Restorative Lake Sciences™

Bear Lake 2025 Aquatic Vegetation, Water Quality, and 2026 Management Recommendations Report

December 2025

Bear Lake 2025 Aquatic Vegetation, Water Quality, and 2026 Management Recommendations Report

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Table of Contents

Section 1: Bear Lake Summary (2025)..... 4

Section 2: Bear Lake Water Quality Data (Historic-2025)..... 5

Section 3: Bear Lake Aquatic Vegetation Data (2025)..... 15

Section 4: Bear Lake Macroinvetebrates (2025)..... 19

Section 5: Management Recommendations for 2026……22

Section 1

Bear Lake 2025 Aquatic Vegetation, Water Quality, and 2026 Management Recommendations Report

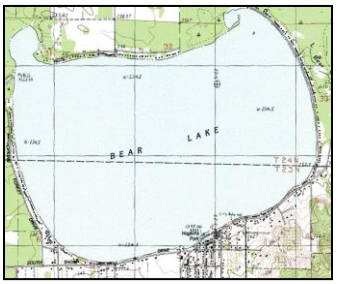
The following information is a summary of key lake findings collected in 2025.

The overall condition of Bear Lake is ranked in the top 15% of developed lakes of similar size in the state of Michigan (based on RLS evaluations). The water clarity in 2025 was good with an average of 13.5 feet. The nutrient concentrations in the lake are considered low to moderate yet are adequate to support robust submersed aquatic plant growth due to the high-water clarity. Invasive species such as Eurasian Watermilfoil (EWM) are able to grow in moderate nutrient waters and thus are a challenge to the Bear Lake ecosystem. Bear Lake had a total of 6.6 acres of EWM in 2025 which was effectively treated with the new systemic herbicide ProcellaCOR® just after the initial survey. Rotating active ingredients is key to minimizing plant resistances. Protection of the 15 native aquatic plant species is paramount for the health of the lake fishery, and these plants should not be managed unless they are a nuisance to lakefront property owners and possess navigational and recreational hazards. Biodiversity was reduced in 2025 and was likely attributed to the harsh winter conditions that reduced seedbank germination of all species in Bear Lake.

The lake did experience depletion of dissolved oxygen with depth during the mid-summer sampling in the East Basin, otherwise oxygen levels held consistent which is common for a large lake that minimally stratifies. Trends for most water quality parameters are shown below. Overall, Bear Lake is a very stable aquatic ecosystem with excellent aquatic vegetation biodiversity, relative abundance, water clarity, neutral pH and soft water alkalinity, and low to moderate nutrients.

Section 2

Bear Lake Water Quality Data 2025



Water Quality Parameters Measured

There are hundreds of water quality parameters that can be measured on an inland lake, but several are critical indicators of lake health. These parameters include water temperature (measured in °C), dissolved oxygen (measured in mg/L), pH (measured in standard units-SU), conductivity (measured in micro-Siemens per centimeter-µS/cm), total alkalinity or hardness (measured in mg of calcium carbonate per liter-mg $CaCO_3$/L), total dissolved solids (mg/L), Secchi transparency (feet), total phosphorus and total nitrogen (both in mg/L), chlorophyll-*a* (in µg/L), and algal community composition. Graphs that show critical trends for some parameters in spring and late summer of each year are displayed below. Trend data were calculated using mean values for each parameter for spring and summer over each sampling location. Table 1 below demonstrates how lakes are classified based on key parameters. Bear Lake would be considered mesotrophic (relatively productive) since it does contain ample phosphorus, nitrogen, and aquatic vegetation growth but has excellent water clarity and moderate algal growth. 2025 water quality data for Bear Lake is shown below in Tables 2-4. Three deep basins were measured, with the West Basin located at the NW corner of the lake, the Central Basin located at the central portion of the lake, and the East Basin located at the northeastern portion of the lake (Figure 1). These parameters are discussed below along with water quality data specific to Bear Lake which were collected on August 18, 2025.

Table 1. Lake trophic classification (MDNR).

Lake Trophic Status	*Total Phosphorus (mg/L)*	*Chlorophyll-a (µg L^{-1})*	*Secchi Transparency (feet)*
Oligotrophic	**< 0.010**	**< 2.2**	**> 15.0**
Mesotrophic	**0.010 – 0.020**	**2.2 – 6.0**	**7.5 – 15.0**
Eutrophic	**> 0.020**	**> 6.0**	**< 7.5**

Table 2. Bear Lake Water Quality Parameter Data Collected over the East Deep Basin on August 18, 2025.

Depth ft.	*Water Temp ºC*	*DO mg/L*	*pH S.U.*	*Cond. µS/cm*	*Turb. NTU*	*TDS mg/L*	*Total Kjeldahl Nitrogen mg/L*	*Total Alk. mg/L $CaCO_3$*	*Total Phos. mg/L*
0	26.2	8.5	8.4	232	0.3	149	<0.50	55	0.010
12	25.8	8.5	8.4	232	0.9	149	0.50	55	0.010
23	22.4	3.9	7.5	240	1.6	153	3.8	54	0.160*

Table 3. Bear Lake Water Quality Parameter Data Collected over the Central Deep Basin on August 18, 2025. *TP likely elevated due to sediment in sample.

Depth ft.	*Water Temp ºC*	*DO mg/L*	*pH S.U.*	*Cond. µS/cm*	*Turb. NTU*	*TDS mg/L*	*Total Kjeldahl Nitrogen mg/L*	*Total Alk. mg/L $CaCO_3$*	*Total Phos. mg/L*
0	26.1	8.6	8.4	230	0.6	148	0.5	55	0.012
8	25.6	8.6	8.4	230	0.7	148	0.5	55	0.010
19	23.1	8.5	8.4	230	2.2	148	0.5	53	0.010

Table 4. Bear Lake Water Quality Parameter Data Collected over the West Basin on August 18, 2025.

Depth ft.	*Water Temp ºC*	*DO mg/L*	*pH S.U.*	*Cond. µS/cm*	*Turb. NTU*	*TDS mg/L*	*Total Kjeldahl Nitrogen mg/L*	*Total Alk. mg/L $CaCO_3$*	*Total Phos. mg/L*
0	26.7	8.6	8.5	230	0.3	148	<0.50	54	0.010
10	25.5	8.6	8.5	230	0.9	148	0.6	53	<0.010
20	24.1	8.4	8.3	230	2.2	148	0.5	51	0.012

Figure 1: 2025 Water quality sampling locations on Bear Lake.

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen that exists in the water column. In general, dissolved oxygen levels should be greater than 5 mg/L to sustain a healthy warm-water fishery. Dissolved oxygen concentrations in Bear Lake may decline if there is a high biochemical oxygen demand (BOD) where organismal consumption of oxygen is high due to respiration. Dissolved oxygen is generally higher in colder waters. Dissolved oxygen is measured in mg/L with the use of a dissolved oxygen meter and/or through the use of Winkler titration methods. The dissolved oxygen concentrations in Bear Lake were healthy and declined minimally with depth. This may be due to an early fall turn over and reduced stratification due to constant mixing of the lake water. **The dissolved oxygen concentrations in Bear Lake support both a warm water and cool water fishery with an average concentration of around 8.0 mg/L in 2025.** Figure 2 below shows the changes in mean dissolved oxygen with time in Bear Lake.

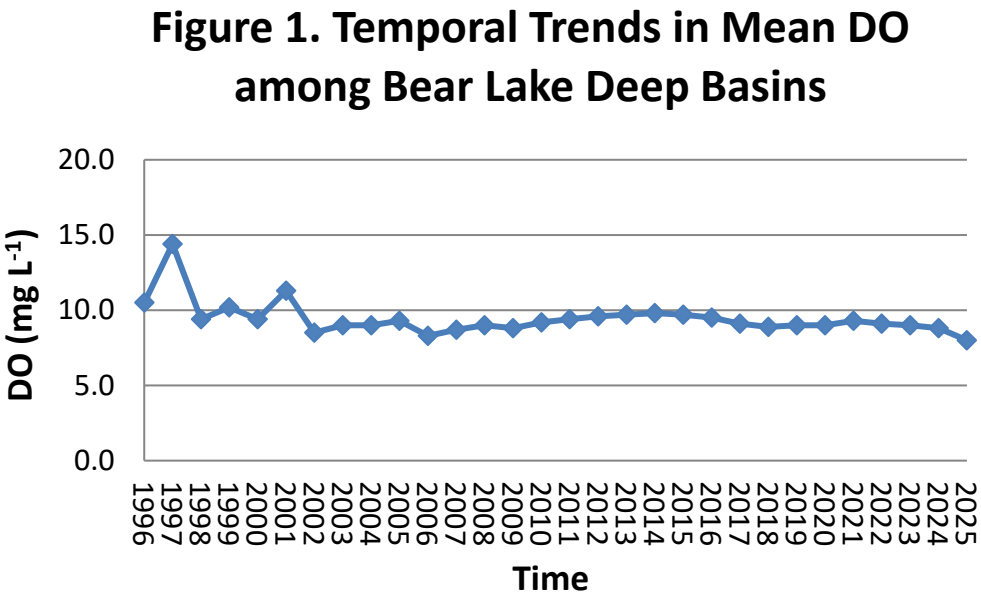


Figure 2: Temporal Trends in Mean Dissolved Oxygen in Bear Lake.

Water Clarity (Transparency) Data & Turbidity

Secchi transparency readings allow us to estimate where the photic to aphotic zones transition. The transparency throughout Bear Lake is adequate (mean of 13.5 feet in 2025; Figure 3) to allow abundant growth of algae and aquatic plants in the majority of the littoral zone of the lake.

Secchi transparency is variable and depends on the number of suspended particles in the water (often due to windy conditions of lake water mixing) and the amount of sunlight present at the time of measurement. Other parameters such as turbidity (measured in NTU's) and

Total Dissolved Solids (measured in mg/L) are correlated with water clarity and show an increase as clarity decreases. **The turbidity and total dissolved solids in Bear Lake during the 2025 sampling event were also quite low at ≤2.2 NTU's and 153 mg/L, respectively.**

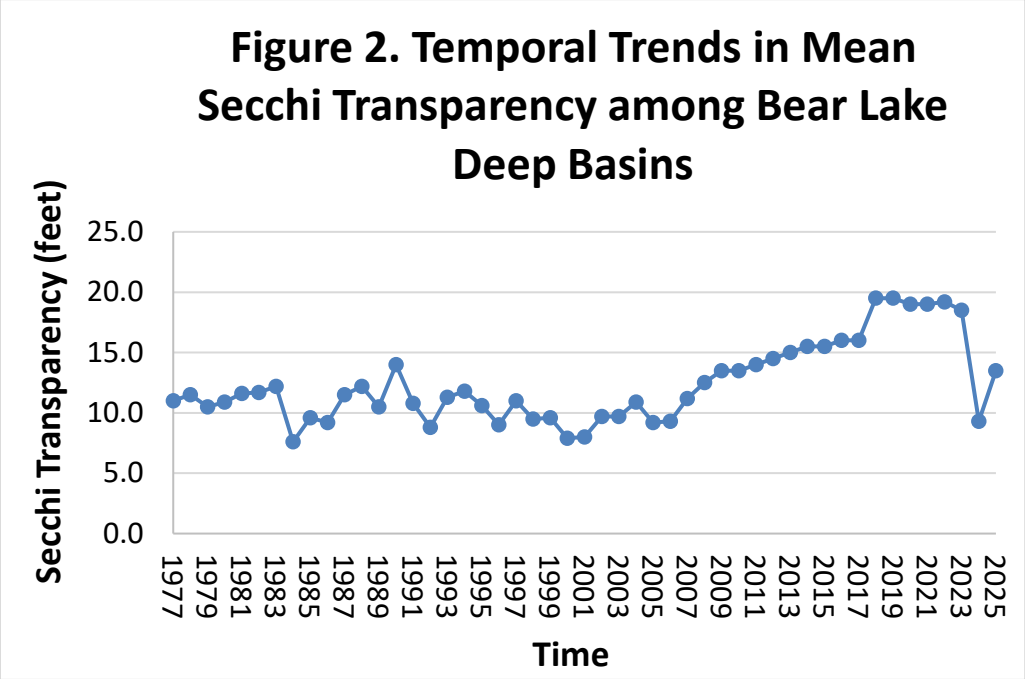


Figure 3: Temporal trends in mean Secchi transparency within Bear Lake.

Total Phosphorus

Total phosphorus (TP) is a measure of the amount of phosphorus (P) present in the water column. Phosphorus is the primary nutrient necessary for abundant algae and aquatic plant growth. TP concentrations are usually higher at increased depths due to higher release rates of P from lake sediments under low oxygen (anoxic) conditions. Phosphorus may also be released from sediments as pH increases. Fortunately, even though the TP levels in Bear Lake are moderate, the dissolved oxygen levels are good enough at the bottom to not cause release of phosphorus from the bottom. TP concentrations ranged from 0.010-0.160 mg/L during the 2025 season sampling event but the 0.016 value was likely an outlier due to possible sediment in the sample and thus was not factored into the analysis. **The mean TP concentration was around 0.011 mg/L (Figure 4) in 2025, which is quite low and favorable and below the eutrophic threshold. Most of the TP is being sequestered by aquatic plants.**

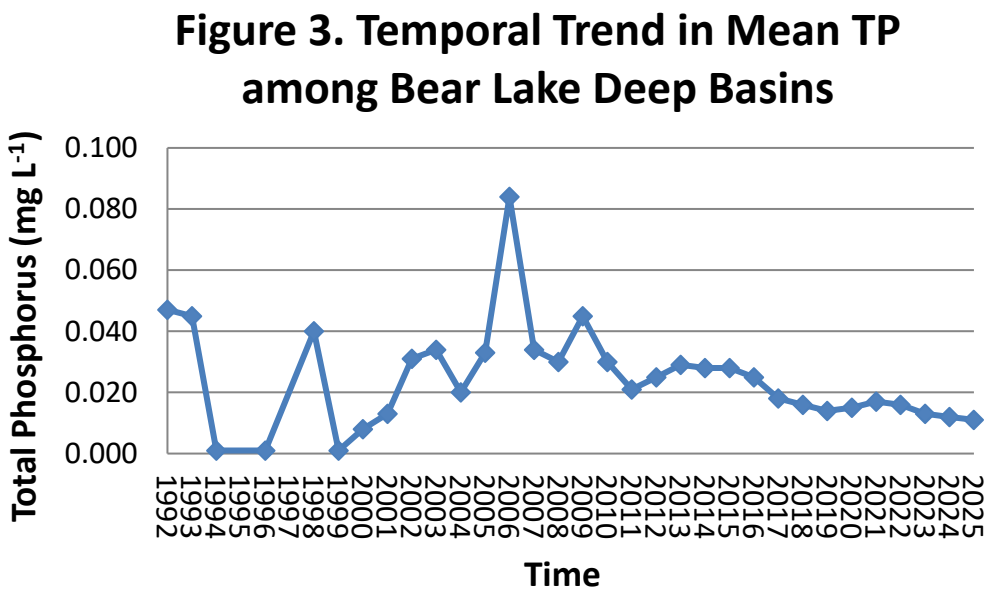


Figure 4: Temporal trend in mean Total Phosphorous levels within Bear Lake.

Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (TKN) is the sum of organic nitrogen plus ammonia (NH_3) forms in freshwater systems. Much nitrogen (amino acids and proteins) also comprises the bulk of living organisms in an aquatic ecosystem. Nitrogen originates from atmospheric inputs (i.e., burning of fossil fuels), wastewater sources from developed areas (i.e., runoff from fertilized lawns), agricultural lands, septic systems, and from waterfowl droppings. It also enters lakes through groundwater or surface drainage, drainage from marshes and wetlands, or from precipitation (Wetzel, 2001). In lakes with an abundance of nitrogen (N: P > 15), phosphorus may be the limiting nutrient for phytoplankton and aquatic macrophyte growth. Alternatively, in lakes with low nitrogen concentrations (and relatively high phosphorus), the blue-green algae populations may increase due to the ability to fix nitrogen gas from atmospheric inputs.

Lakes with a mean TKN value of 0.66 mg/L may be classified as oligotrophic, those with a mean TKN value of 0.75 mg/L may be classified as mesotrophic, and those with a mean TKN value greater than 1.88 mg/L may be classified as eutrophic. **Bear Lake contained TKN concentrations between 0.5-3.8 mg/L during the 2025 sampling event which is considered oligo-mesotrophic and is desirable with the exception of the 3.8 value that could have been due to sediment in the sample**.

Total Alkalinity

Lakes with high alkalinity (>150 mg/L of $CaCO_3$) can tolerate larger acid inputs with less change in water column pH. Many Michigan lakes contain high concentrations of $CaCO_3$ and are categorized as having "hard" water.

Total alkalinity may change on a daily basis due to the re-suspension of sedimentary deposits in the water and respond to seasonal changes due to the cyclic turnover of the lake water. **The alkalinity in Bear Lake averaged 54 mg/L of $CaCO_3$ (Figure 5) in 2025, which is low and indicates a soft water lake.**

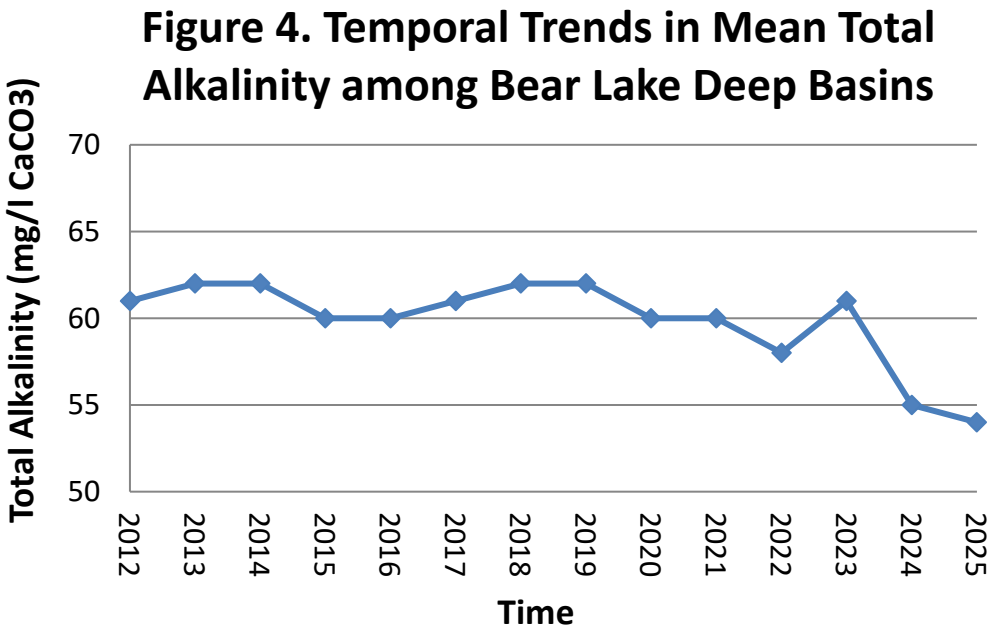


Figure 5: Temporal trends in mean total alkalinity within Bear Lake.

pH

Most Michigan lakes have pH values that range from 6.5 to 9.5. Acidic lakes (pH < 7) are rare in Michigan and are most sensitive to inputs of acidic substances due to a low acid neutralizing capacity (ANC). Bear Lake is considered "slightly basic" on the pH scale. **The mean pH of Bear Lake during the 2025 sampling event averaged 8.3 S.U. which is ideal for an inland soft water lake (Figure 6).** pH values may change over time due to photosynthesis of submersed aquatic vegetation and algae.

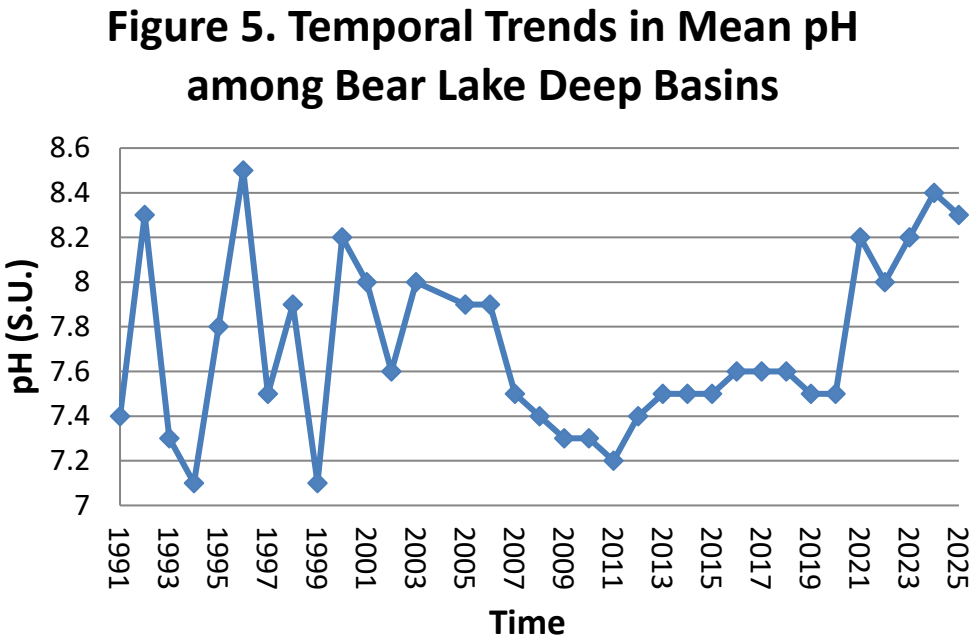


Figure 6: Temporal trends in mean pH within Bear Lake.

Conductivity

Conductivity is a measure of the number of mineral ions present in the water, especially those of salts and other dissolved inorganic substances. Conductivity generally increases as the amount of dissolved minerals, salts, and temperatures increase. **The conductivity values for Bear Lake during the 2025 sampling event (Figure 7) averaged 232 µS/cm which is favorable for an inland lake.** Severe water quality impairments do not occur until values exceed 800 µS/cm and are toxic to aquatic life around 1,000 µS/cm.

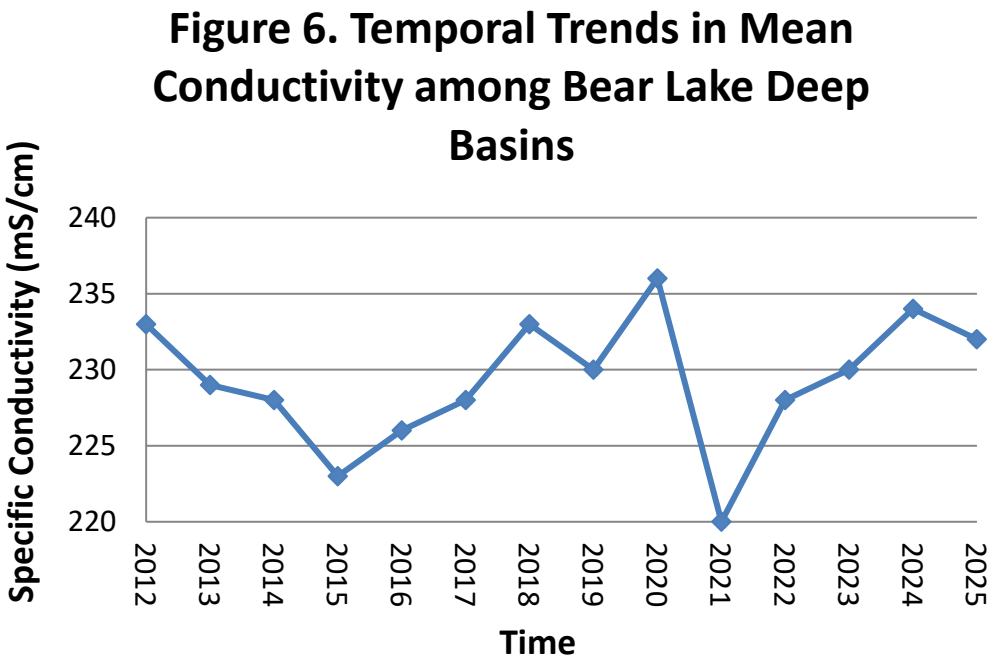


Figure 7: Temporal trends in mean Conductivity within Bear Lake.

Chlorophyll-*a* and Algal Species Composition

Chlorophyll-*a* is a measure of the amount of green plant pigment present in the water, often in the form of planktonic algae. High chlorophyll-*a* concentrations are indicative of nutrient-enriched lakes. Chlorophyll-*a* concentrations greater than 6 µg L^{-1} are found in eutrophic or nutrient-enriched aquatic systems, whereas chlorophyll-*a* concentrations less than 2.2 µg/L are found in nutrient-poor or oligotrophic lakes. **The mean chlorophyll-*a* concentrations during the 2025 sampling event in Bear Lake was 2.0 µg/L which is moderately low for an inland Michigan lake and is expected given less runoff from rainfall events in 2025.**

The algal genera were determined from composite water samples collected over the deep basins of Bear Lake in 2025 were analyzed with a compound bright field microscope. The genera present included the Chlorophyta (green algae): *Scenedesmus* sp., *Chlorella* sp., *Haematococcus* sp., *Mougeotia* sp., *Pediastrum* sp., *Cosmarium* sp., *Quadrigula* sp., and *Rhizoclonium* sp.; the Bascillariophyta (diatoms)*: Navicula* sp., *Fragillaria* sp., *Synedra* sp., *Stephanodiscus* sp.*,* and *Cymbella* sp. The aforementioned species indicate a diverse algal flora and represent a good diversity of alga with an abundance of diatoms that are indicative of great water quality. Microscopic photos of some key algae in Bear Lake are shown below (Figures 8-11).

Figure 8: Ulothrix - A Green Algae in Bear Lake

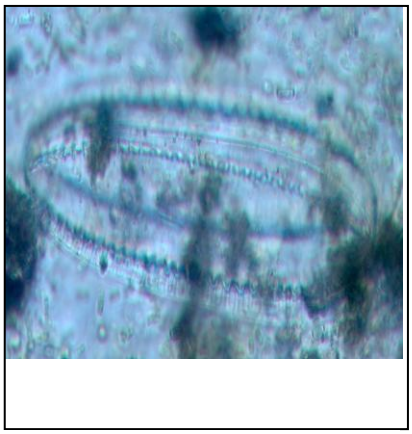


Figure 9: *Navicula* - A diatom algae in Bear Lake

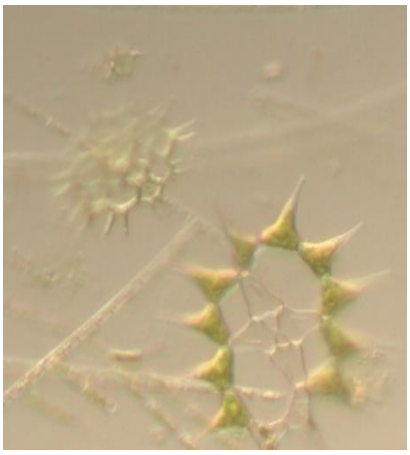


Figure 10: Pediastrum - Green Algae in Bear Lake

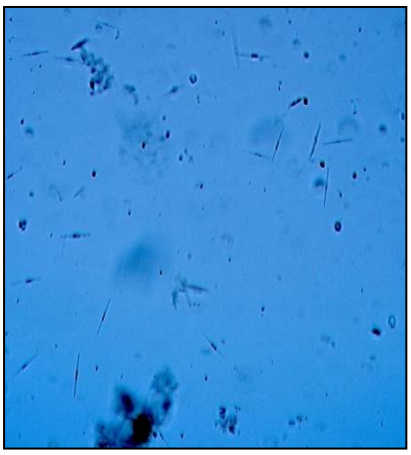


Figure 11: *Synedra* – A diatom algae in Bear Lake

Section

3

Aquatic Vegetation Data (2025)

Status of Native Aquatic Vegetation in Bear Lake

The native aquatic vegetation present in Bear Lake is essential for the overall health of the lake and the support of the lake fishery. The whole-lake species surveys on August 18, 2025 determined that there were a total of 15 native aquatic plant species in Bear Lake. These included 11 submersed species, 2 floating-leaved species, and 2 emergent species. This indicates a high biodiversity of aquatic vegetation in Bear Lake. This is a reduction from previous years and may have been attributed to the harsh winter conditions and reduced germination. The overall % cover of the lake by native aquatic plants is moderate relative to the lake size and thus these plants should be protected unless they grow near swim areas at nuisance levels. The most common native aquatic plants included: 1) White-stem Pondweed (Figure 12), a common tall and leafy aquatic plant with a distinctive white stem, often found in dense patches; 2) Chara (Figure 13) which is ideal for fish and macroinvertebrate communities; and 3) Fern-leaf pondweed (Figure 13) which is a pondweed with flat leaves that resembles a brownish-green fern that tends to grow in shallow to medium depth waters. A list of all native aquatic plants (scientific and common names) and their relative abundance in 2025 is found in Table 5 below.

Figure 12. White-stem Pondweed

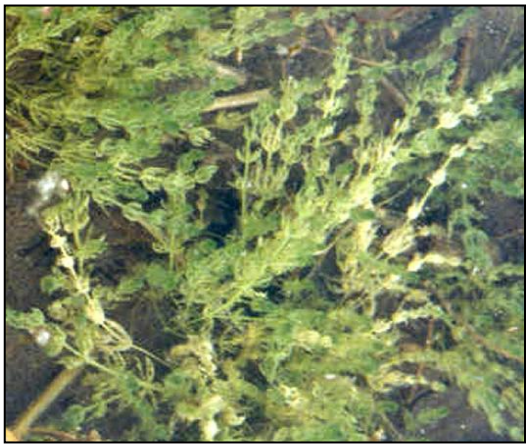


Figure 13. Chara

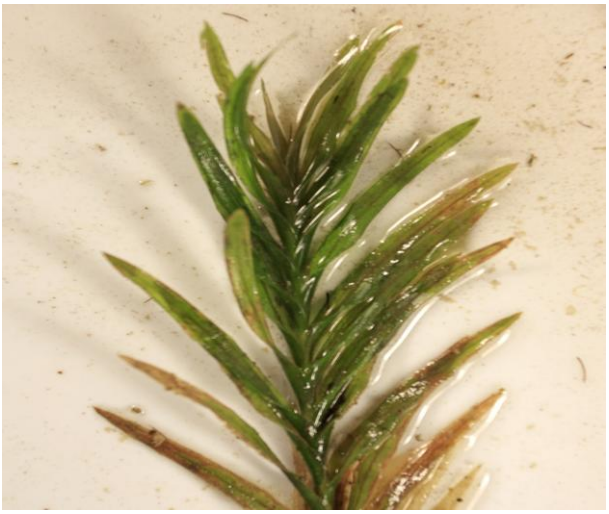


Figure 14. Fern-leaf Pondweed

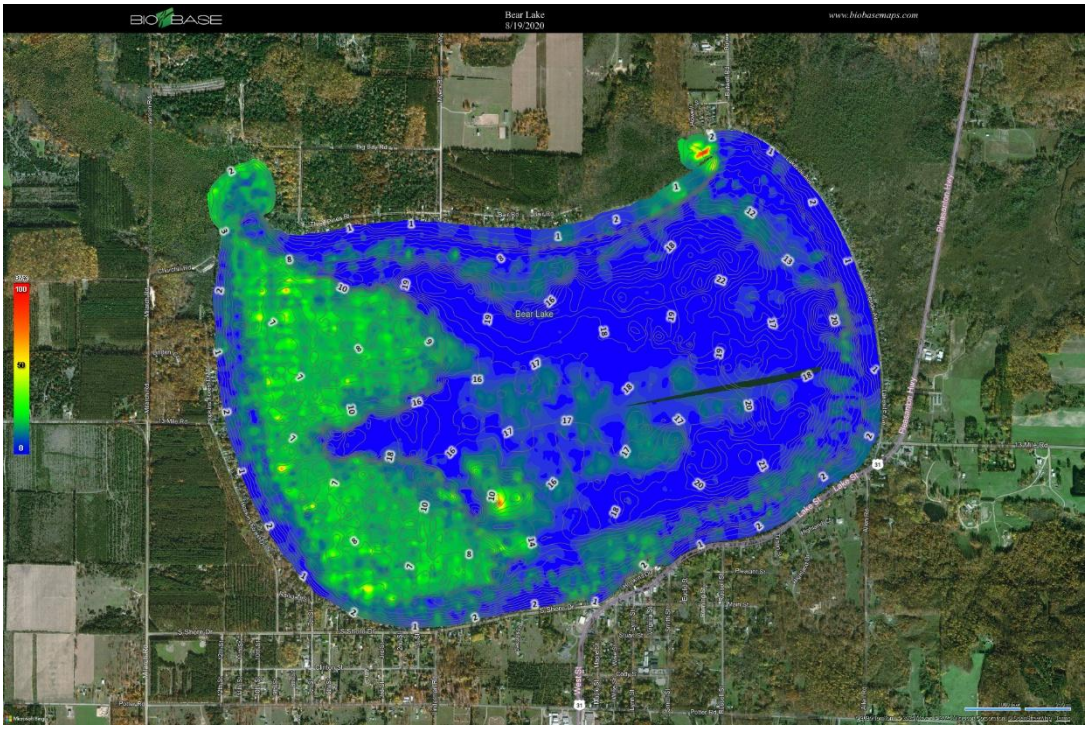


Figure 15: Bear Lake biovolume map from the August 18-19, 2025 survey.

Table 5: Bear Lake Native Aquatic Plant Species and Relative Abundance (August 18, 2025).

Native Aquatic Plant Species	*Aquatic Plant Common Name*	*% cover in/around Bear Lake*
Chara vulgaris	Muskgrass	3.1
Potamogeton illinoensis	Illinois Pondweed	1.1
Potamogeton pusillus	Small-leaf Pondweed	0.7
Potamogeton robbinsii	Fern-leaf Pondweed	1.5
Stuckenia pectinata	Sago Pondweed	0.1
Potamogeton natans	Floating-Leaf Pondweed	0.2
Potamogeton praelongus	White-stem Pondweed	4.4
Potamogeton gramineus	Variable-leaf Pondweed	0.6
Potamogeton zosteriformis	Flat-stem Pondweed	0.2
Vallisneria americana	Wild Celery	0.3
Najas guadalupensis	Southern Naiad	1.2
Nymphaea odorata	White Waterlily	0.7
Nuphar variegata	Yellow Waterlily	0.2
Schoenoplectus acutus	Bulrushes	0.6
Decodon verticillatus	Swamp Loosestrife	0.7

Status of Invasive (Exotic) Aquatic Plant Species in Bear Lake

The amount of Eurasian Watermilfoil (Figure 16) present in Bear Lake varies each year and is dependent upon climatic conditions, especially runoff-associated nutrients. In 2025, the EWM was low in the spring with 6.6 acres found on May 13, 2025 (Figure 17). These areas were treated by PLM with oversight by RLS the following week on May 19, 2025. Treatment included the systemic herbicide ProcellaCOR®. No additional treatments were needed in 2025

Figure 16. Eurasian Watermilfoil

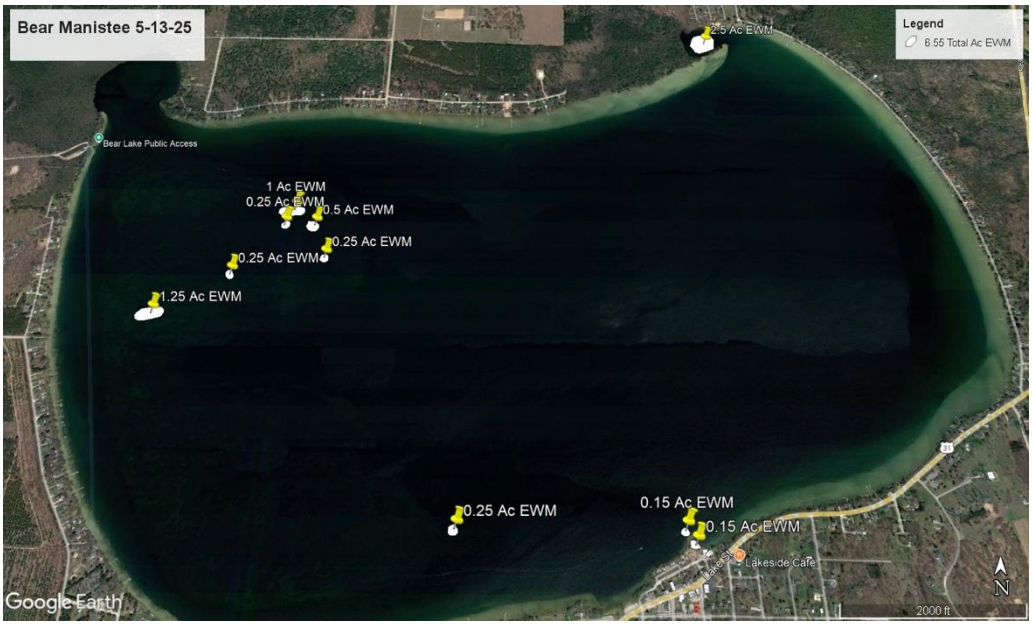


Figure 17. Distribution of EWM in Bear Lake (May 13, 2025).

Section

4

Bear Lake Sediment Macroinvertebrate Data (2025)

Freshwater macroinvertebrates are ubiquitous, as even the most impacted lake contains some representatives of this diverse and ecologically important group of organisms. Benthic macroinvertebrates are key components of lake food webs both in terms of total biomass and in the important ecological role that they play in processing of energy. Others are important predators, graze algae on rocks and logs, and are important food sources (biomass) for fish. The removal of macroinvertebrates has been shown to impact fish populations and total species richness of an entire lake or stream food web (Lenat and Barbour 1994). In the food webs of lakes, benthic macroinvertebrates have an intermediate position between primary producers and higher trophic levels (as fish) on the other side. Hence, they play an essential role in key ecosystem processes (food chain dynamics, productivity, nutrient cycling, and decomposition). These may also include many rare species.

Several characteristics of benthic macroinvertebrates make them useful bio-indicators of lake water quality including that many are sensitive to changes in physical, chemical, and biological conditions of a lake, many complete their life cycle in a single year, their life cycles and ecological requirements are generally well known, they are sessile organisms and cannot readily escape pollution or other negative aspects, and they are easily collected. As benthic macroinvertebrates respond sensitively not only to pollution, but also to a number of other human impacts (hydro-logical, climatological, morphological, navigational, recreational, and others), they could potentially be used for a holistic indication system for lake ecosystem health (Solimini et *al*. 2006).

Restorative Lake Sciences, LLC, collected aquatic macroinvertebrate samples from three separate locations within Bear Lake, Manistee County, Michigan on October 16, 2025 (Table 6). The sampling found five key taxa which included mayflies (*Hexagenia limbata*, Ephemeridae), midges (Chironomindae), damselfly larvae, caddisfly larvae, and zebra mussels (Dreisseniidae). Of all the species found, all were native except for the zebra mussels. While the majority of the species were native, some are located universally in low quality and high-quality water. The midge larvae family Chironomidae can be found in both high- and low-quality water (Lenat and Barbour 1994). The mayfly, *Hexagenia limbata*, found within this lake, has been shown to be linked with good water quality and was found later in the season but not present in the 2025 samples collected.

Eurasian watermilfoil (*Myriophyllum spicatum*) has been shown to negatively influence both fish and macroinvertebrate communities (Lillie and Budd 1992). In addition to exotic and invasive macroinvertebrate species, macroinvertebrate assemblages can be affected by land-use. Stewart et *al.* (2000) showed that macroinvertebrates were negatively affected by surrounding land-use. They also indicated that noted these land-use practices are important to restoration and management of lakes. Schreiber et *al*. (2003) stated that disturbance and anthropogenic land use changes are usually considered to be key factors facilitating biological invasions.

Table 6. 2025 Bear Lake Macroinvertebrates (October 16, 2025).

Sample 1 Bear Lake Marina	**Sample type – Dip Net/Sediment Grab**				
		Trichoptera	Limnephilidae	5	Caddis larvae
		Veneroida	Dreissenidae	9	Zebra Mussels
		Gastropoda	Physidae	19	Pond snails
			Total	**33**	
		Diptera	Chironomidae	10	Midge larvae
		Veneroida	Dreissenidae	3	Zebra Mussels
		Gastropoda	Physidae	6	Pond snails
			Total	**19**	
Sample 2 Mid-lake sample	**Sample type – Sediment Grab**				
		Trichoptera	Limnephilidae	2	Caddis larvae
		Gastropoda	Physidae	5	Pond snails
		Diptera	Chironomidae	16	Midge Larvae
		Odonata	Coregonidae	4	Damselfly larvae
			Total	**27**	

Section 5

Management Recommendations for 2026

Public hearings were held on July 12, 2022 by the Bear Lake Improvement Board (BLIB) to determine if ongoing management of Bear Lake was practical. There was overwhelming support at the hearings based on feedback and public comment from Bear Lake riparians. The cost of managing Bear Lake has declined significantly over the past decade due to effective and intensive management efforts, especially regarding whole-lake species inventories. RLS cautioned the BLIB and public that at any time a seedbank re-emergence can occur in any year due to environmental conditions, and vigorous and costly treatments may be needed when this occurs. It is not usually a frequent occurrence, but all boards should have a robust reserve in case of this natural event.

In 2026, continuous whole-lake geo-referenced aquatic vegetation surveys are needed to determine the precise locations of EWM or other problematic invasives in and around Bear Lake. This is especially important since the highly invasive submersed aquatic plant *Hydrilla* has been found in a few Michigan ponds and numerous Midwest lakes. These surveys should occur in late May, early June, and again post-treatment in 2026 and in-between as needed if more treatments become necessary. As in previous years, scientists from RLS will be present to oversee aquatic herbicide applications.

Due to the relative scarcity of native aquatic vegetation in Bear Lake (relative to the lake area), the treatment of these species with aquatic herbicides is not recommended. The plan for 2026 includes the use of high dose systemic aquatic herbicides as used in 2025, which includes ProcellaCOR® with or without the contact herbicide diquat. This was used to reduce the tolerance of EWM to commonly used triclopyr and 2,4-D. The latter products may be used in 2026 for chemical product rotation to reduce herbicide tolerance by EWM if needed.

Water quality parameters in the main lake will also be monitored and graphed with historical data to observe long-term trends. This has been important since the nutrient concentrations and other parameters have demonstrated that Bear Lake is a stable and healthy aquatic ecosystem and that nutrients appear to be in balance. Nutrients are likely to increase in summer as aquatic plants grow, and decay and this process results in nutrient release or during periods of heavy runoff.

Bear Lake was initially treated for over 330 acres of EWM in 2008. Since then, the lake has been treated for anywhere from 7 to 75 acres on an annual basis.

The scientists at RLS think that lake management which maintains EWM levels below 10% of the lakes surface areas are being managed successfully. Though EWM is an invasive plant that we want to minimize, it is a plant that is excellent fish cover in limited amounts. RLS surveys are intensive and site-specific, but it is impossible to find every hidden stem of EWM. RLS uses the latest technologies including GPS location of EWM and BioBase® scanning to help quantify the bio-volume of all aquatic vegetation. Below is a history of the annual acres treated to date.

Year	Acres treated (rounded)
2008	330
2009	11
2010	7
2011	11
2012	70
2013	10
2014	10
2015	29
2016	11
2017	17
2018	32
2019	75
2020	10
2021	11
2022	51
2023	24.5
2024	7.8
2025	6.6

In conclusion, Bear Lake is a very healthy lake with excellent aquatic plant biodiversity, very good water clarity, moderate nutrients, and a healthy lake fishery. Management of the EWM and protection of the water quality are paramount for the long-term health of the lake.