CEDAR LAKE
2025 AQUATIC VEGETATION SURVEY REPORT

PREPARED FOR THE CEDAR LAKE ASSOCIATION

DECEMBER 9, 2025

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1. Introduction

Arrowwood Environmental (AE) was retained by the Cedar Lake Association to conduct an inventory of aquatic vegetation in Cedar Lake in Monkton Vermont. The inventory is part of an ongoing effort to control Eurasian watermilfoil (*Myriophyllum spicatum*, EWM) in the lake. The survey consisted of an inventory and mapping of EWM in the lake as well as a quantitative grid point survey of all aquatic vegetation in the lake. This report summarizes the methodology and results of the 2025 survey.

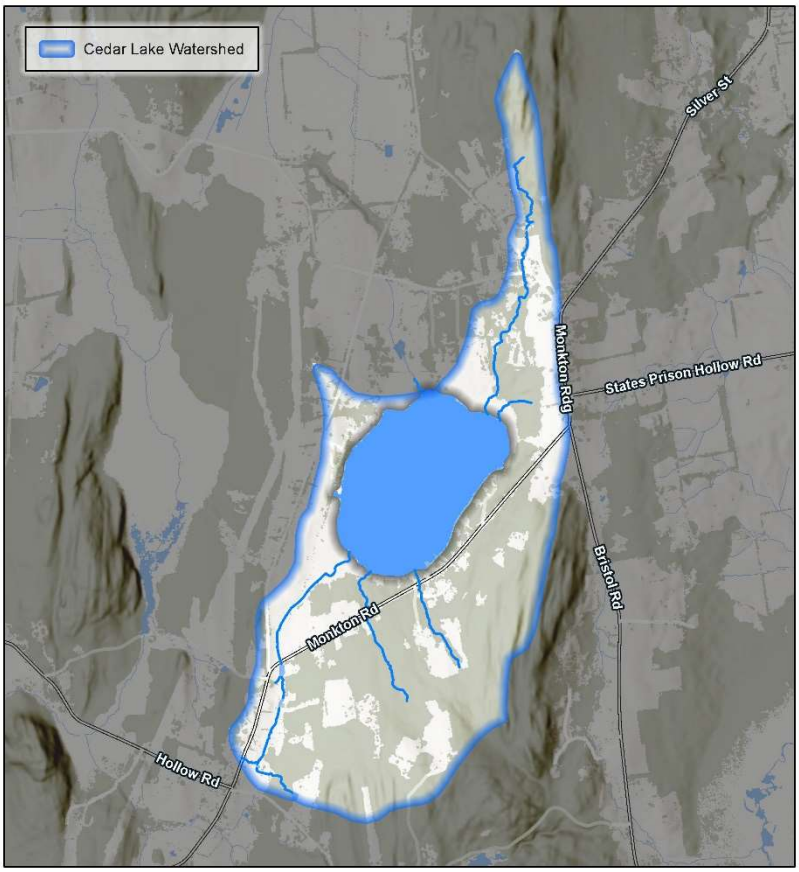


Figure 1. Cedar Lake Watershed

Cedar Lake is a 128-acre lake with a maximum depth of 13 feet.

Three small inlets feed the lake on the south end, while two small inlets enter the lake on the north end. The outlet is located on the northwestern shore where it feeds an unnamed tributary of Lewis Creek.

Lakes are typically classified based on physical parameters such as size, depth, trophic status and alkalinity. Cedar Lake is underlain by sandstones and dolostones of the Monkton Quartzite Formation. The underlying bedrock can impact the chemistry of the water, in this case resulting in a waterbody with high alkalinity. The chemistry and nutrient content of the water is also highly influenced by the nature

of the surface water inputs and the land-use surrounding the lake. Landuse in the Cedar Lake watershed is a mixture of forested lands, agricultural fields, and rural residential development. In their analysis of watershed landuse, Vermont Department of Environmental Conservation considers the Cedar Lake watershed to be "highly disturbed." This is based on the amount of landuse under development or agricultural use within the watershed that may have an impact on water quality in the lake (Vermont Department of Environmental Conservation 2025).

Trophic status is a way to categorize different lakes based on the amount of biologically useful nutrients in the water (mainly phosphorus and nitrogen). Oligotrophic lakes are lakes with very low nutrients available for plant (including algae) growth. Because of this low amount of growth, plant and algae productivity is low and water clarity can be quite high. Mesotrophic lakes have a moderate degree of nutrients available for plant growth and eutrophic lakes are those with a large amount of nutrients. Eutrophic lakes can have low water clarity because of the higher degree of algae growth that is possible when nutrients such as phosphorus are plentiful.

Since phosphorus is typically the limiting nutrient for aquatic plant growth, a common measurement to determine trophic status is to measure the phosphorus content of the lake during spring turn-over. This is the phosphorus that will be available for plant and algae growth during the growing season. Based on the most recent spring phosphorus measurements (12.5ug/l in 2021), Cedar Lake is considered a mesotrophic lake (Vermont Department of Environmental Conservation 2025).

Finally, lakes and ponds are also classified based their size and depth. Small, shallow waterbodies are generally considered "ponds" and larger, deeper waterbodies are considered "lakes". Limnologists often don't like to split waterbodies up into "lake" and "pond" because there is so much variation that, in some cases, the distinction can be difficult. In addition, in common parlance, the terms "pond" and "lake" are used freely and there are many cases where lakes are called ponds and ponds are

called lakes. Despite this, there are some salient differences between lakes and ponds that are worth noting. The figure below summarizes the main differences between these two types of waterbodies.

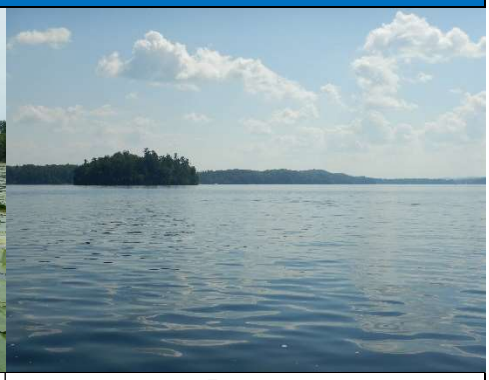
	Pond	Lake
		
Depth	Shallow	Deep
Photic zone	Throughout	On Margins
Aquatic vegetation	Dense throughout	Areas without
Pelagic (deep water)	Absent	Present
Thermal Stratification	Absent	Present - seasonal turnover
Fish species	Warm water	Warm & cold water

Figure 2. Characteristics of Lakes and Ponds

Given these distinctions, technically speaking, Cedar Lake is a pond. With a maximum depth of 13 feet, there are no deeper, pelagic areas in the pond. Due to this, the pond does not stratify in the summer or provide habitat for cold water species such as trout and salmon. However, although the photic zone is throughout the pond, aquatic vegetation is generally absent from areas in the center that are greater than 12' deep. Unlike some ponds, Cedar Lake doesn't have aquatic vegetation from shore-to-shore.

2. Methods

The study area for the aquatic plant inventory consisted of the entirety of Cedar Lake with the shoreline boundaries derived from the Vermont Hydrography Dataset (VHD). Only aquatic species and emergent species that typically occur within aquatic plant communities were included in this inventory. This includes aquatic vascular plants as well as macroalgae, together considered aquatic "macrophytes."

Field work on Cedar Lake system was conducted by Arrowwood personnel on September 3 and 4, 2025. During the field work, the lake was circumnavigated with a kayak.

Two different methods were used to inventory aquatic macrophytes in Cedar Lake: Grid Point Sampling, and Visual Littoral Surveys. The methodology used for each of these survey types is outlined below.

A. Grid Point Sampling

The Grid Point Sampling method provides a systematic and standardized procedure for sampling aquatic vegetation in lakes and lakes (Hauxwell et al. 2010). A total of 52 grid points were located throughout the littoral zone of Cedar Lake as shown on the map in Appendix 2a.

Table 1. Aquatic sampling rake data collected at each grid point

METRIC	Description and categories	
RAKE FULLNESS	*Amount of aquatic vegetation on the sampling rake*	
	None	No plants present on rake
	Single	A single plant present on rake
	Low	Sparse vegetation present on rake
	Medium	Moderate amount of vegetation on rake, typically enough to cover center of the rake but not the tines
	High	Large amount of vegetation on rake, typically enough to cover the rake tines, difficult to bring into the boat
SPECIES ABUNDANCE	*Ranking of abundance of each species on sampling rake*	
	Single	A single plant present on rake
	Low	Species was sparse on rake
	Medium	Species was moderately abundant on rake
	High	Species was abundant on rake

The lake boundary and predetermined grid point locations were uploaded to an iPhone or iPad data collector, running ArcGIS Collector and Survey123 field data collection applications. An ortho-photo basemap project was created on the iPhone/iPad with the grid point locations for use during the fieldwork. This system was used to navigate to each grid point using a boat. All data was recorded using a digital data form on the data collection unit. Tables 1 and 2 list the data and categories of data that were collected at each grid point.

Table 2. Vegetation abundance and site data collected at each grid point

METRIC	Description and categories	
BIOMASS	*Amount of plant growth vertically in the water column*	
	None	No aquatic plants present
	Low	Plants growing only as a low layer above the sediment
	Moderate	Plants growing well into the water column but generally not reaching the water surface
	High	Plants filling the water column and/or surfacing enough to be a possible recreational nuisance
	Very High	Plants filling the water column and completely covering the surface; obvious nuisance conditions
PERCENT COVER SUBMERGED	A record of the percentage of the lake bottom covered by submerged aquatic plants using the following cover categories: <1%; 1-5%; 5-25%; 25-50%; 50-75%; 75-100%	
PERCENT COVER FLOATING	A record of the percentage of the lake surface covered by floating aquatic plants using the following cover categories: 1-5%; 5-25%; 25-50%; 50-75%; 75-100%	
NONNATIVE INVASIVE SPECIES (NNIS)	Presence of invasive species with species name and number of plants or percent cover of NNIS plants using the following cover categories: <1%; 1-5%; 5-25%; 25-50%; 50-75%; 75-100%	
SEDIMENT TYPE	Type of sediment present using the following categories: Bedrock; Boulder; Cobble; Gravel; Sand; Silt; Clay; Muck	
WATER DEPTH	Depth of water taken using sonar (from motorboat) or kayak paddle (from kayak).	
AQUATIC NATURAL COMMUNITY	Type of aquatic natural community present at grid point	

An aquatic survey rake was used to gather the vegetation data at each point location. In waters shallower than 8', a rake on a pole was used to sample vegetation. In waters deeper than 8', a survey rake attached to a rope was used to sample vegetation. Rake fullness, as outlined in Table 1, was recorded for each sample to obtain information about vegetation density (Hauxwell et al. 2010; Madsen et al. 1996). Each aquatic plant on the rake was identified to species, if possible. Specimens that were difficult to identify in the field were collected and examined under a dissecting scope.

Voucher specimens of many species recorded in the lake were collected and stored at either the Arrowwood Herbarium or at the Pringle Herbarium at the University of Vermont. The abundance of each species on the rake was recorded using the categories outlined in Table 1.

In addition to rake data, vegetation abundance and general site data (described in Table 2) was collected at each grid point.

Overall plant biomass data is used to understand the potential for aquatic plants growing at levels high enough to reach nuisance conditions. The categories for this metric are shown in Table 2. Since this metric measures potential nuisance conditions, it is largely dependent upon water depth in addition to plant growth. Dense plant growth in the water column, for example, does not generally present nuisance conditions if it is well below the surface of the lake. The same amount of growth, however, in very shallow water would potentially create nuisance conditions.

Percent cover of both submerged and floating aquatic plants was recorded at each grid point using the categories shown in Table 2. Recording percent cover of aquatic plants is a similar metric as the biomass but not dependent on water depth. If submerged vegetation was growing dense enough that it was laying on the surface of the water, it was considered a floating aquatic plant for this metric.

Figure 3. Aquatic sampling rake

Presence or absence of non-native invasive species was evaluated in an approximately 500 square foot area at each grid sampling point. Data on either the number of plants or the percent cover that the plants occupy was recorded as outlined in Table 2. If an NNIS infestation was widespread, "off-grid" sampling points were used to determine the boundaries of the infestation (see Visual Littoral Survey methods below).

Water depth and sediment type data were collected at each grid point as outlined in Table 2. For each grid point where the aquatic natural community was known, data was collected on the presence of this type.

B. Visual Littoral Survey

The grid point sampling provides a systematic and repeatable method for sampling aquatic vegetation; however, it does not provide information about the nature of aquatic vegetation between the grid points. Relying solely on this method, therefore, has the potential to leave significant gaps in the knowledge of aquatic vegetation in the overall lake. The visual littoral survey method was employed to fill in these gaps and provide a more complete picture of aquatic vegetation presence and distribution. This survey methodology is based on methods from the Vermont Agency of Natural Resources Department of Environmental Conservation (2006) field manual.

When navigating in between grid point locations, aquatic vegetation was viewed from the boat. An "off-grid" data point was taken to document invasive species, record information about aquatic natural communities, record areas of high biomass, document rare species or record other features of interest. Data was recorded on the digital data collection form at these "off-grid" points. Only a subset of the data presented in Tables 1 and 2 was collected at these points related to the specific feature being documented. In some cases, a field sketch map of a particular

feature (typically an EWM infestation or natural community) was used to document the extent of the feature. This was conducted on the iPhone/iPad using a basic line feature class.

Mapping the distribution and abundance of EWM was a major focus of the visual littoral survey. Dedicated visual littoral surveys were conducted to map EWM throughout the entire littoral zone. Sub-meter capable GPS systems and specific EWM data mapping protocol using ArcGIS Quick Capture were used for efficient data collection of EWM infestations. This methodology allows for the rapid collection of percent cover data, plant count data and infestation boundary data.

C. Creating maps of EWM and Natural Communities

Once field work was complete, the spatial data was analyzed in ArcGIS. In order to create a complete map of aquatic vegetation in the lake, the grid points and off-grid points were used to create a polygon layer of vegetation. Using ortho-photo interpretation, bathymetric maps of the lake and the field data, a polygon feature class was created of the different aquatic natural communities. This map provides the extent of the aquatic vegetation in the lake at the time of the survey (the littoral zone).

Using the littoral zone as a baseline, the EWM point data was used to create a map of EWM infestations. Different polygons of EWM were created for each of the different density categories shown in Table 3. In some cases, the transition between the different density categories in the lake was gradual; the boundaries shown on the final map are therefore considered approximate.

Table 3. Percent cover categories

Percent Cover	Density Description
0	None
1-5%	Trace
5-25%	Sparse
25-50%	Moderate
50-75%	Moderate-Dense
75-100%	Dense

The map of EWM presence in the Lake should be viewed in conjunction with ongoing EWM control activities. The presence and density of EWM surveyed are, in many cases, dependent on and determined by EWM control efforts.

D. Aquatic Plant Species List

A list of all aquatic plant species encountered during the inventory is included in the results section. This list was compiled from the grid point and off-grid point samples and the visual littoral surveys. Grid point rake sampling generally favors larger species and species that are dominant. This sampling method tends to miss species that are uncommon, species that occur in isolated habitats, or species that are small or grow along the sediment surface. For this reason, species that were noted during the visual littoral surveys were also recorded.

Table 4. Plant rarity ranking

S-Rank	Description
S1	Very rare
S2	Rare
S3	Uncommon
S4	Common
S5	Common and Widespread

The Vermont Natural Heritage Inventory (NHI) maintains a list of species that are rare, threatened and endangered in the state. Determination of how rare or common a particular species is in the state is based on rarity rankings (Table 4) assigned to each species by Vermont NHI. This methodology was used in Sunrise Lake to determine if any of the species documented were considered rare or uncommon. A discussion of uncommon species encountered during the inventory is included in the results.

3. Results

The results of the aquatic plant inventory for Cedar Lake are presented in two sections below: A) Native Aquatic Vegetation and B) Non-native Invasive Species.

A. Native Aquatic Vegetation

A list of all aquatic species documented during the inventory is presented in Table 5.

Humped bladderwort (*Utricularia gibba*) is the only species that is not a common and widespread species in the state. This small, carnivorous aquatic plant is considered uncommon in Vermont (S3-ranked). It is a free-floating species that was found in low abundance throughout the lake. It is most common in areas deeper than 7 feet deep where it forms dense tangled mats attached to submerged vegetation.

Table 5. Plant species documented in Cedar Lake

Latin Name	Common Name	S-Rank*
Ceratophyllum demersum	coontail	
Nitella spp.	stonewort	
Myriophyllum sibiricum	northern water-milfoil	
Myriophyllum spicatum	Eurasian water-milfoil	
Elodea canadensis	water-weed	
Najas flexilis	common naiad	
Vallisneria americana	eel-grass	
Utricularia gibba	humped bladderwort	S3
Utricularia macrorrhiza	common bladderwort	
Nymphaea odorata	waterlily	
Nymphaea odorata ssp. tuberosa	large water-lily	
Ludwigia palustris	common water-purslane	
Heteranthera dubia	water star-grass	
Potamogeton gramineus	grass-leaved pondweed	
Potamogeton illinoensis	Illinois pondweed	
Potamogeton natans	floating pondweed	
Potamogeton praelongus	white-stemmed pondweed	
Potamogeton zosteriformis	zigzag pondweed	
Stuckenia pectinata	sago pondweed	
Typha latifolia	broad-leaved cat-tail	

The different species listed in Table 5 are often found together in assemblages known as natural communities. A map of the aquatic natural communities in Cedar Lake is shown in Appendix 2.

The two vegetation types shown mapped in Cedar Lake are the Water Lily Aquatic Community and the Robbins-Illinois Pondweed Community. Each of these is described below. As can be seen on this map, vegetation is generally absent from areas deeper than 12-13' deep, and there is an unvegetated area in the center of the Lake.

Figure 4. Water Lily Aquatic Community

The Water Lily Aquatic Community is a common aquatic community in our region and occupies shallow ponds and sheltered bays in larger lakes. It is characterized by a layer of floating-leaved aquatic species such as water lily (*Nymphaea odorata*). The abundance of this floating-leaved layer varies widely and includes areas with sparse (25% cover) to areas with near complete cover. In Cedar Lake, this community occupies the shallow shores around the margins of the Lake and is most abundant along the southern shore. Cover of submerged species beneath the water lily leaves is inversely related to the cover of floating leaves present. Common submerged species include stonewort (*Nitella spp.*), waterweed (*Elodea canadensis)*, *eel-grass (Vallinseria americana)* and zigzag pondweed (*Potamogeton zosteriformis*).

The Robbins-Illinois Pondweed Community is a common submerged aquatic community found in moderate-high alkalinity lakes throughout our region. In Cedar Lake, Robbins pondweed is absent, but Illinois pondweed is very common. Stonewort is also a common component of this community in Cedar Lake, where it can form a dense growth along the lake bottom. In many places, this dense

"understory" is interrupted only by scattered patches of the taller pondweeds, which grow to the water's surface. Waterweed, eel-grass, and zigzag pondweed are also present and can be locally abundant. Eel-grass, in particular, is common in the shallower areas of this community.

Figure 5. Robbins-Illinois Pondweed Community

Analysis of the grid sampling survey data is presented in summary form in Table 4. The dataset allows for analysis of the most abundant species that occur on the rake samples shown as the Frequency of Occurrence (FOO). Full results of the rake samples are included in the tables in Appendix 1.

The list of species in these tables is arranged from most abundant to least abundant species encountered during the 2025 rake sampling.

Table 6. Frequency of occurrence (FOO) data for Cedar Lake

Latin Name	Common Name	Count	FOO 2025
Myriophyllum spicatum	Eurasian water-milfoil	24	46%
<Null>	NA	17	33%
Nitella spp.	stonewort	17	33%
Potamogeton illinoensis	Illinois pondweed	13	25%
Vallisneria americana	eel-grass	10	19%
Elodea canadensis	water-weed	9	17%
Nymphaea odorata	waterlily	5	10%
Potamogeton zosteriformis	zigzag pondweed	5	10%
Heteranthera dubia	water star-grass	2	4%
Utricularia gibba	humped bladderwort	2	4%
Ceratophyllum demersum	coontail	1	2%
Myriophyllum sibiricum	northern water-milfoil	1	2%
Najas flexilis	common naiad	1	2%
Utricularia macrorrhiza	common bladderwort	1	2%

The most common species documented on the rake samples in Cedar Lake was EWM. More data on the distribution and abundance of this non-native invasive species is found in Section 3b below. The <Null> values shown in Table 6 are rake samples that lack vegetation. The three most common native species on the rake samples were stonewort, eel-grass and water-weed.

B. Non-Native Aquatic Species

EWM was the only aquatic invasive species documented in Cedar Lake during the current inventory. Summary data on EWM abundance in Cedar Lake is shown in Table 7. Maps of EWM distribution in the Lake are included in Appendix 2.

Table 7. Summary data on EWM abundance in Cedar Lake

EWM Density	Acres 2025
None	0
Trace	32.3
Sparse	17.9
Moderate	9.1
Moderate-Dense	7.5
Dense	27.7

As the data in Table 7 and map in Appendix 2 illustrate, EWM was widespread and abundant throughout Cedar Lake at the time of the current inventory. Overall, EWM was less abundant on the western side of the lake than on the eastern side. Only scattered EWM plants (Sparse density) were found in the northwestern end of the lake especially in the shallower areas. In contrast, a ring of Dense EWM was found nearly encircling the entire Lake. Areas of Moderate and Moderate-Dense EWM were also found, though mainly restricted to the eastern half of the Lake.

4. Conclusion

An inventory was conducted of native and non-native aquatic vegetation in Cedar Lake using grid-point sampling and visual littoral surveys. Nineteen species of native aquatic plants and a single non-native species were documented during this inventory. Two native natural community types were mapped in the Lake: Water Lily Aquatic Community and Robbin-Illinois Pondweed Community. EWM was the only non-native aquatic species documented during the inventory, however, this species was widespread and abundant in Cedar Lake. EWM was less abundant on the western side of the lake than the eastern side. Dense EWM infestations totaled nearly 28 acres and were found throughout the lake, though restricted to the deeper areas on the eastern end. Tracking the distribution and abundance of EWM in the lake will help guide management in 2026.

5. Literature Cited

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Appendix 1: Cedar Lake Aquatic Sampling Rake Data

1=Single 2=Low 4=Moderate 4=High
** Points with no plants on rake are not shown*

Grid Point	Ceratophyllum demersum	Elodea canadensis	Heteranthera dubia	Myriophyllum sibiricum	Myriophyllum spicatum	Najas flexilis	Nitella spp.	Nymphaea odorata	Potamogeton illinoensis	Potamogeton zosteriformis	Utricularia gibba	Utricularia macrorrhiza	Vallisneria americana
3							4		2			2	2
5							4						
16							4						
18							4		2				2
20							4		2				
22							3						
24							2		2				
26		4						3		2			
42							4		1				
44							4		2				
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48					2								
50					2								
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54		2			2				2				
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74							4						
76					2								
86					4								
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104					2		2		2		2		2
106					1								
130		4	2		2								3
132		2			2								
142					2		2	2					3
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157		2			3				2				
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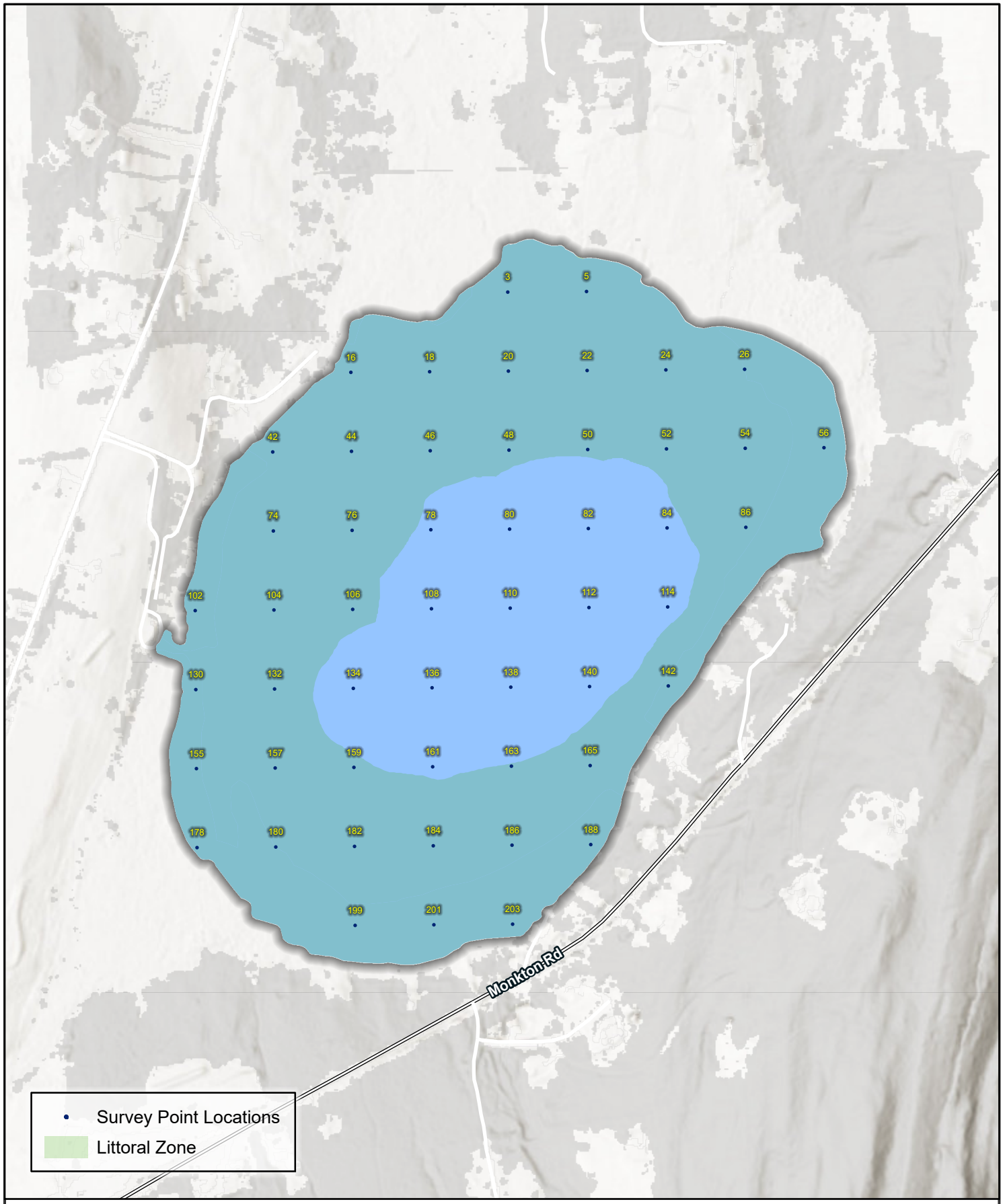
165					3								
180		2			2					2			
182					2				2				

Grid Point	Ceratophyllum demersum	Elodea canadensis	Heteranthera dubia	Myriophyllum sibiricum	Myriophyllum spicatum	Najas flexilis	Nitella spp.	Nymphaea odorata	Potamogeton illinoensis	Potamogeton zosteriformis	Utricularia gibba	Utricularia macrorrhiza	Vallisneria americana
184		2			2		2						
186					3								
188					2		3		2				2
199					2								2
201		3	2	2				2	2	2			
203					4								

Appendix 2a: Cedar Lake Grid Point Location Map

Appendix 2b: Cedar Lake Aquatic Natural Community Map

Appendix 2c: Cedar Lake 2025 Eurasian Watermilfoil Map



Cedar Lake, Monkton, Vt.

Monday, December 08, 2025 File: CedarLake:8.5x11 Report Appendix
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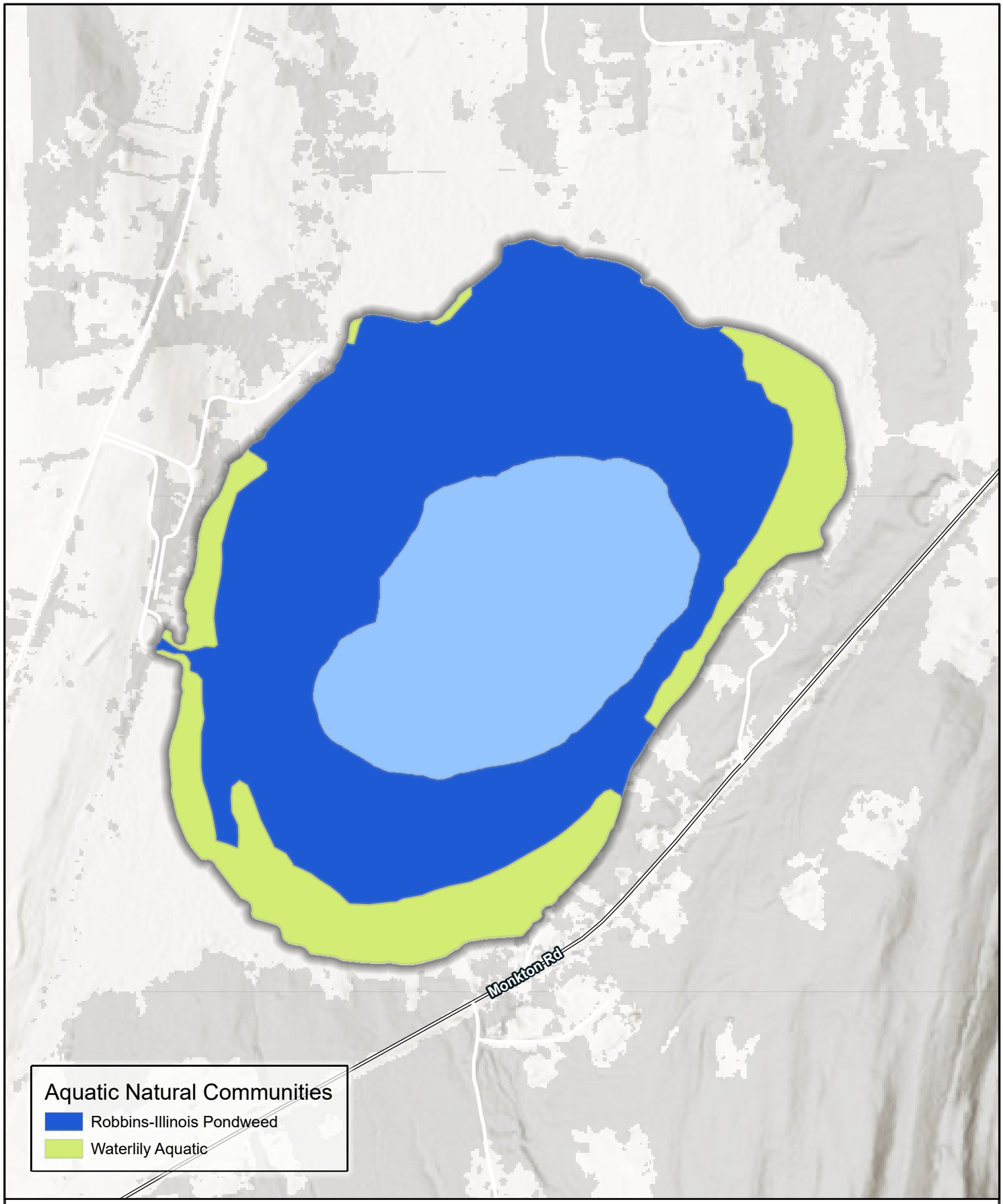

Cedar Lake, Monkton, Vt.

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Prepared By: A Worthley *WGS 1984 Web Mercator Auxiliary Sphere*

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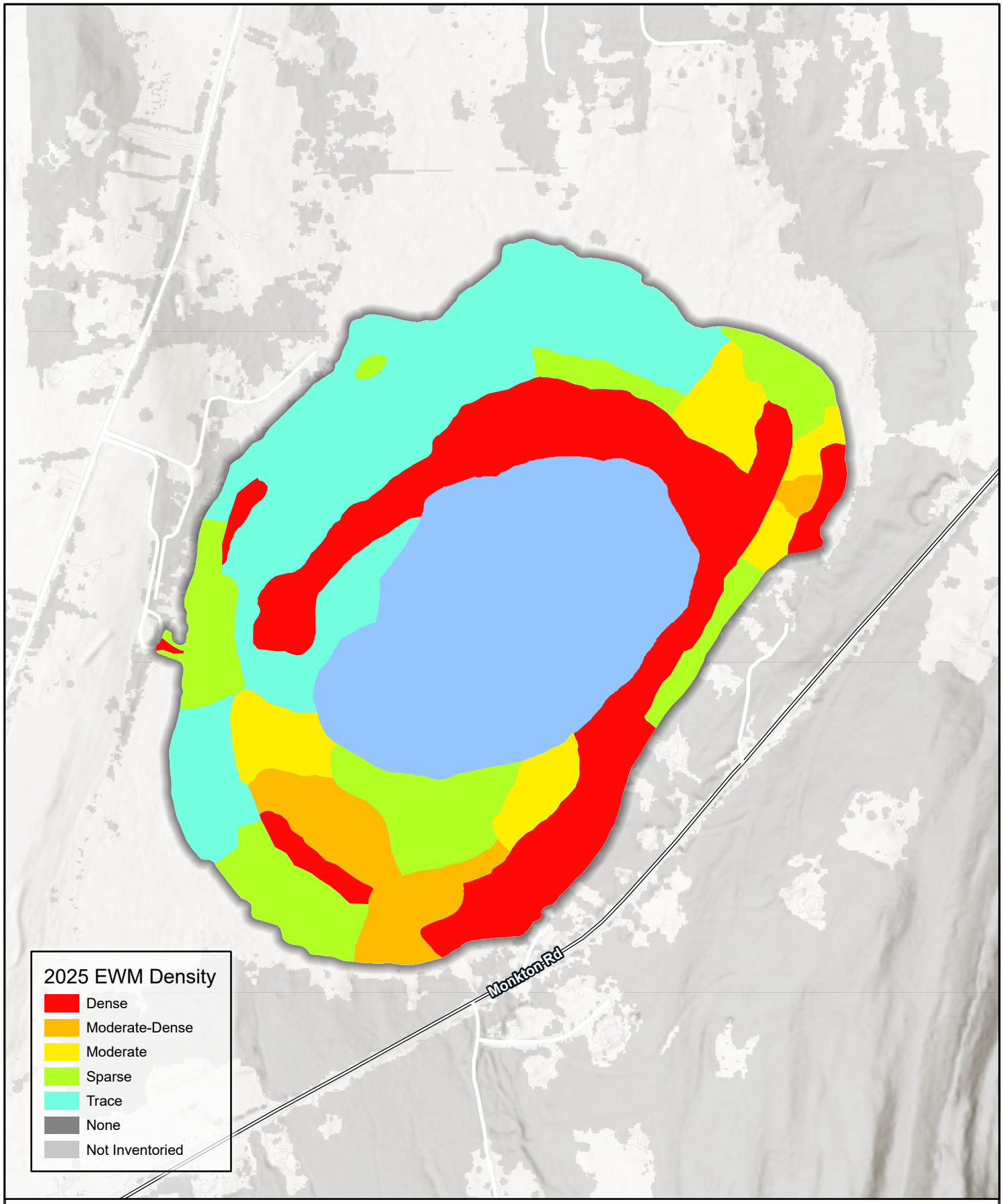

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