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Aquatic Plant Community of the Red Cedar Lakes: 2018

- **Red Cedar Lake** – Barron County, WI (#2109600)
- **Hemlock Lake** – Barron County, WI (#2109800)
- **Balsam Lake** – Washburn County, WI (#2112800)
- **Mud Lake** – Washburn County, WI (#2112800)

Surveyed Aug 28 – Sep 7, 2018

Survey, Analysis, and Reporting by:
James A. Johnson – *Aquatic Ecologist, Freshwater Scientific Services, LLC*
Certified Lake Manager
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Introduction

Value of Aquatic Plants

Aquatic plants play an important role in freshwater lakes. They anchor sediments, buffer wave action, oxygenate water, and provide valuable habitat for aquatic animals. Consequently, the amount and type of plants in a lake can greatly affect nutrient cycling, water clarity, and food-web interactions (Jeppeson et al. 1998). Furthermore, plants are very important for fish reproduction, survival, and growth, and can greatly impact the type and size of fish in a lake. Unfortunately, healthy aquatic plant communities are often degraded by poor water clarity, excessive plant control activities, and the invasion on non-native nuisance plants. These disruptive forces alter the diversity and abundance of aquatic plants in lakes and can lead to undesirable changes in many other aspects of a lake's ecology. Consequently, it is very important that lake managers find a balance between controlling nuisance plant growth and maintaining a healthy, diverse plant community.

Purpose of Aquatic Plant Surveys

These surveys were designed to map the extent of curlyleaf pondweed beds and provide detailed, statistical assessments of the aquatic plant communities in Red Cedar Lake, Hemlock Lake, Balsam Lake, and Mud Lake (collectively referred to as the "Red Cedar Lakes" hereafter). The information gained from these assessments provides a baseline for evaluating any changes in the plant community over the coming years, and will help to guide responsible vegetation management planning.

Objectives of Aquatic Plant Surveys

1) Estimate the percent of each lake that supports vegetation
2) Estimate the maximum depth of plant growth in each lake
3) Develop a list of the aquatic plant species found in each lake
4) Characterize the distribution and abundance of plant species in each lake
5) Calculate plant community statistics

Description of Lakes

The four Red Cedar Lakes straddle the border between Barron and Washburn Counties in northwestern Wisconsin (Figs. 1 and 2, Table 1). These lakes are all interconnected and can be accessed from multiple public and private boat launches, and are highly valued in the region for fishing and boating.

Hemlock and Mud Lakes are fertile waterbodies (eutrophic) that typically experience low to moderate summer water clarity (average Secchi ~5 ft, Table 1). By contrast, Balsam and Red Cedar Lake are less fertile (mesotrophic) and typically experience greater summer water clarity (average Secchi ~8 to 11 ft, Table 1).

All four of the surveyed lakes are known to be infested with curlyleaf pondweed (*Potamogeton crispus*), an invasive, non-native, aquatic plant. The Red Cedar Lakes Association has plans to actively management curlyleaf in the lakes over the coming years.

Figure 1. Map of showing Balsam, Red Cedar, Hemlock and Mud Lakes.

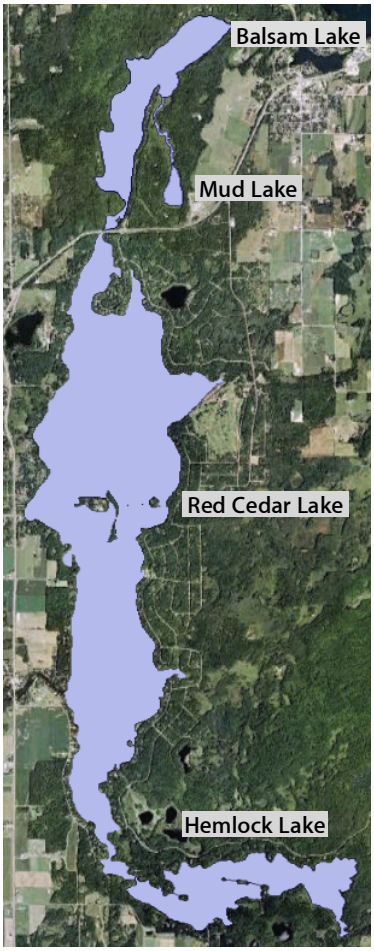


Figure 2. Location of the Red Cedar Lakes

Table 1. Lake identifiers and characteristics (WDNR 2011)

	Red Cedar	Hemlock	Balsam	Mud
County	Barron	Barron	Washburn	Washburn
ID# (WBIC)	21-096-00	21-098-00	21-128-00	–
Surface Area *(acres)*	1841	357	295	28
Maximum Depth *(ft)*	53	21	49	26
Mean Depth *(ft)*	27	8	25	4
Summer Water Clarity *(ft)*	8	5	11	~5
Trophic State (fertility)	mesotrophic	eutrophic	mesotrophic	eutrophic

Bathymetric Maps

Figure 3. *Red Cedar Lake* bathymetry map. (WDNR map superimposed over aerial image). Areas deeper than ~20 ft are shaded dark blue.

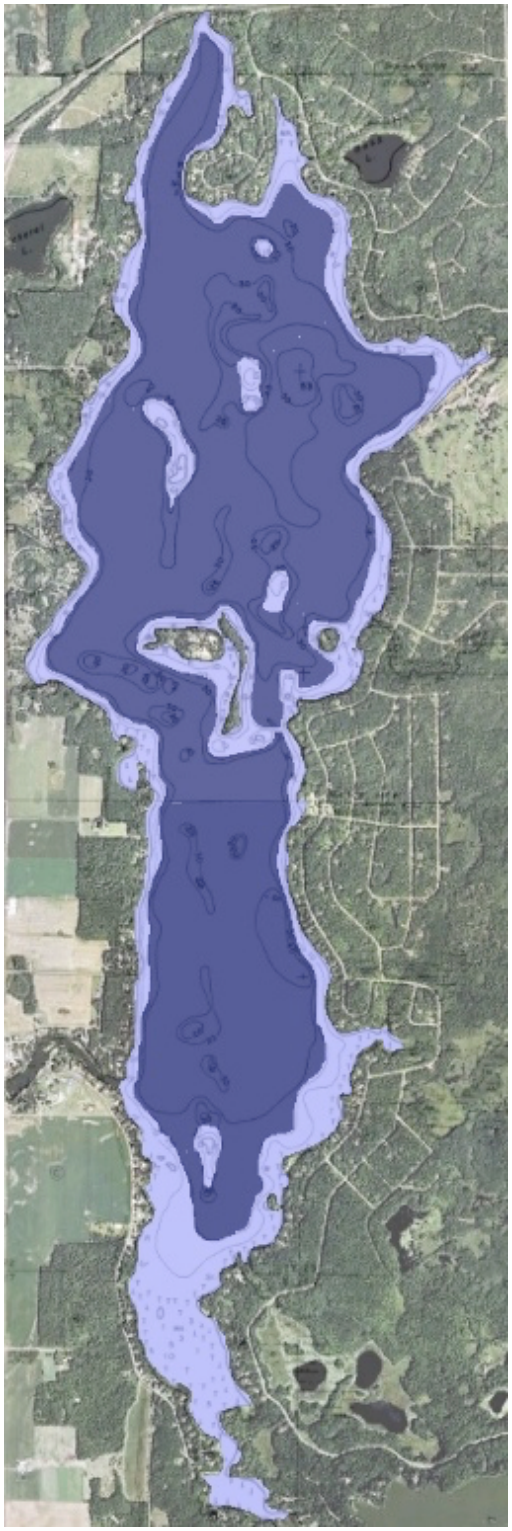
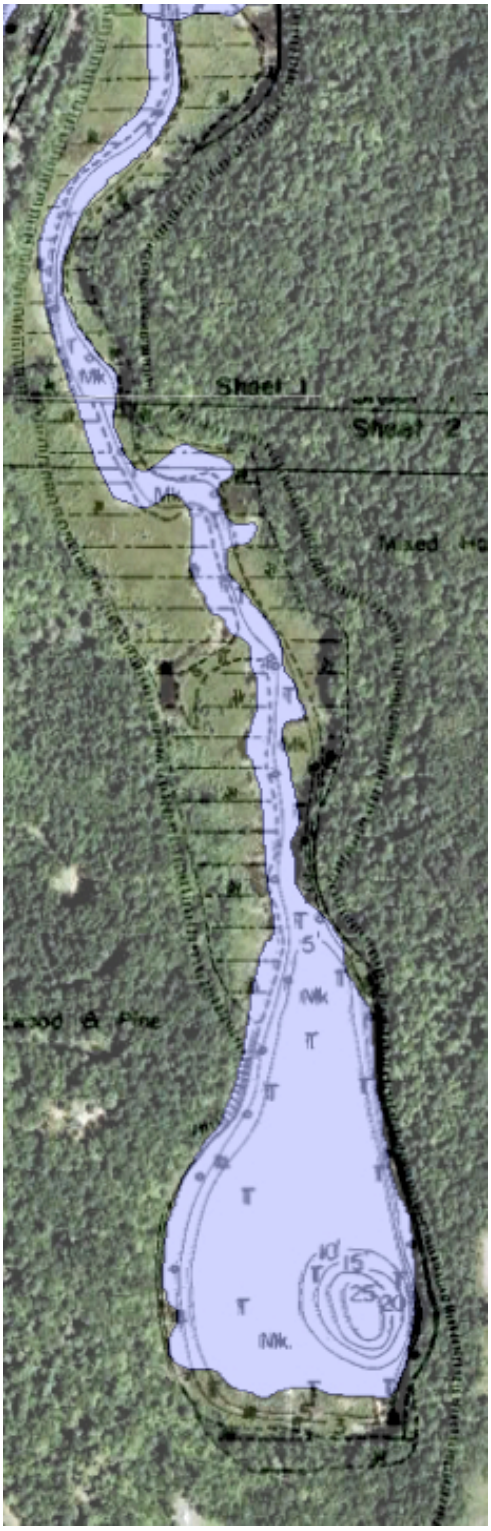


Figure 4. *Mud Lake* bathymetry map. (WDNR map superimposed over aerial image).



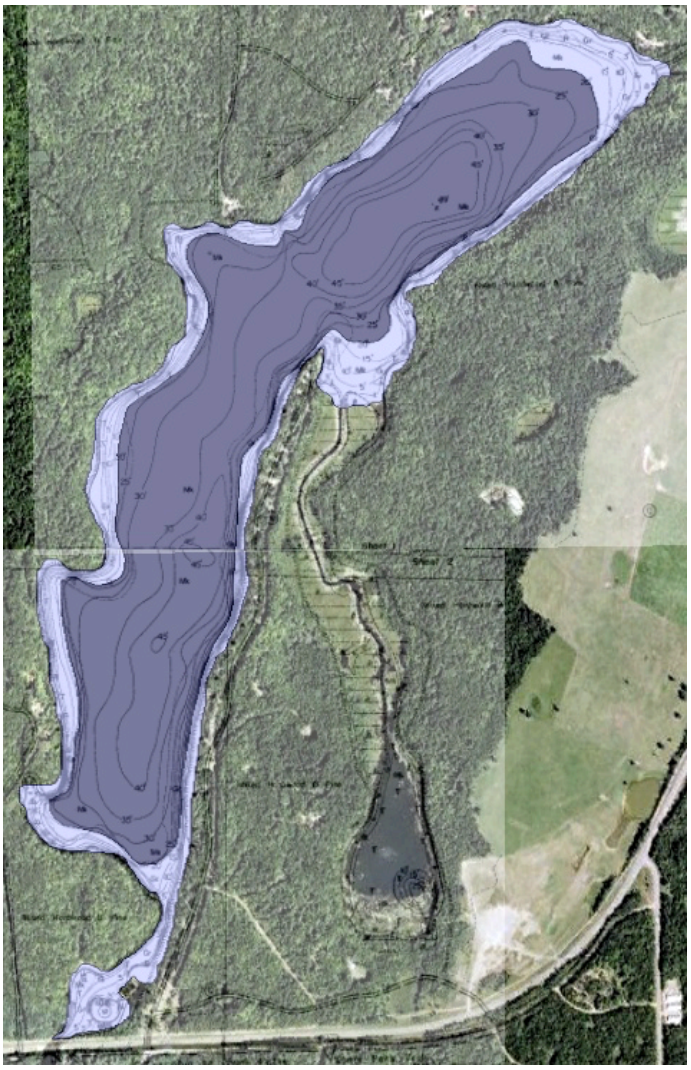
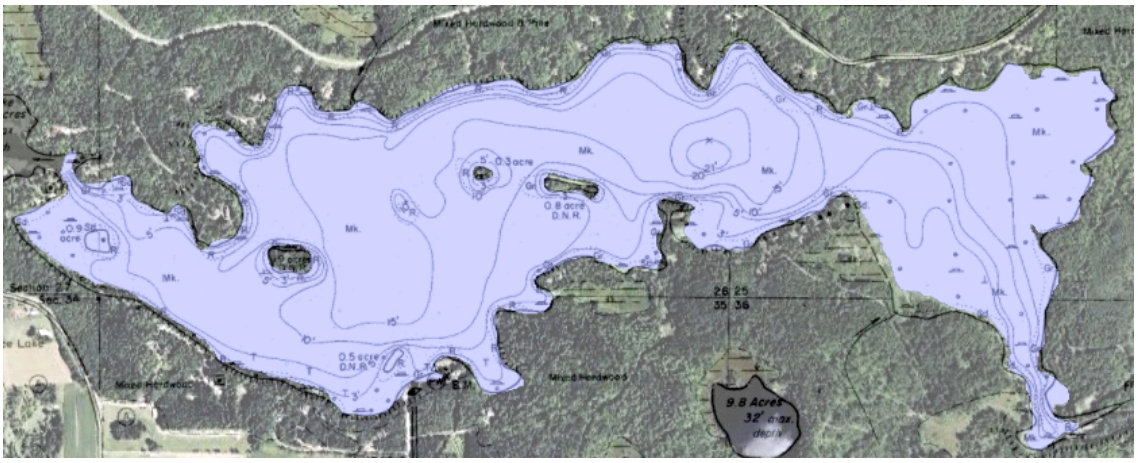


Figure 5. *Balsam Lake* bathymetry map. (WDNR map superimposed over aerial image). Areas deeper than ~20 ft are shaded dark blue.

Figure 6. *Hemlock Lake* bathymetry map. (WDNR map superimposed over aerial image).



Sampling & Analysis Methods

2018 Summer Aquatic Plant Surveys

Freshwater Scientific Services, LLC completed lake-wide vegetation surveys for each of the four lakes between Aug 28 and Sep 7, 2018 using the point-intercept method described by Madsen (1999). These surveys incorporated assessments at roughly 100 to 400 points in each lake (Figs. 7–10). These points were arranged in a grid across each lake (points provided by WDNR). We then loaded the sample point locations onto a handheld GPS unit (Garmin GPSMAP-78) to enable navigation to each point while in the field.

At each designated location, we sampled plants using a rake. For sites shallower than 10 ft, we used a double-headed, 14-tine rake on a pole; for sites deeper than 10 ft, we used an identical rake head attached to a 50-ft rope. To ensure that each sample collected plants from a consistent area of lake sediment, we dragged the rake (13 inches wide) approximately 1 foot along the bottom before retrieving (WDNR 2010). For each rake sample, all of the retrieved plants were piled on top of the rake head and assigned density ratings from 1 to 3 based upon rake coverage as described in Table 2. Shoreland plant species were noted as present when observed growing in the water near the sampled points, however we did not conduct intensive shoreland plant surveys.

We assigned density ratings for all plants collectively (whole rake density) as well as for each individual plant species retrieved on the rake. Additional species that were observed growing within 10 ft of a sample point but not retrieved on the rake were given a rating of zero for that site. These "zero" species were included in the final species lists and distribution maps, but were not included in the calculation of plant community metrics and statistics.

Table 2. Description of rake density ratings (WDNR 2010)

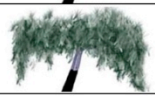
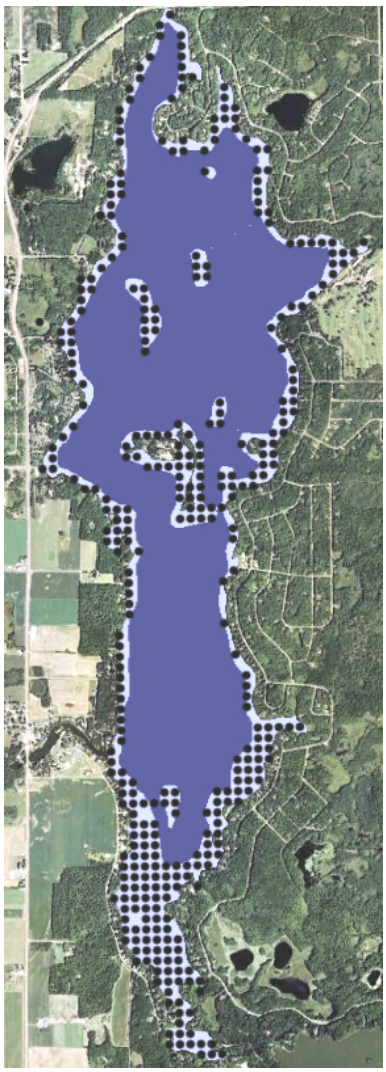
Density Rating	Rake Coverage	Description
1		Only a few plants retrieved
2		Plants cover full length of rake head, but do not cover the tines completely
3		Plants completely cover rake head and tines

Figure 7. *Red Cedar Lake* – Map of sample points used for the 2018 point-intercept plant survey (areas deeper than ~20 ft are shaded in dark blue), and plot of sampling effort (number of points) by depth zone



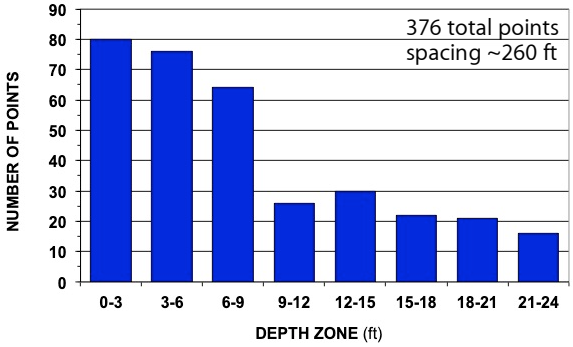
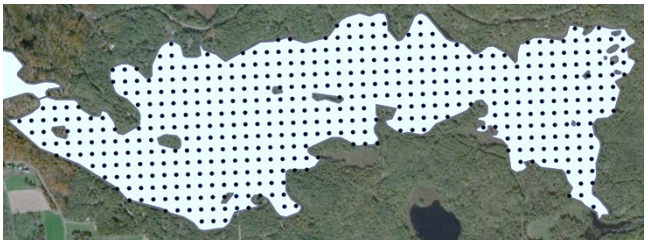


Figure 8. *Hemlock Lake* – Map of sample points used for the 2018 point-intercept plant survey, and plot of sampling effort (number of points) by depth zone.



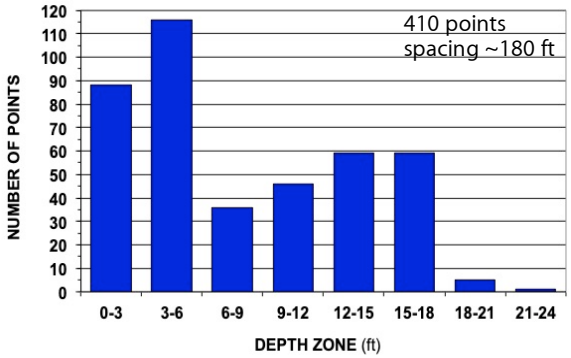
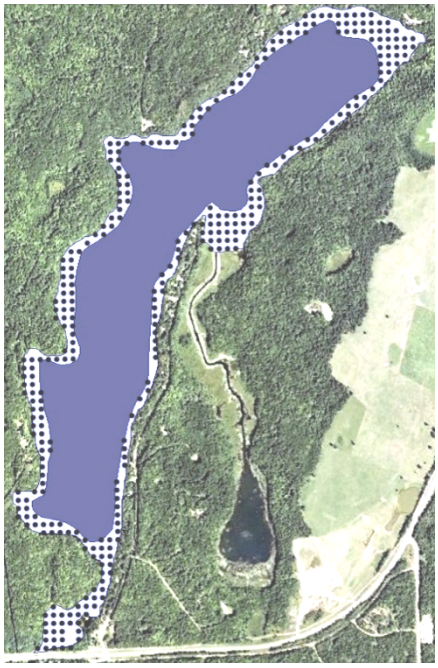


Figure 9. *Balsam Lake* – Map of sample points used for the 2011 point-intercept plant survey (areas deeper than ~20 ft are shaded in dark blue), and plot of sampling effort (number of points) by depth zone



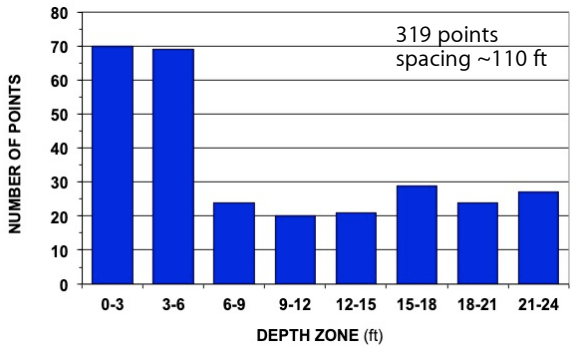
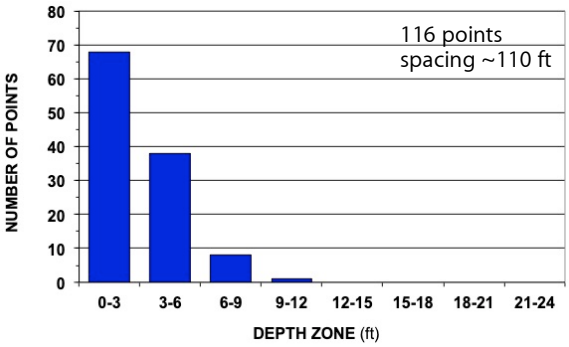


Figure 10. *Mud Lake* – Map of sample points used for the 2011 point-intercept plant survey, and plot of sampling effort (number of points) by depth zone. Areas deeper than ~20 ft are shaded in dark blue.



Aquatic Plant Survey Data Analysis

Frequency of Aquatic Plant Species (% Occurrence)

Plant frequency is the percent of sampled points where a given taxon of plant (most taxa identified to species) was found. This indicates how common each taxon was, but does not reflect the density of the plant growth. We calculated plant frequency for (1) the entire portion of the lake shallower than the observed maximum depth of plant growth (*littoral frequency*, WDNR 2010), (2) areas shallower than a fixed depth of 15 ft to allow for easier comparisons between lakes, and (3) within specific depth zones to show plant distribution by depth.

Density of Aquatic Plant Growth

Plant density provides an estimate of the abundance or biomass of plants. For each lake, we calculated average plant densities for (1) the entire area shallower than the maximum depth of plant growth (*littoral density*), (2) within specific depth zones, and (3) within plant beds (*bed density*).

Littoral density is a measure of how densely each plant species grew throughout the littoral area (<maximum depth of growth) of the lake. This assessment provides an indication of whether plants formed widespread, dense growth in the littoral area of the lake. In general, density ratings greater than 2 are often associated with nuisance growth, particularly for plant species that can grow to the surface. Conversely, density ratings below 2 represent light to moderate plant density that would not be expected to impair lake recreation.

Bed density is a measure of how densely a plant species grew in the beds where it was found – disregarding sites where it was not found. For example, if a given plant species was only found in a 1-acre patch in a large lake, but was growing very densely in that area, it would have a very low littoral density, but a high bed density. Bed density is useful for identifying plant species that may form localized areas of nuisance growth.

Aquatic Plant Community Statistics

In addition to reporting the frequency and density of individual plant species in the lakes, we have included plant community statistics and indices that evaluate all of the plants collectively (*Simpson's Diversity*, *Floristic Quality Index* (FQI), *Aquatic Macrophyte Community Index* (AMCI), etc.). These plant community assessments provide a simple way to evaluate the diversity and ecological quality of the plant community in the lakes, compare between lakes, and detecting changes in the lakes over time.

Description of Calculated Statistics and Metrics

% Occurrence

Description: The percent of sampled locations shallower than a reference depth where a given plant species was found; in this report, we have calculated the % occurrence (1) using all points shallower than 15 ft ("littoral"), and (2) using all points shallower than the maximum depth of plant growth (95th percentile) in each lake (WDNR 2010).

Formula: = Number of points with a given species ÷ Total # points *(only from sites < reference depth)*

% Littoral Area Vegetated

Description: The percent of the littoral area (<15 ft deep) that supported plants of any kind

Formula: = $VA_{lit} \div TA_{lit}$

- VA_{lit} = Vegetated Littoral Area = ∑ Thiessen polygon areas for vegetated littoral points
- TA_{lit} = Total Littoral Area = (Total Basin Area) – (Area >15 ft)

% Lake Area Vegetated

Description: The percent of the entire lake area that supported plants of any kind

Formula: = Vegetated Area ÷ Total Lake Area

- Vegetated Area = ∑ Thiessen polygon areas for points with vegetation
- Total Lake Area = Area calculated using delineated shoreline in ArcView GIS

% Lake with Surface Vegetation

Description: The percent of the entire lake area with plants that reach the water's surface. This is a good indicator of recreational impairment.

Formula: = Area with surface growth ÷ Total Lake Area

- Area with surface growth = ∑ Thiessen polygon areas for points with surface vegetation
- Total Lake Area = Area calculated using delineated shoreline in ArcView GIS

Species Richness

Description: The number of different plant species found in the lake. Greater richness often translates into greater habitat diversity for fish.

Formula: = Total number of plant species encountered during the survey

Simpson's Diversity

Description: How "mixed" or diverse is the plant community? Lakes with many plant species that are evenly mixed throughout the lake have high diversity; those dominated by only one or two species have low diversity. A higher value (up to 1.0) indicates greater diversity.

Formula: = 100 x (1 – ∑ (Relative Frequency of encountered taxa^2))

- Relative Frequency = (% occurrence of a species) ÷ (∑ % occurrence for all species found) (see Nichols et al. 2000)

Average Number of Native Species/Point

Description: Another measure of the diversity of native plants in the lake.

Formula: = ∑(#Native species per littoral point) ÷ # of littoral points sampled

Results – Red Cedar Lake

Table 3. *Red Cedar Lake:* 2018 *Plant Frequency and Density*. *Max* = % occurrence using all points where depth was ≤ the 95th percentile of the max depth of growth, *<15ft* = % occurrence for depths ≤15 ft, *LITTORAL DENSITY* = mean density rating using all points where depth was ≤ the 95th percentile of the max depth of growth

COMMON NAME	SCIENTIFIC NAME	%OCCURRENCE Max	%OCCURRENCE <15ft	LITTORAL DENSITY
SUBMERSED PLANTS				
Coontail	*Ceratophyllum demersum*	46	44	0.6
Wild celery	*Vallisneria americana*	45	42	0.6
Flat-stem pondweed	*Potamogeton zosteriformis*	33	31	0.4
Canadian waterweed	*Elodea canadensis*	31	29	0.4
Clasping-leaf pondweed	*Potamogeton richardsonii*	29	28	0.4
Northern watermilfoil	*Myriophyllum sibiricum*	28	26	0.4
Fern-leaf pondweed	*Potamogeton robbinsii*	18	18	0.3
Slender naiad	*Najas flexilis*	16	15	0.2
Stiff pondweed	*Potamogeton strictifolius*	16	15	0.2
Large-leaf pondweed	*Potamogeton amplifolius*	10	10	0.1
Nitella	*Nitella sp.*	8	8	0.1
Stiff water crowfoot	*Ranunculus aquatilis*	8	8	0.1
Water marigold	*Bidens beckii*	6	6	0.1
Small pondweed	*Potamogeton pusillus*	6	6	0.1
Common bladderwort	*Utricularia vulgaris*	6	6	0.1
Water stargrass	*Heteranthera dubia*	5	5	0.1
White-stem pondweed	*Potamogeton praelongus*	5	5	0.1
Creeping bladderwort	*Utricularia gibba*	5	5	<0.1
Muskgrass	*Chara sp.*	3	3	<0.1
Aquatic moss	*Aquatic Moss*	1	1	<0.1
Curly-leaf pondweed	*Potamogeton crispus*	1	1	<0.1
Variable pondweed	*Potamogeton gramineus*	1	1	<0.1
Ribbon-leaf pondweed	*Potamogeton epihydrus*	1	1	<0.1
Needle spikerush	*Eleocharis acicularis*	<1	<1	<0.1
Illinois pondweed	*Potamogeton illinoensis*	<1	<1	<0.1
Twin-stemmed bladderwort	*Utricularia geminiscapa*	<1	<1	<0.1
FLOATING PLANTS				
Star duckweed	*Lemna trisulca*	12	11	0.1
White waterlily	*Nymphaea odorata*	11	10	0.1
Small duckweed	*Lemna minor*	5	5	<0.1
Bull-head pond-lily	*Nuphar variegata*	4	4	<0.1
Common watermeal	*Wolffia columbiana*	3	3	<0.1
Large Duckweed	*Spirodela polyrhiza*	2	2	<0.1
Crystalwort	*Riccia fluitans*	1	1	<0.1
Floating-leaf pondweed	*Potamogeton natans*	<1	<1	<0.1
EMERGENT PLANTS				
Arrowhead	*Sagittaria sp.*	1	1	<0.1
Sparganium sp.	*Sparganium sp.*	1	1	<0.1
Creeping spikerush	*Eleocharis palustris*	P	P	–
Hardstem bulrush	*Schoenoplectus acutus*	P	P	–
Cattail	*Typha sp.*	P	P	–

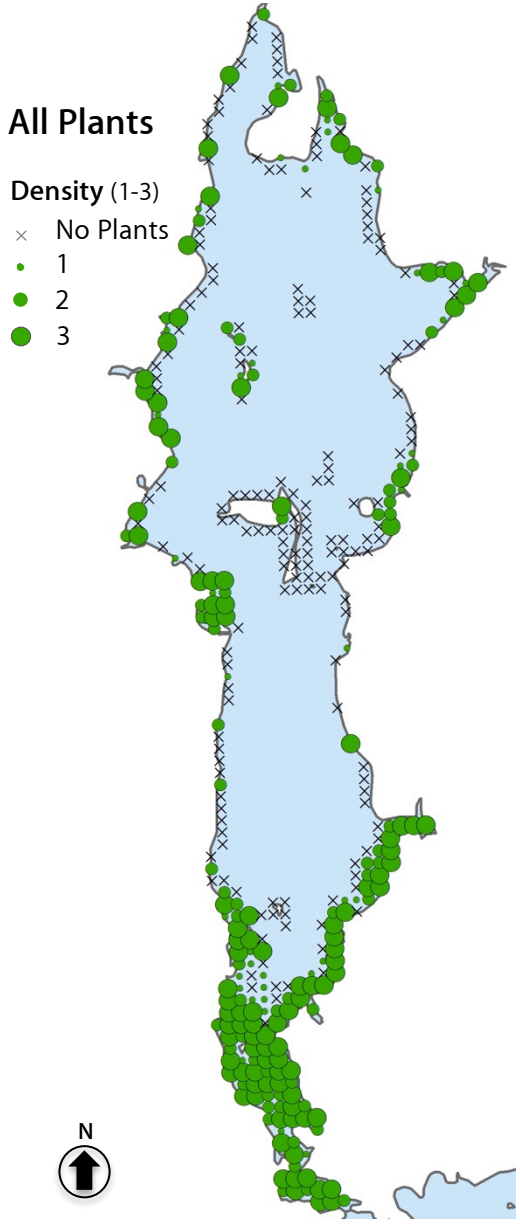
Table 4. *Red Cedar Lake:* 2018 aquatic plant community metrics

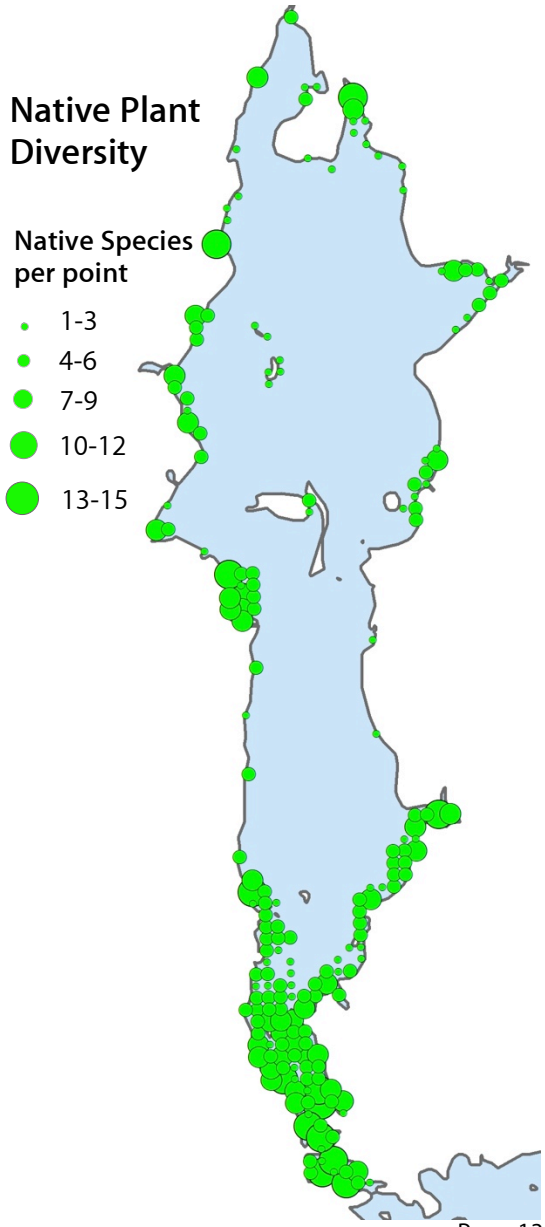
RED CEDAR LAKE

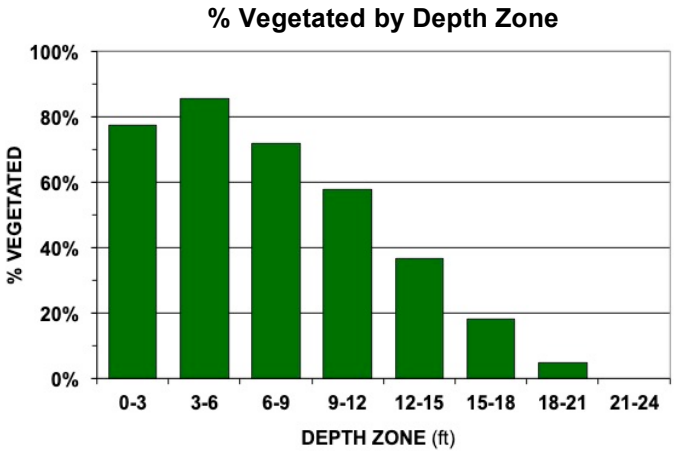
WHOLE-LAKE METRICS	2018
Lake Area	1897 acres
Total Points Sampled	376
Vegetated Area	308 acres *(16%)*
Area with Veg. to Surface	65 acres *(4%)*
Max Depth of Growth (95%)	14.1 ft
Native Submersed Taxa	25
Native Floating/Emergent Taxa	13
Non-Native Submersed Taxa	1

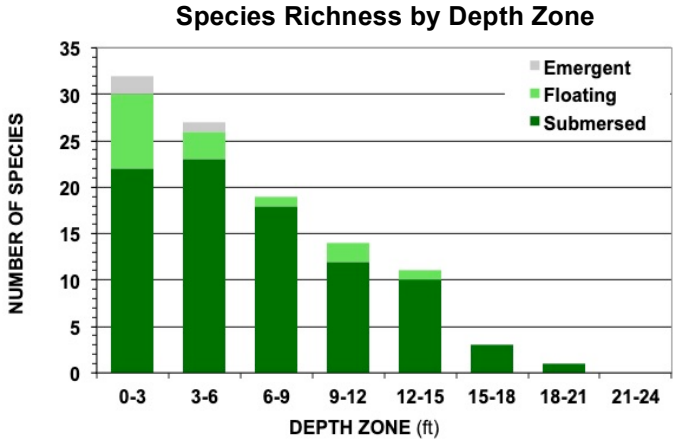
LITTORAL METRICS	2018
Littoral Area (≤15 ft)	384 acres
Littoral Points Sampled	262
% Littoral Points Vegetated	74%
Mean Plant Height	1.9 ft
% of Max Littoral Biovolume	39%
Mean Native Taxa / Point	3.7
Simpson's Diversity	93.2
Floristic Quality (FQI)	34.1
AMCI Score (Nichols et al. 2000)	54

Red Cedar Lake – Aquatic Plant Community





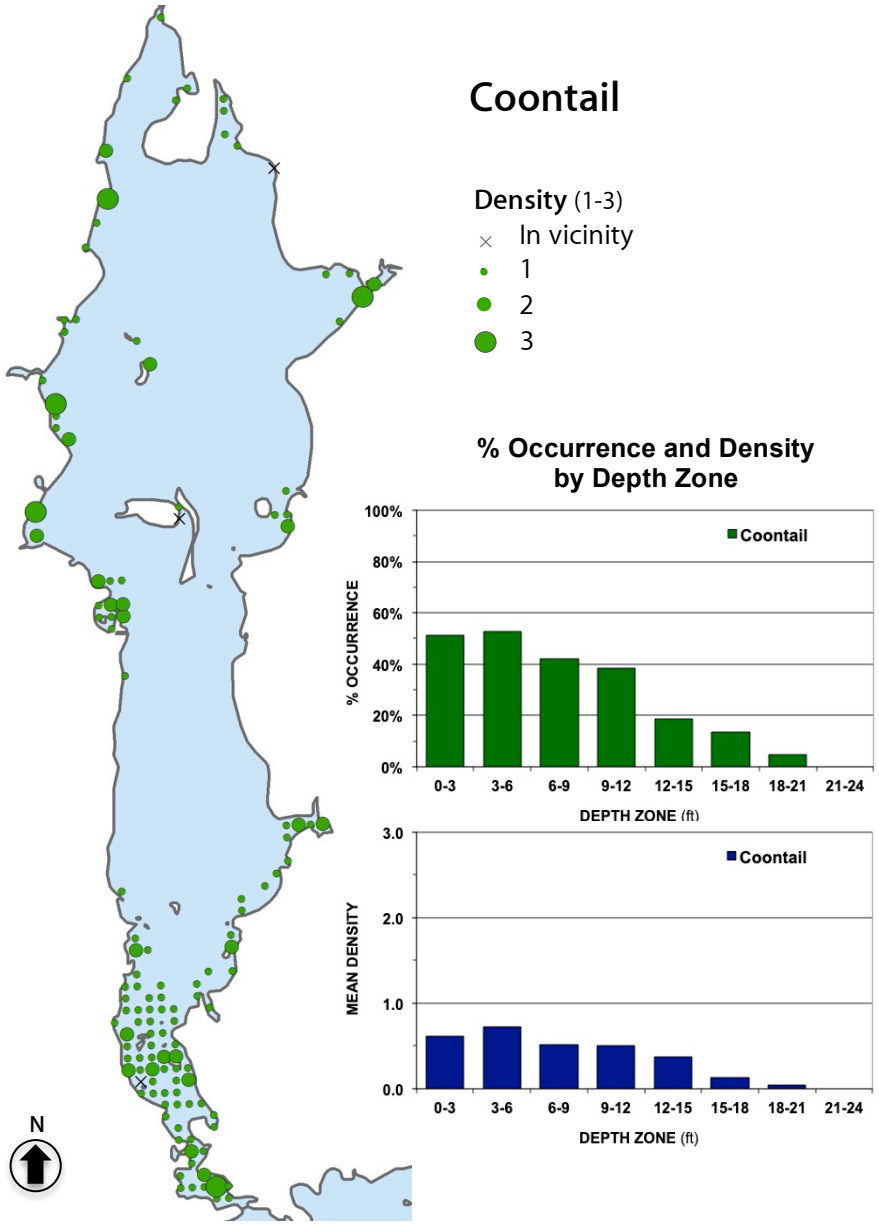


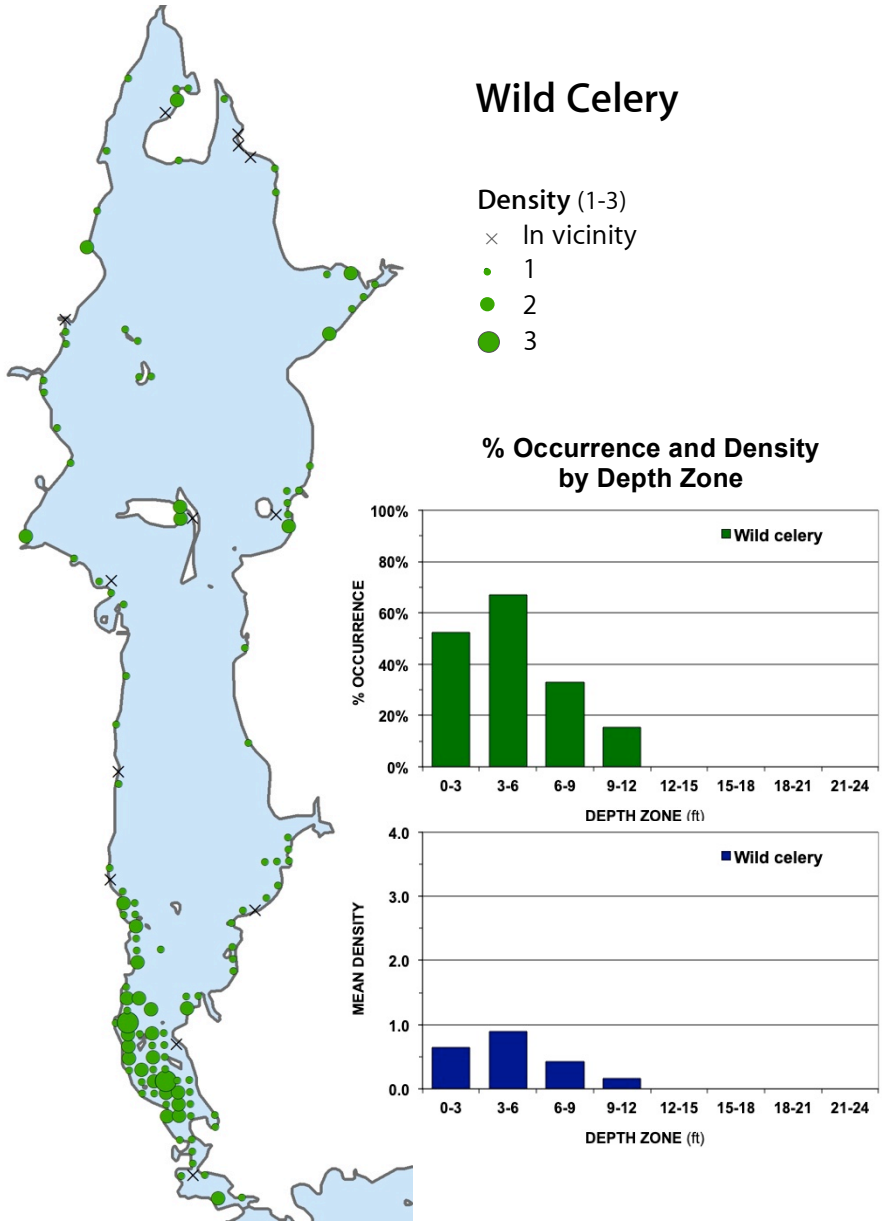


Surveyed: Aug 29 – Sep 7, 2018
Surveyor: JA Johnson
Methods: Rake, Depth Rod

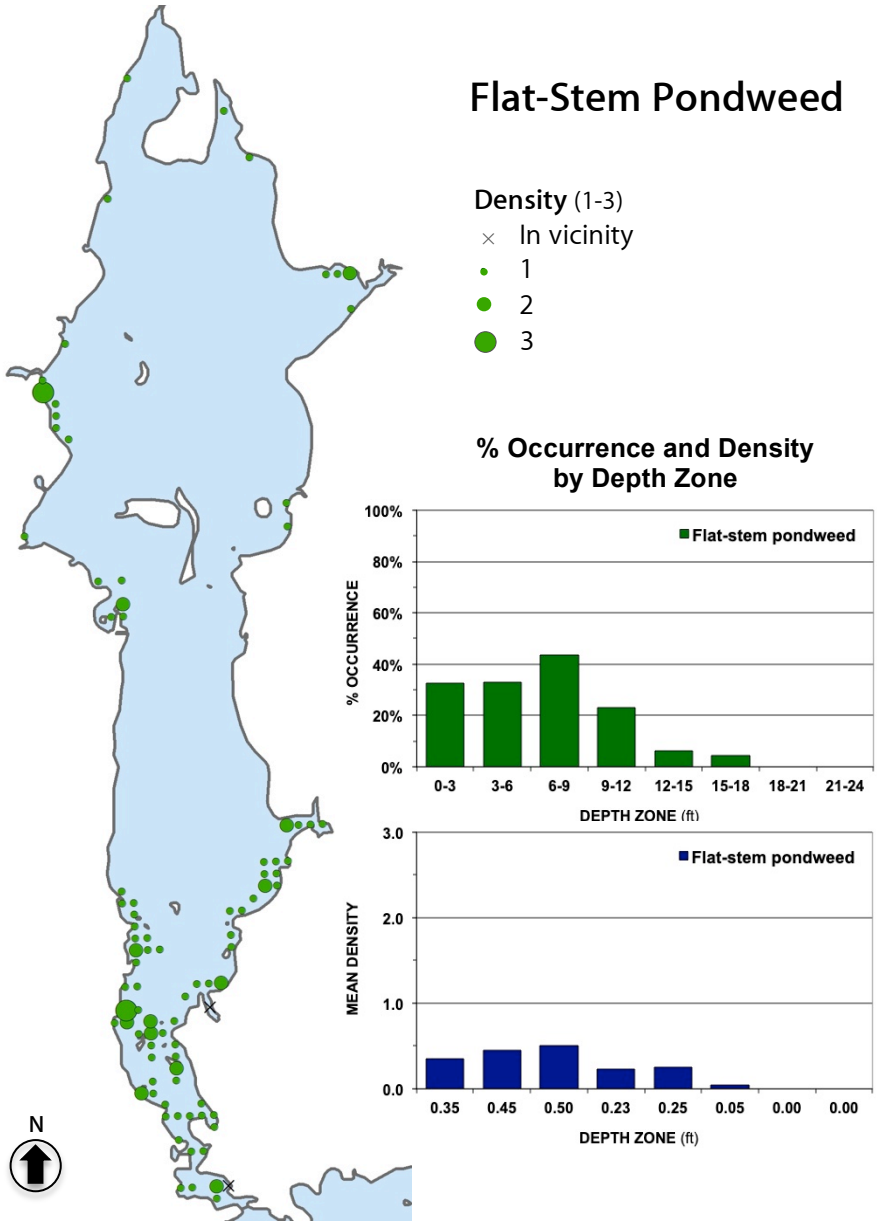
freshwater SCIENTIFIC SERVICES

Red Cedar Lake – Aquatic Plant Species (Submersed)





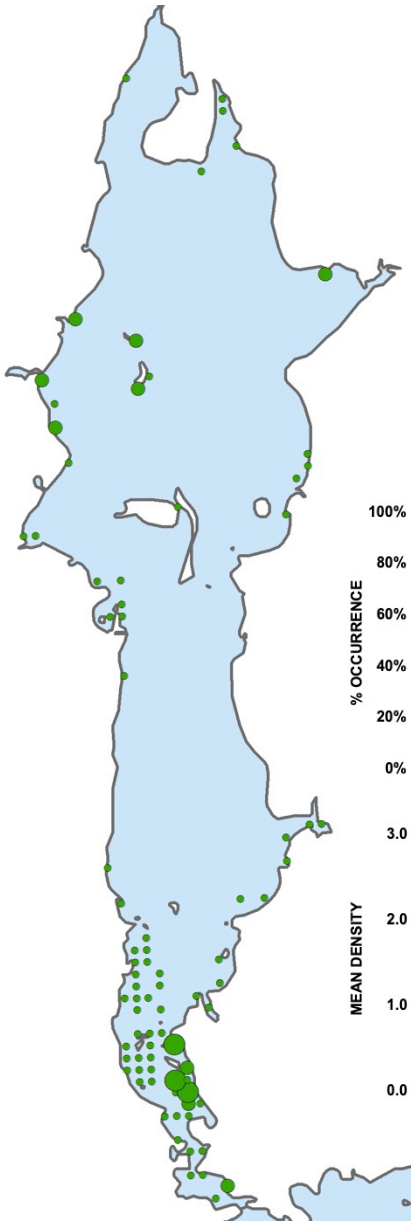
Red Cedar Lake – Aquatic Plant Species (Submersed)



Flat-Stem Pondweed

Density (1-3)
× In vicinity
• 1
● 2
● 3

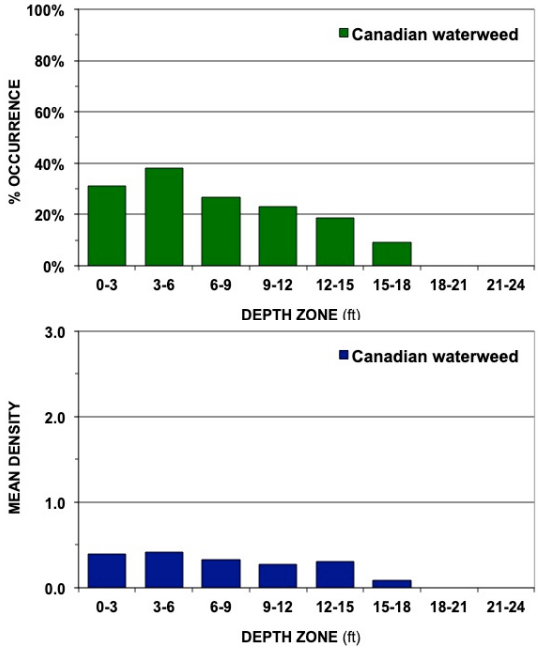
% Occurrence and Density by Depth Zone



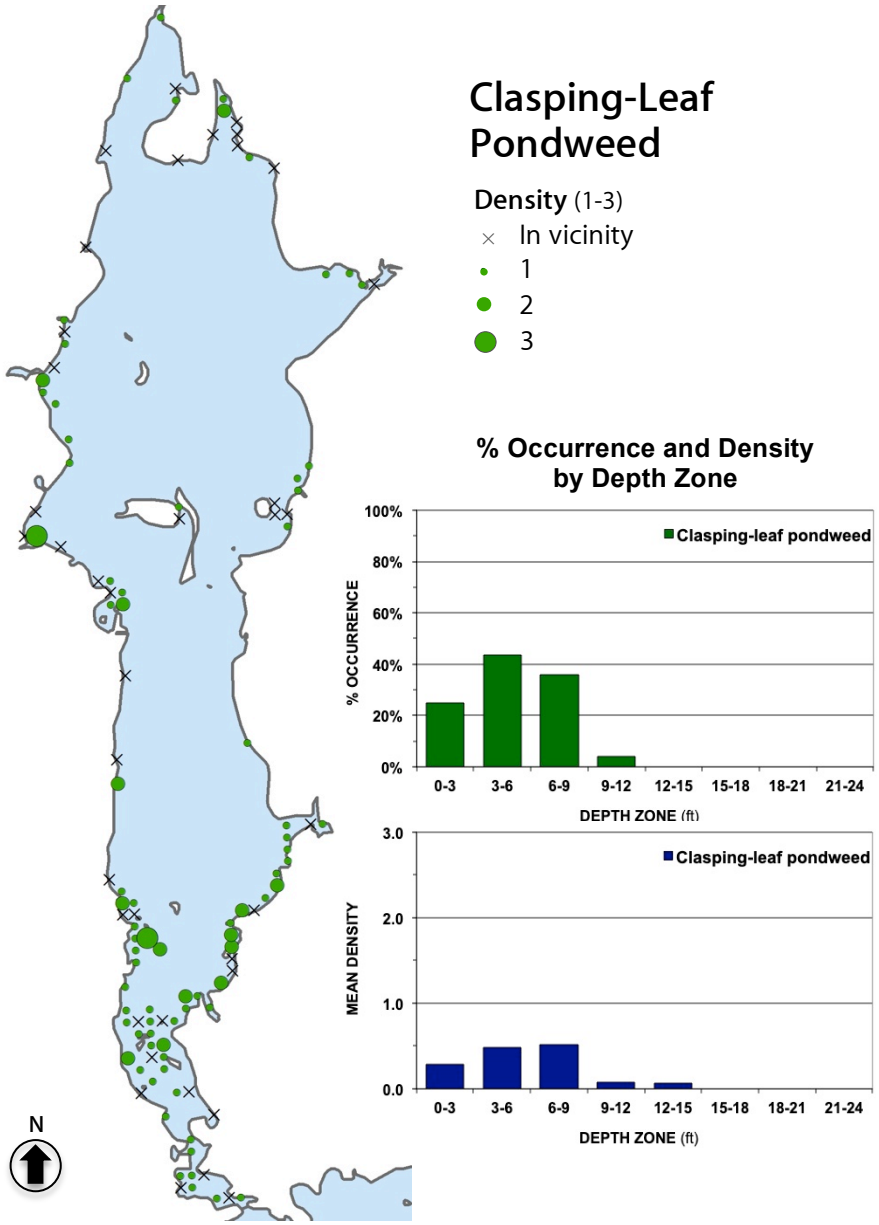
Canadian Waterweed

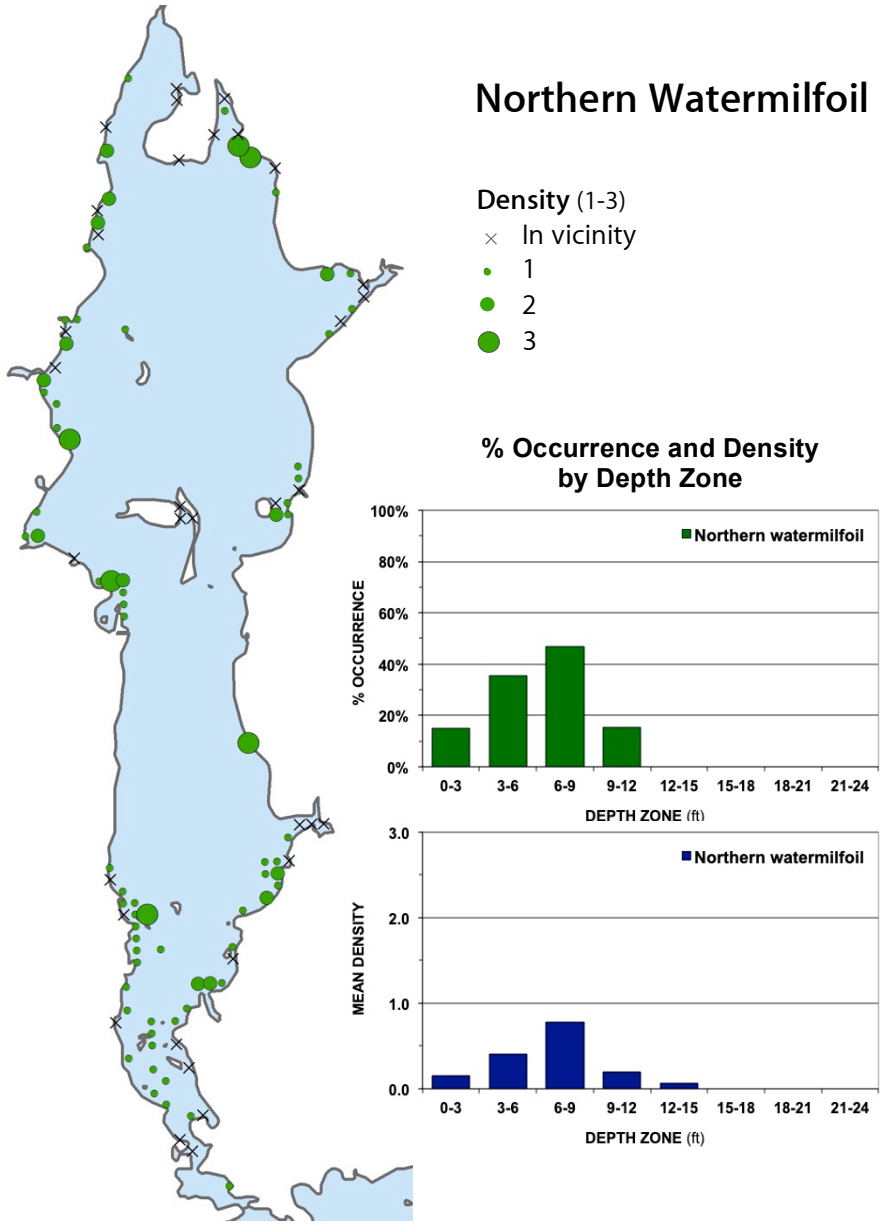
Density (1-3)
× In vicinity
• 1
● 2
● 3

% Occurrence and Density by Depth Zone

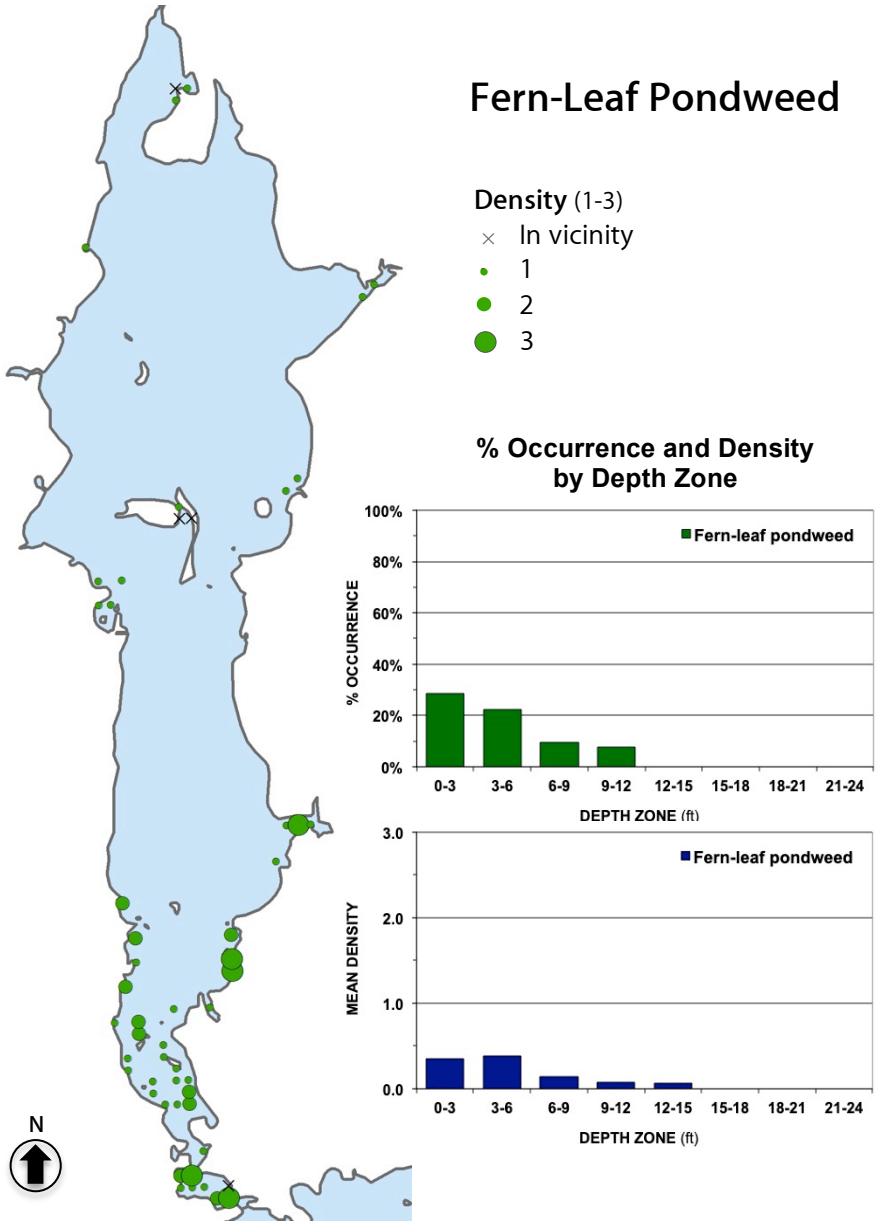


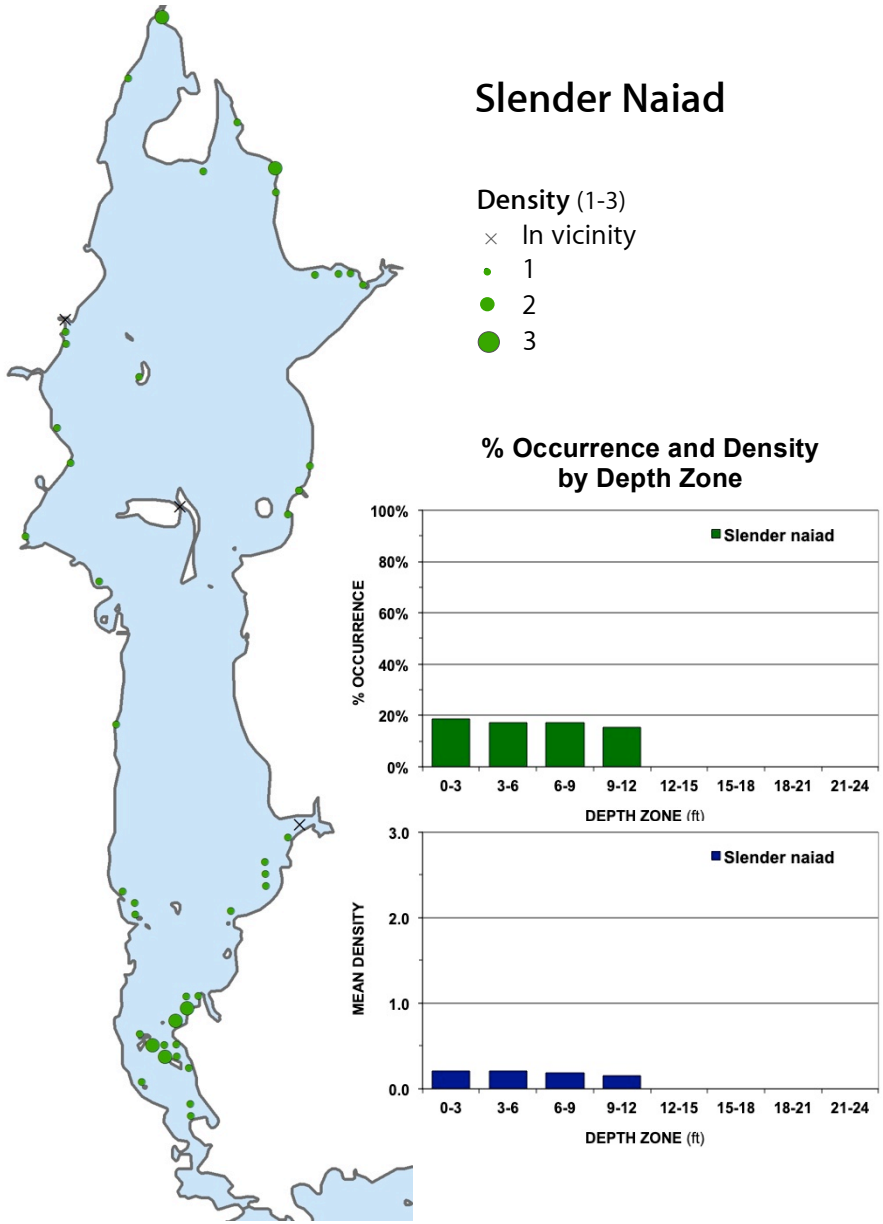
Red Cedar Lake – Aquatic Plant Species (Submersed)



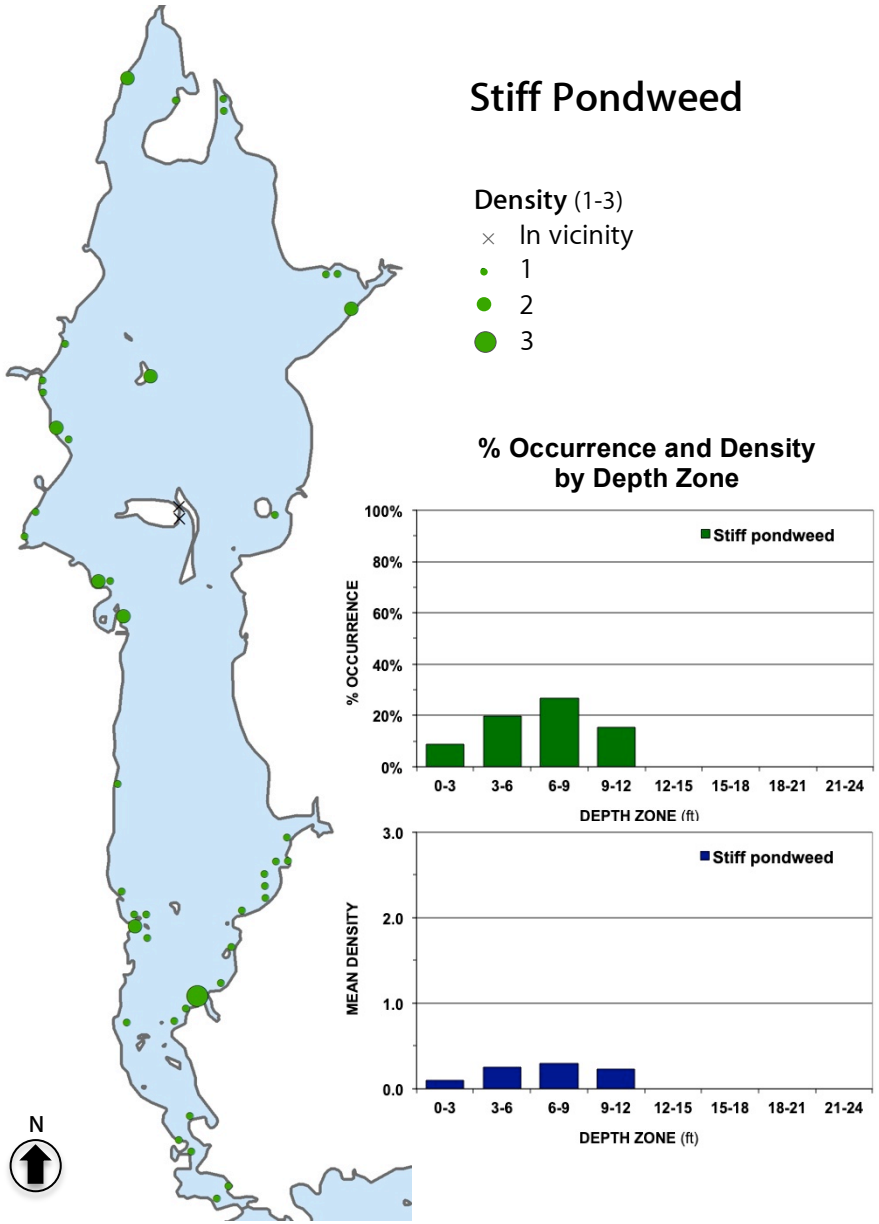


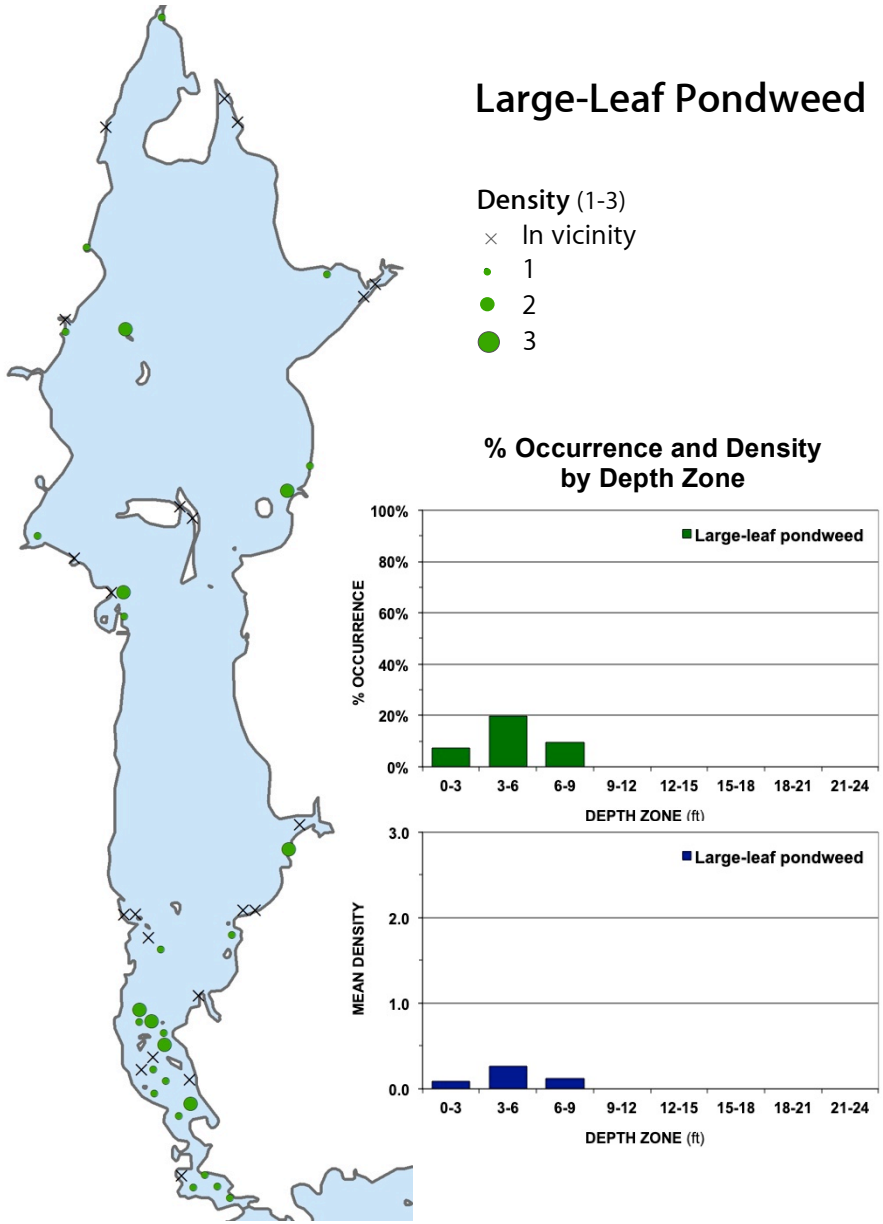
Red Cedar Lake – Aquatic Plant Species (Submersed)



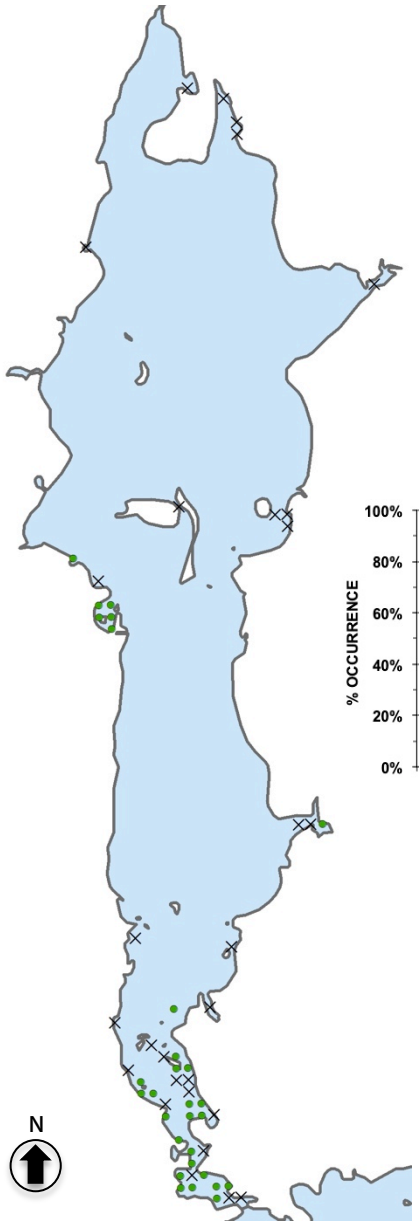


Red Cedar Lake – Aquatic Plant Species (Submersed)





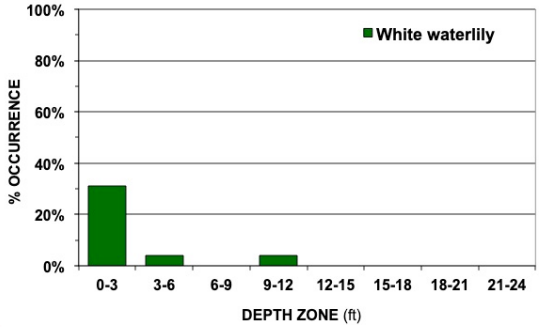
Red Cedar Lake – Aquatic Plant Species (Floating)

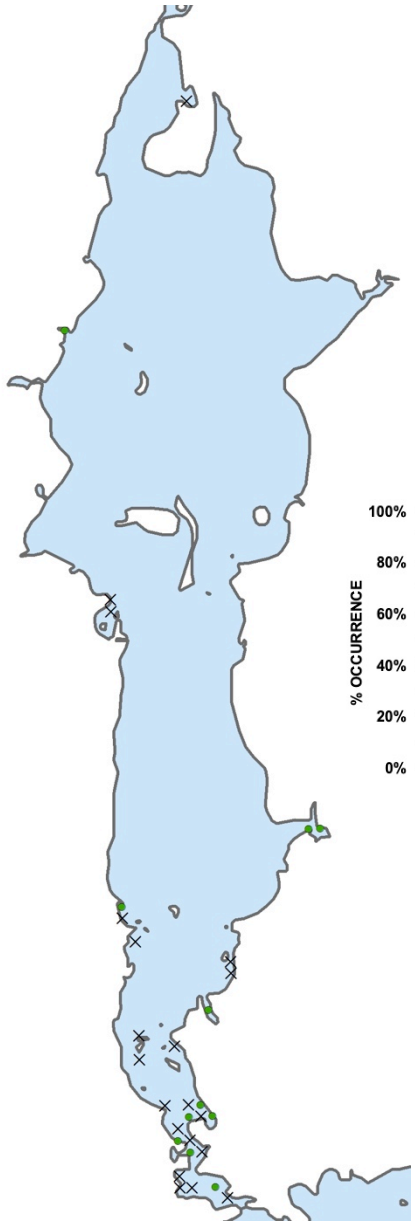


White Waterlily

Density (1-3)
- × In vicinity
- 1
- 2
- 3

% Occurrence by Depth Zone

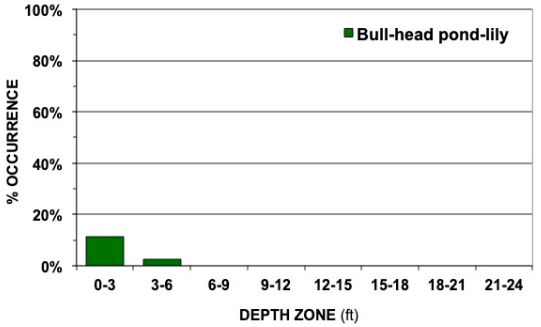




Bull-Head Pond Lily

Density (1-3)
- × In vicinity
- 1
- 2
- 3

% Occurrence by Depth Zone



Results – Hemlock Lake

Table 5. *Hemlock Lake: 2018 Plant Frequency and Density*. *Max* = % occurrence using all points where depth was ≤ the 95th percentile of the max depth of plant growth, *<15ft* = % occurrence for depths ≤15 ft, *LITTORAL DENSITY* = mean density rating using all points where depth was ≤ the 95th percentile of the max depth of growth

COMMON NAME	SCIENTIFIC NAME	%OCCURRENCE Max	%OCCURRENCE <15ft	LITTORAL DENSITY
SUBMERSED PLANTS				
Coontail	*Ceratophyllum demersum*	85	73	1.3
Fern-leaf pondweed	*Potamogeton robbinsii*	54	47	0.9
Canadian waterweed	*Elodea canadensis*	43	37	0.5
Flat-stem pondweed	*Potamogeton zosteriformis*	25	21	0.3
Common bladderwort	*Utricularia vulgaris*	24	21	0.2
Water marigold	*Bidens beckii*	20	17	0.2
Small pondweed	*Potamogeton pusillus*	17	15	0.2
Creeping bladderwort	*Utricularia gibba*	17	15	0.2
Wild celery	*Vallisneria americana*	13	11	0.2
Northern watermilfoil	*Myriophyllum sibiricum*	13	11	0.1
Large-leaf pondweed	*Potamogeton amplifolius*	9	8	0.1
Twin-stemmed bladderwort	*Utricularia geminiscapa*	9	7	0.1
Nitella	*Nitella* sp.	4	3	<0.1
Stiff water crowfoot	*Ranunculus aquatilis*	4	3	<0.1
Clasping-leaf pondweed	*Potamogeton richardsonii*	4	3	<0.1
Whorled watermilfoil	*Myriophyllum verticillatum*	3	3	<0.1
Aquatic moss	*Aquatic moss*	3	3	<0.1
Water stargrass	*Heteranthera dubia*	3	3	<0.1
White-stem pondweed	*Potamogeton praelongus*	2	2	<0.1
Curly-leaf pondweed	*Potamogeton crispus*	2	1	<0.1
Slender naiad	*Najas flexilis*	1	1	<0.1
Blunt-leaf pondweed	*Potamogeton obtusifolius*	1	1	<0.1
Stiff pondweed	*Potamogeton strictifolius*	1	1	<0.1
Muskgrass	*Chara* sp.	<1	<1	<0.1
Alpine pondweed	*Potamogeton alpinus*	<1	<1	<0.1
Variable pondweed	*Potamogeton gramineus*	<1	<1	<0.1
Needle spikerush	*Eleocharis acicularis*	P	P	–
Ribbon-leaf pondweed	*Potamogeton epihydrus*	P	P	–
FLOATING PLANTS				
Star duckweed	*Lemna trisulca*	36	30	0.4
White waterlily	*Nymphaea odorata*	31	26	0.3
Large Duckweed	*Spirodela polyrhiza*	23	19	0.2
Bull-head pond-lily	*Nuphar variegata*	17	15	0.2
Small duckweed	*Lemna minor*	13	11	0.1
Crystalwort	*Riccia fluitans*	13	11	0.1
Common watermeal	*Wolffia columbiana*	13	11	0.1
Floating-leaf pondweed	*Potamogeton natans*	8	6	0.1
Water smartweed	*Polygonum amphibium*	P	P	–
EMERGENT PLANTS				
Sparganium sp.	*Sparganium* sp.	3	3	<0.1
Arrowhead	*Sagittaria* sp.	2	1	<0.1
Creeping spikerush	*Eleocharis palustris*	1	1	<0.1
Hardstem bulrush	*Schoenoplectus acutus*	<1	<1	<0.1

Additional emergent taxa observed in Hemlock Lake: *Equisetum fluviatile (horsetail/scouring rush), Heteranthera reniformis (kidneyleaf mudplantain), Iris versicolor (blue-flag iris), Schoenoplectus pungens (three-square rush), Schoenoplectus tabernaemontani (softstem bulrush), Typha sp. (cattail), Zizania palustris (wild rice)*

Table 6. *Hemlock Lake:* 2018 aquatic plant community metrics

HEMLOCK LAKE

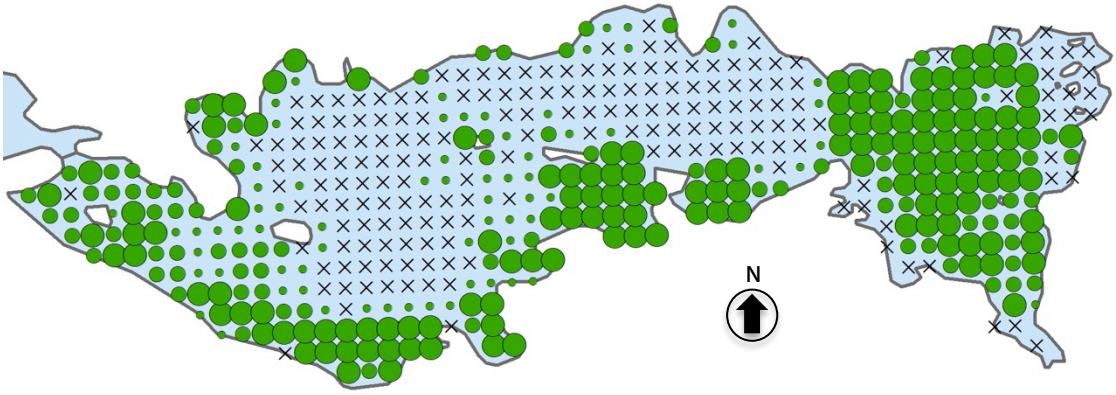
WHOLE-LAKE METRICS	2018
Lake Area	365 acres
Total Points Sampled	410
Vegetated Area	222 acres *(61%)*
Area with Veg. to Surface	97 acres *(27%)*
Max Depth of Growth (95%)	12.8 ft
Native Submersed Taxa	27
Native Floating/Emergent Taxa	20
Non-Native Submersed Taxa	1

LITTORAL METRICS	2018
Littoral Area (≤15 ft)	226 acres
Littoral Points Sampled	304
% Littoral Points Vegetated	93%
Mean Plant Height	2.1 ft
% of Max Littoral Biovolume	41%
Mean Native Taxa / Point	5.2
Simpson's Diversity	93.1
Floristic Quality (FQI)	38.7
AMCI Score (Nichols et al. 2000)	53

Hemlock Lake – Aquatic Plant Community

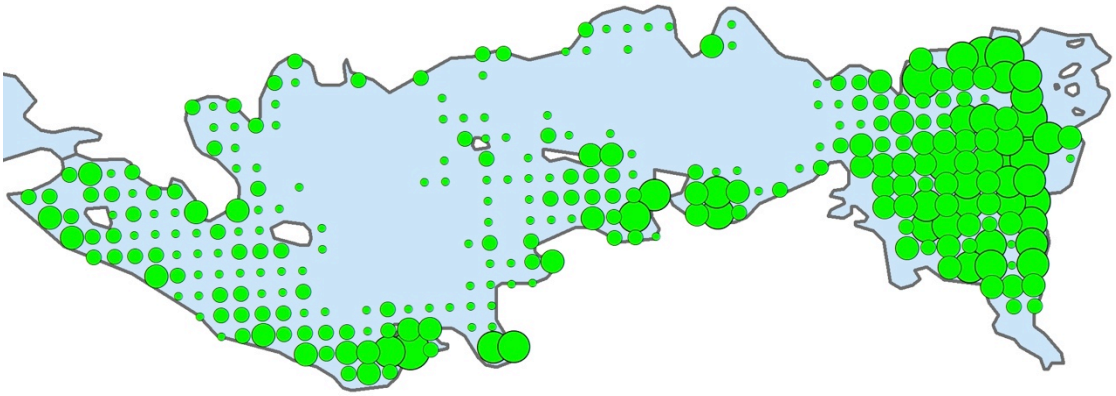
All Plants

Density (1-3)
- × No Plants
- 1
- 2
- 3



Native Plant Diversity

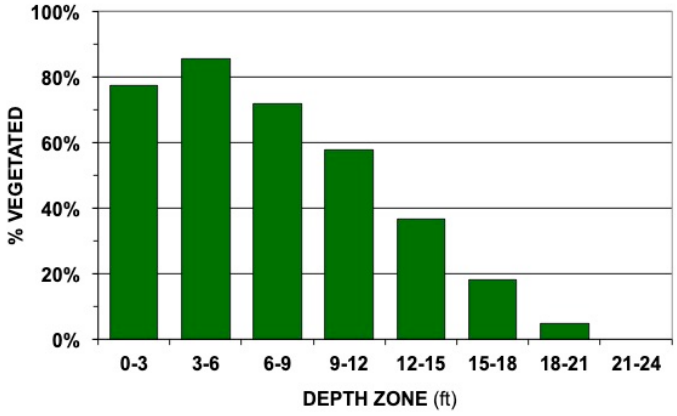
Native Species per point
- 1-3
- 4-6
- 7-9
- 10-12
- 13-15



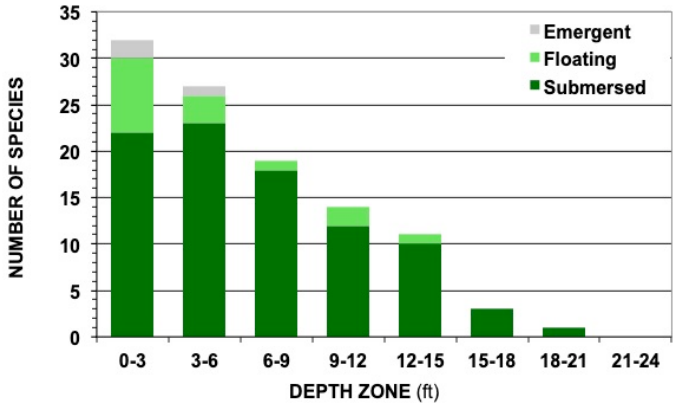
Surveyed: Aug 28–29, 2018
Surveyor: JA Johnson
Methods: Rake, Depth Rod

freshwater SCIENTIFIC SERVICES

% Vegetated by Depth Zone



Species Richness by Depth Zone

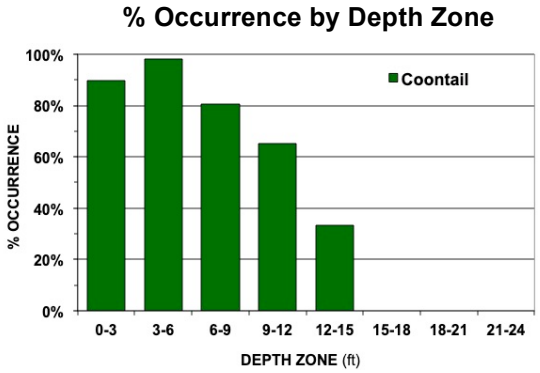


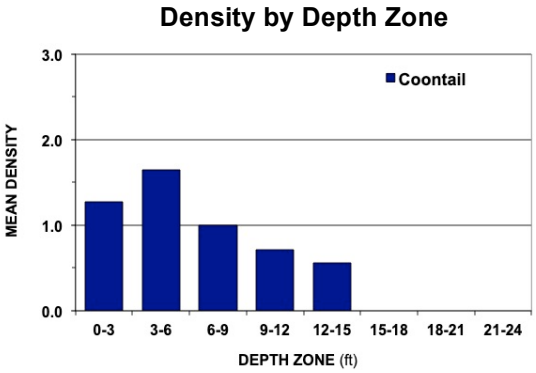
Hemlock Lake – Aquatic Plant Species (Submersed)

Coontail

Density (1-3)
- × In vicinity
- 1
- 2
- 3

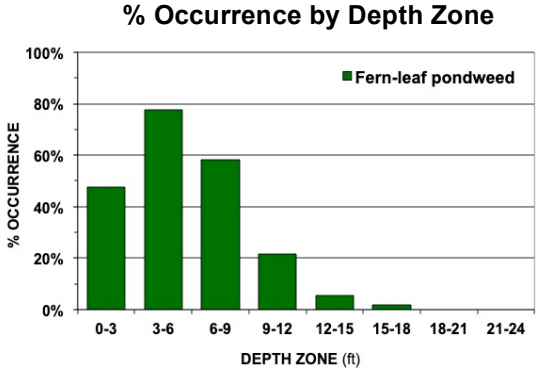
N

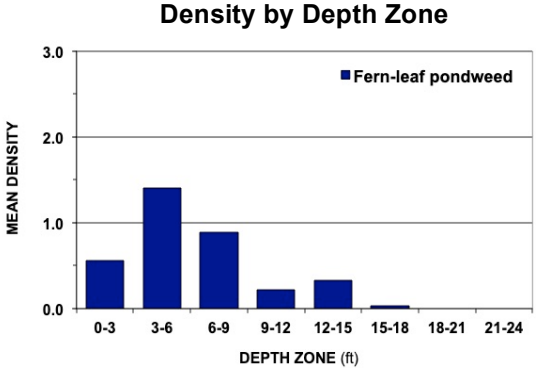




Fern-Leaf Pondweed

Density (1-3)
- × In vicinity
- 1
- 2
- 3



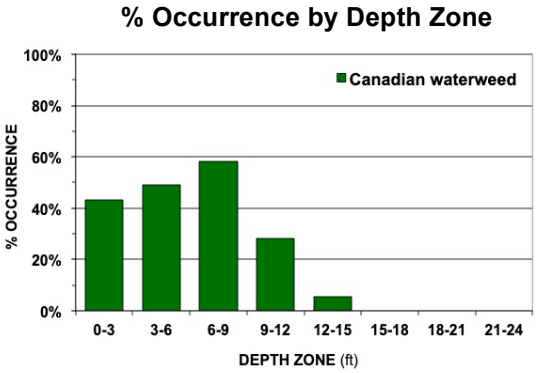


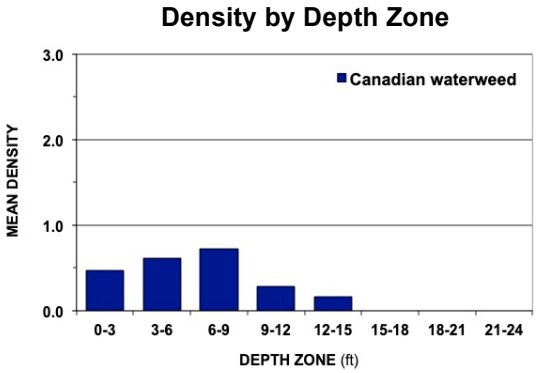
Hemlock Lake – Aquatic Plant Species (Submersed)

Canadian Waterweed

Density (1-3)
- × In vicinity
- 1
- 2
- 3

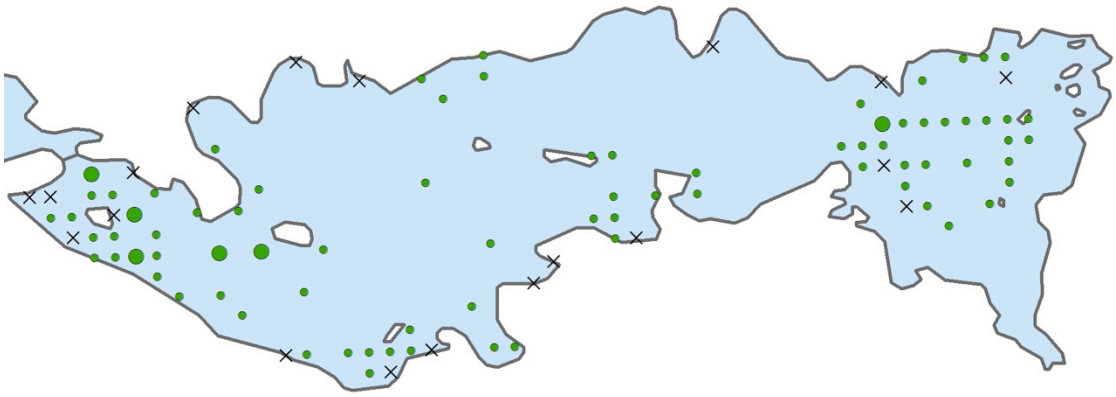
N

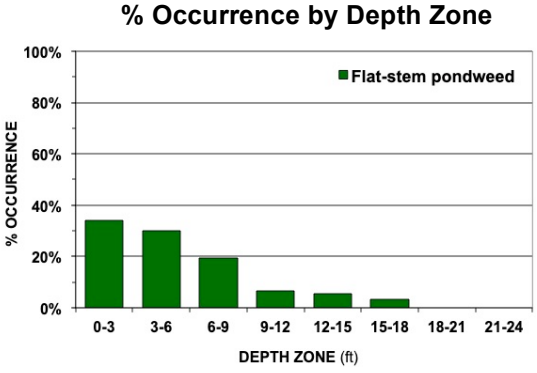


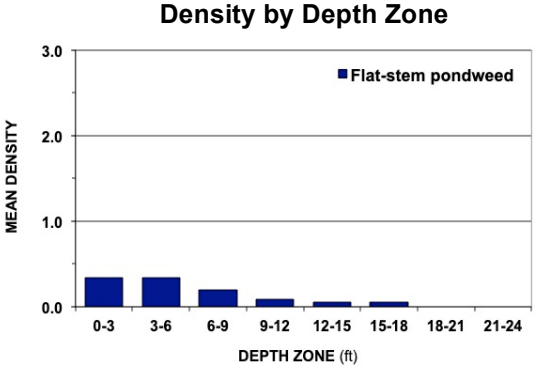


Flat-Stem Pondweed

Density (1-3)
- × In vicinity
- 1
- 2
- 3

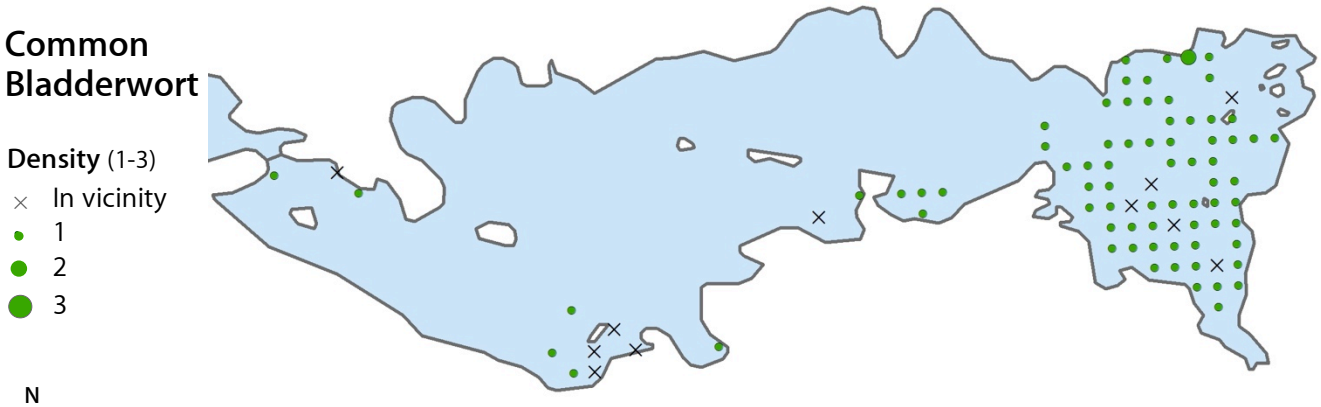


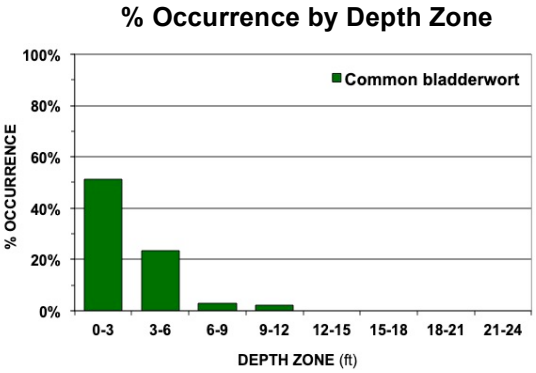


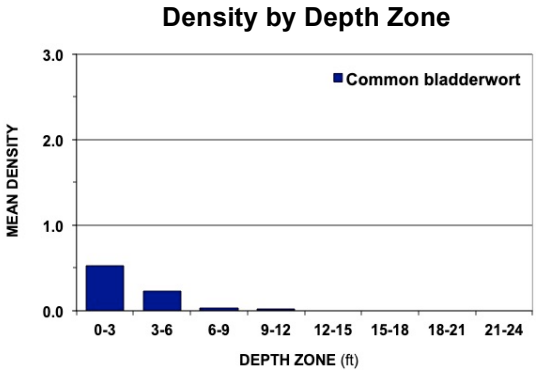


Hemlock Lake – Aquatic Plant Species (Submersed)

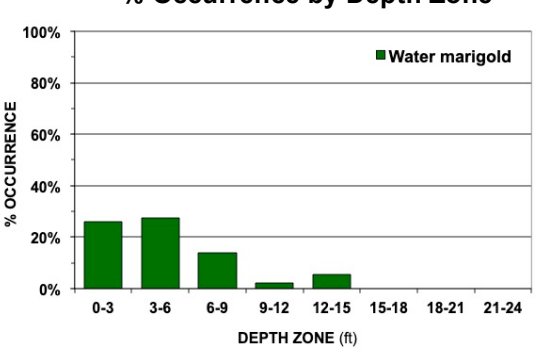
Common Bladderwort

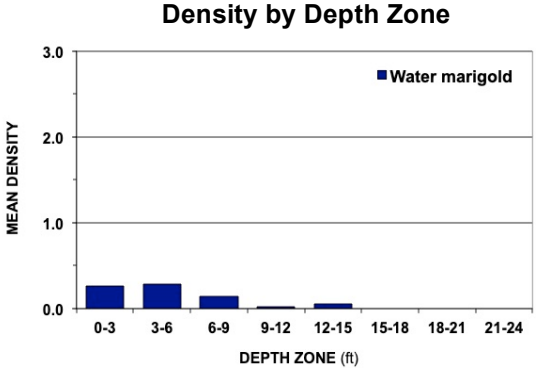






Water Marigold



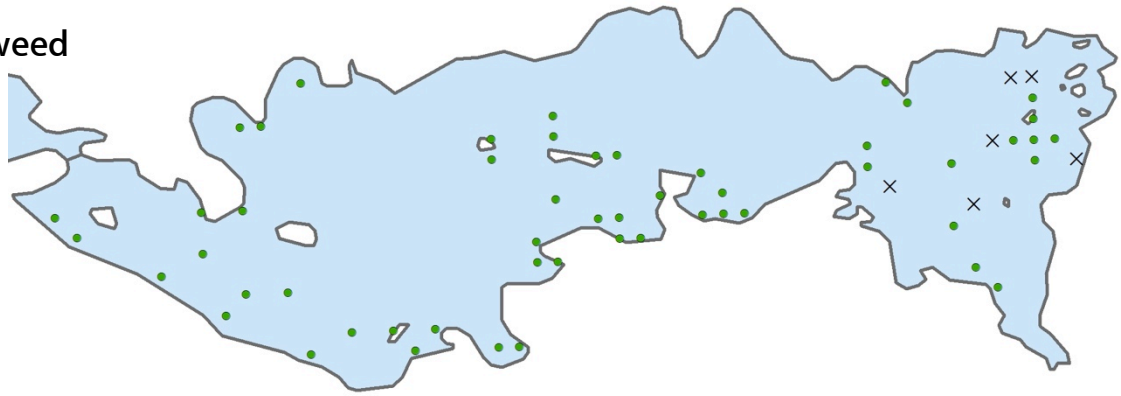


Hemlock Lake – Aquatic Plant Species (Submersed)

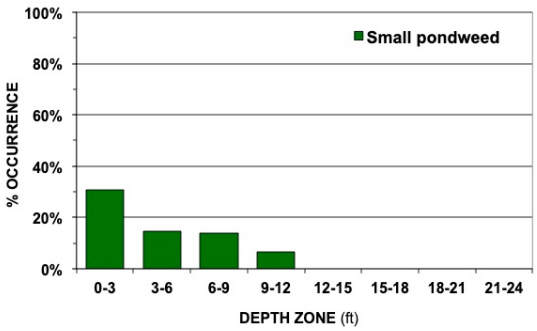
Small Pondweed

Density (1-3)
- × In vicinity
- 1
- 2
- 3

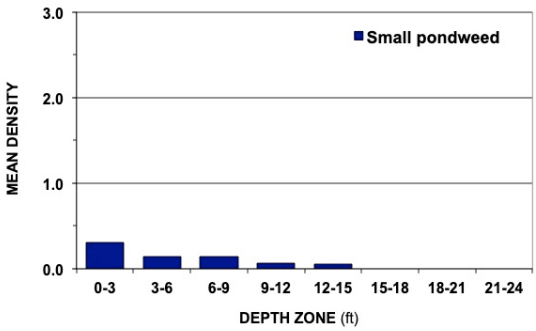
N



% Occurrence by Depth Zone



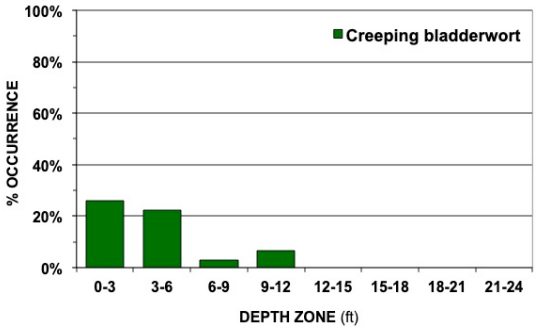
Density by Depth Zone



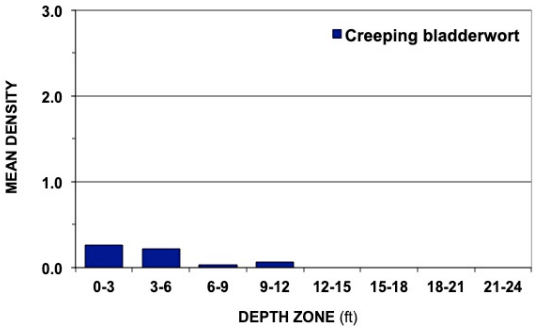
Creeping Bladderwort

Density (1-3)
- × In vicinity
- 1
- 2
- 3

% Occurrence by Depth Zone



Density by Depth Zone

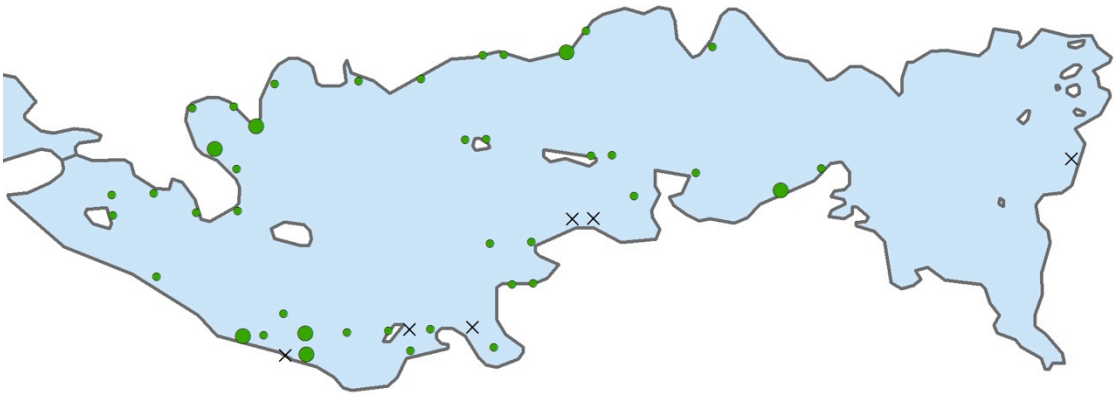


Hemlock Lake – Aquatic Plant Species (Submersed)

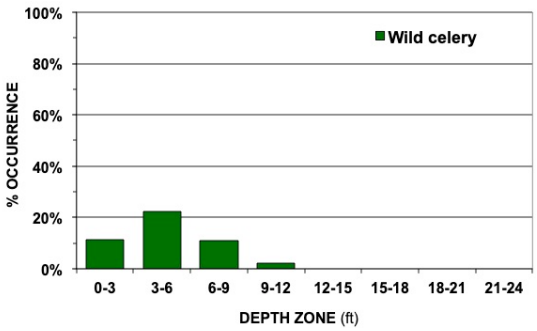
Wild Celery

Density (1-3)
- × In vicinity
- 1
- 2
- 3

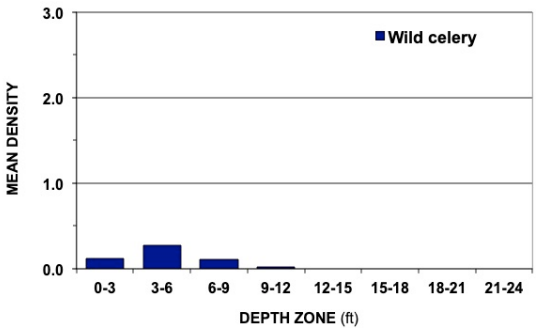
N



% Occurrence by Depth Zone

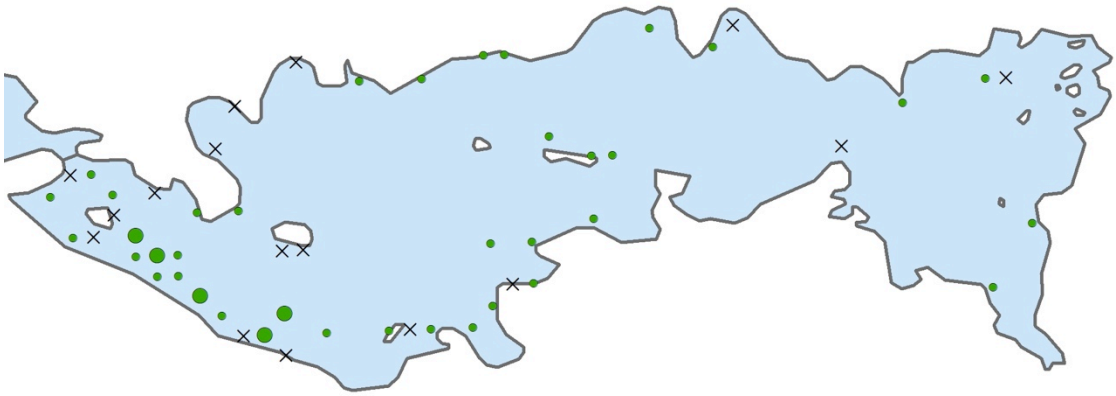


Density by Depth Zone

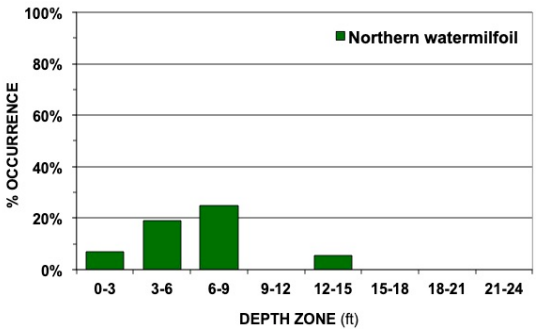


Northern Watermilfoil

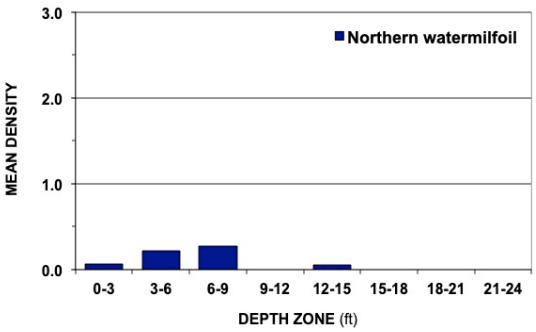
Density (1-3)
- × In vicinity
- 1
- 2
- 3



% Occurrence by Depth Zone



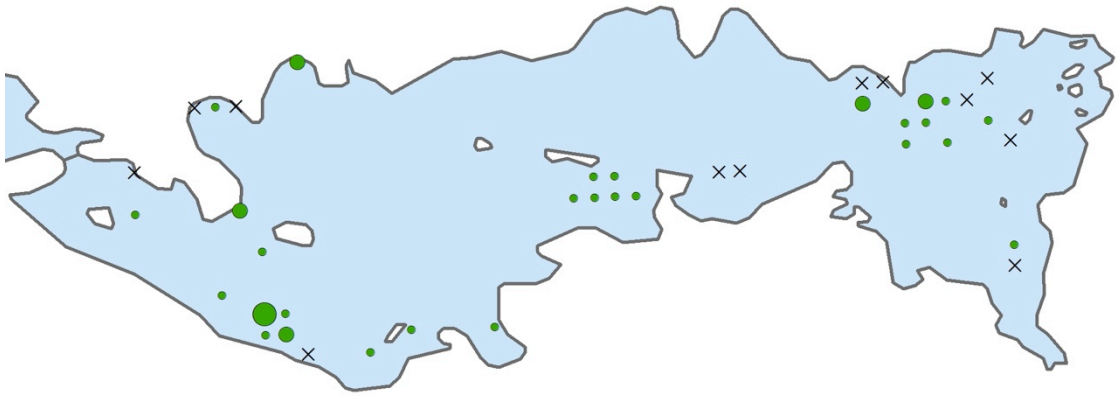
Density by Depth Zone



Hemlock Lake – Aquatic Plant Species (Submersed)

Large-Leaf Pondweed

Density (1-3)
- × In vicinity
- 1
- 2
- 3



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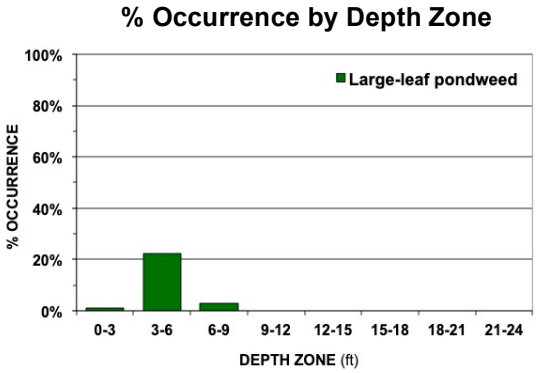
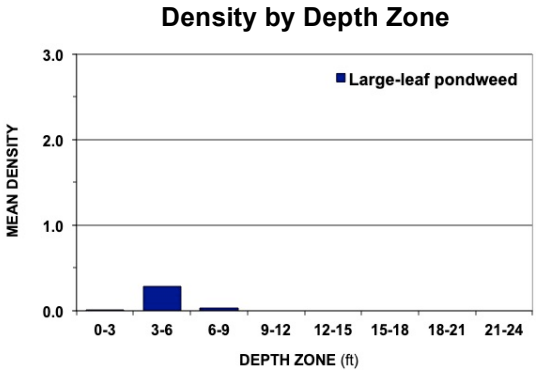
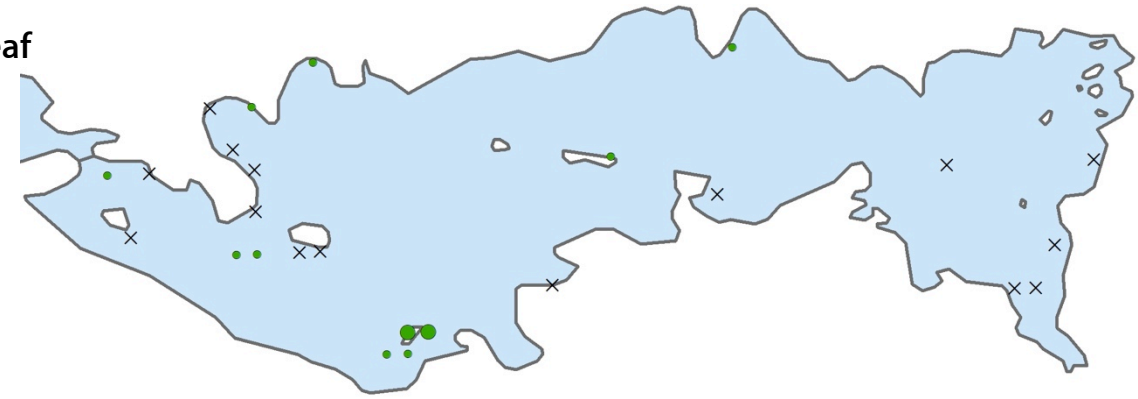
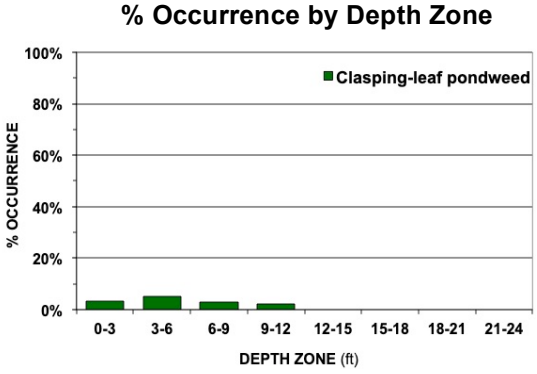


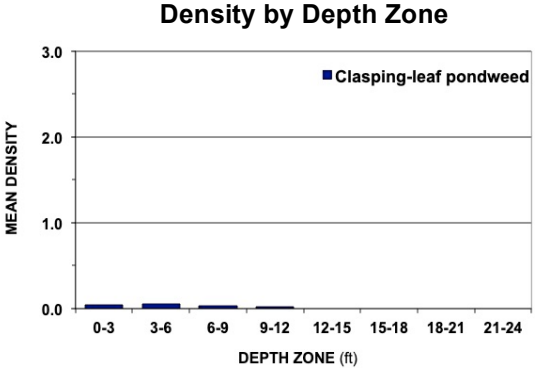


Clasping-Leaf Pondweed

Density (1-3)
- × In vicinity
- 1
- 2
- 3





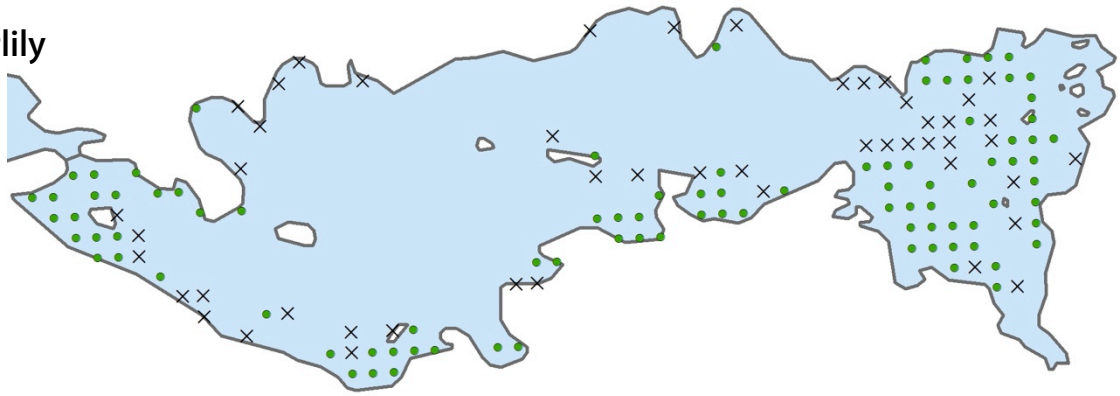


Hemlock Lake – Aquatic Plant Species (Floating)

White Waterlily

Density (1-3)
- × In vicinity
- 1
- 2
- 3

N

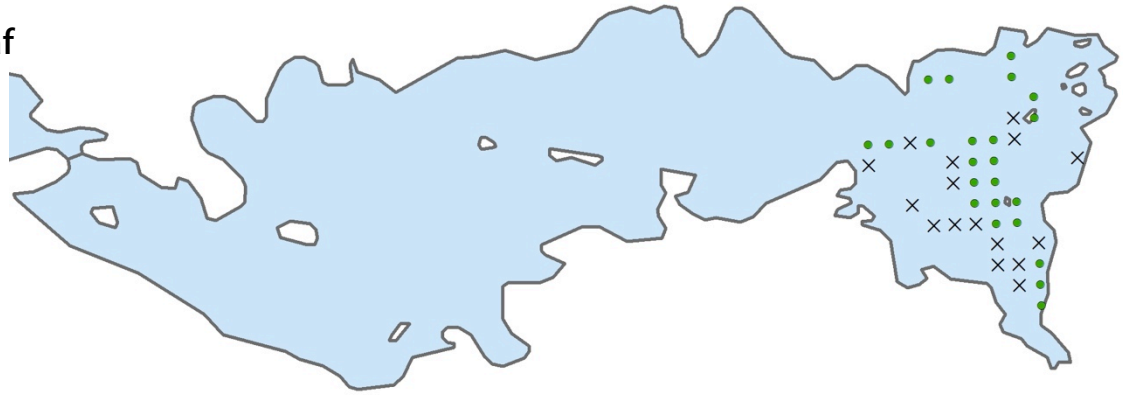


Bullhead Pond Lily

Density (1-3)
- × In vicinity
- 1
- 2
- 3

Floating-Leaf Pondweed

Density (1-3)
- × In vicinity
- 1
- 2
- 3



Results – Balsam & Mud Lake

Table 7. *Balsam Lake: 2018 Plant Frequency and Density*. *Max* = % occurrence using all points where depth was ≤ the 95th percentile of the max depth of plant growth, *<15ft* = % occurrence for depths ≤15 ft, *LITTORAL DENSITY* = mean density rating using all points where depth was ≤ the 95th percentile of the max depth of growth

COMMON NAME	SCIENTIFIC NAME	%OCCURRENCE Max	%OCCURRENCE <15ft	LITTORAL DENSITY
SUBMERSED PLANTS				
Coontail	*Ceratophyllum demersum*	49	47	0.8
Flat-stem pondweed	*Potamogeton zosteriformis*	25	23	0.3
Northern watermilfoil	*Myriophyllum sibiricum*	16	15	0.2
Clasping-leaf pondweed	*Potamogeton richardsonii*	16	15	0.2
Fern-leaf pondweed	*Potamogeton robbinsii*	15	15	0.2
Large-leaf pondweed	*Potamogeton amplifolius*	13	12	0.2
Wild celery	*Vallisneria americana*	13	12	0.1
Canadian waterweed	*Elodea canadensis*	11	10	0.1
Stiff water crowfoot	*Ranunculus aquatilis*	8	7	0.1
Water marigold	*Bidens beckii*	6	6	0.1
Stiff pondweed	*Potamogeton strictifolius*	6	5	0.1
Water stargrass	*Heteranthera dubia*	3	3	<0.1
Curly-leaf pondweed	*Potamogeton crispus*	2	2	<0.1
Muskgrass	*Chara* sp.	2	1	<0.1
Slender naiad	*Najas flexilis*	2	1	<0.1
Small pondweed	*Potamogeton pusillus*	2	1	<0.1
Nitella	*Nitella* sp.	1	1	<0.1
Sago pondweed	*Stuckenia pectinata*	<1	<1	<0.1
FLOATING PLANTS				
Star duckweed	*Lemna trisulca*	21	19	0.2
White waterlily	*Nymphaea odorata*	12	11	0.1
Small duckweed	*Lemna minor*	9	9	0.1
Bull-head pond-lily	*Nuphar variegata*	4	3	<0.1
Large Duckweed	*Spirodela polyrhiza*	4	3	<0.1
Common watermeal	*Wolffia columbiana*	3	2	<0.1
Floating-leaf pondweed	*Potamogeton natans*	1	1	<0.1
Water smartweed	*Polygonum amphibium*	<1	<1	<0.1
EMERGENT PLANTS				
Sparganium sp.	*Sparganium* sp.	2	1	<0.1
Arrowhead	*Sagittaria* sp.	1	1	<0.1
Northern wild rice	*Zizania palustris*	1	1	<0.1
Northern blue flag	*Iris versicolor*	P	P	–
Hardstem bulrush	*Schoenoplectus acutus*	P	P	–
Cattail	*Typha* sp.	P	P	–

Table 8. *Balsam Lake:* 2018 aquatic plant community metrics

BALSAM LAKE

WHOLE-LAKE METRICS	2018
Lake Area	365 acres
Total Points Sampled	410
Vegetated Area	222 acres *(61%)*
Area with Veg. to Surface	97 acres *(27%)*
Max Depth of Growth (95%)	12.8 ft
Native Submersed Taxa	27
Native Floating/Emergent Taxa	20
Non-Native Submersed Taxa	1

LITTORAL METRICS	2018
Littoral Area (≤15 ft)	226 acres
Littoral Points Sampled	304
% Littoral Points Vegetated	93%
Mean Plant Height	2.1 ft
% of Max Littoral Biovolume	41%
Mean Native Taxa / Point	5.2
Simpson's Diversity	93.1
Floristic Quality (FQI)	38.7
AMCI Score (Nichols et al. 2000)	53

Table 9. *Mud Lake: 2018 Plant Frequency and Density*. *Max* = % occurrence using all points where depth was ≤ the 95th percentile of the max depth of plant growth, *<15ft* = % occurrence for depths ≤15 ft, *LITTORAL DENSITY* = mean density rating using all points where depth was ≤ the 95th percentile of the max depth of growth

COMMON NAME	SCIENTIFIC NAME	%OCCURRENCE Max	%OCCURRENCE <15ft	LITTORAL DENSITY
SUBMERSED PLANTS				
Coontail	*Ceratophyllum demersum*	82	81	1.2
Slender naiad	*Najas flexilis*	54	52	0.8
Canadian waterweed	*Elodea canadensis*	47	47	0.6
Muskgrass	*Chara* sp.	29	29	0.5
Clasping-leaf pondweed	*Potamogeton richardsonii*	18	18	0.2
Wild celery	*Vallisneria americana*	15	14	0.2
Flat-stem pondweed	*Potamogeton zosteriformis*	13	13	0.1
Sago pondweed	*Stuckenia pectinata*	11	10	0.1
Fern-leaf pondweed	*Potamogeton robbinsii*	10	10	0.1
Whorled watermilfoil	*Myriophyllum verticillatum*	7	8	0.1
Aquatic moss	*Aquatic moss*	4	4	<0.1
Northern watermilfoil	*Myriophyllum sibiricum*	5	4	<0.1
Common bladderwort	*Utricularia vulgaris*	5	4	<0.1
Small pondweed	*Potamogeton pusillus*	4	3	<0.1
Stiff water crowfoot	*Ranunculus aquatilis*	4	3	<0.1
Water stargrass	*Heteranthera dubia*	3	3	<0.1
Curly-leaf pondweed	*Potamogeton crispus*	2	3	<0.1
Water marigold	*Bidens beckii*	2	2	<0.1
Nitella	*Nitella* sp.	1	2	<0.1
Large-leaf pondweed	*Potamogeton amplifolius*	2	2	<0.1
Stiff pondweed	*Potamogeton strictifolius*	2	2	<0.1
Horned pondweed	*Zannichellia palustris*	P	P	–
FLOATING PLANTS				
White waterlily	*Nymphaea odorata*	36	35	0.4
Star duckweed	*Lemna trisulca*	21	23	0.2
Floating-leaf pondweed	*Potamogeton natans*	22	21	0.2
Small duckweed	*Lemna minor*	11	10	0.1
Large Duckweed	*Spirodela polyrhiza*	4	3	<0.1
Bull-head pond-lily	*Nuphar variegata*	1	1	<0.1
EMERGENT PLANTS				
Arrowhead	*Sagittaria* sp.	3	3	<0.1
Sparganium sp.	*Sparganium* sp.	1	1	<0.1
Creeping spikerush	*Eleocharis palustris*	P	P	–
Hardstem bulrush	*Schoenoplectus acutus*	P	P	–
Cattail	*Typha* sp.	P	P	–
Northern wild rice	*Zizania palustris*	P	P	–

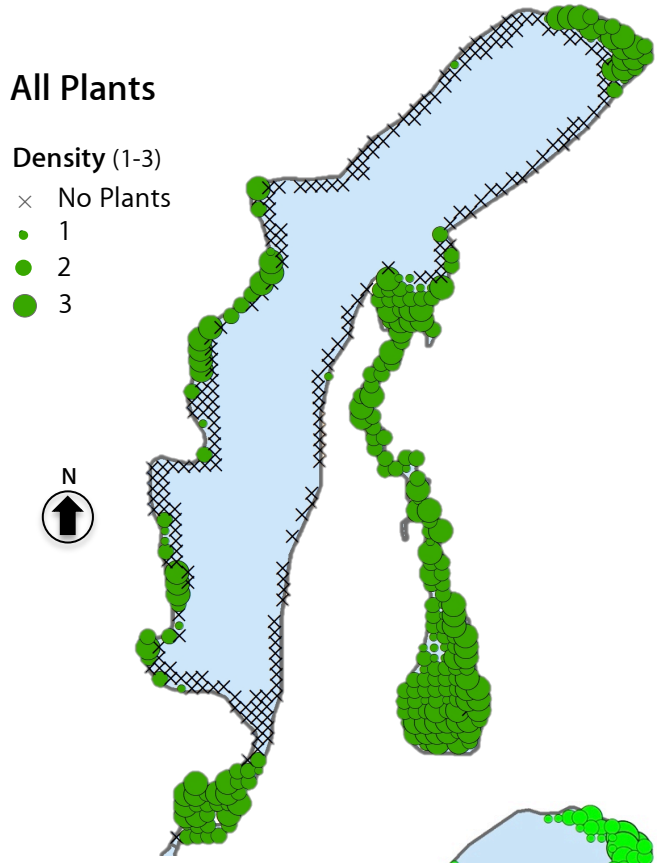
Table 10. *Mud Lake:* 2018 aquatic plant community metrics

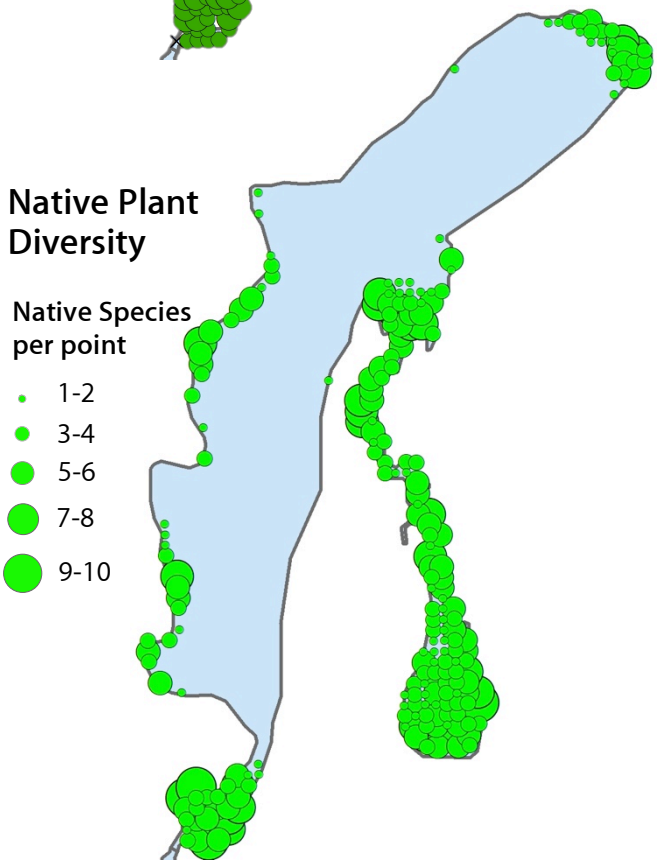
MUD LAKE

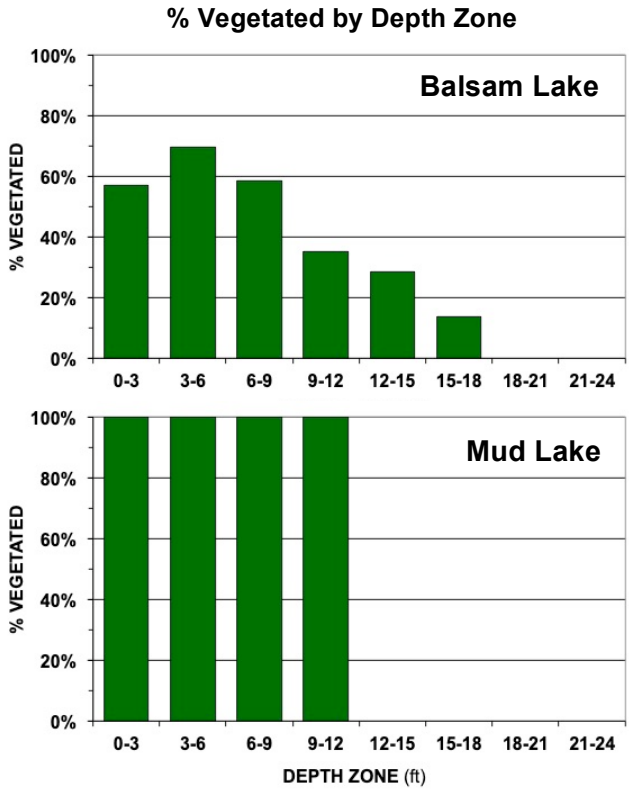
WHOLE-LAKE METRICS	2018
Lake Area	34 acres
Total Points Sampled	116
Vegetated Area	33 acres *(95%)*
Area with Veg. to Surface	15 acres *(43%)*
Max Depth of Growth (95%)	6.9 ft
Native Submersed Taxa	22
Native Floating/Emergent Taxa	12
Non-Native Submersed Taxa	1

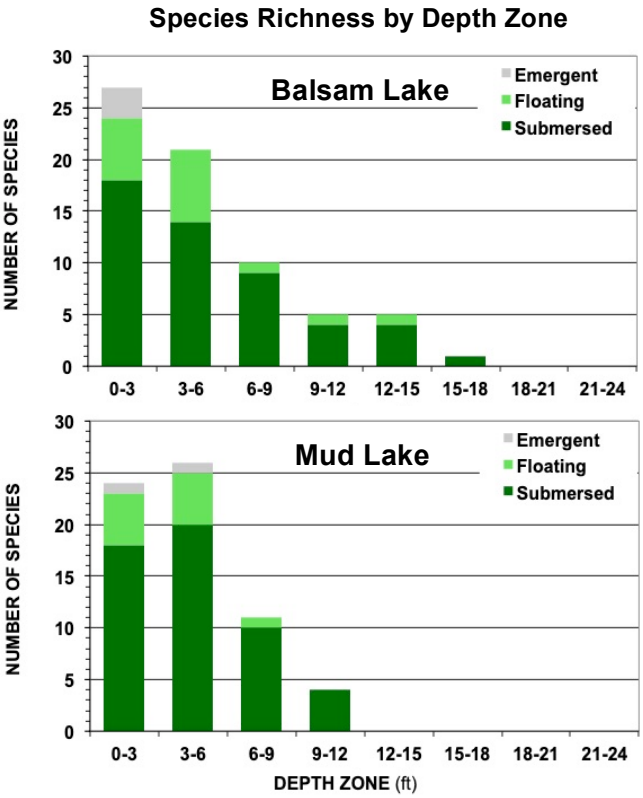
LITTORAL METRICS	2018
Littoral Area (≤15 ft)	31 acres
Littoral Points Sampled	110
% Littoral Points Vegetated	100%
Mean Plant Height	1.6 ft
% of Max Littoral Biovolume	55%
Mean Native Taxa / Point	4.1
Simpson's Diversity	90.6
Floristic Quality (FQI)	31.2
AMCI Score (Nichols et al. 2000)	44

Balsam & Mud Lake – Aquatic Plant Community

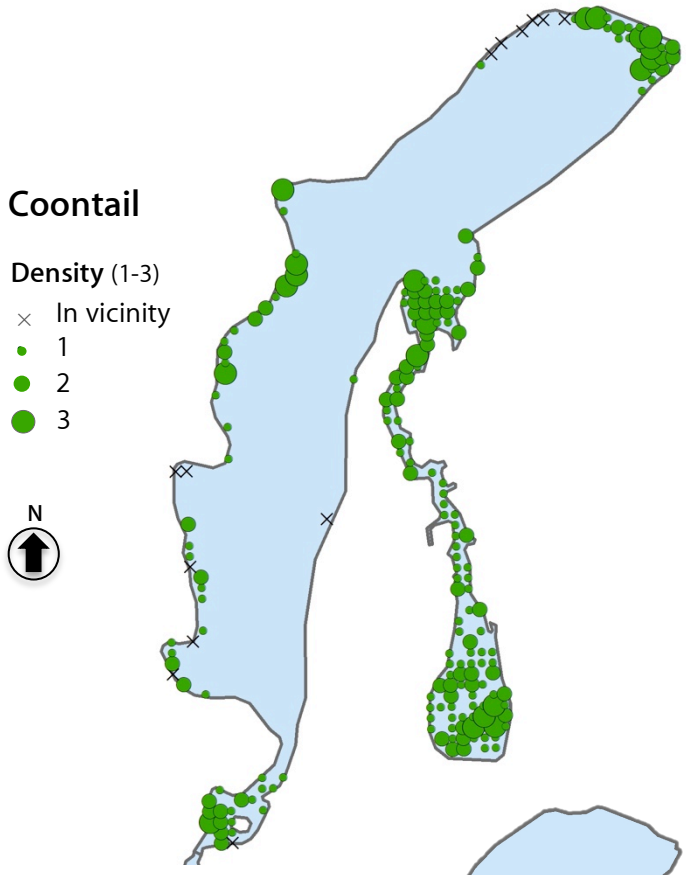


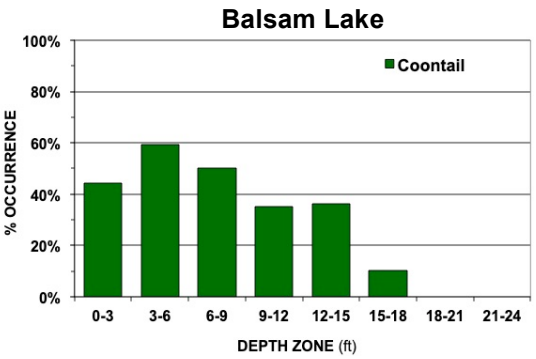


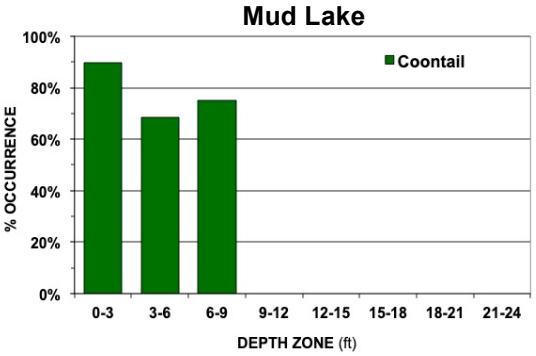


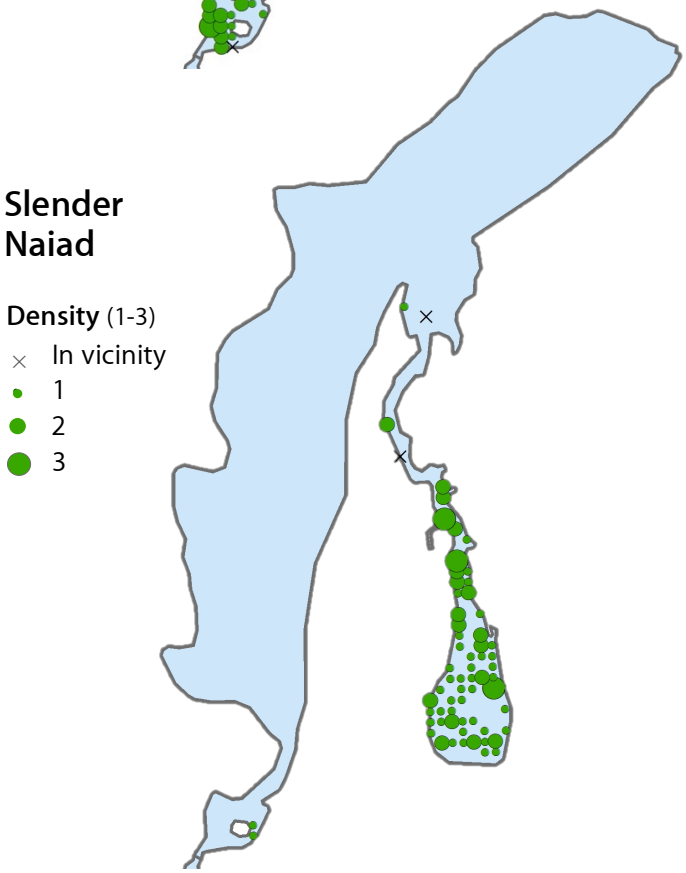


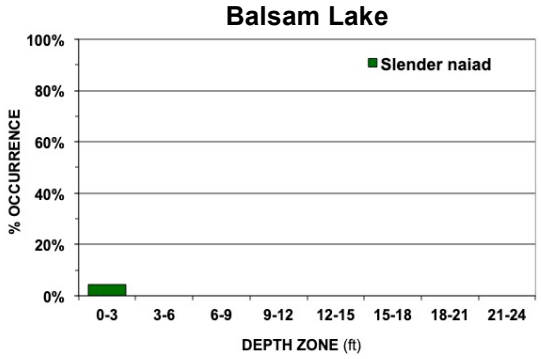
Balsam & Mud Lake – Aquatic Plant Species (Submersed)

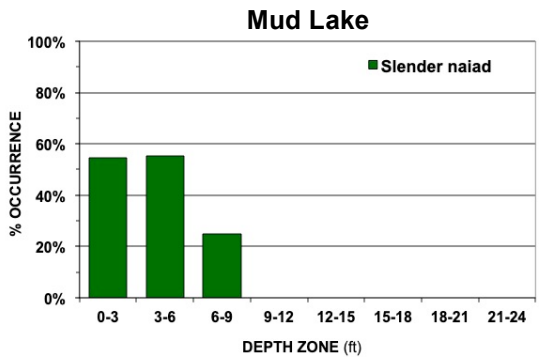




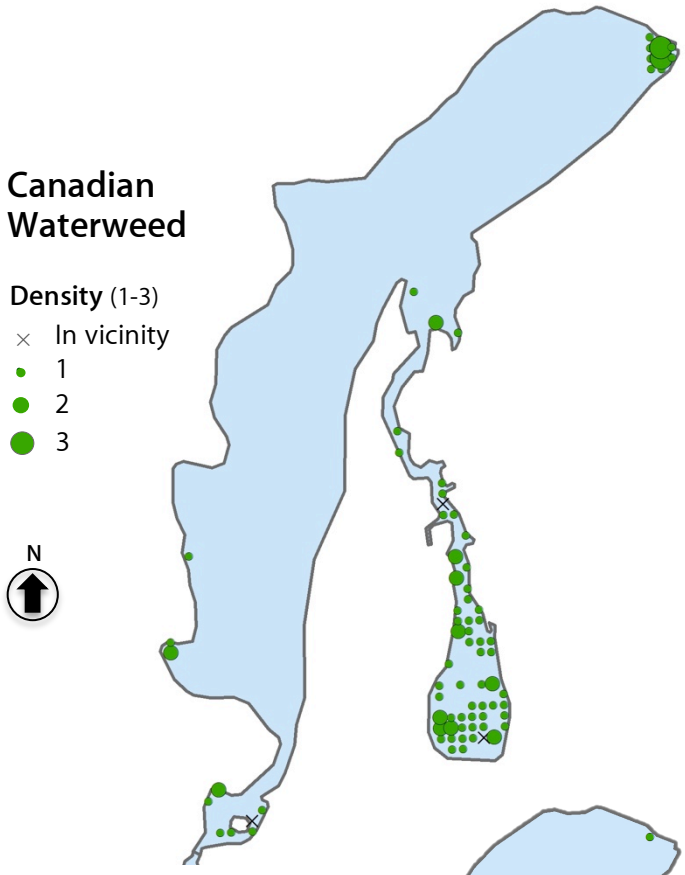


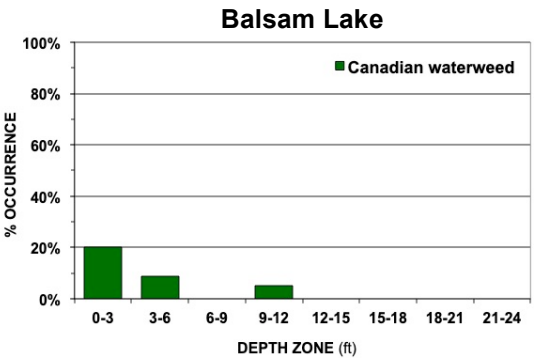


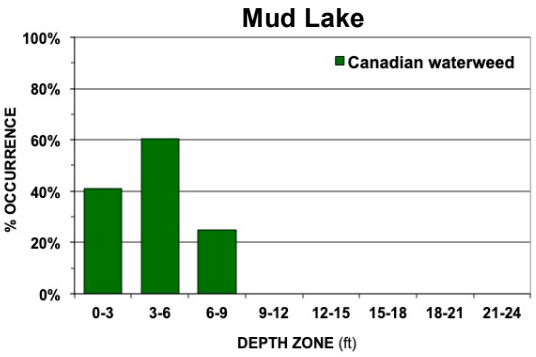


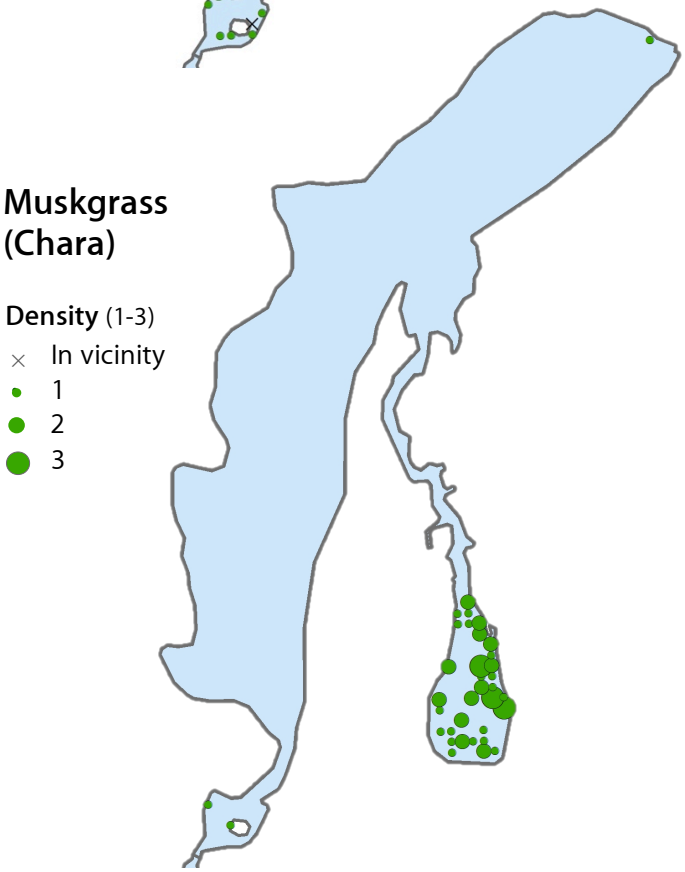


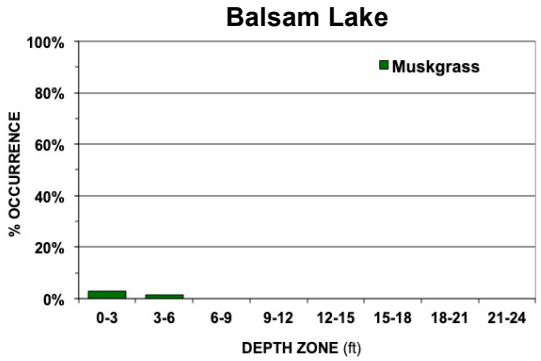
Balsam & Mud Lake – Aquatic Plant Species (Submersed)

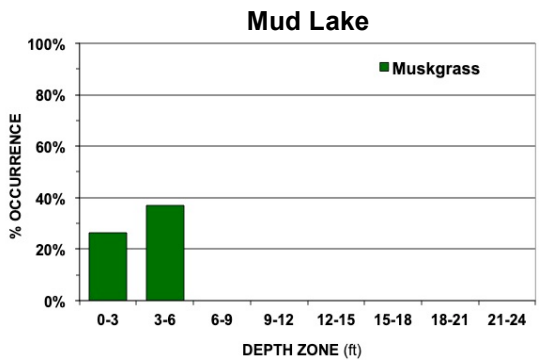




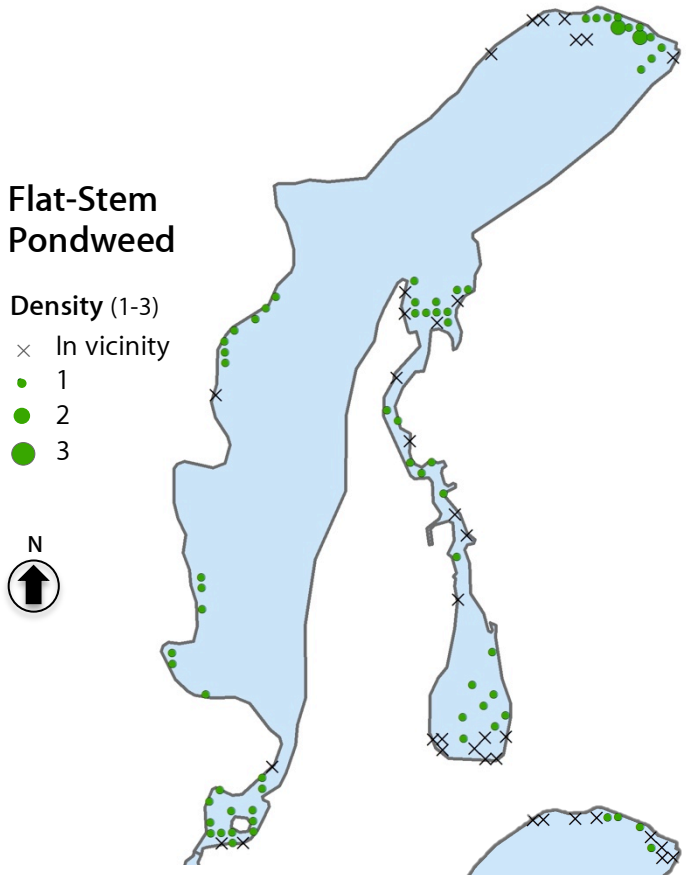


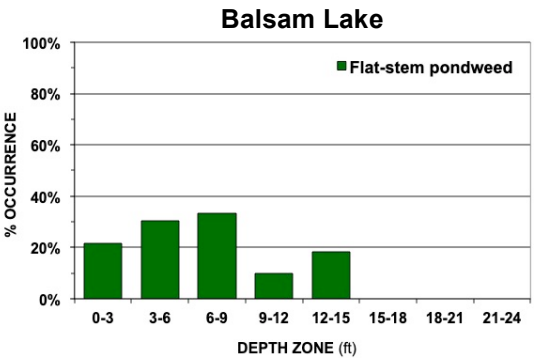


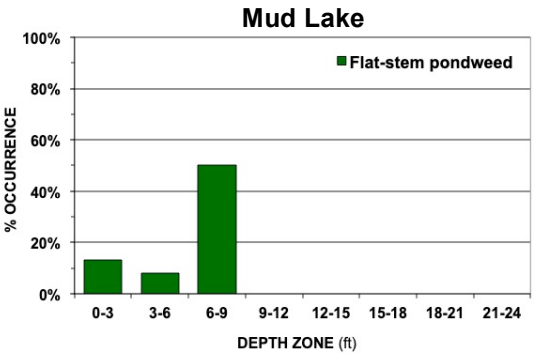


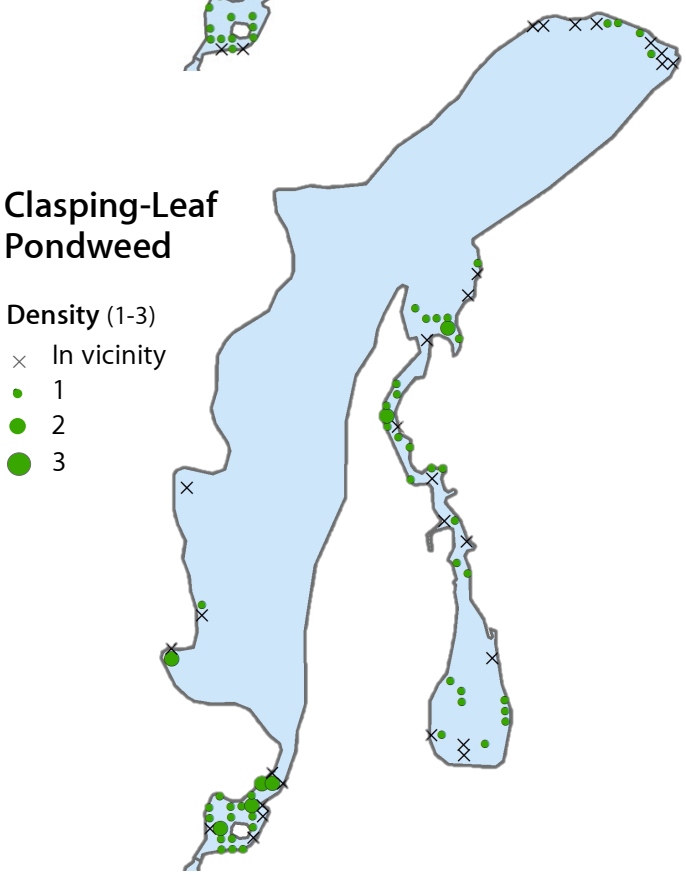


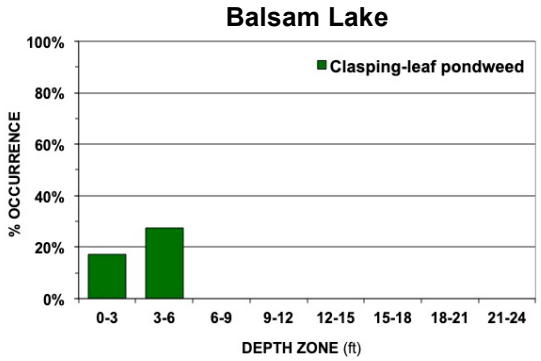
Balsam & Mud Lake – Aquatic Plant Species (Submersed)

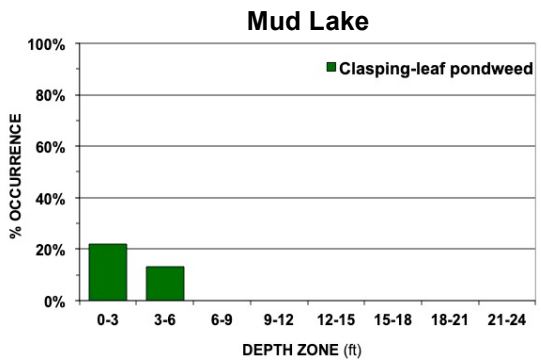




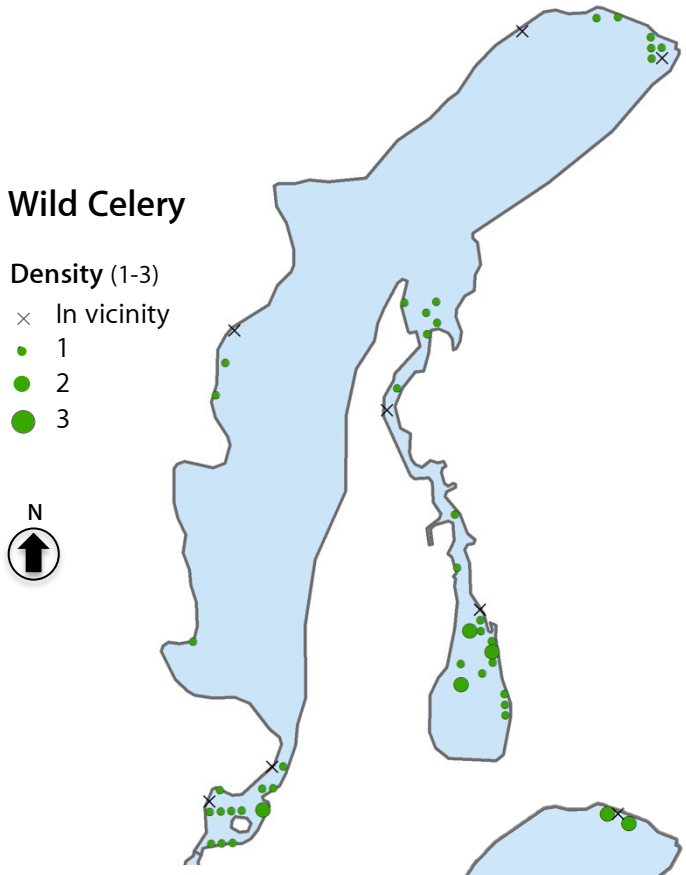


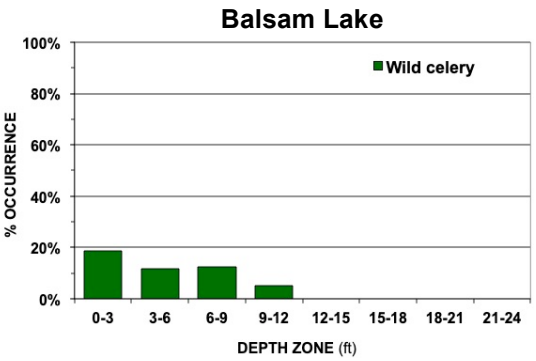


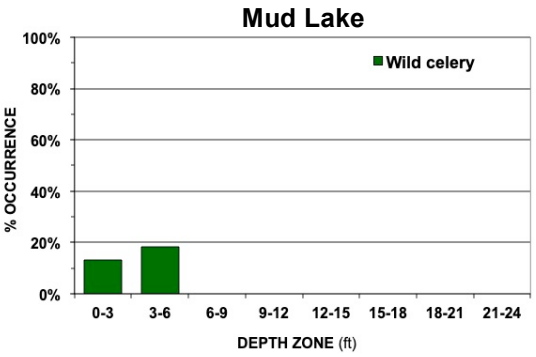


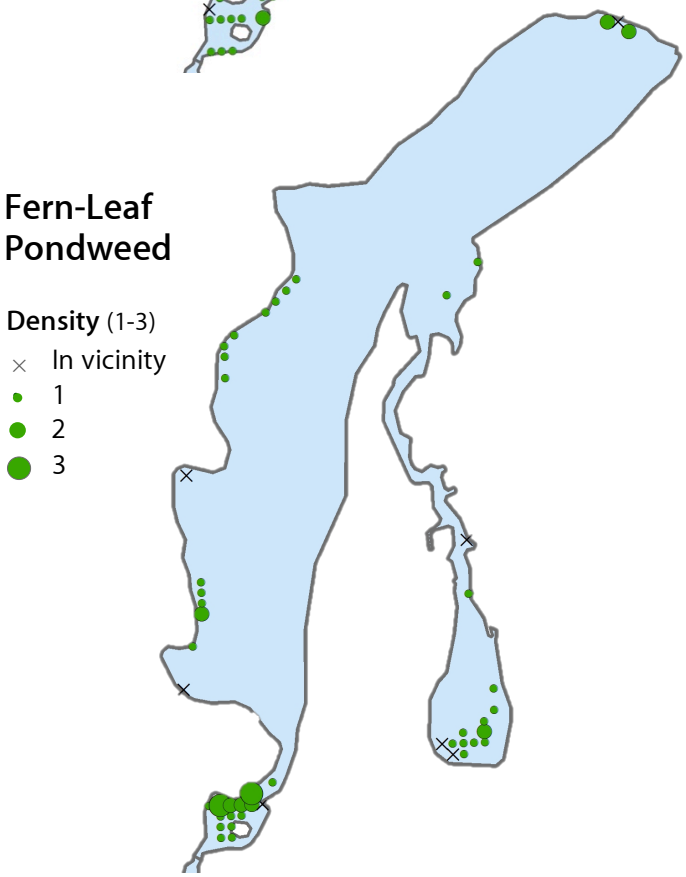


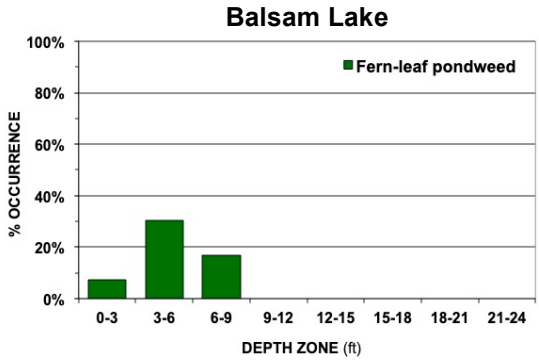
Balsam & Mud Lake – Aquatic Plant Species (Submersed)

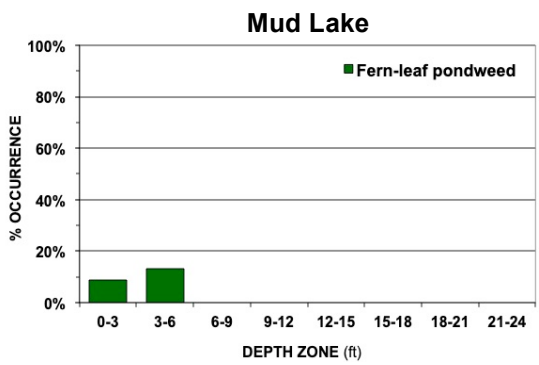




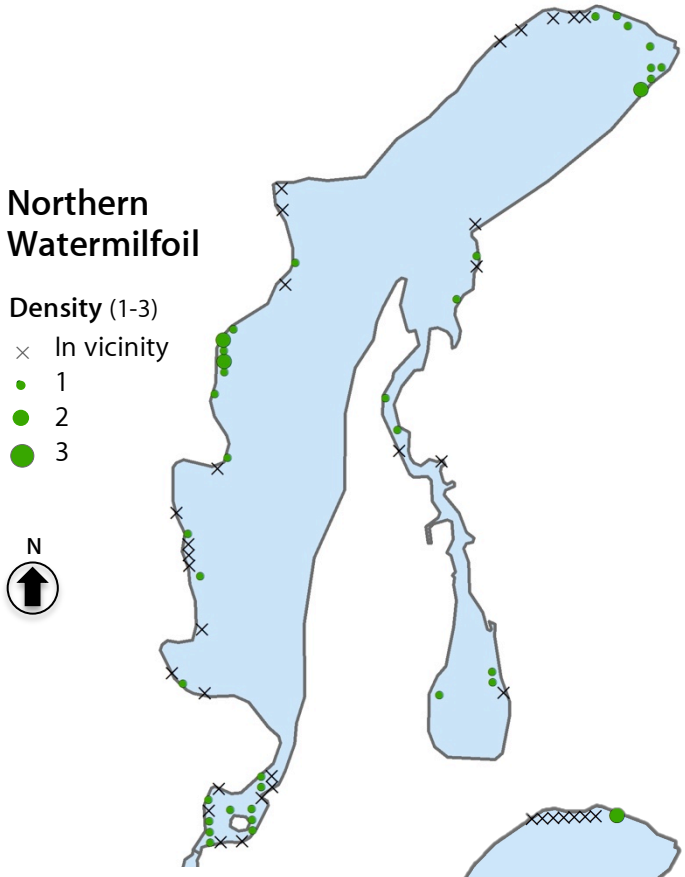


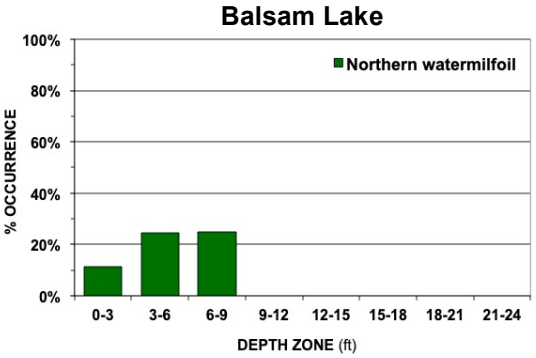


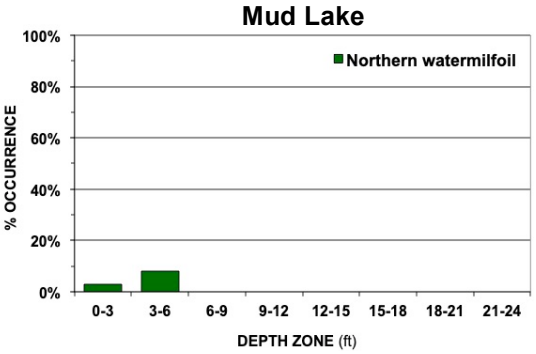


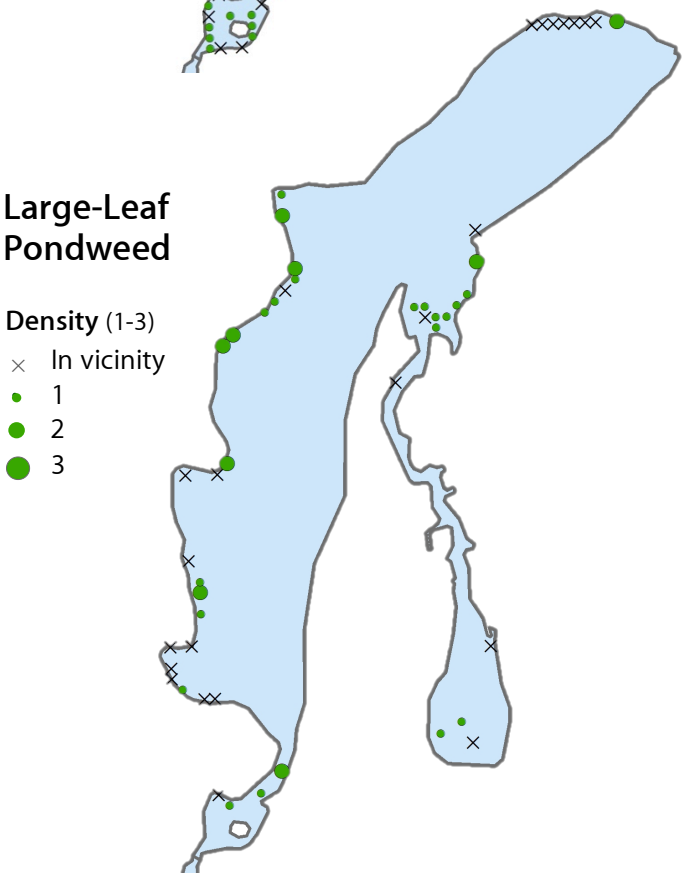


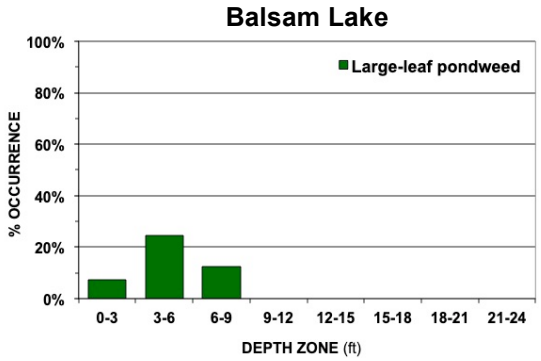
Balsam & Mud Lake – Aquatic Plant Species (Submersed)

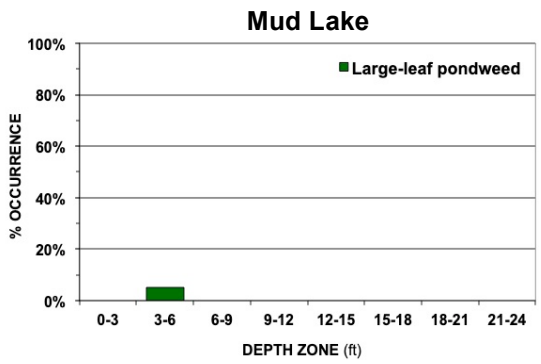




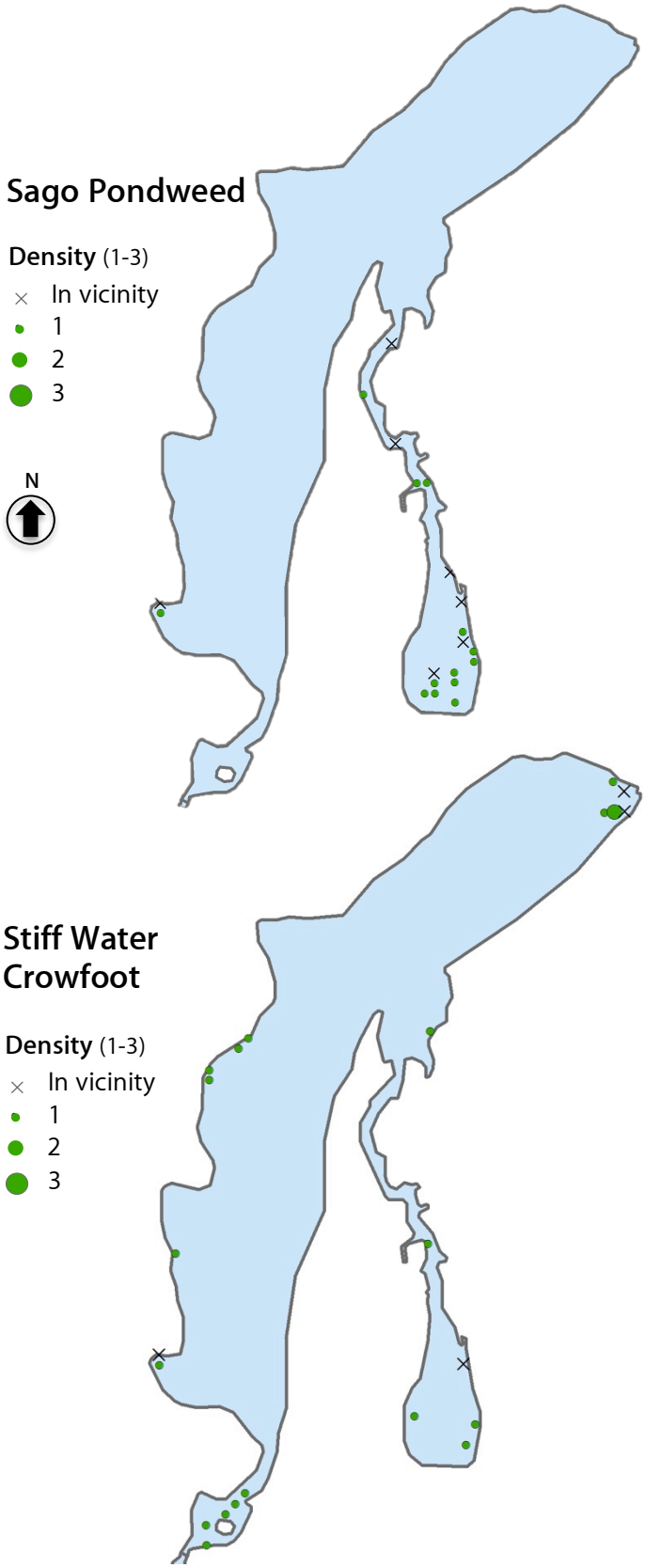


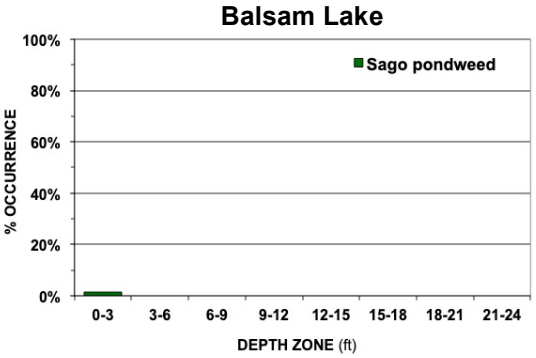


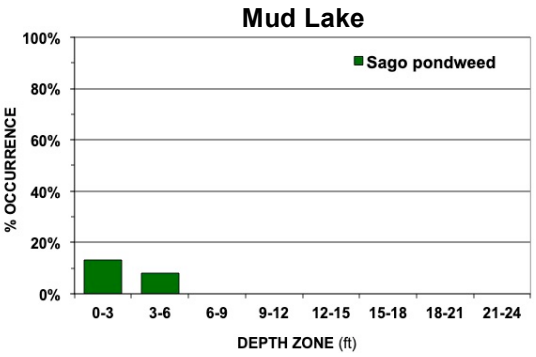


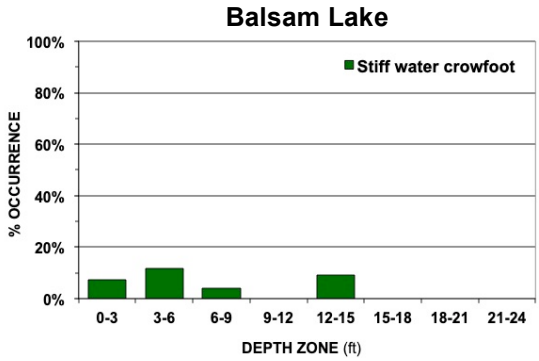


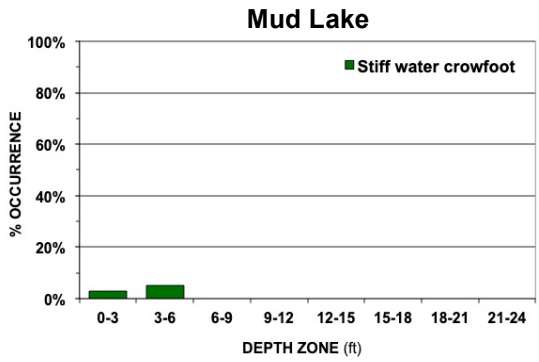
Balsam & Mud Lake – Aquatic Plant Species (Submersed)



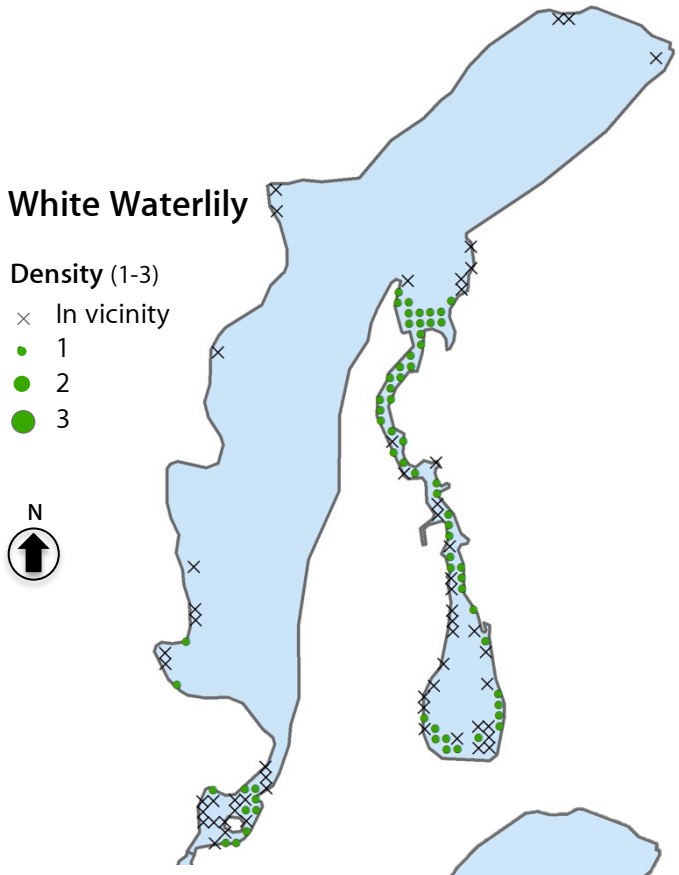


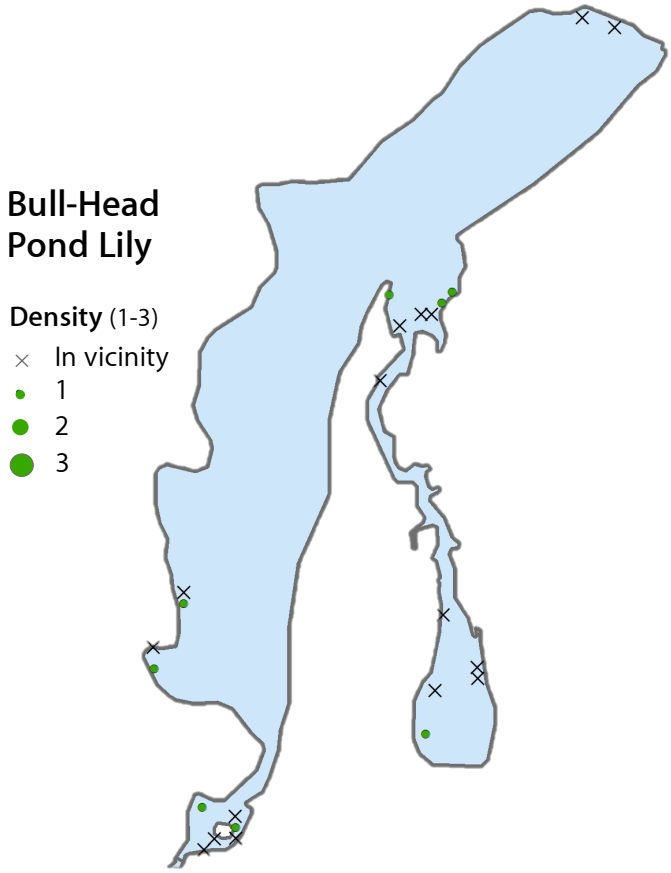


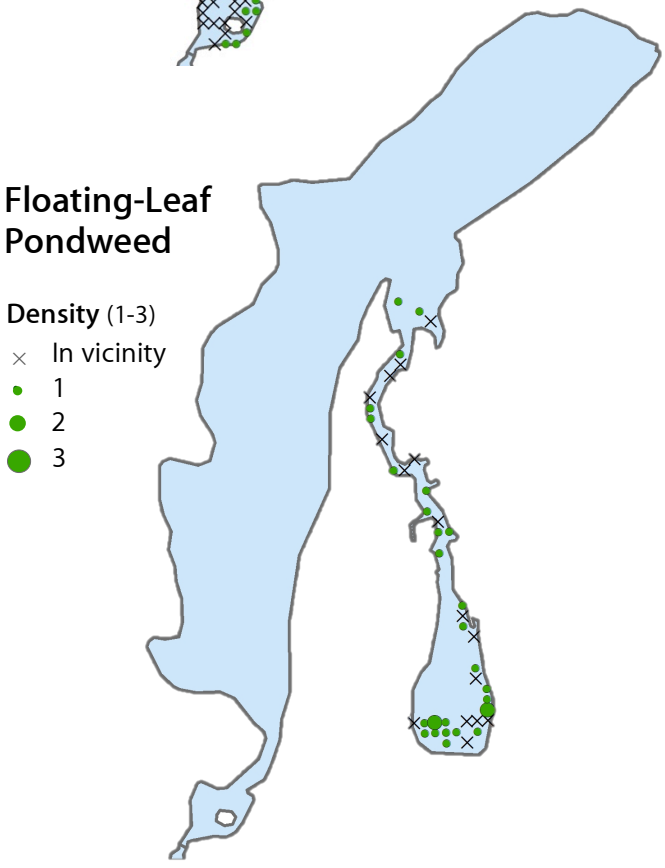




Balsam & Mud Lake – Aquatic Plant Species (Floating)







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