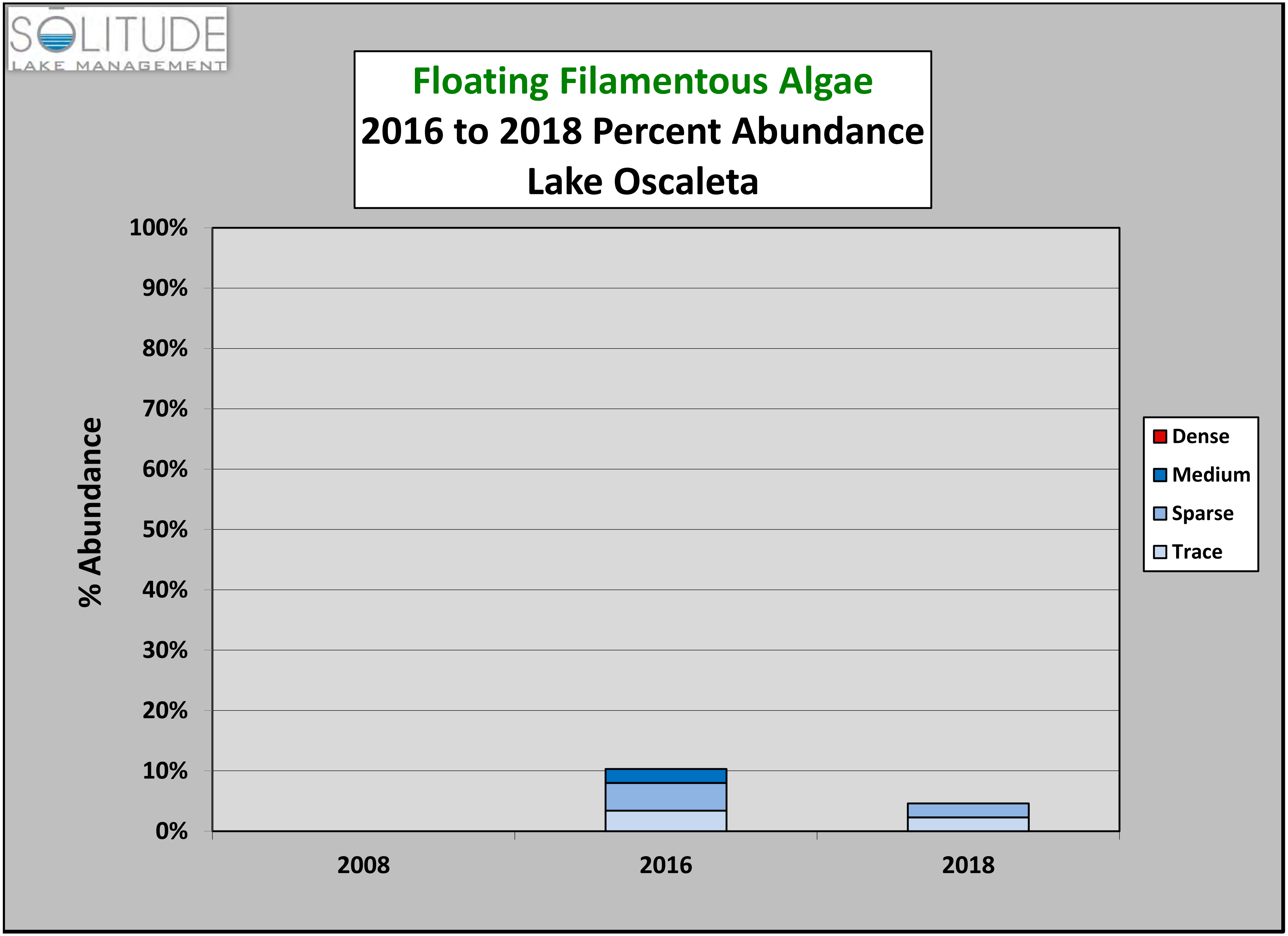
SOLITUDE
LAKE MANAGEMENT
Robbin's Pondweed (Potamogeton robbinsii)
2016 to 2018 Percent Abundance
Lake Oscaleta
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Abundance
2008
2016
2018
Dense
Medium
Sparse
Trace

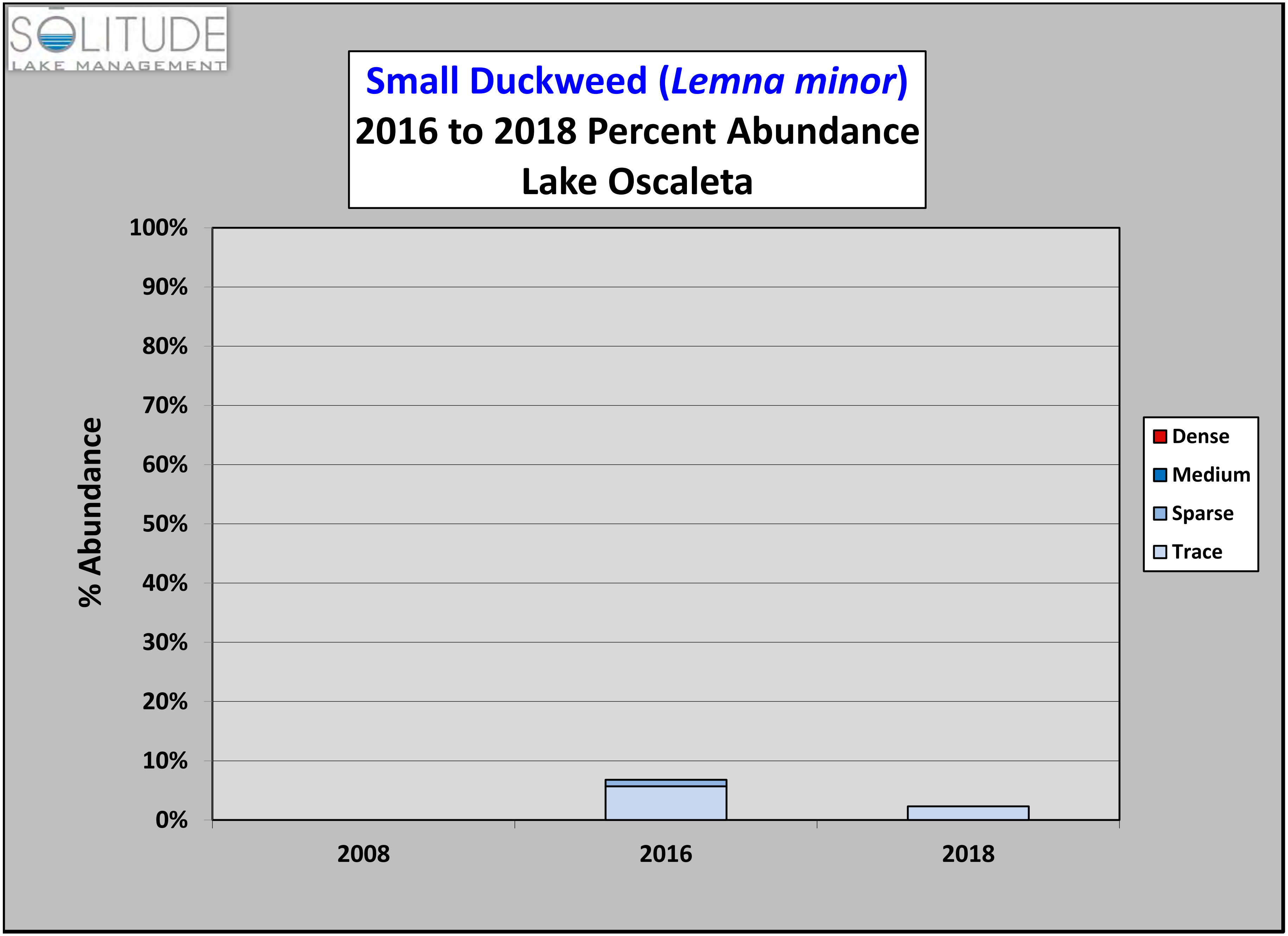


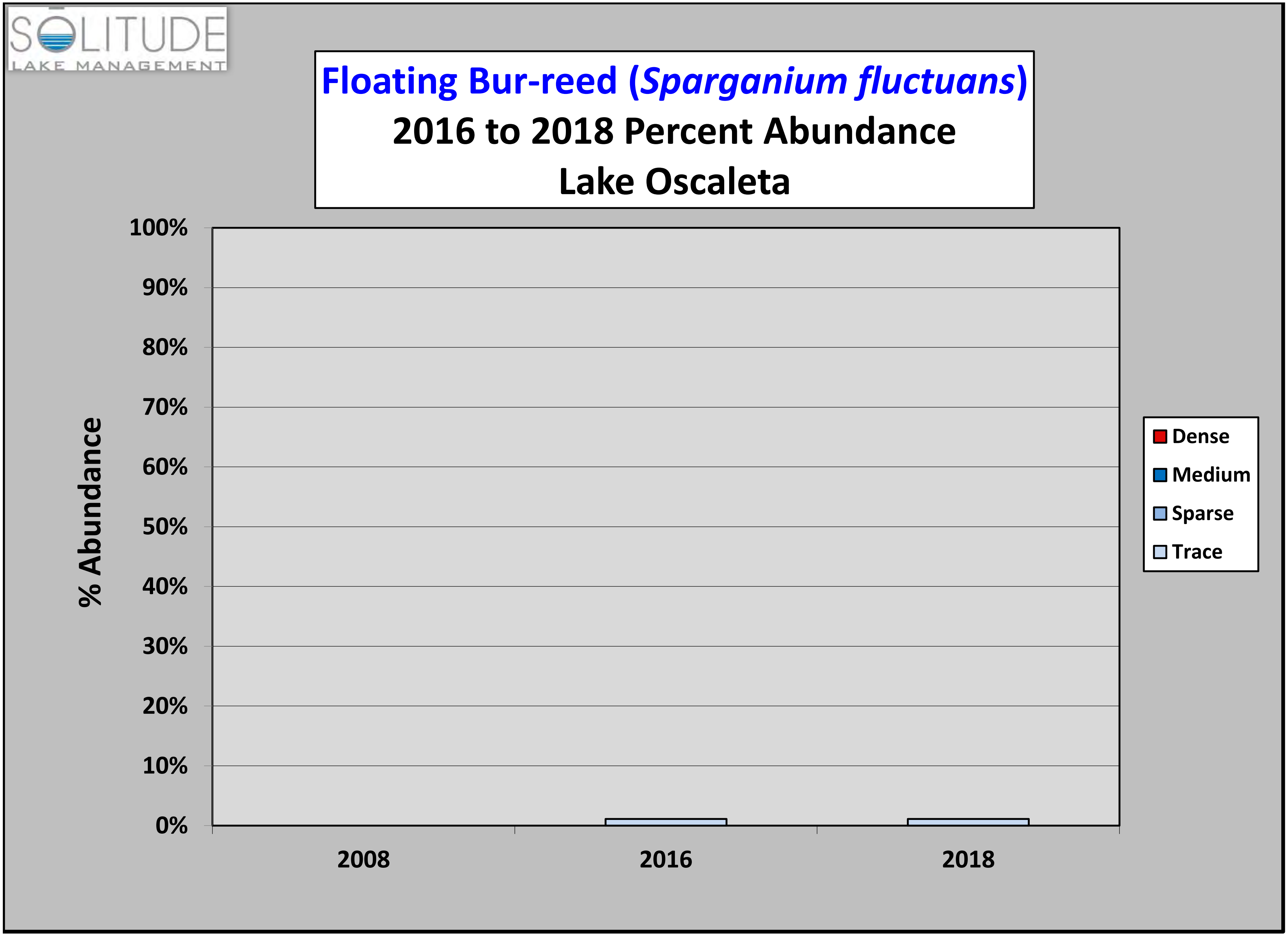
SOLITUDE
LAKE MANAGEMENT
Curly-leaf Pondweed (*Potamogeton crispus*)
2016 to 2018 Percent Abundance
Lake Oscaleta
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Abundance
2008
2016
2018
Dense
Medium
Sparse
Trace

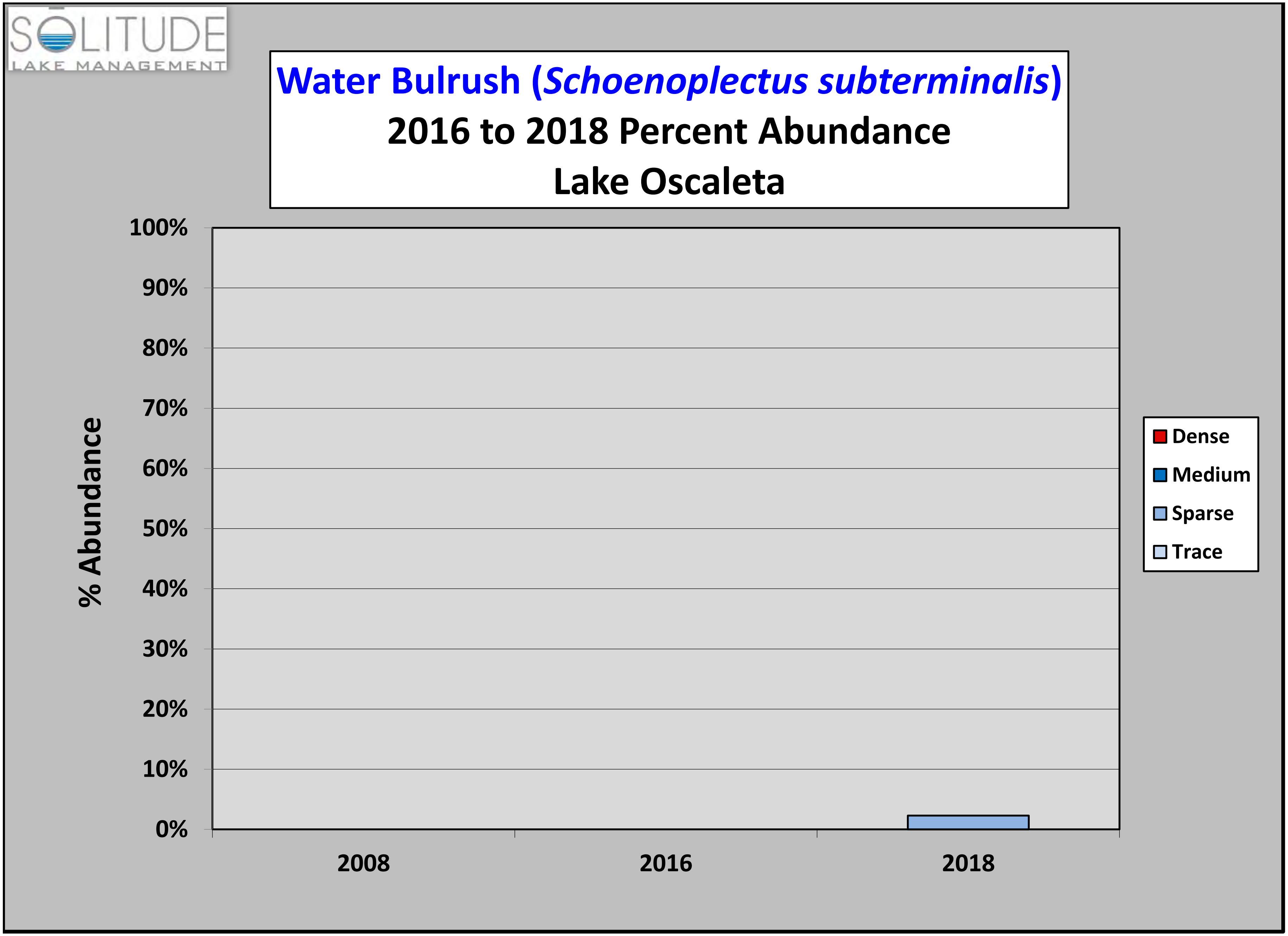


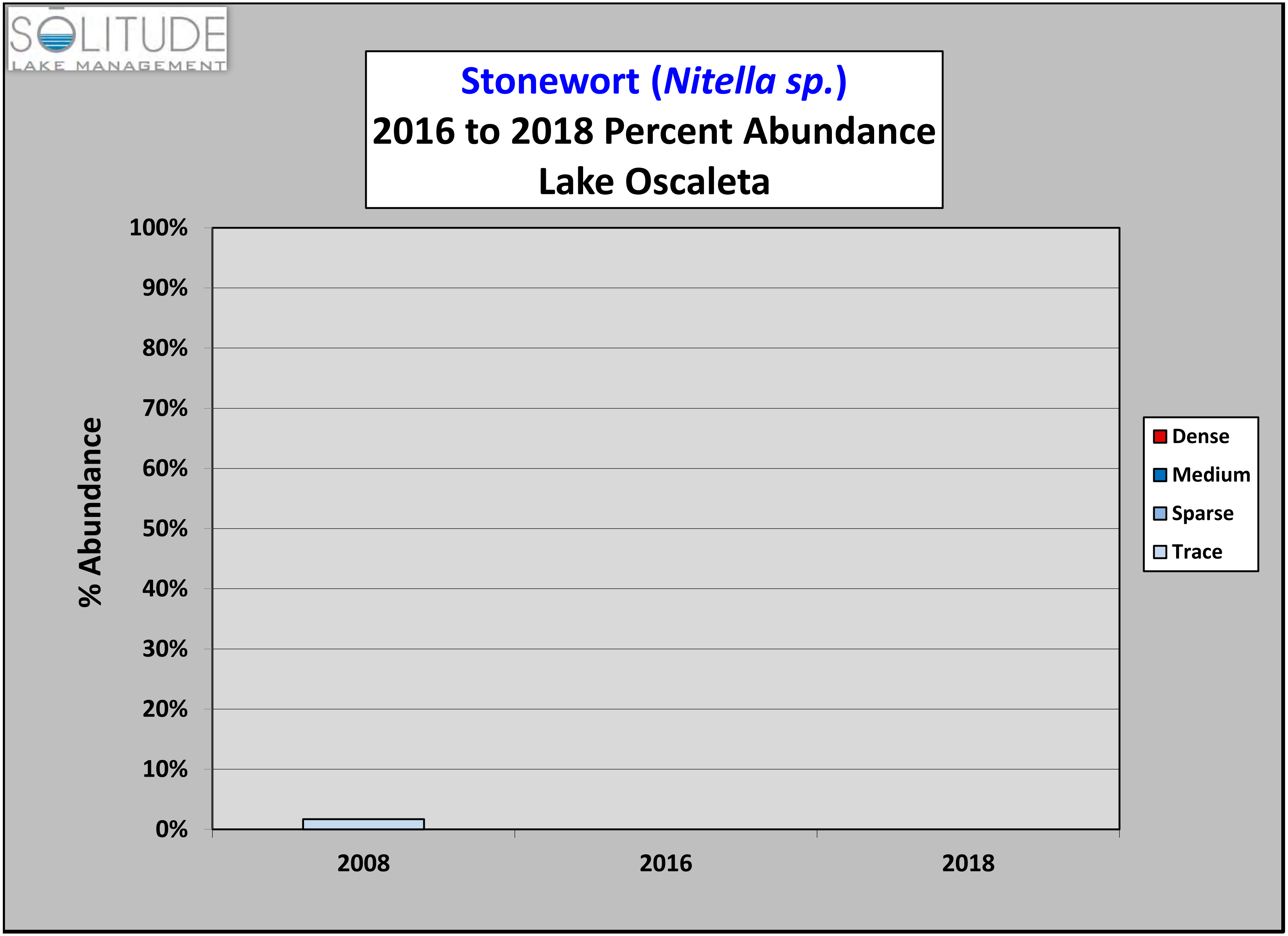
Leafy Pondweed (Potamogeton foliosus)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


SOLITUDE LAKE MANAGEMENT
Floating Filamentous Algae
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


Small Duckweed (*Lemna minor*)
2016 to 2018 Percent Abundance
Lake Oscaleta
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Abundance
2008
2016
2018
Dense
Medium
Sparse
Trace


SOLITUDE
LAKE MANAGEMENT
Floating Bur-reed (Sparganium fluctuans)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


SOLITUDE
LAKE MANAGEMENT
Water Bulrush (*Schoenoplectus subterminalis*)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


Stonewort (Nitella sp.)
2016 to 2018 Percent Abundance
Lake Oscaleta
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

Floating Aquatic Plant Density

Trace

Medium

Sparse

Dense

SŌLITUDE
LAKE MANAGEMENT

Submersed Aquatic Plant Density

Trace

Medium

Sparse

Dense

SOLITUDE
LAKE MANAGEMENT

Lake Oscaleta
Aquatic Macrophyte Abundance Distribution
July 20, 26, & 27, 2018

	Total		Trace		Sparse		Medium		Dense	
	Sites	%	Sites	%	Sites	%	Sites	%	Sites	%
TOTAL SITES	88									
TOTAL SUBMERSED VEGETATION	77	88%	33	43%	26	34%	12	16%	6	8%
EURASIAN WATER MILFOIL	58	66%	48	83%	7	12%	2	3%	1	2%
BASSWEED	47	53%	33	70%	9	19%	4	9%	1	2%
COONTAIL	35	40%	27	77%	4	11%	4	11%	0	0%
CREEPING BLADDERWORT	32	36%	18	56%	13	41%	1	3%	0	0%
ROBBIN'S PONDWEED	20	23%	14	70%	0	0%	3	15%	3	15%
BENTHIC FILAMENTOUS ALGAE	14	16%	10	71%	4	29%	0	0%	0	0%
RIBBON-LEAF PONDWEED	10	11%	6	60%	2	20%	2	20%	0	0%
ARROWHEAD (ROSETTE)	9	10%	9	100%	0	0%	0	0%	0	0%
BRITTLE NAIAD	4	5%	4	100%	0	0%	0	0%	0	0%
COMMON WATERWEED	3	3%	3	100%	0	0%	0	0%	0	0%
CURLY-LEAF PONDWEED	3	3%	3	100%	0	0%	0	0%	0	0%
LEAFY PONDWEED	2	2%	1	50%	1	50%	0	0%	0	0%
WILD CELERY	2	2%	1	50%	0	0%	0	0%	1	50%
PONDWEED SPECIES	1	1%	1	100%	0	0%	0	0%	0	0%
TOTAL FLOATING VEGETATION	77	88%	12	16%	20	26%	20	26%	25	32%
WHITE WATER LILY	66	75%	13	20%	22	33%	12	18%	19	29%
WATERSHIELD	39	44%	14	36%	17	44%	6	15%	2	5%
SPATTERDOCK	37	42%	14	38%	9	24%	9	24%	5	14%
FLOATING FILAMENTOUS ALGAE	4	5%	2	50%	2	50%	0	0%	0	0%
WATER BULRUSH	2	2%	0	0%	2	100%	0	0%	0	0%
SMALL DUCKWEED	2	2%	2	100%	0	0%	0	0%	0	0%
BUR-REED	1	1%	1	100%	0	0%	0	0%	0	0%

Sample Point Location

Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Sample Point

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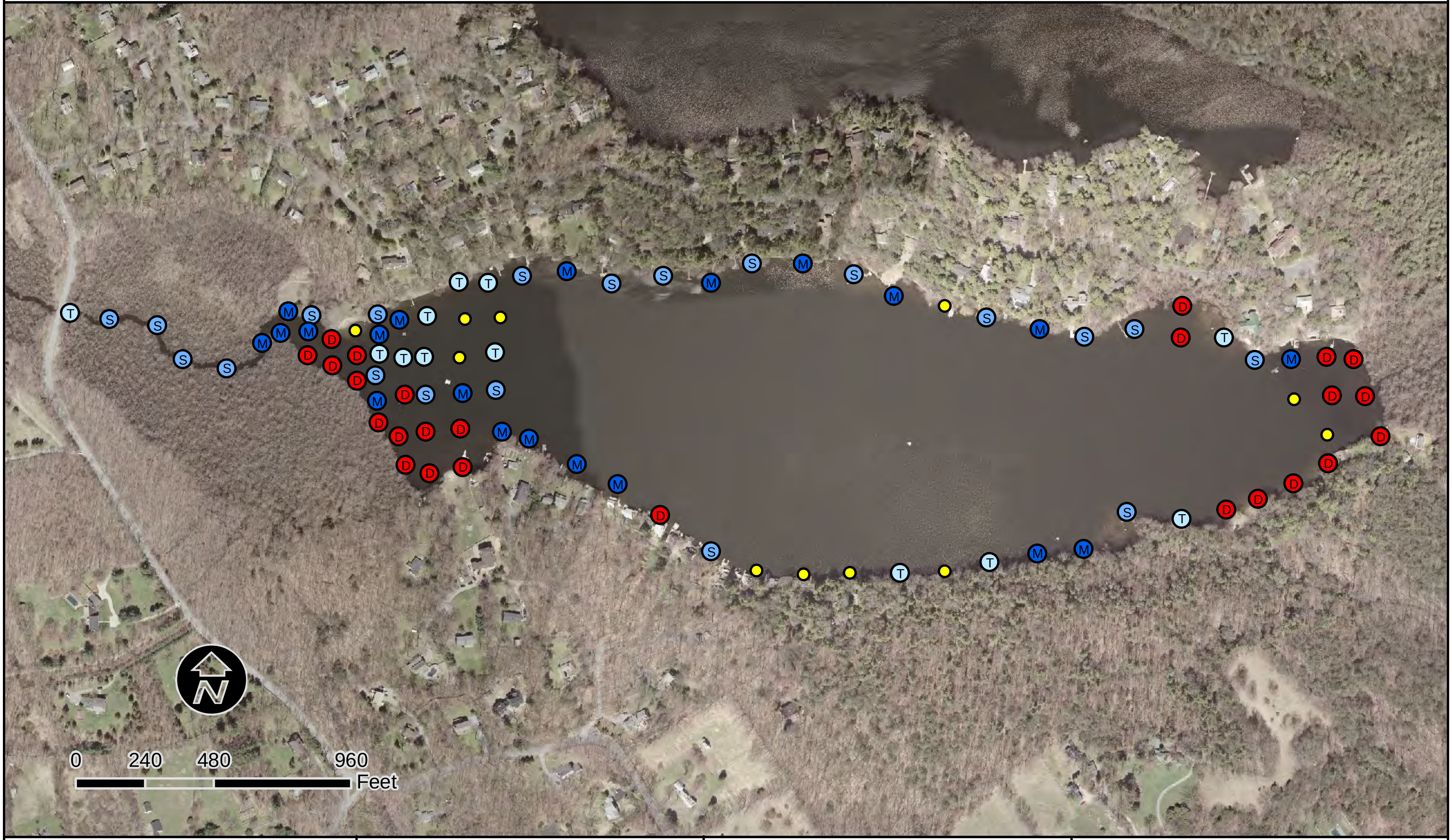
888.480.5253
www.solitudelakemanagement.com

Total Floating Vegetation Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	77	88%
Trace	12	16%
Sparse	20	26%
Medium	20	26%
Dense	25	32%

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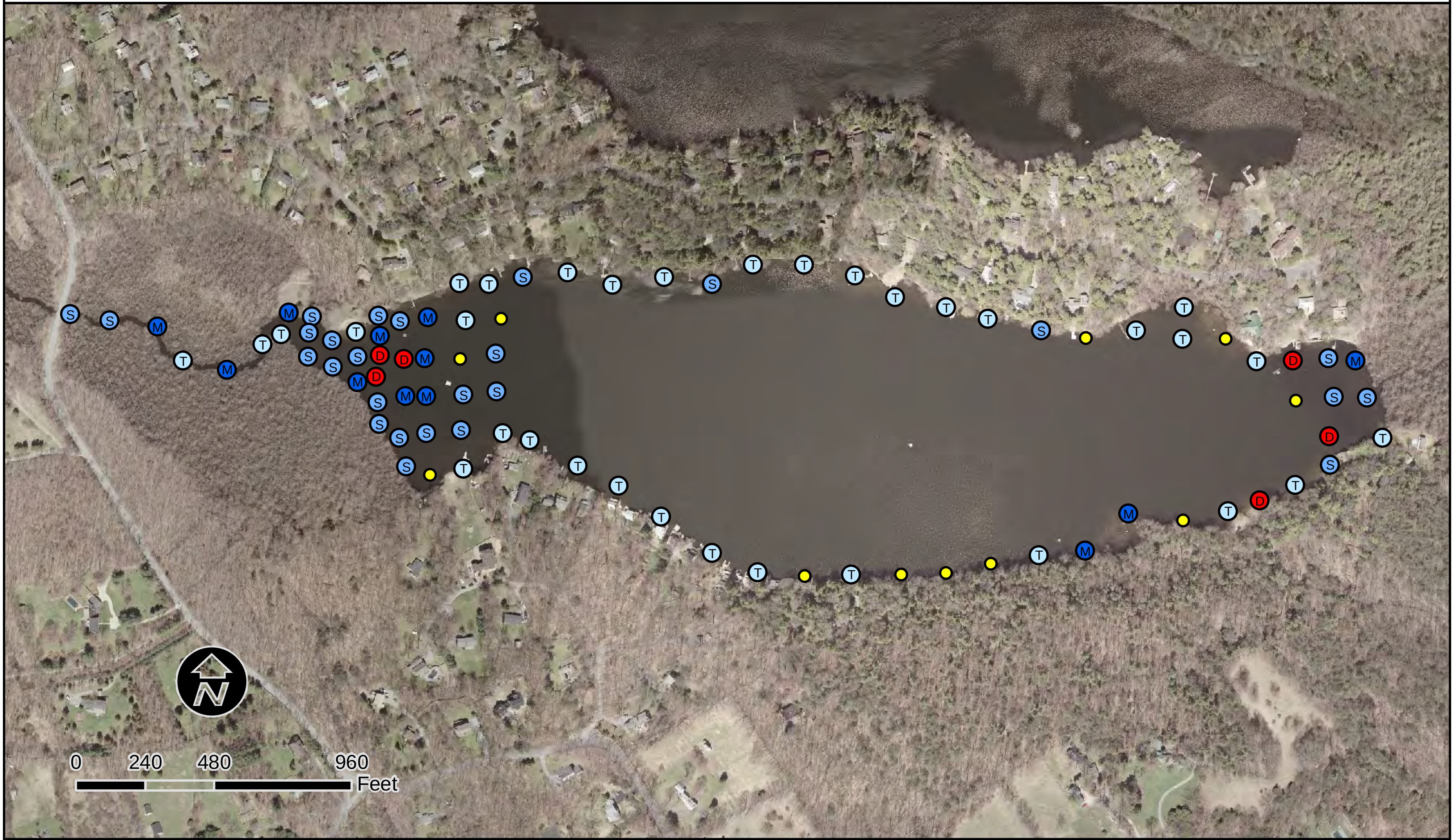
888.480.5253
www.solitudelakemanagement.com

Total Submersed Vegetation Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- (yellow) = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	77	88%
Trace	33	43%
Sparse	26	34%
Medium	12	16%
Dense	6	8%

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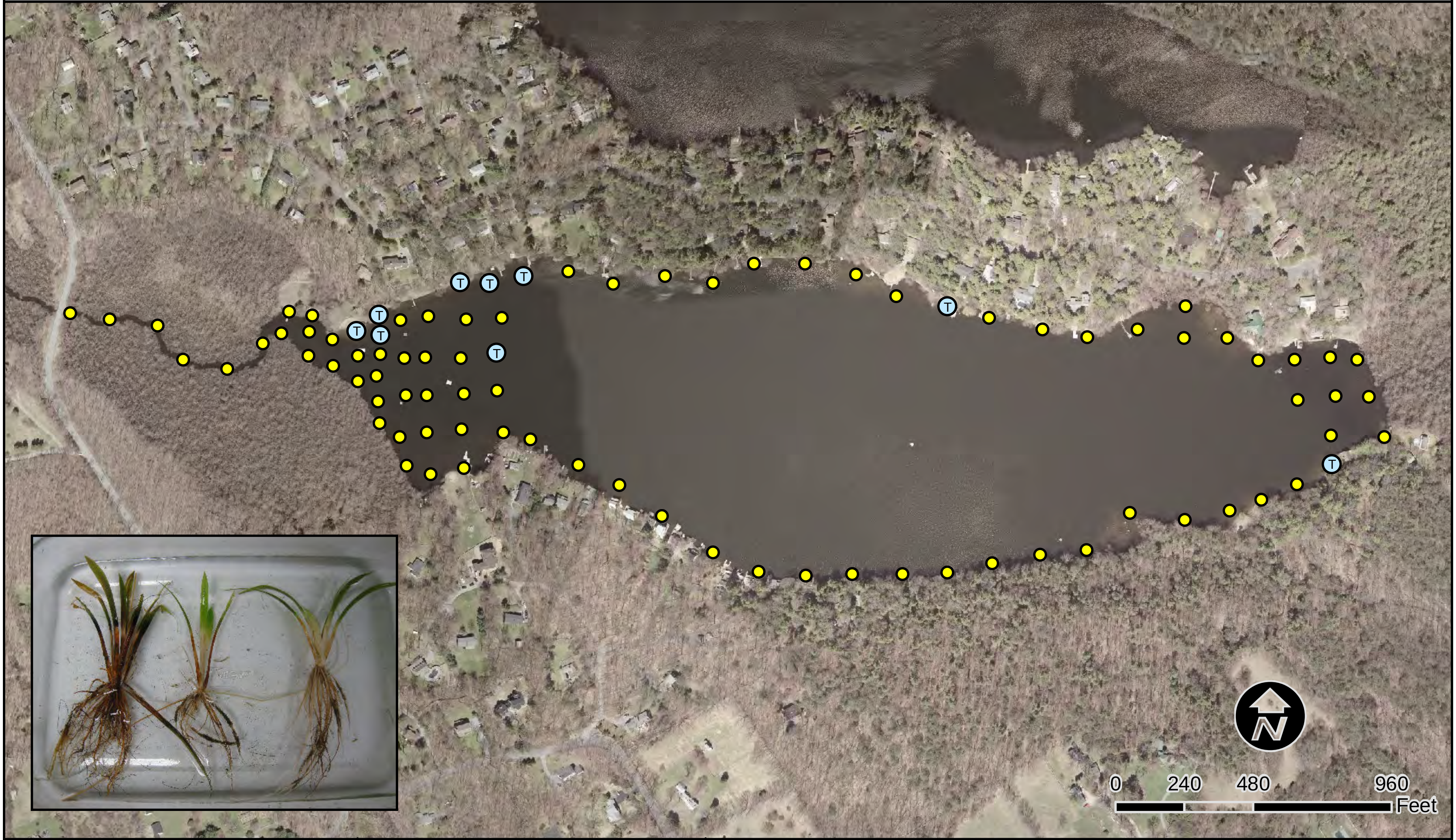
Arrowhead Rosette (*Sagittaria sp.*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	9	10%
Trace	9	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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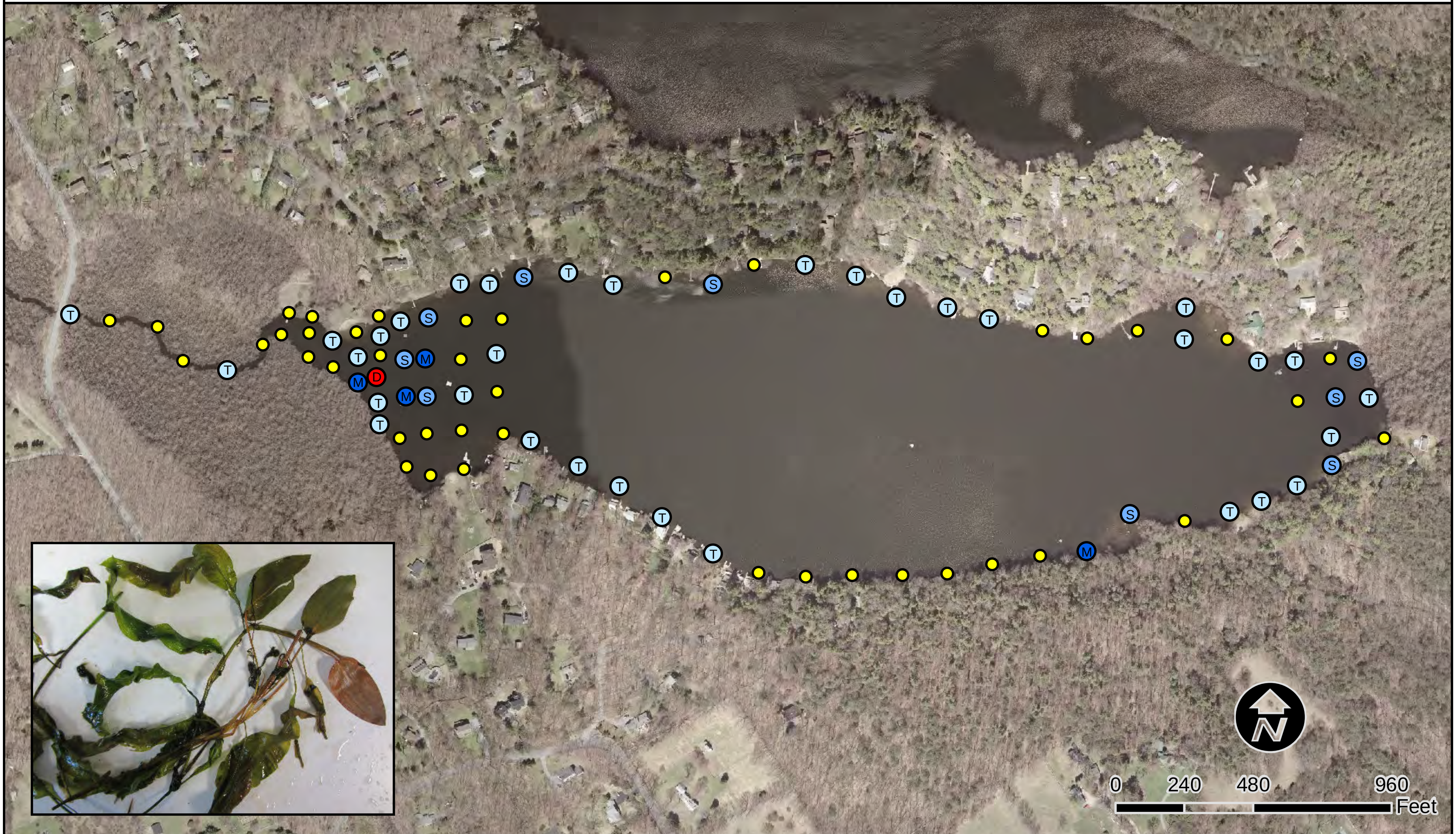
Bassweed (*Potamogeton amplifolius*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	47	53%
Trace	33	70%
Sparse	9	19%
Medium	4	9%
Dense	1	2%

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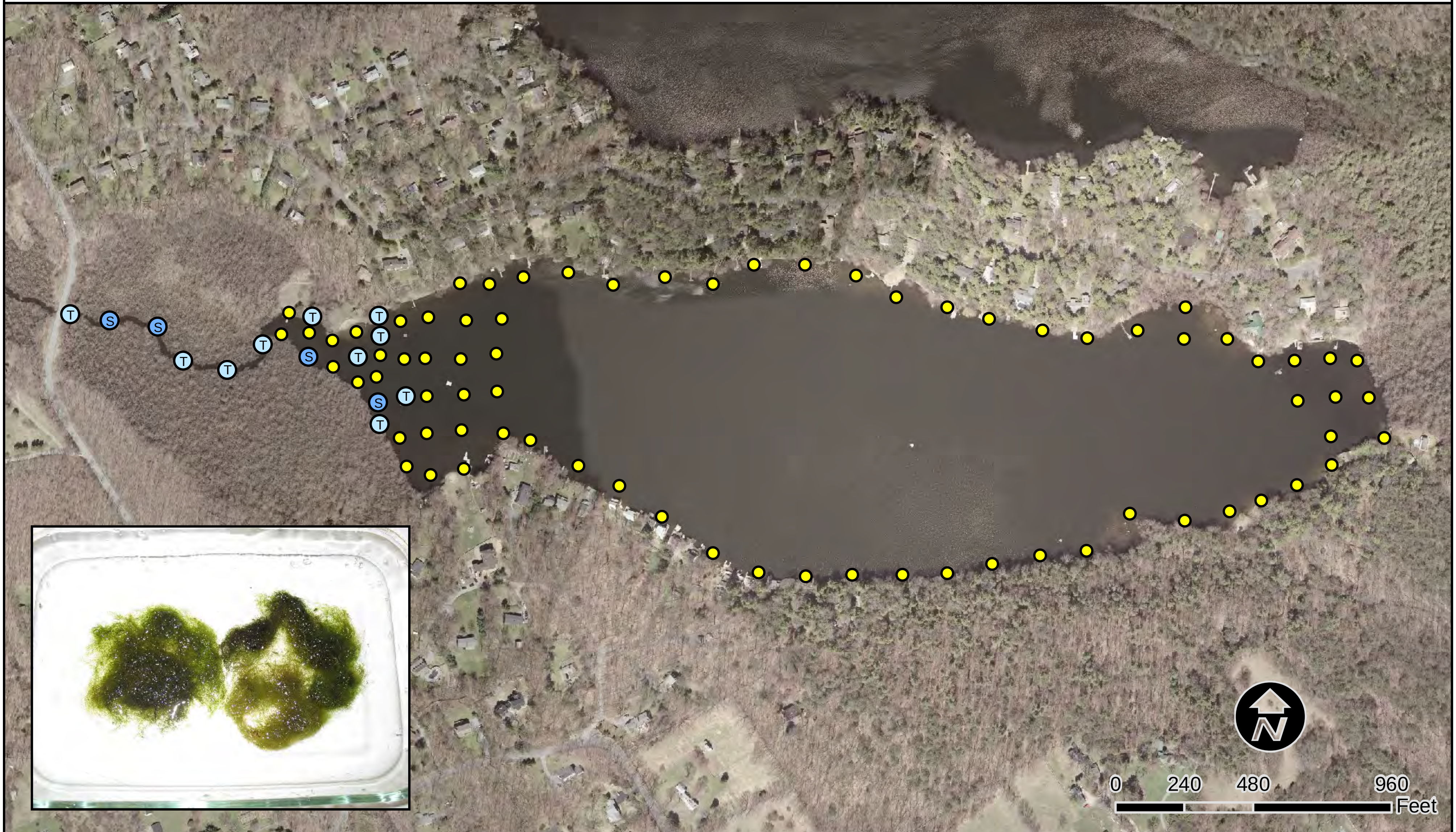
Benthic Filamentous Algae Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	14	16%
Trace	10	71%
Sparse	4	29%
Medium	0	0%
Dense	0	0%

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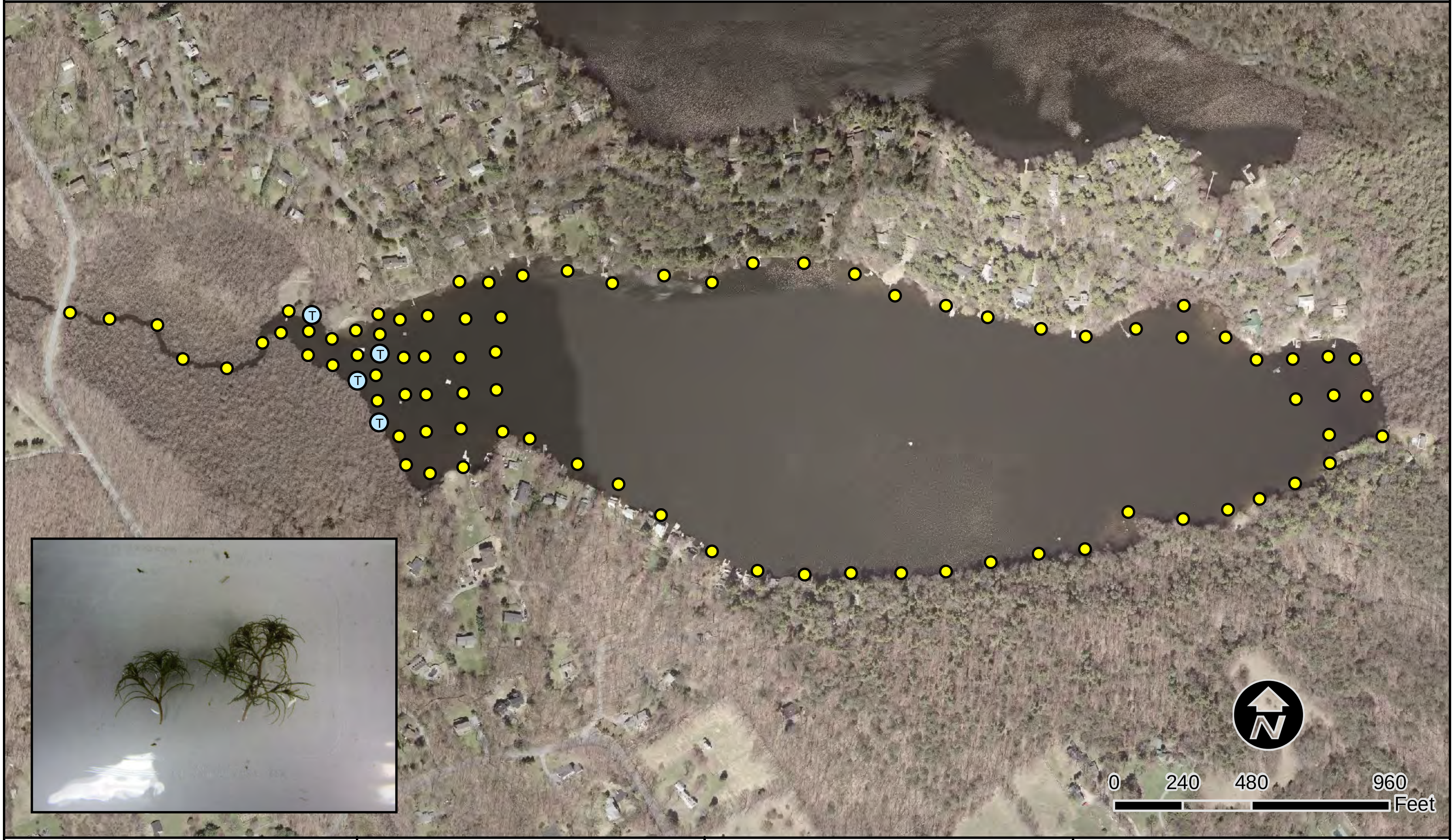
Brittle Naiad (*Najas minor*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- ● = No Plants
- Ⓣ = Trace Plants
- Ⓢ = Sparse Plants
- Ⓜ = Medium Plants
- Ⓓ = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	4	5%
Trace	4	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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Water Bulrush (*Schoenoplectus subterminalis*) Distribution

Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	2	2%
Trace	0	0%
Sparse	2	100%
Medium	0	0%
Dense	0	0%

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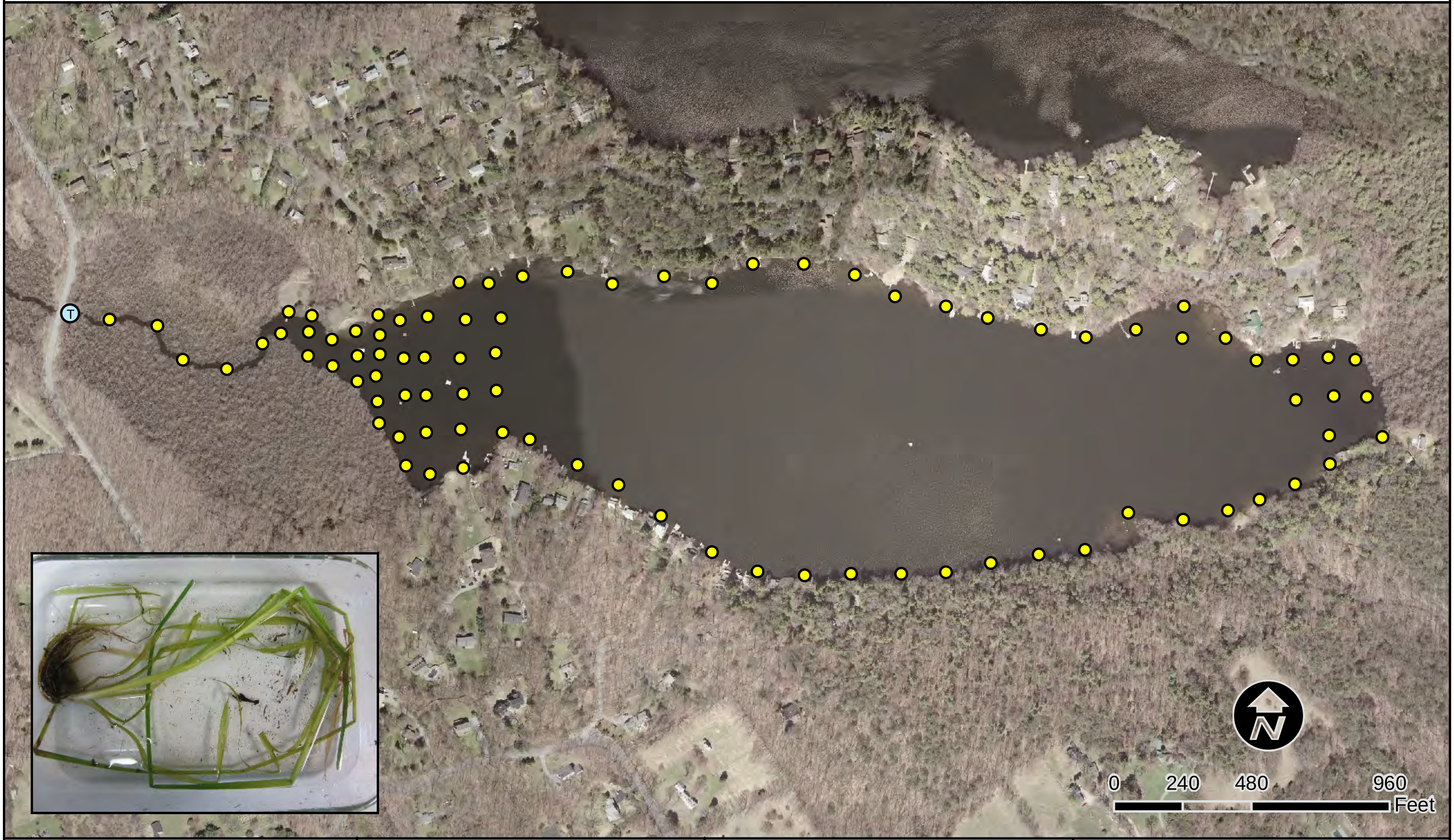
Floating Bur-reed (*Sparganium fluctuans*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	1	1%
Trace	1	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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Common Waterweed (*Elodea canadensis*) Distribution

Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	3	3%
Trace	3	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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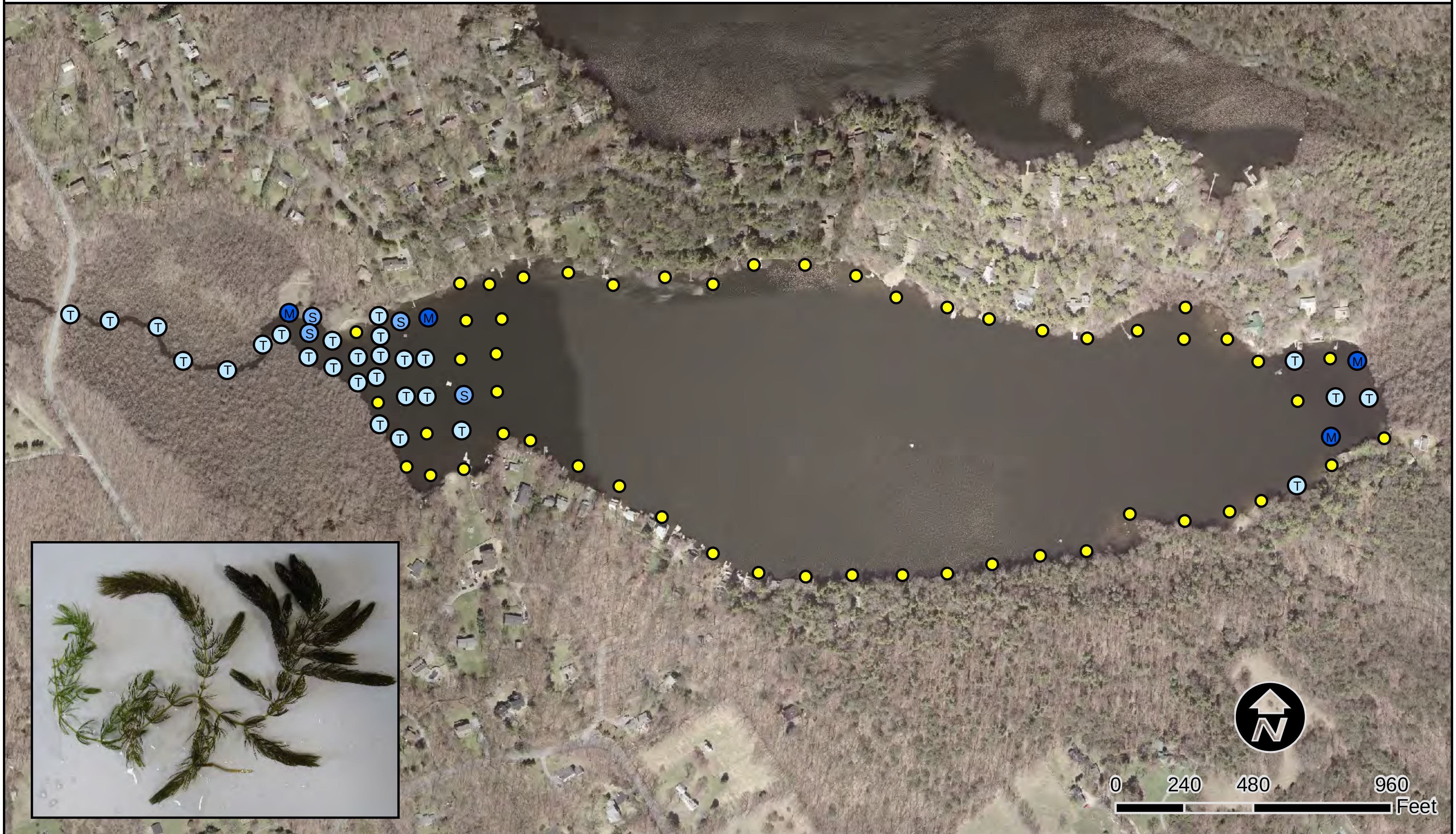
Coontail (*Ceratophyllum demersum*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	35	40%
Trace	27	77%
Sparse	4	11%
Medium	4	11%
Dense	0	0%

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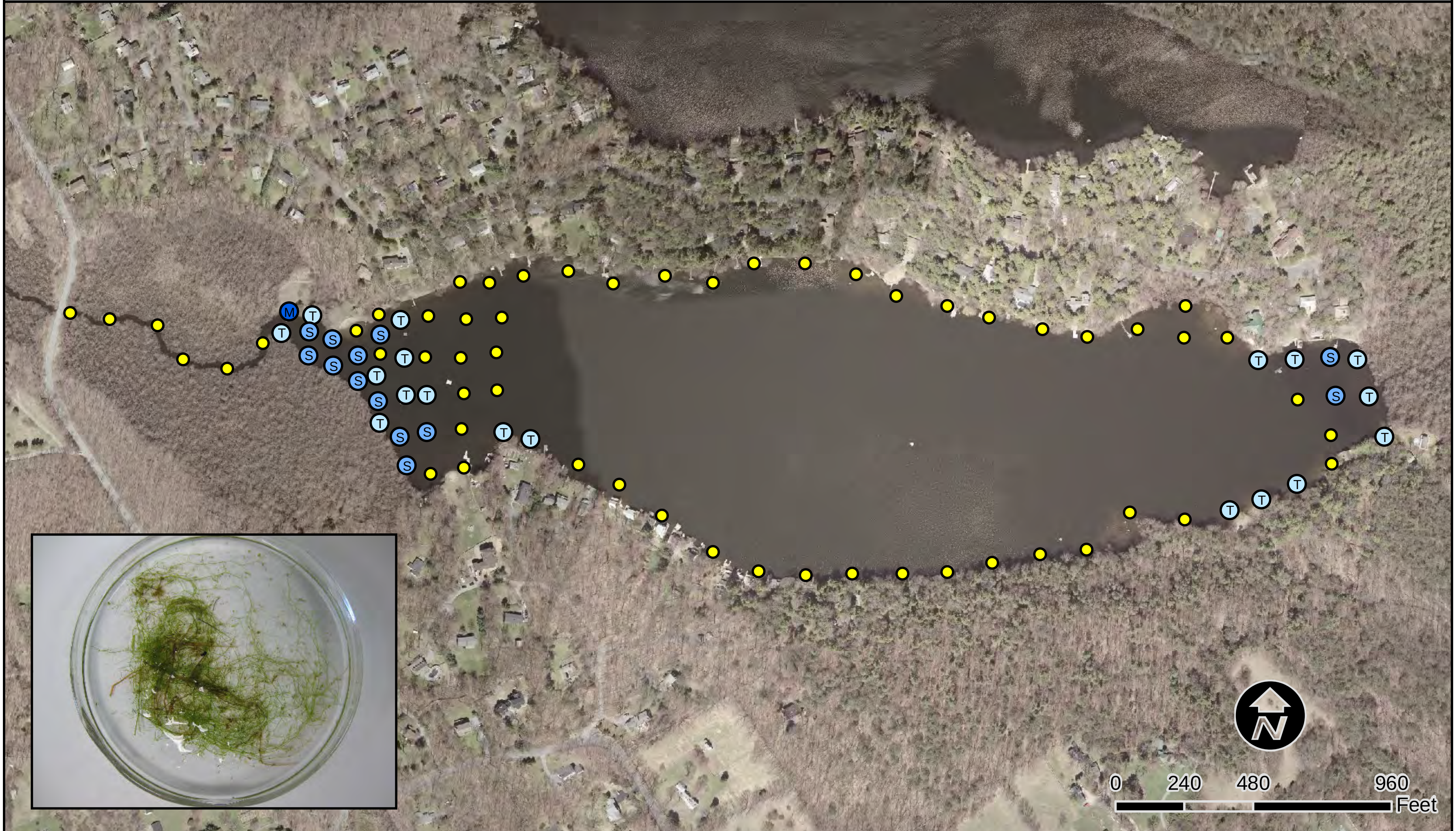
Creeping Bladderwort (*Utricularia gibba*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	32	36%
Trace	18	56%
Sparse	13	41%
Medium	1	3%
Dense	0	0%

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Curly-leaf Pondweed (*Potamogeton crispus*) Distribution

Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	3	3%
Trace	3	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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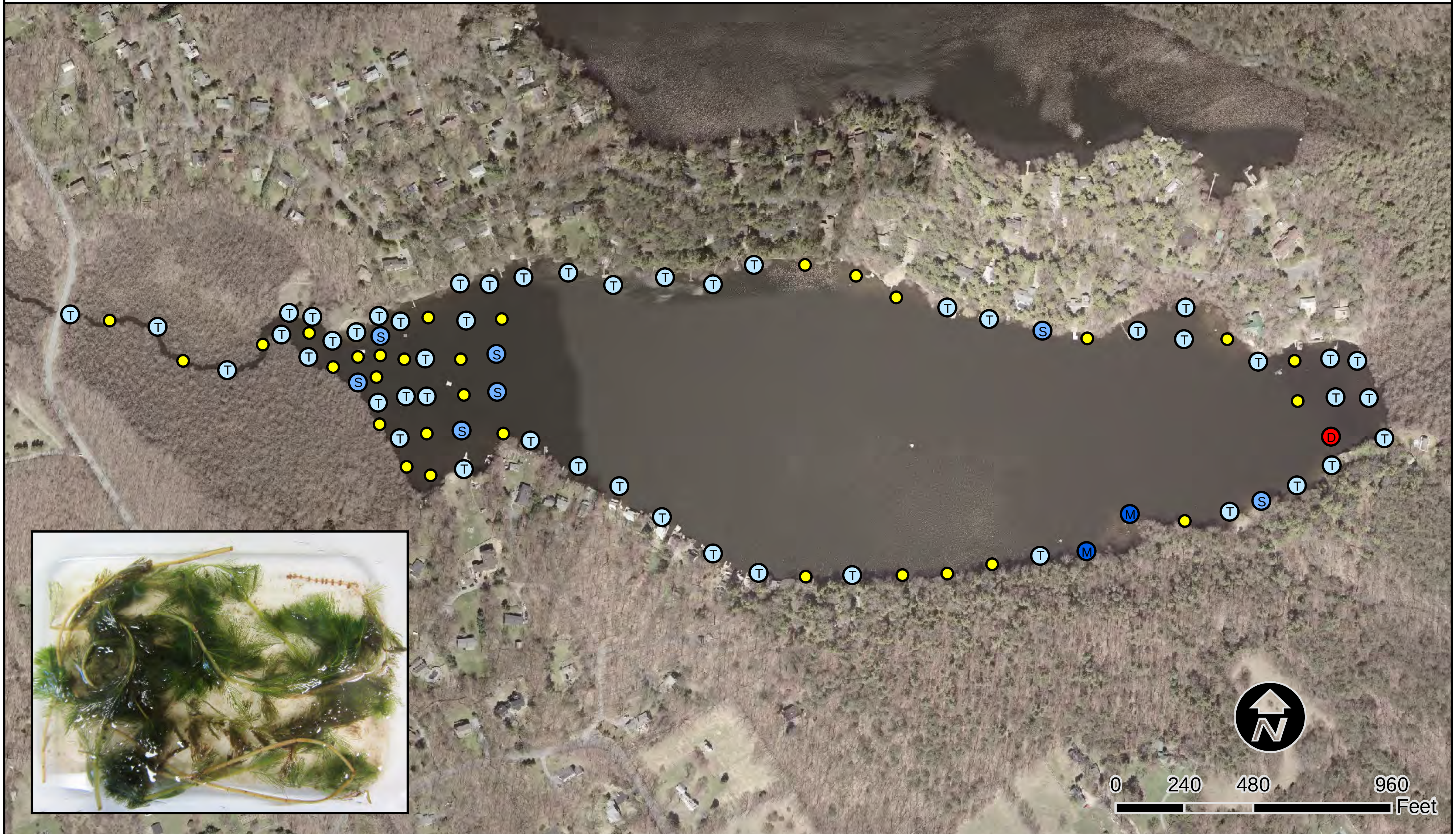
Eurasian Water Milfoil (*Myriophyllum spicatum*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- (yellow) = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	58	66%
Trace	48	83%
Sparse	7	12%
Medium	2	3%
Dense	1	2%

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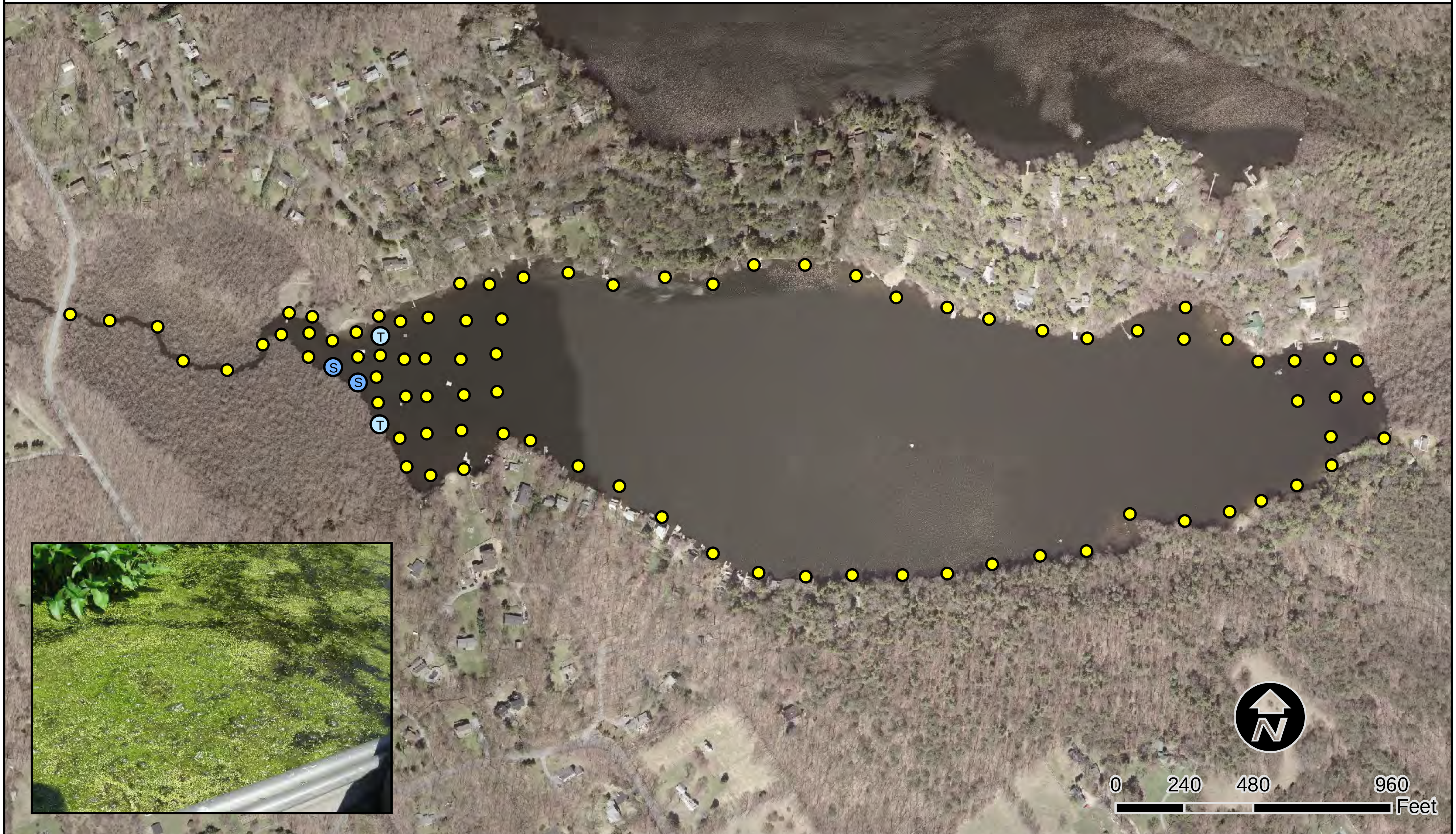
Floating Filamentous Algae Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	4	5%
Trace	2	50%
Sparse	2	50%
Medium	0	0%
Dense	0	0%

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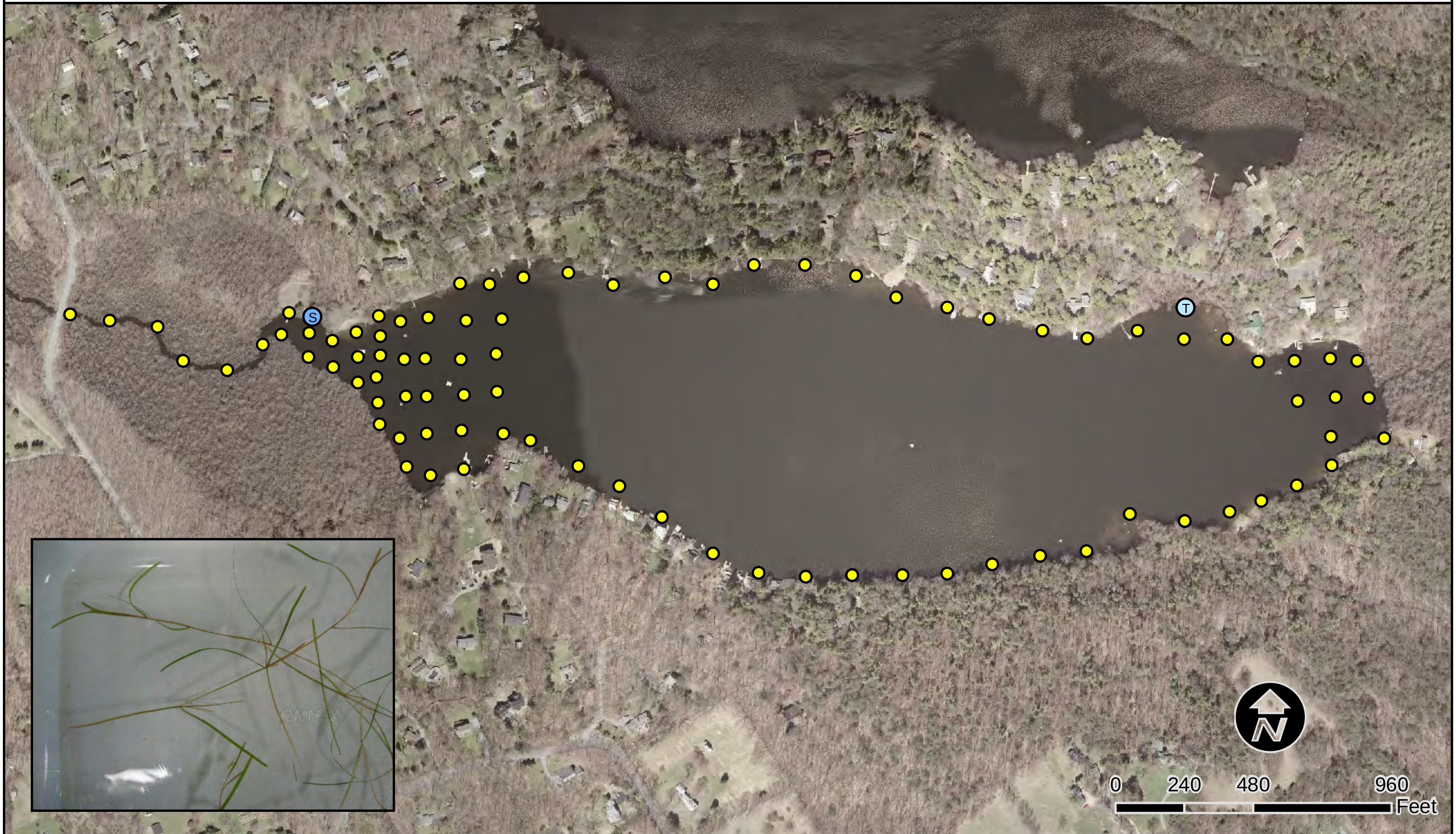
Leafy Pondweed (*Potamogeton foliosus*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- = Trace Plants
- = Sparse Plants
- = Medium Plants
- = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	2	2%
Trace	1	50%
Sparse	1	50%
Medium	0	0%
Dense	0	0%

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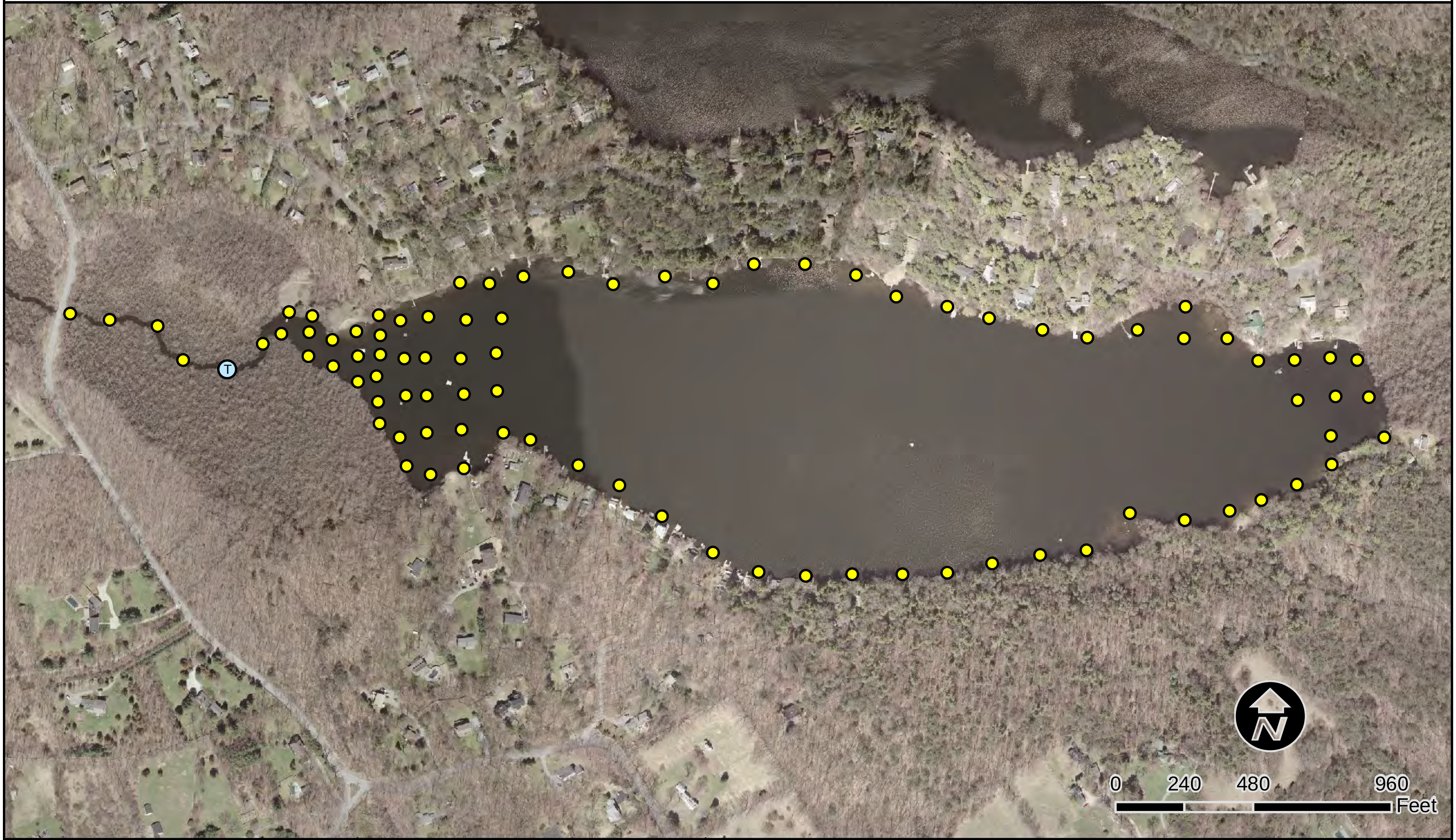
Pondweed Species (*Potamogeton sp.*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	1	1%
Trace	1	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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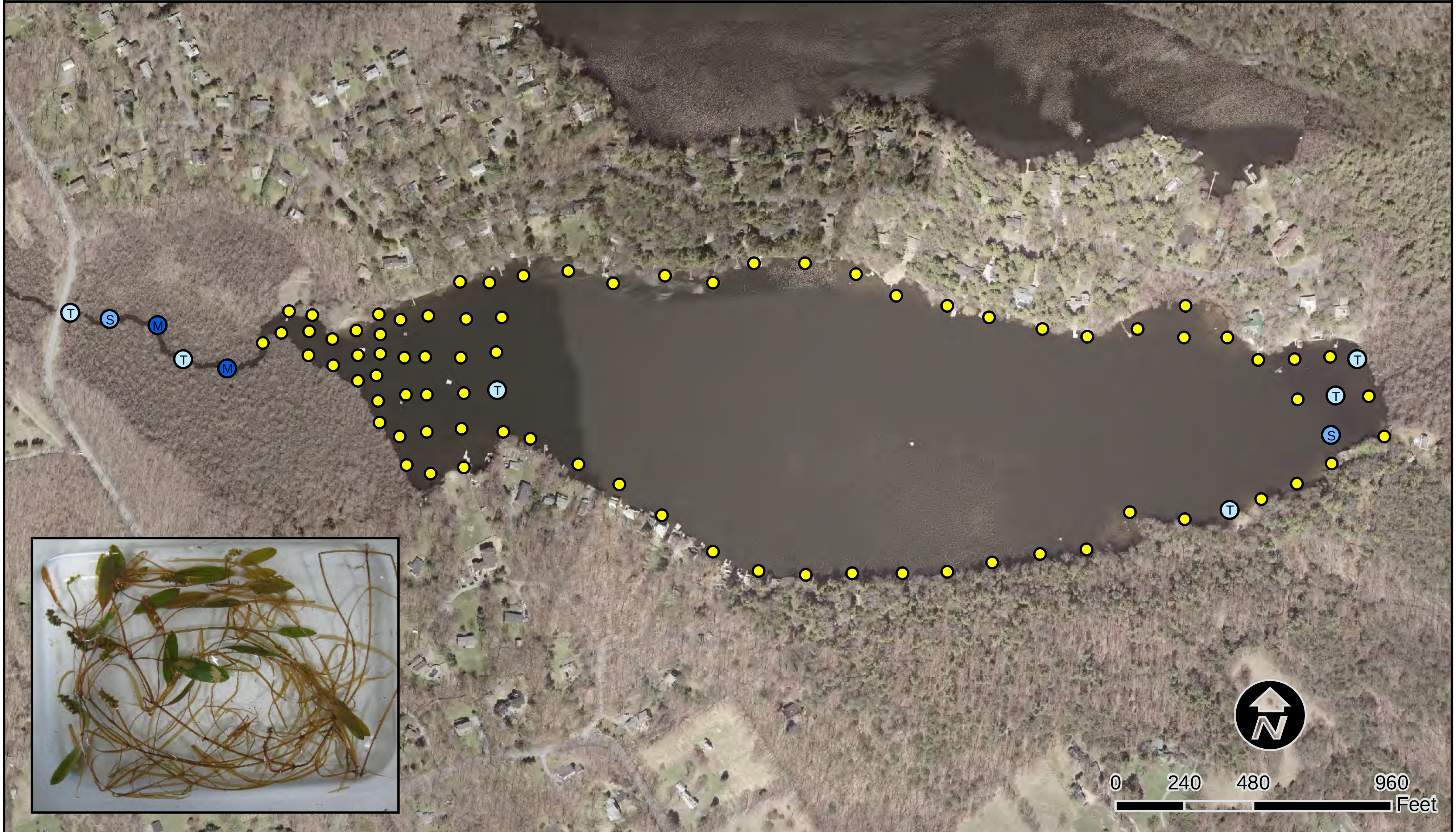
Ribbon-leaf Pondweed (*Potamogeton epihydrus*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- (yellow) = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	10	11%
Trace	6	60%
Sparse	2	20%
Medium	2	20%
Dense	0	0%

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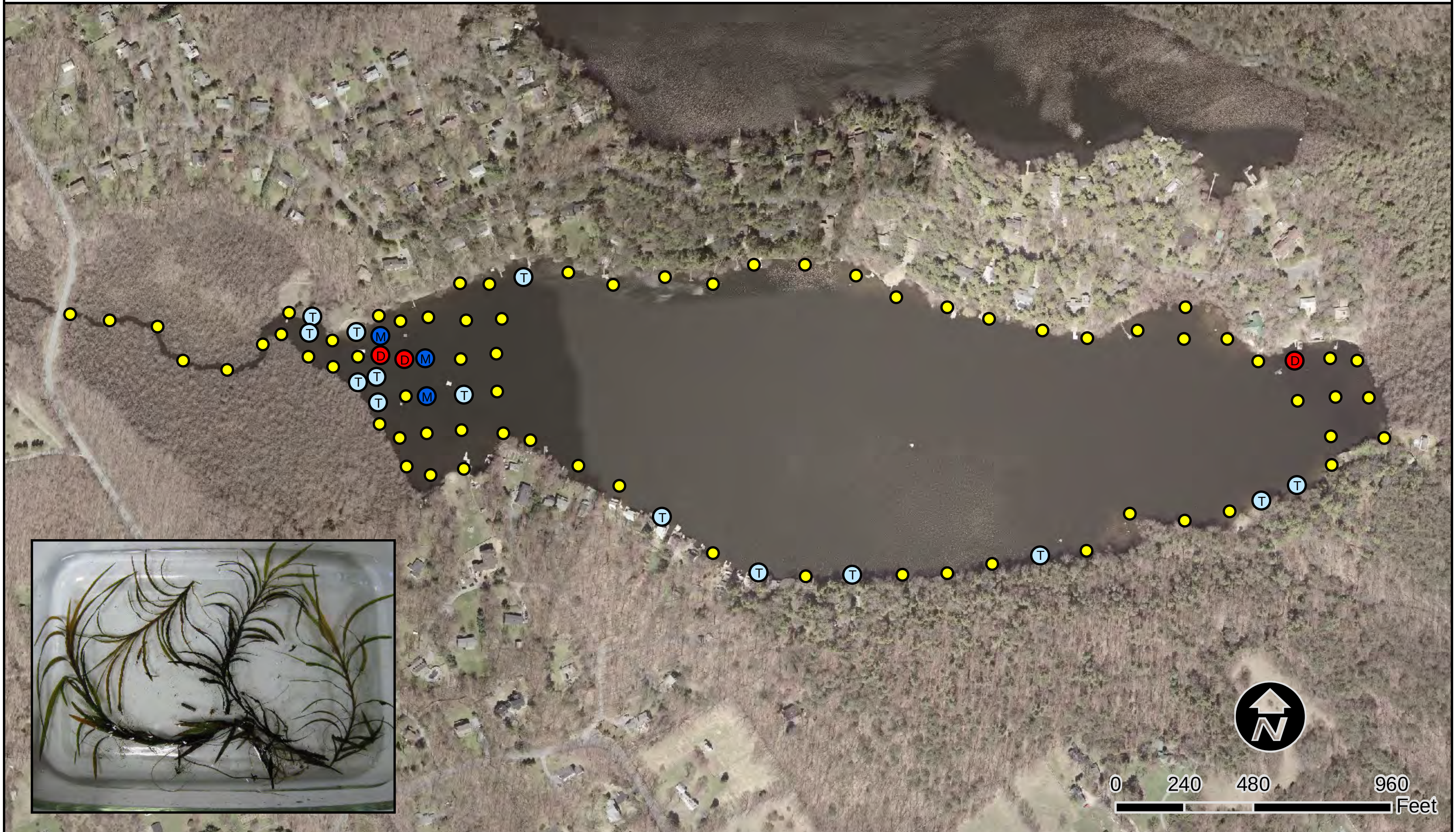
Robbin's Pondweed (*Potamogeton robbinsii*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- (yellow) = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	20	23%
Trace	14	70%
Sparse	0	0%
Medium	3	15%
Dense	3	15%

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Small Duckweed (*Lemna minor*) Distribution

Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- ● = No Plants
- Ⓣ = Trace Plants
- Ⓢ = Sparse Plants
- Ⓜ = Medium Plants
- Ⓓ = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	2	2%
Trace	2	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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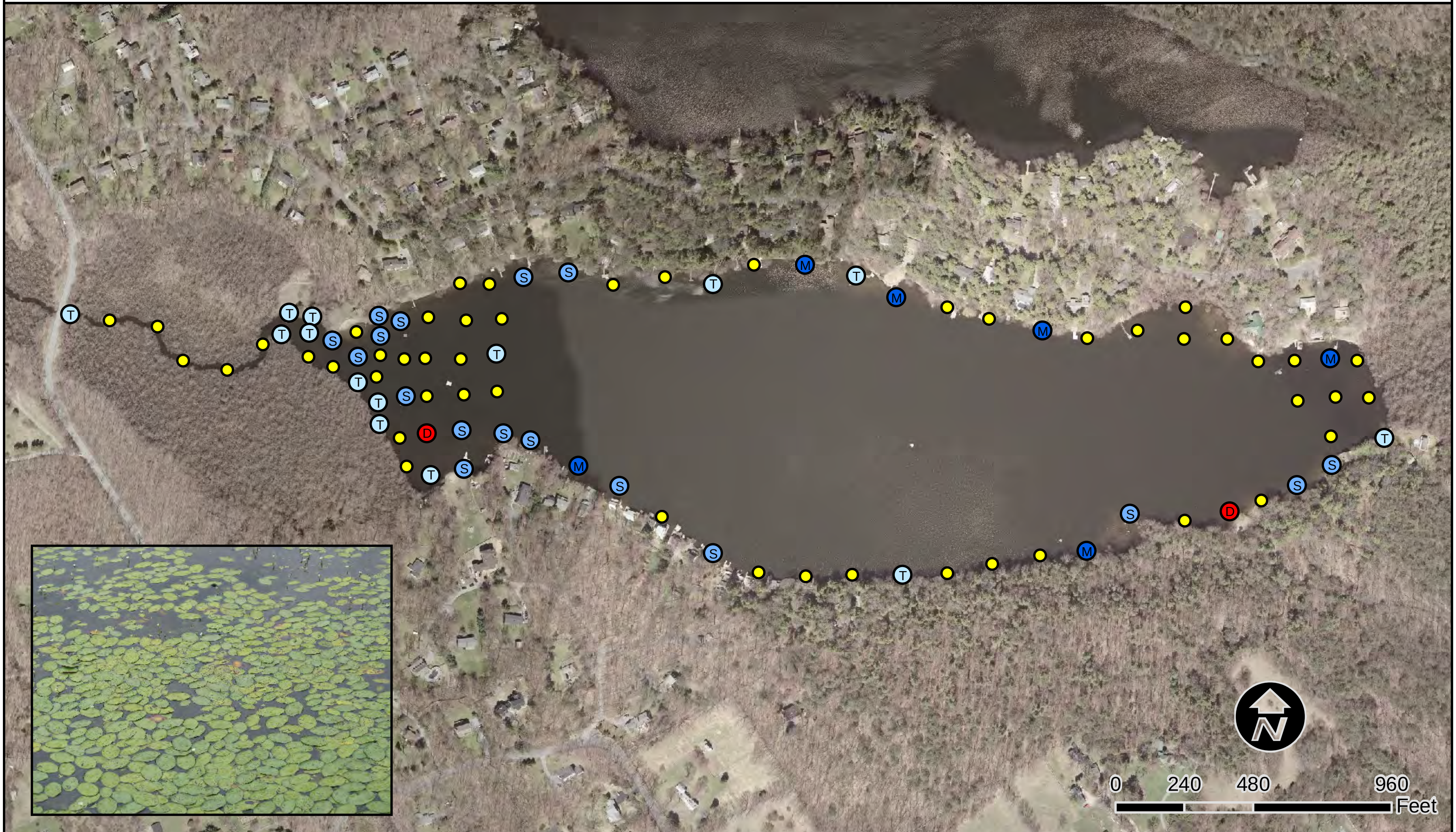
Watershield (*Brasenia schreberi*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	39	44%
Trace	14	36%
Sparse	17	44%
Medium	6	15%
Dense	2	5%

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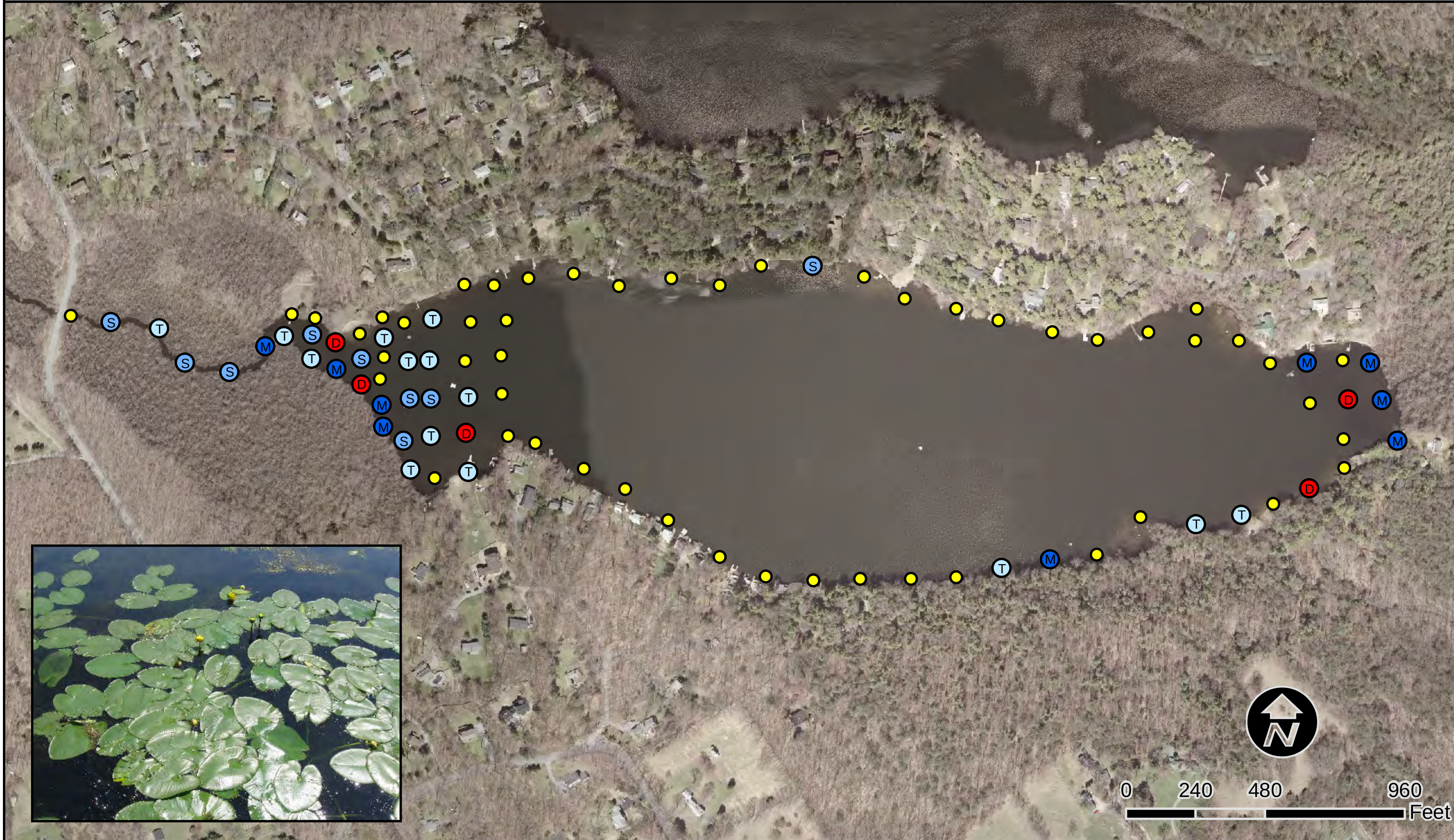
Spatterdock (*Nuphar variegata*) Distribution



Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	37	42%
Trace	14	38%
Sparse	9	24%
Medium	9	24%
Dense	5	14%

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White Water Lily (*Nymphaea odorata*) Distribution

Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	66	75%
Trace	13	20%
Sparse	22	33%
Medium	12	18%
Dense	19	29%

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Wild Celery (*Vallisneria americana*) Distribution

Lake Oscaleta
Aquatic Vegetation Survey
July 20, 26, & 27, 2018

Total Sample Sites: 88

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	2	2%
Trace	1	50%
Sparse	0	0%
Medium	0	0%
Dense	1	50%

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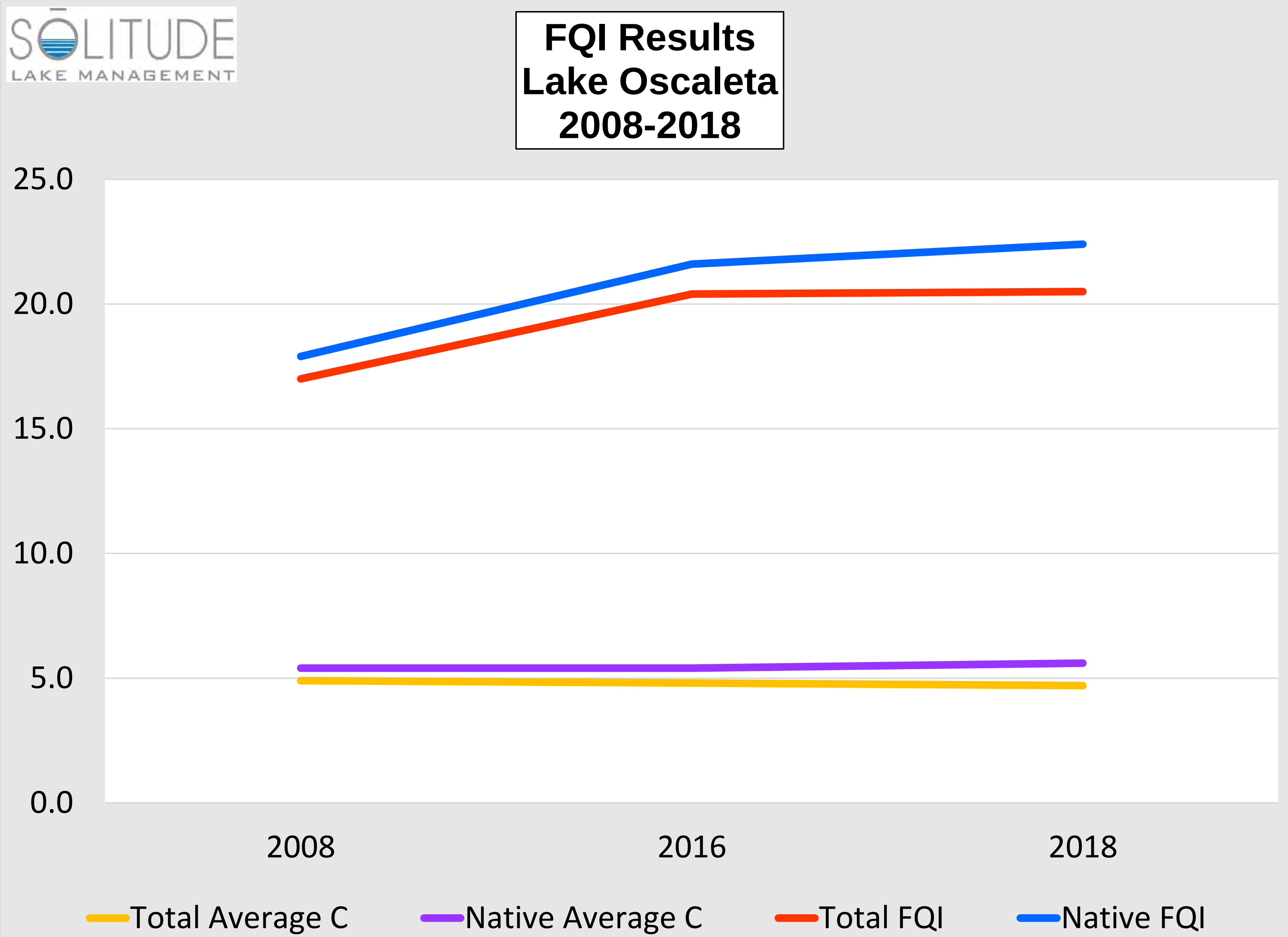
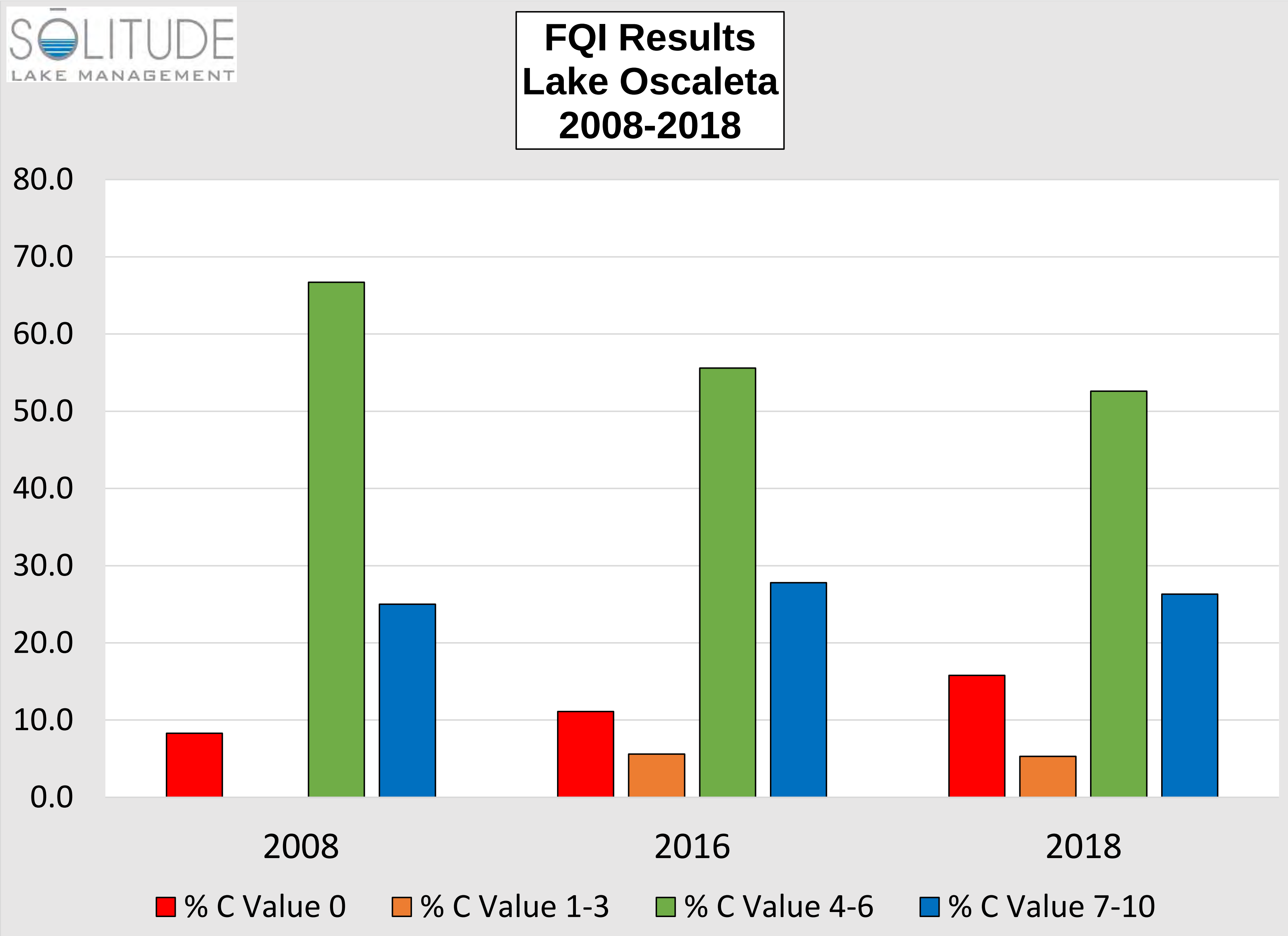

FQI Results
Lake Oscaleta
2008-2018
25.0
20.0
15.0
10.0
5.0
0.0
2008
2016
2018
Total Average C
Native Average C
Total FQI
Native FQI



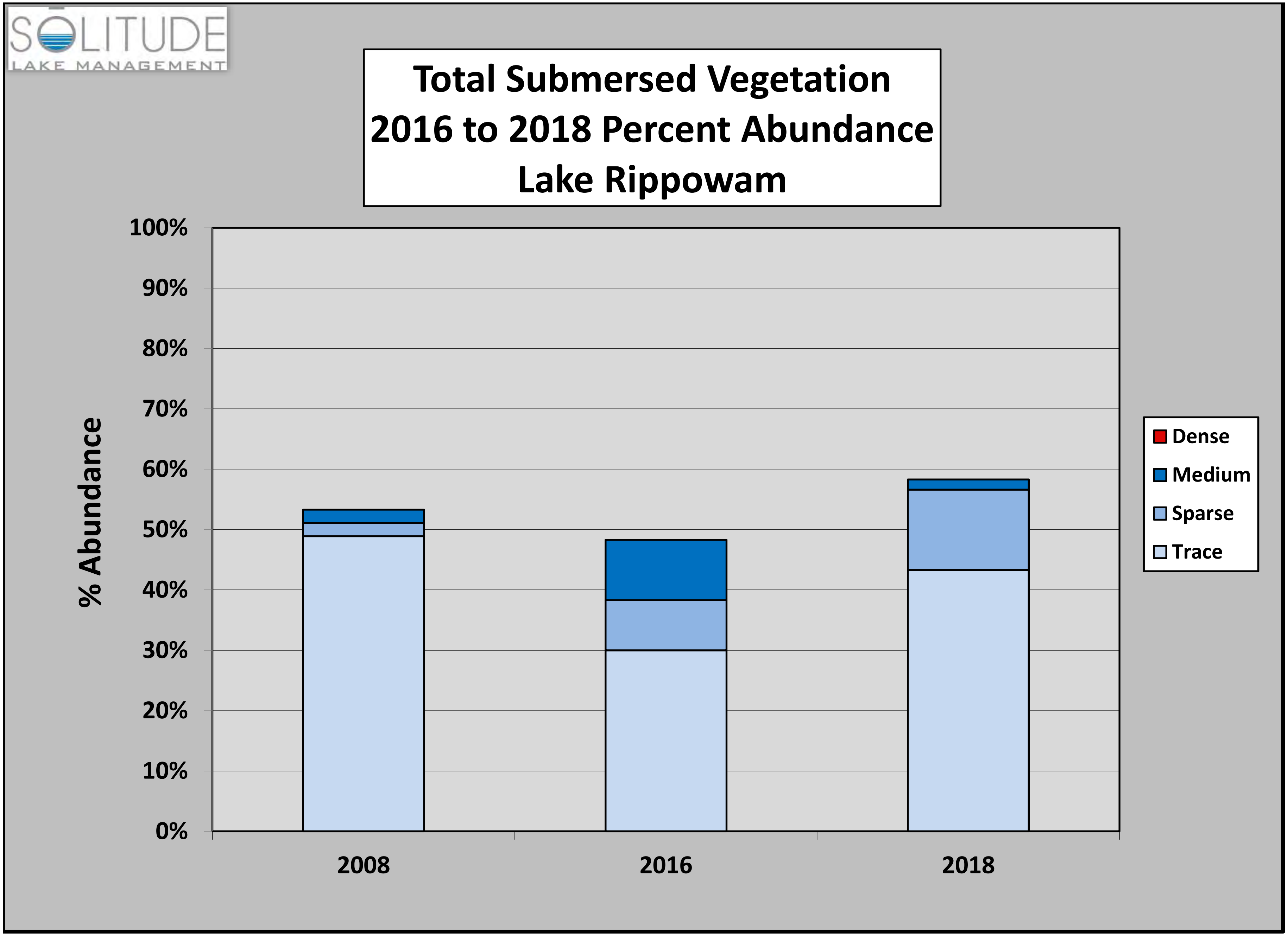
FQI Results
Lake Oscaleta
2008-2018
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
2008
2016
2018
% C Value 0
% C Value 1-3
% C Value 4-6
% C Value 7-10

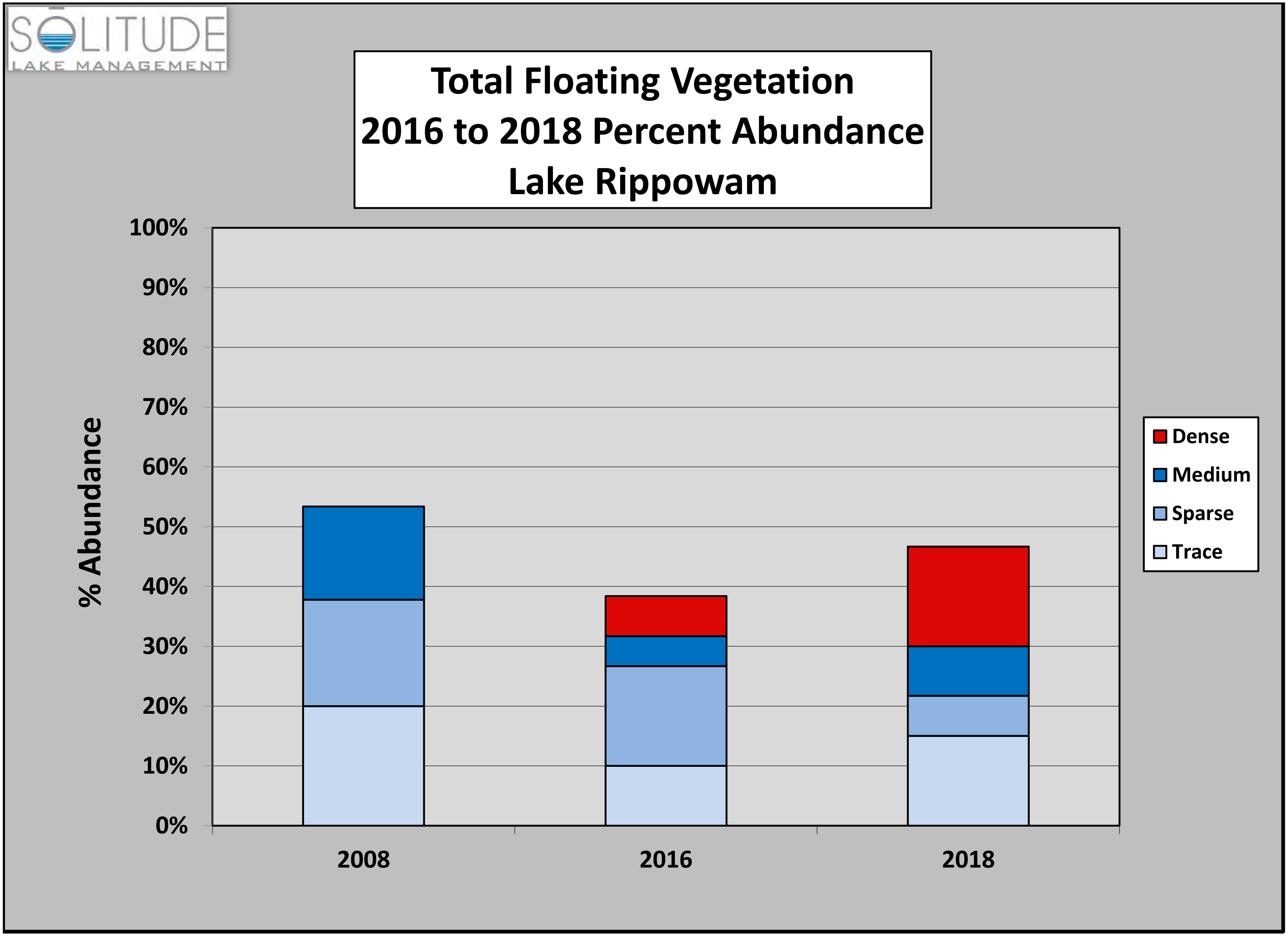
Appendix: Lake Rippowam

2008 – 2018 Percent Abundance Graphs

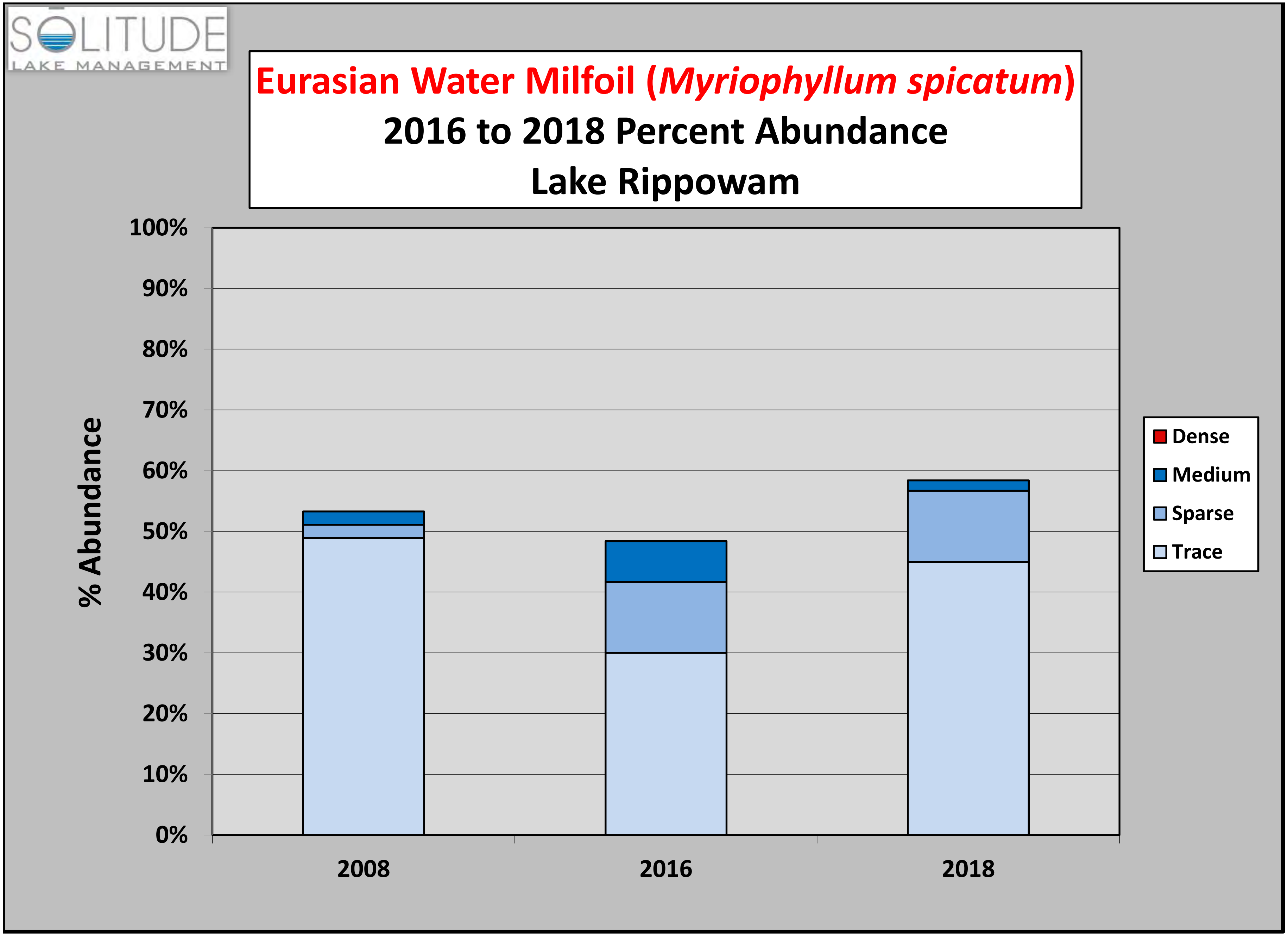
2018 Survey Maps

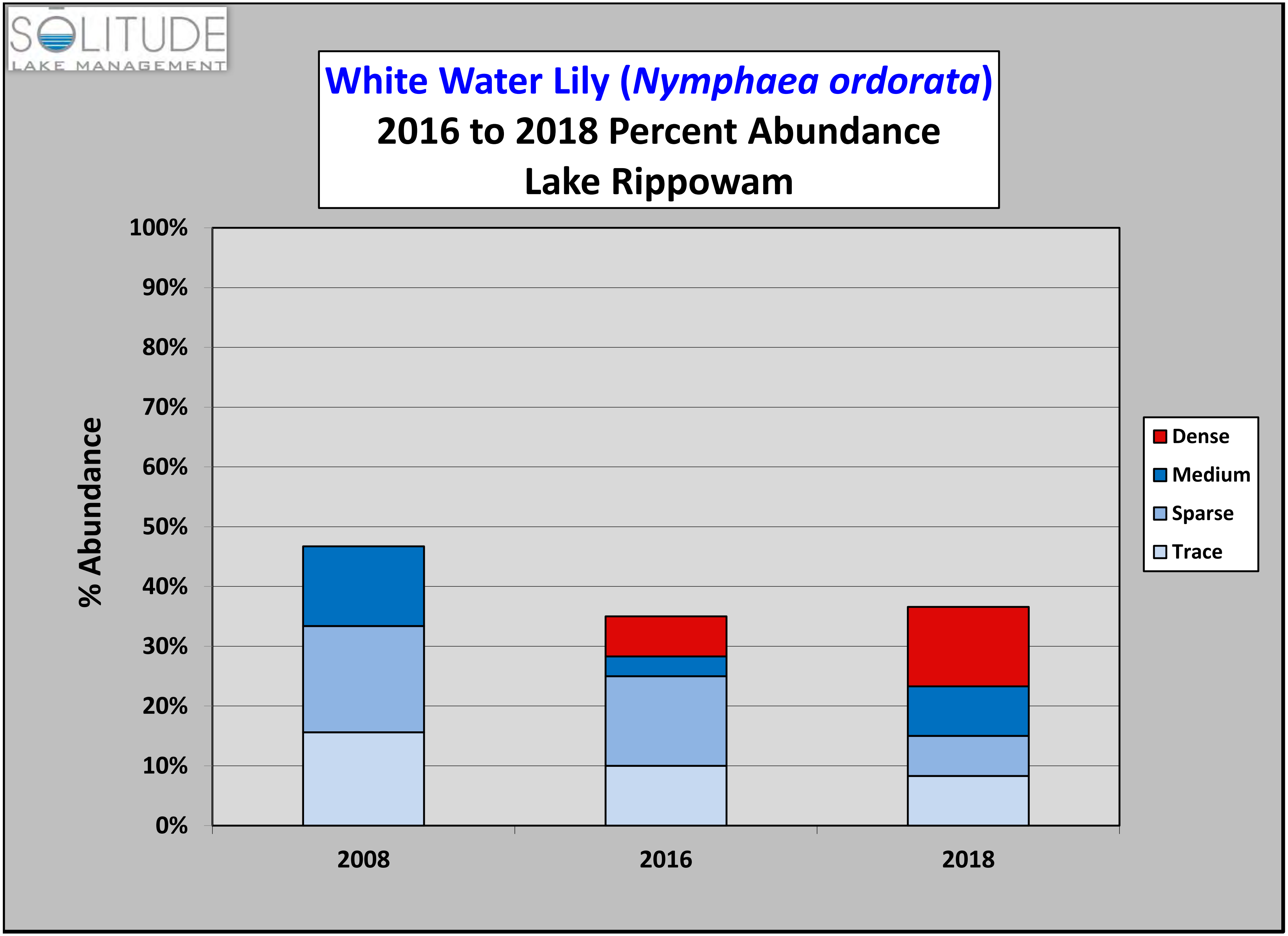
FQI Figures

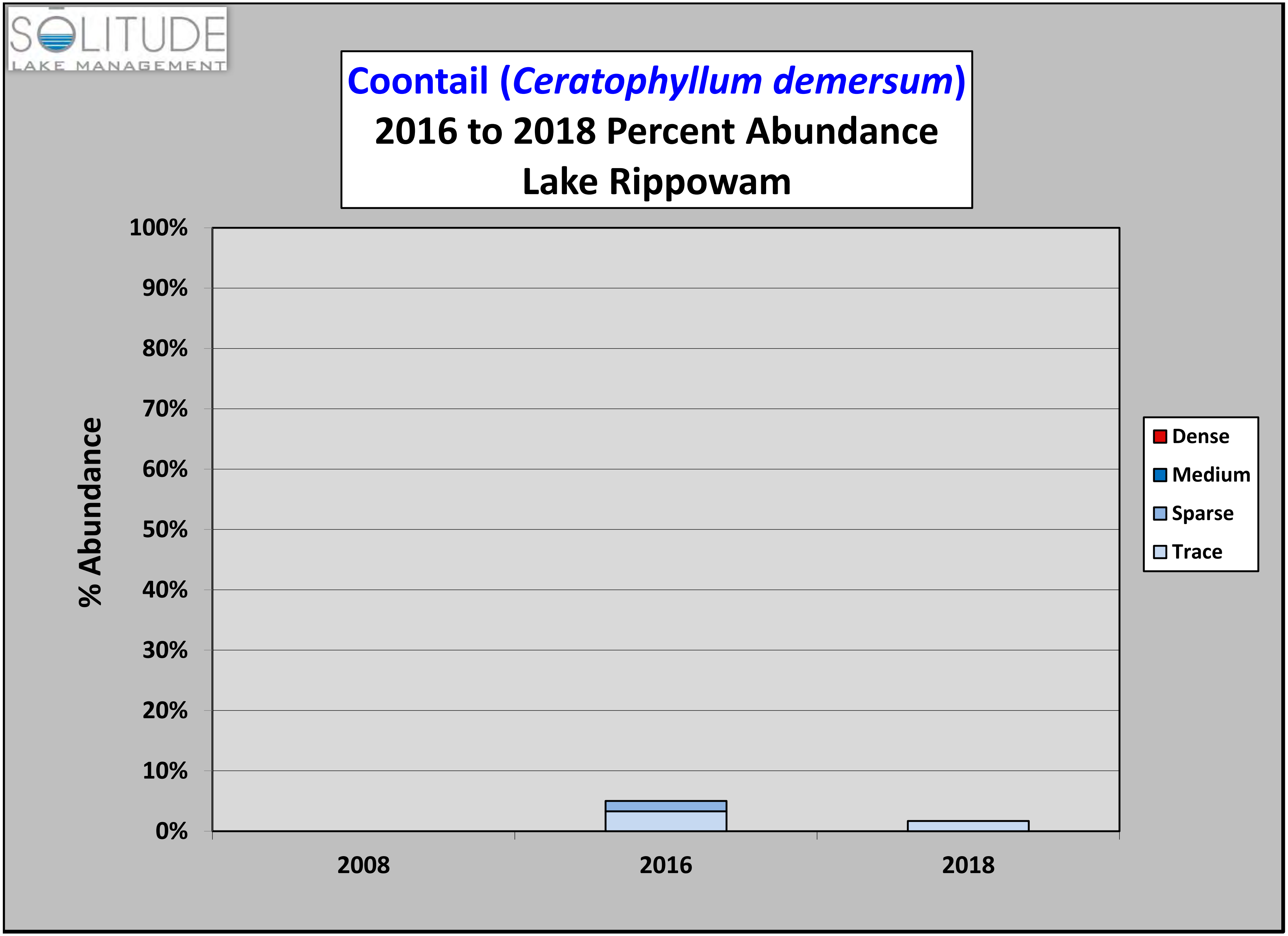

SOLITUDE
LAKE MANAGEMENT
Total Submersed Vegetation
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

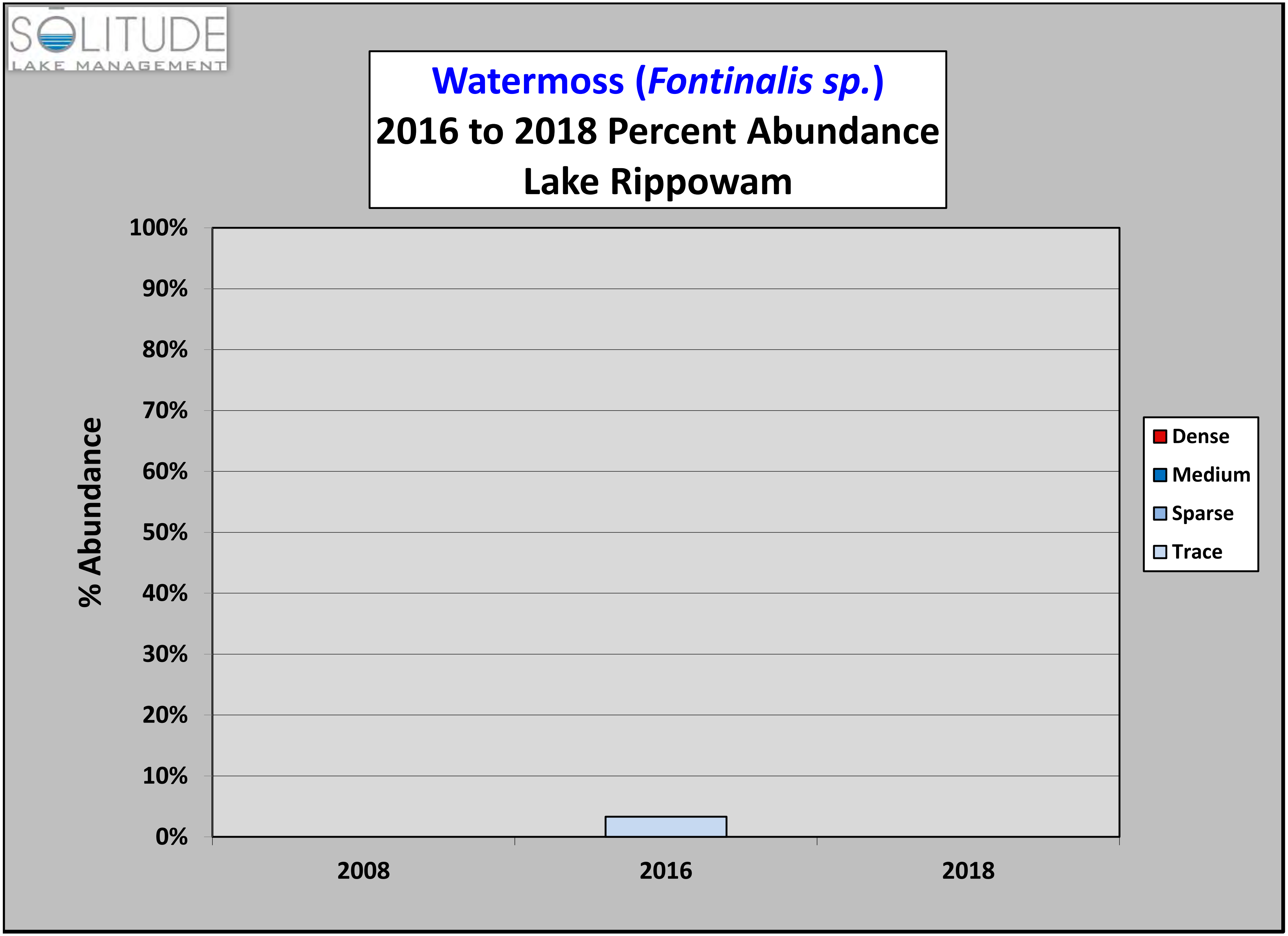


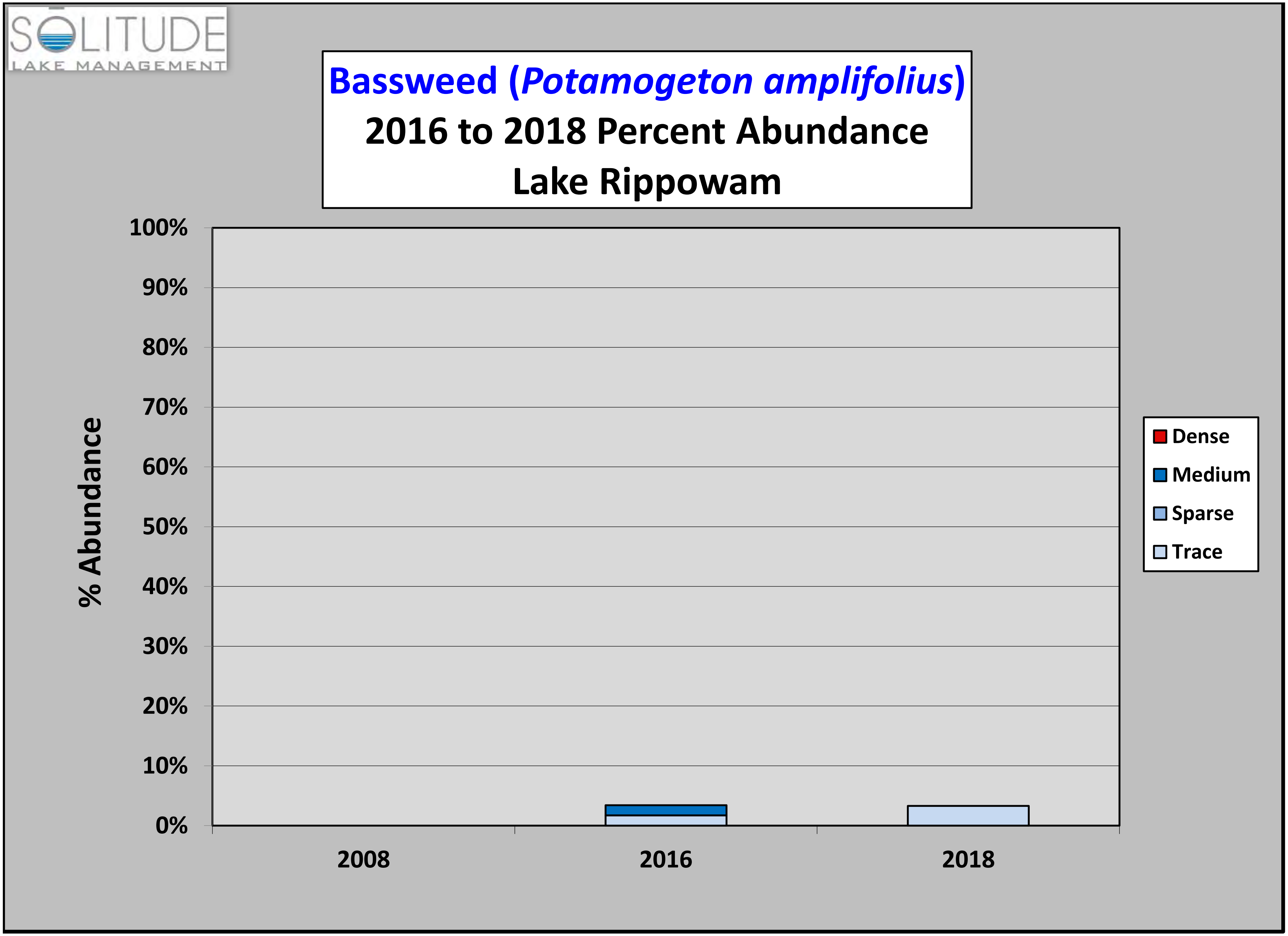
SOLITUDE
LAKE MANAGEMENT
Total Floating Vegetation
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


SOLITUDE
LAKE MANAGEMENT
Eurasian Water Milfoil (*Myriophyllum spicatum*)
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

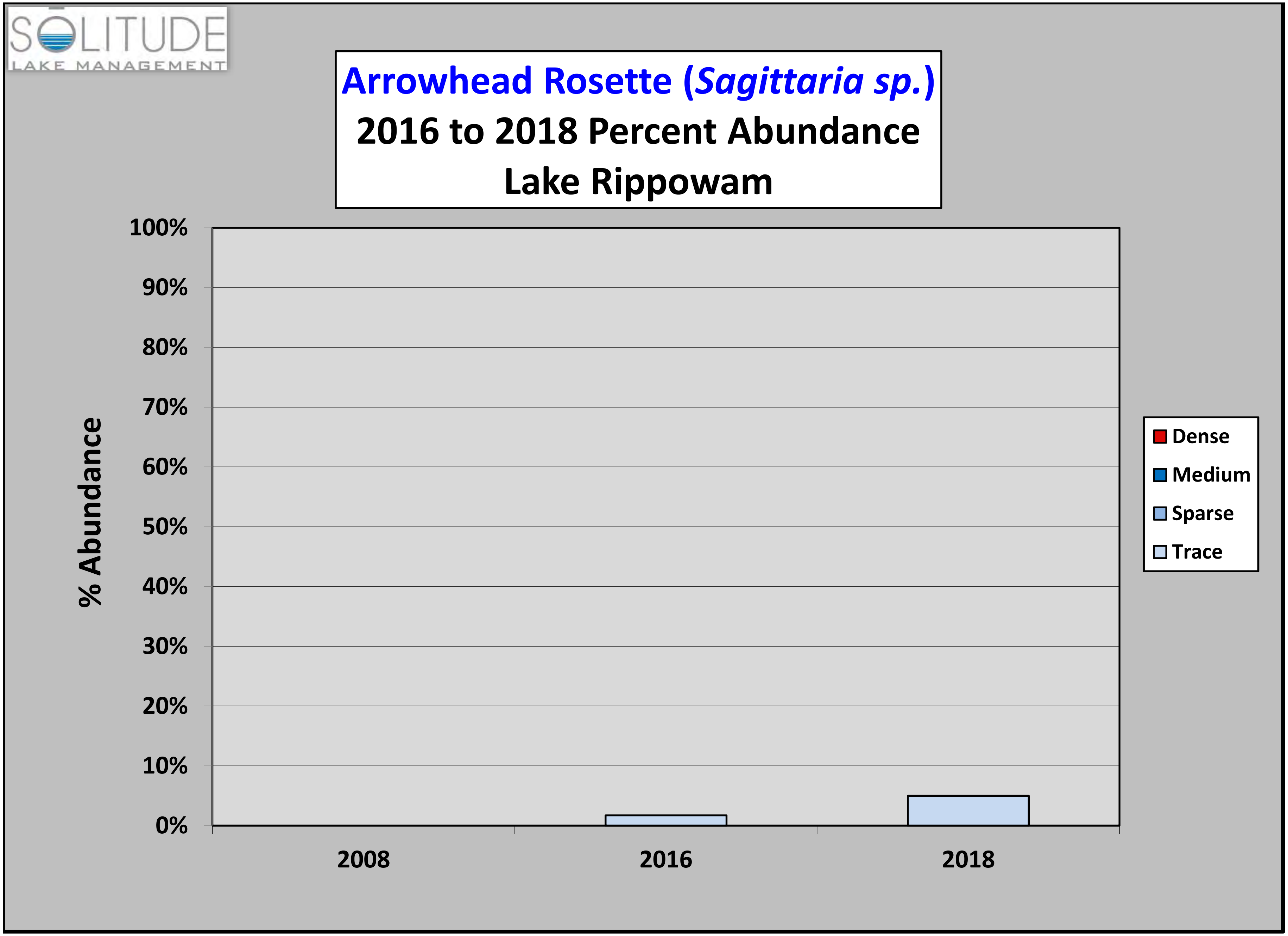

SOLITUDE
LAKE MANAGEMENT
White Water Lily (Nymphaea ordorata)
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


Coontail (*Ceratophyllum demersum*)
2016 to 2018 Percent Abundance
Lake Rippowam
SOLITUDE LAKE MANAGEMENT
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

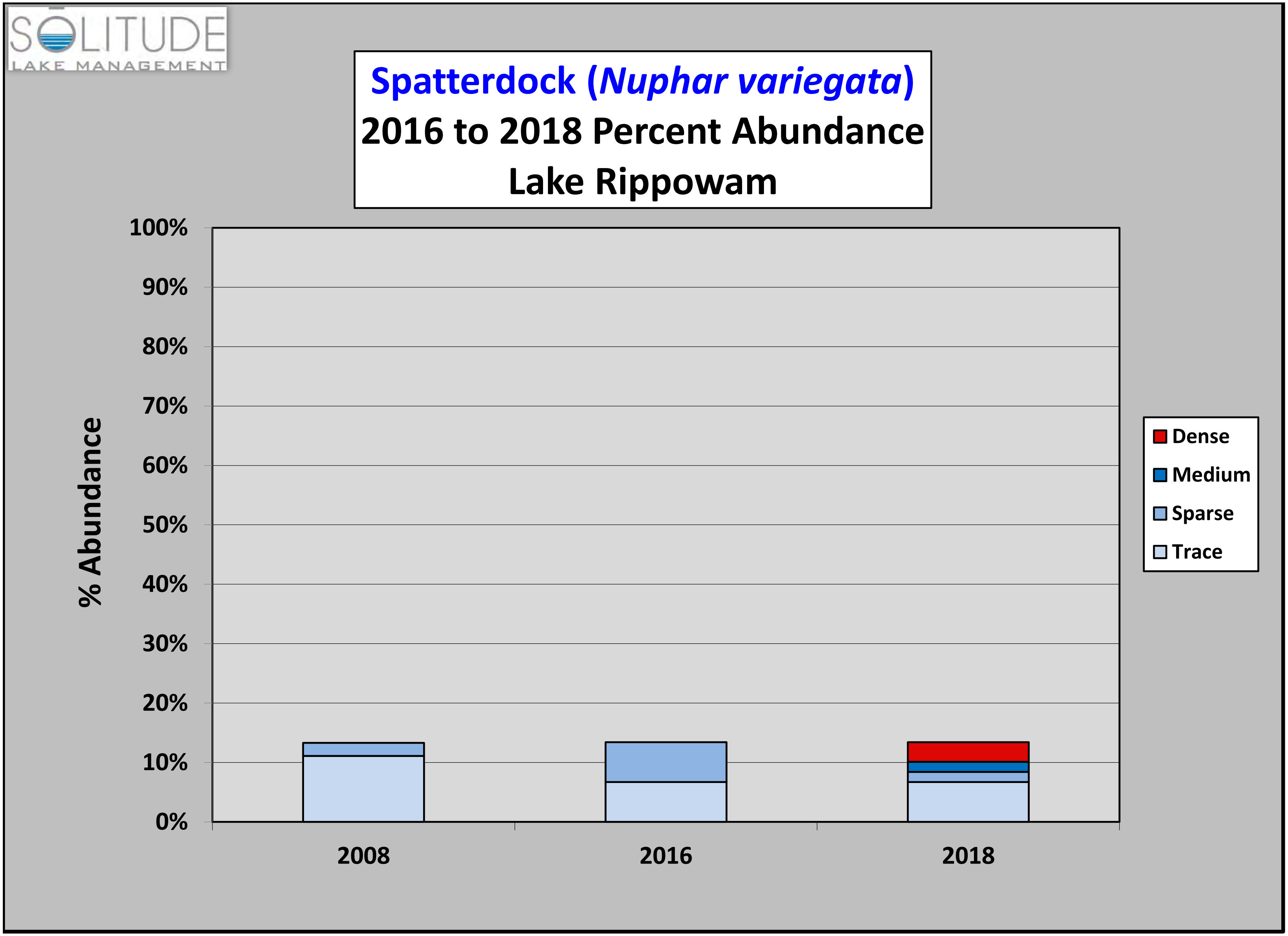

SOLITUDE LAKE MANAGEMENT
Watermoss (Fontinalis sp.)
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace



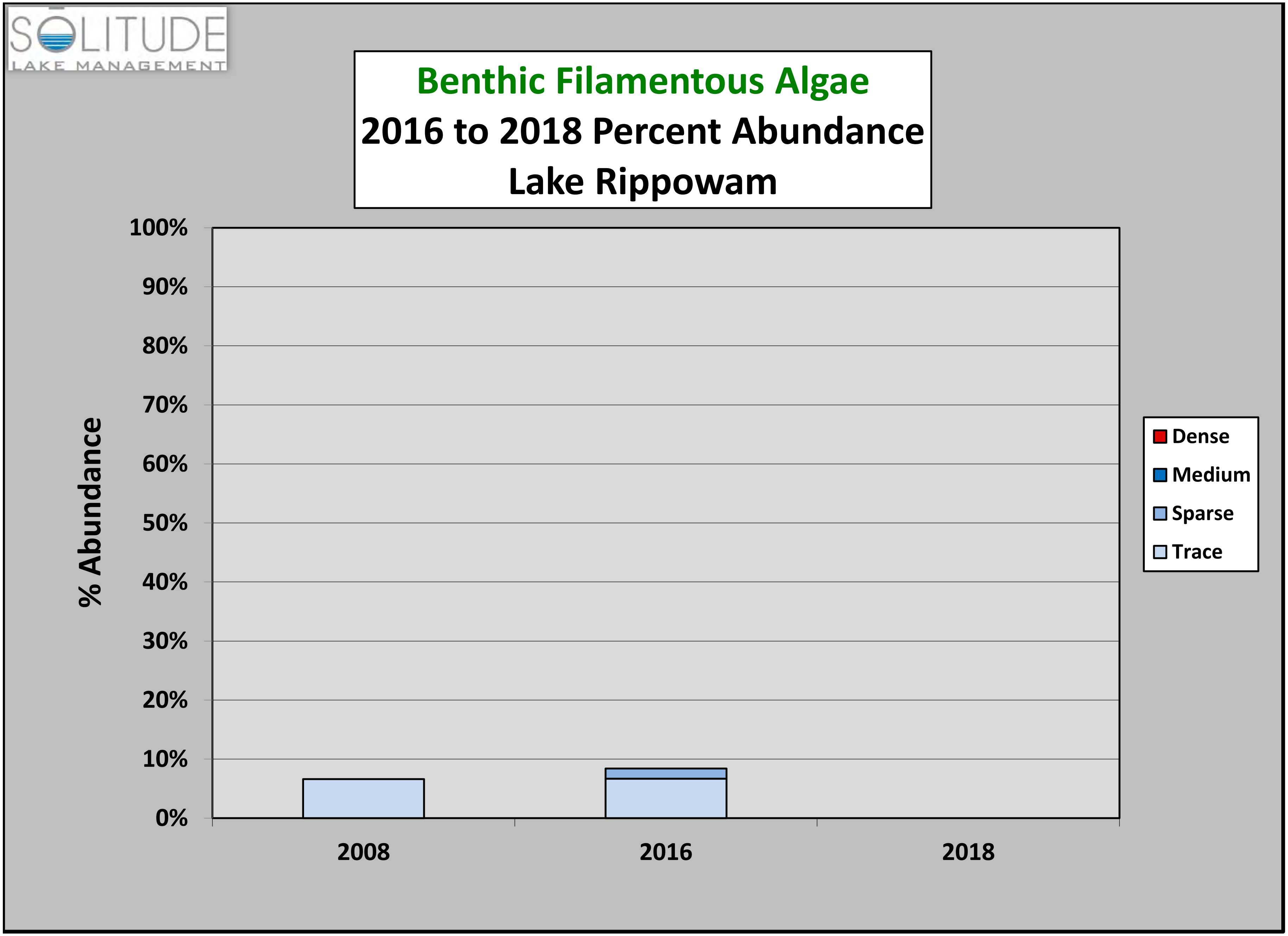
SOLITUDE
LAKE MANAGEMENT
Bassweed (Potamogeton amplifolius)
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

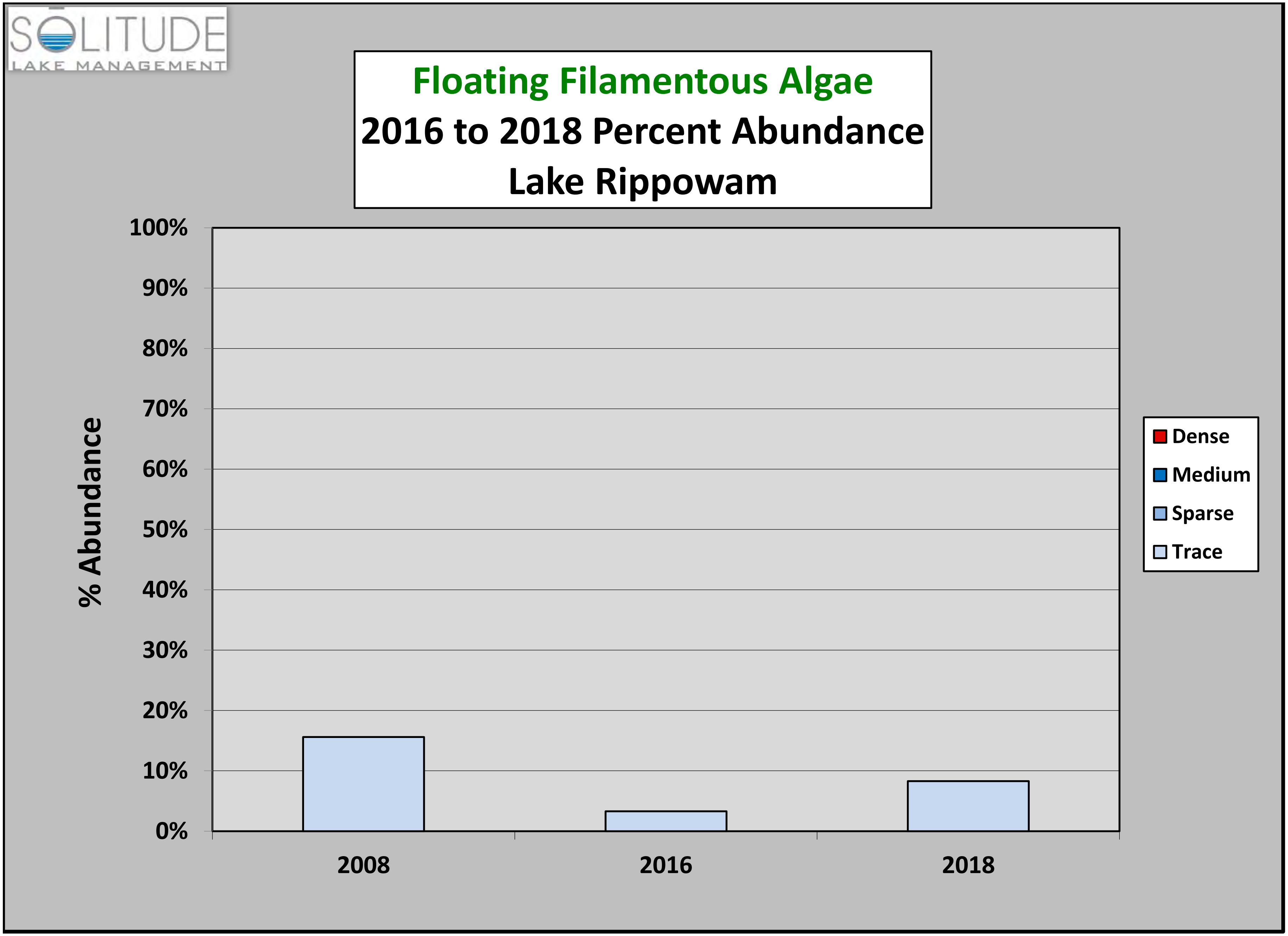


Arrowhead Rosette (Sagittaria sp.)
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

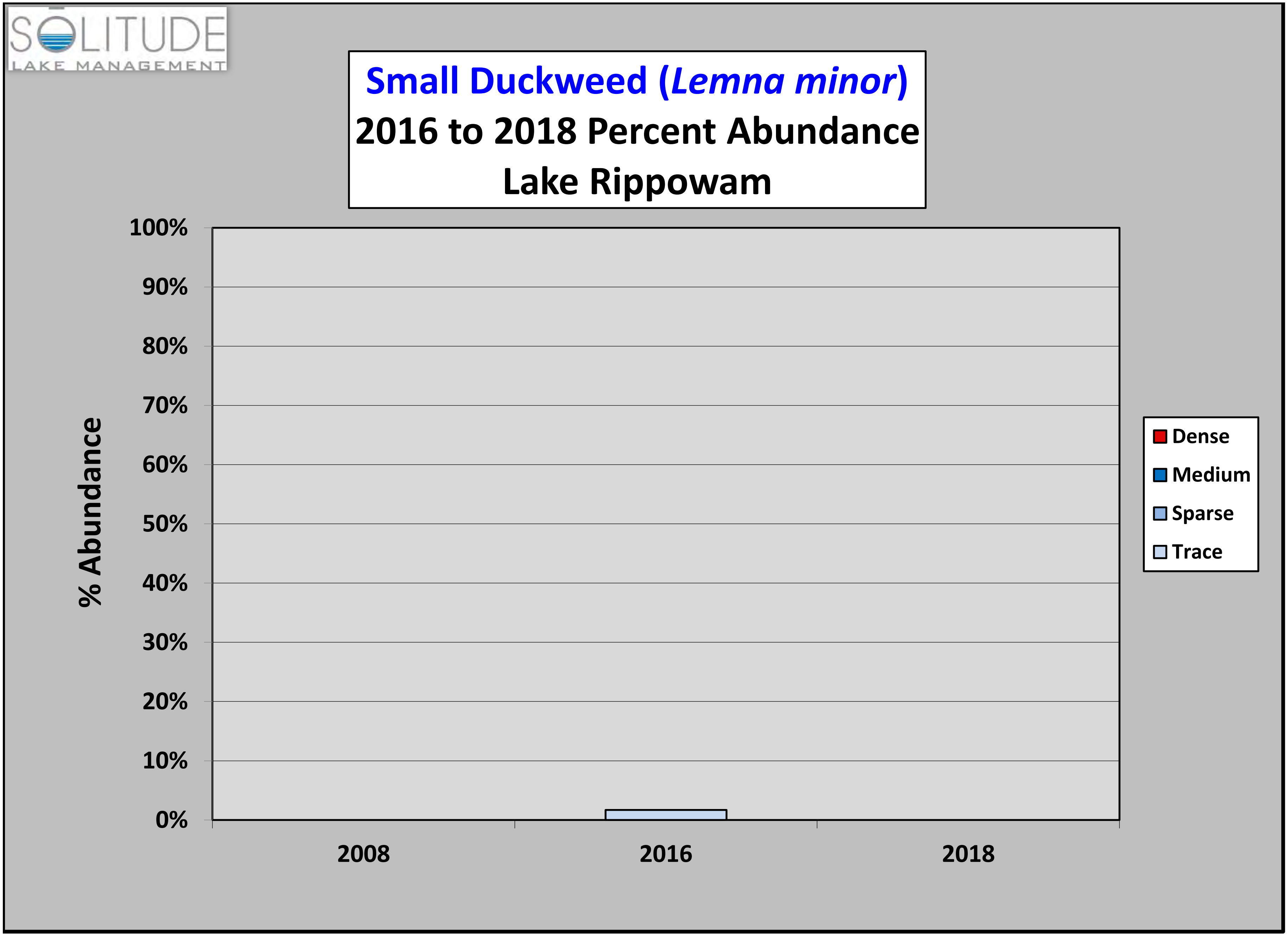


SOLITUDE
LAKE MANAGEMENT
Spatterdock (Nuphar variegata)
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


SOLITUDE
LAKE MANAGEMENT
Benthic Filamentous Algae
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace



SOLITUDE
LAKE MANAGEMENT
Floating Filamentous Algae
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace


SOLITUDE
LAKE MANAGEMENT
Small Duckweed (*Lemna minor*)
2016 to 2018 Percent Abundance
Lake Rippowam
% Abundance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2016
2018
Dense
Medium
Sparse
Trace

Floating Aquatic Plant Density

Trace

Medium

Sparse

Dense

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Submersed Aquatic Plant Density

Trace

Medium

Sparse

Dense

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LAKE MANAGEMENT

Lake Rippowam
Aquatic Macrophyte Abundance Distribution
July 26, 2018

	Total		Trace		Sparse		Medium		Dense	
	Sites	%	Sites	%	Sites	%	Sites	%	Sites	%
TOTAL SITES	60									
TOTAL SUBMERSED VEGETATION	35	58%	26	74%	8	23%	1	3%	0	0%
EURASIAN WATER MILFOIL	35	58%	27	77%	7	20%	1	3%	0	0%
ARROWHEAD (ROSETTE)	3	5%	3	100%	0	0%	0	0%	0	0%
BASSWEED	2	3%	2	100%	0	0%	0	0%	0	0%
COONTAIL	1	2%	1	100%	0	0%	0	0%	0	0%
TOTAL FLOATING VEGETATION	28	47%	9	32%	4	14%	5	18%	10	36%
WHITE WATER LILY	21	35%	5	24%	4	19%	4	19%	8	38%
SPATTERDOCK	8	13%	4	50%	1	13%	1	13%	2	25%
FLOATING FILAMENTOUS ALGAE	5	8%	5	100%	0	0%	0	0%	0	0%

Sample Point Location

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Sample Point

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Total Floating Vegetation Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	28	47%
Trace	9	32%
Sparse	4	14%
Medium	5	18%
Dense	10	36%

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Total Submersed Vegetation Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	35	58%
Trace	26	74%
Sparse	8	23%
Medium	1	3%
Dense	0	0%

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Arrowhead Rosette (*Sagittaria sp.*) Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	3	5%
Trace	3	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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Bassweed (*Potamogeton amplifolius*) Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	2	3%
Trace	2	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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Coontail (*Ceratophylllum demersum*) Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	1	2%
Trace	1	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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Eurasian Water Milfoil (*Myriophyllum spicatum*) Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	35	58%
Trace	27	77%
Sparse	7	20%
Medium	1	3%
Dense	0	0%

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Floating Filamentous Algae Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- = No Plants
- = Trace Plants
- = Sparse Plants
- = Medium Plants
- = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	5	8%
Trace	5	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

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Spatterdock (*Nuphar variegata*) Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- = No Plants
- T = Trace Plants
- S = Sparse Plants
- M = Medium Plants
- D = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	8	13%
Trace	4	50%
Sparse	1	13%
Medium	1	13%
Dense	2	25%

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White Water Lily (*Nymphaea ordorata*) Distribution

Lake Rippowam
Aquatic Vegetation Survey
July 26, 2018

Total Sample Sites: 60

Plant Density Legend

- ● = No Plants
- Ⓣ = Trace Plants
- Ⓢ = Sparse Plants
- Ⓜ = Medium Plants
- Ⓓ = Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	21	35%
Trace	5	24%
Sparse	4	19%
Medium	4	19%
Dense	8	38%

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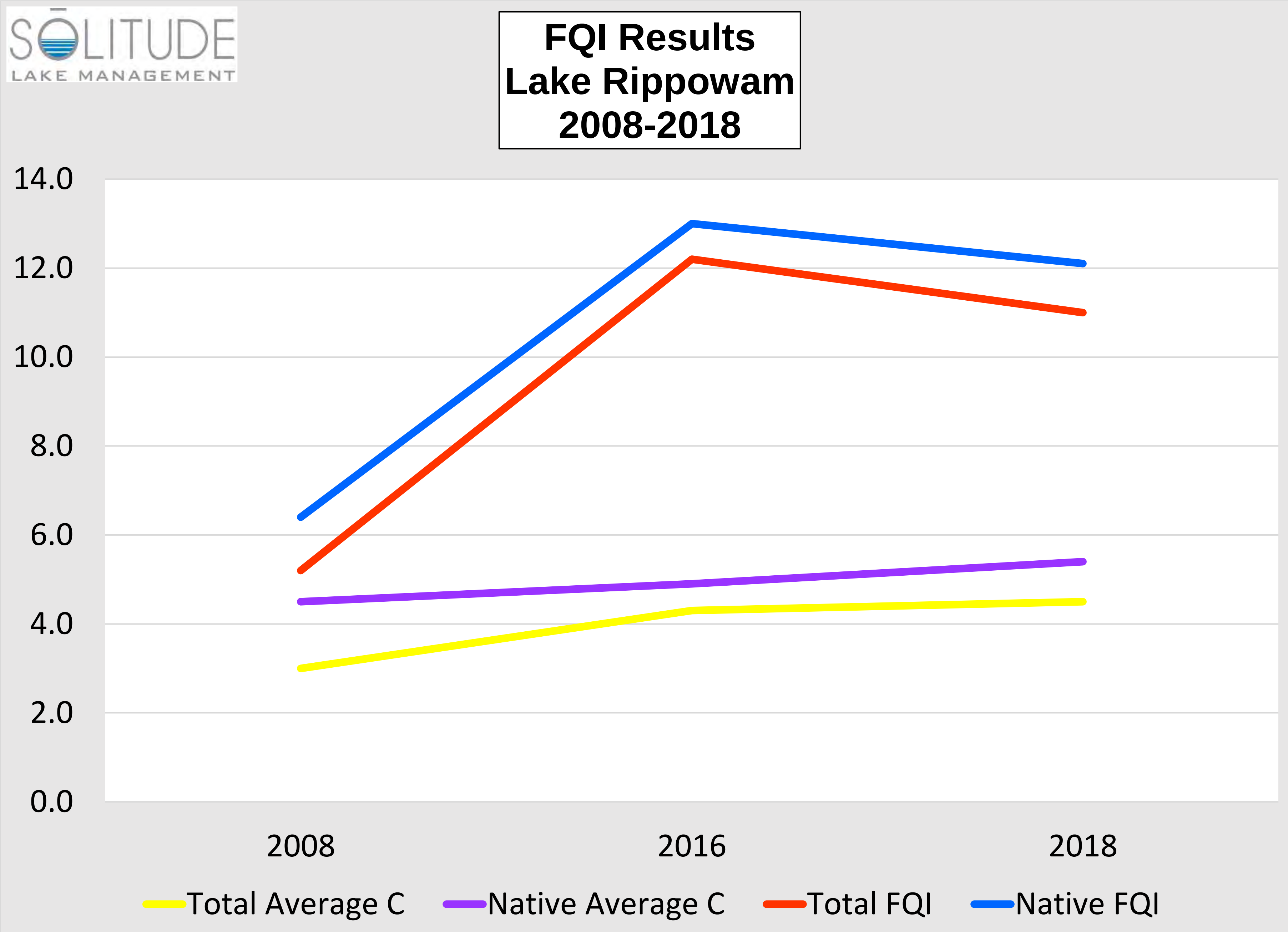
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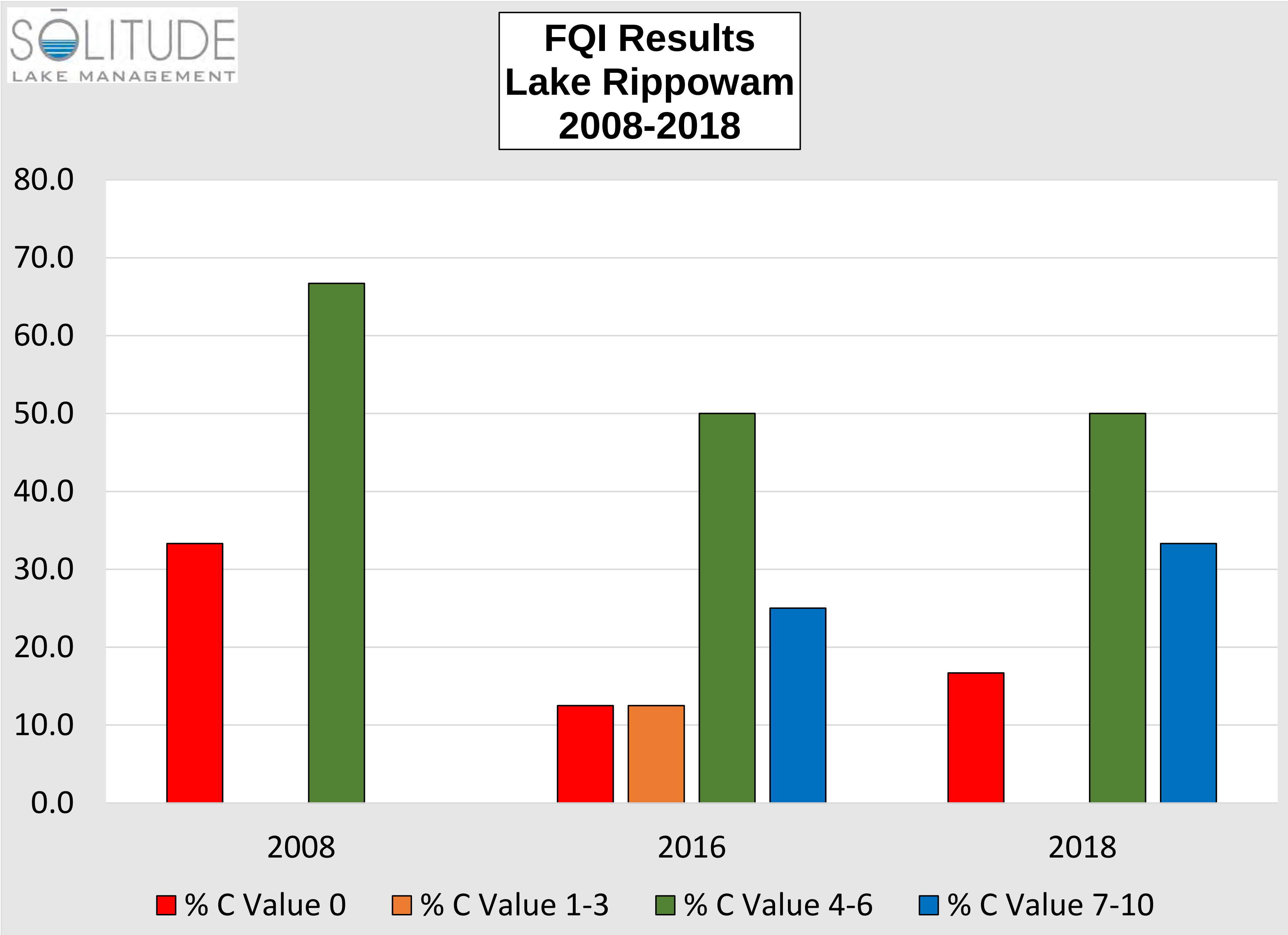
LAKE MANAGEMENT
FQI Results
Lake Rippowam
2008-2018
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
2008
2016
2018
Total Average C
Native Average C
Total FQI
Native FQI



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LAKE MANAGEMENT
FQI Results
Lake Rippowam
2008-2018
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
2008
2016
2018
% C Value 0
% C Value 1-3
% C Value 4-6
% C Value 7-10