EVALUATION OF BEAR LAKE SEDIMENTS AND WATER QUALITY IMPACTS

Draft Final Report – February 2022

Prepared For:

Bear Lake Preservation Association

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SECTION 1

INTRODUCTION

1.1 General Description

This report provides a summary of work efforts performed by Environmental Research & Design, Inc. (ERD) for the Bear Lake Preservation Association (BLPA) to evaluate historical and current water quality in Bear Lake, review short- and long-term impacts from a recent influx of highly turbid runoff from an adjacent construction site, and evaluate potential water quality impacts from existing lake sediments. Bear Lake is part of the Bear Chain-of-Lakes, a 4-lake interconnected chain located in southwest Seminole County. Bear Lake is located on the east side of U.S. 441, approximately 6 miles east of Lake Apopka and 4 miles southeast of the City of Apopka. A location map for Bear Lake is given on Figure 1-1.

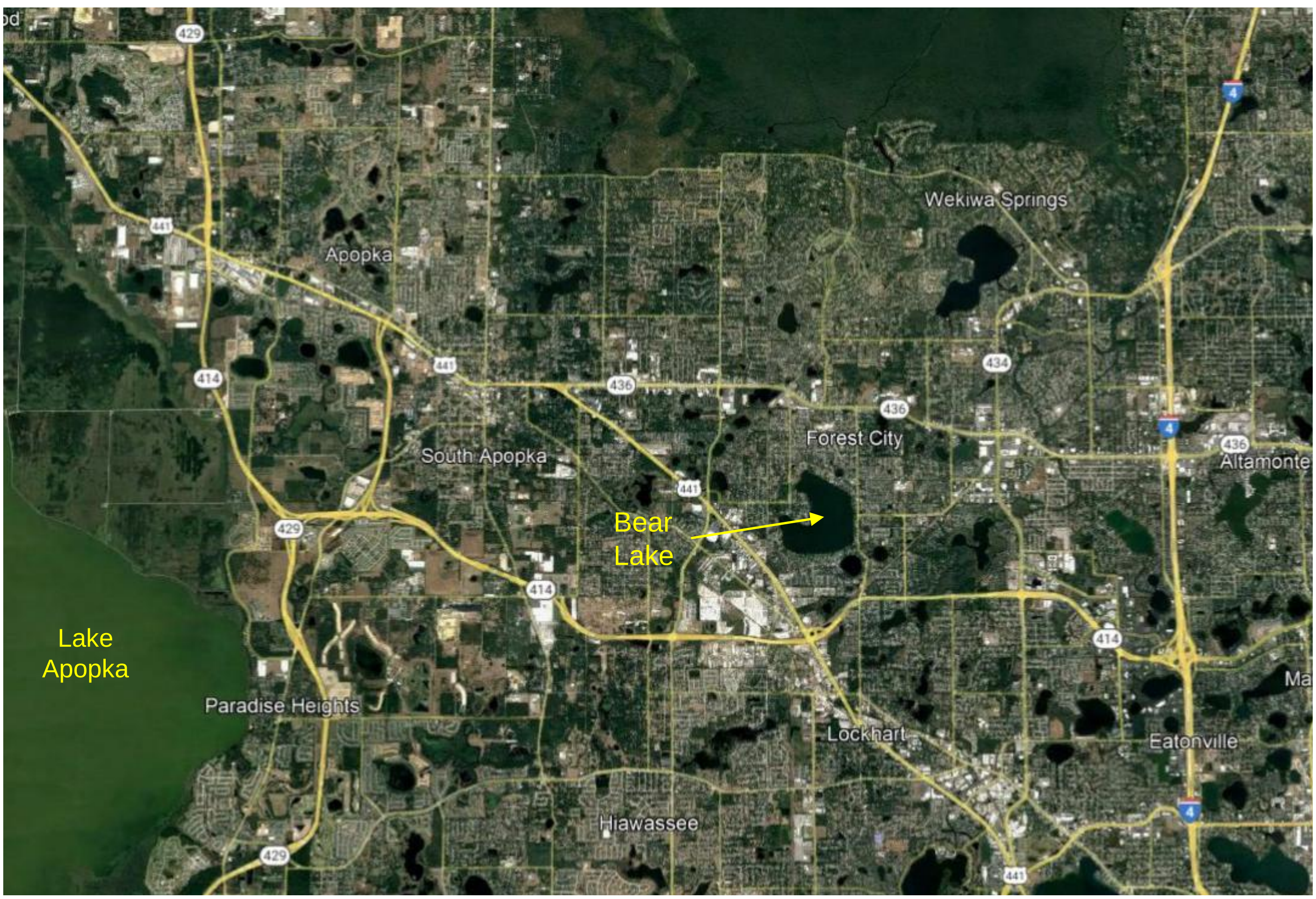

Figure 1-1. Location Map for Bear Lake.

An overview of Bear Lake and the Bear Chain-of-Lakes is given on Figure 1-2. The chain-of-lakes consists of Lake Asher, Bear Lake, Little Bear Lake, and Cub Lake which range in size from 4.1-302 acres. General flow patterns within the chain-of-lakes are also indicated on Figure 1-2. Discharges from the chain migrate in a north-to-northeast direction through a series of wetlands and open channels, ultimately discharging into the Wekiva River Buffer Conservation Area.

Figure 1-2. Overview of Bear Lake and the Bear Chain-of-Lakes.

The watershed areas surrounding the lake have become highly developed, with a mixture of residential and commercial land use activities. Much of the current development was constructed prior to implementation of regulations requiring stormwater treatment, and many areas discharge untreated or partially treated runoff directly into the lake. Historical water quality within the chain-of-lakes has been variable, although generally oligotrophic characteristics have been observed throughout the historical record with the exception of recent years.

1.2 Impaired Waters Designation

Section 303(d) of the Clean Water Act (CWA) requires states to submit lists of surface waterbodies that do not meet applicable water quality standards. These waterbodies are defined as “impaired waters” and Total Maximum Daily Loads (TMDLs) must be established for these waters on a prioritized schedule. The Florida Department of Environmental Protection (FDEP) has established a series of guidelines to identify impaired waters which may require the establishment of TMDLs. Waterbodies within the State of Florida have been divided into five separate groups for planning purposes, with Bear Lake located in the Middle St. Johns Basin in Group 2.

During May 2009, the revised and re-adopted Verified List of impaired waterbodies for the Middle St. Johns Basin was released by FDEP and included Bear Lake, Cub Lake, and Lake Asher. Bear Lake (WBID 3004A) was listed as impaired for nutrients based upon a mean Trophic State Index (TSI) value exceeding 40 during 2007, as well as for mercury based upon analyses conducted on fish collected within the lake. Total phosphorus is stated to be the limiting nutrient within the lake.

However, the Comprehensive Delist List document released by FDEP (dated 6/3/20) indicates that Bear Lake has been removed from the Verified List because TSI is no longer assessed to determine impairment, and at the time of delisting Bear Lake met applicable Numeric Nutrient Criteria (NNC) for total nitrogen, total phosphorus, and chlorophyll-a. An EPA-approved TMDL has been developed for the mercury impairment, and this parameter has also been delisted. There are no current listed improvements for Bear Lake.

1.3 Current Conditions

Development within the Bear Chain-of-Lakes began during the early-1900s and began to expand significantly during the 1940s and 1950s. During that time, the Bear Chain-of-Lakes were reknown for clear water and excellent fishing. Currently, the vast majority of available parcels have been developed, primarily with single-family residential homes. Water quality within the lakes has remained relatively constant over time, although a trend of declining water quality characteristics has been observed within the lakes in recent years. In addition, the growth of submerged vegetation has expanded significantly, particularly in Bear Lake. The residents within the Bear Chain-of-Lakes watershed have shown a high level of interest in maintaining the water quality charcteristics within the lakes and conduct periodic meetings, workshops, and educational activities for watershed residents.

1.4 Previous Studies

During 2010-2012, ERD conducted a hydrologic/nutrient study on the Bear Chain-of-Lakes, funded by the Seminole County Public Works Division. The primary objective of this project was to quantify hydrologic and pollutant loadings to the lakes and identify areas or opportunities where nutrient load reductions could be achieved to maintain and improve water quality within the lakes. A field monitoring program was conducted by ERD from April 2010-June 2011 to collect hydrologic and water quality data for use in developing hydrologic and nutrient budgets for each lake. The hydrologic budgets included estimated inputs from precipitation, stormwater runoff, inflow from interconnected lakes, and groundwater seepage. The nutrient budgets included inputs from bulk precipitation, stormwater runoff, inflow from interconnected lakes, groundwater seepage, and internal recycling.

A detailed evaluation of sediment characteristics in the Bear Chain-of-Lakes was also conducted which included physical and chemical characterization of surficial sediments and evaluation of internal phosphorus recycling. Specific nutrient load reduction projects were evaluated and recommended to maximize load reductions to each lake and improve water quality. The results of the study were summarized and discussed in the document titled "Bear Chain-of-Lakes Hydrologic/Nutrient Budget and Water Quality Management Plan – Final Report" dated September 2012.

The ERD study concluded that Bear Lake receives approximately 298 kg/yr of total phosphorus from the combined sources of precipitation, runoff, overland flow, groundwater seepage, inflow from Lake Asher, and internal recycling. Internal recycling is the dominant loading source, contributing 47% of the annual total phosphorus loadings compared with 32% for precipitation, 13% from runoff, 6% from overland flow, and minimal inputs from groundwater seepage and Lake Asher inflow. The study concluded that a slow but steady decline in water quality would occur in Bear Lake over time due to impacts from watershed development and continued sediment accumulation.

The report recommended multiple stormwater management projects, some of which have been or will be implemented. A whole-lake alum sediment inactivation project was recommended as a comparatively inexpensive method of reducing phosphorus loadings to the lake and improving water quality.

1.5 Previous Alum Application

During 2008, ERD conducted a limited alum application to Bear Lake which was targeted at deeper areas with accumulations of organic muck. A total of 7 tankers, approximately 31,500 gallons, was added over a 4-day period from April 1-4, 2008. This project was funded by the BLPA to evaluate alum effectiveness on reducing sediment phosphorus release and improving water clarity.

1.6 Recent Events

During 2020, construction was initiated on a 7-acre commercial site on the southeast side of Oranole Way and US 441. An overview of the construction site and relationship to Bear Lake is given on Figure 1-3. Runoff discharging from the site flows east where it is collected in a vegetated channel along the rear of the property which passes beneath Linneal Beach Drive through a 24-inch RCP. The runoff then flows in a northerly direction along the power line right-of-way (ROW) before being diverted into the Bear Lake Canal on the west side of the south lobe of the lake. The channel along the property originates on the west side of US 441 and is designated as Sub-basin BL4 in the 2012 ERD nutrient study.

Prior to construction, the property was wooded with two large wetlands. The site was cleared during April-May 2020, and three separate stormwater ponds were constructed to control water during construction and serve as the future stormwater management system. Beginning in early June, while the site consisted of bare dirt, multiple large rain events occurred which caused turbid water to overflow the constructed ponds and discharge from the site into the drainage channel and ultimately into the Bear Lake Canal. The turbid water was dark in color and contained fine organic matter released from clearing the highly organic on-site soils of the construction site. This type of turbidity, often referred to as hard-pan turbidity, contains extremely fine particles which are resistant to settling and can stay in a suspended state for months or years and are difficult to remove from the water column.

During the period from June-September 2020, 12 individual events occurred which caused turbid water to discharge from the construction site into Bear Lake Canal (Nancy Dunn personal communication), and the area received more than 45 inches of rainfall from June-September. Photographs of the discharge events are provided in Figure 1-4. According to Robert Wolford, who provided the photos on Figure 1-4b and 1-4c, water was flowing over Oranole Way at a depth of approximately 1 foot during an event on August 10, 2020. After this event, BLPA attorneys requested immediate redesign of erosion control methods for the completion of the project. The BLPA worked with SJRWMD, Orange and Seminole County Environmental Protection divisions, and the Florida Department of Environmental Protection (FDEP) to install turbidity and erosion control devices, and a new erosion control firm was hired by the contractor on September 30, 2020. The repeated events collapsed stormwater drains and structures, washed out ditches, and caused water main breaks.

Following these events, water clarity in the Bear Lake Canal was approximately 6 inches, and the water clarity in Bear Lake decreased from 9 feet to 5 feet. Impacts on water clarity extended downstream to Cub Lake which receives outflows from Bear Lake. The repeated inflows of turbid water into Bear Lake caused a large influx of fine highly organic soil particles to enter the Canal and Bear Lake. The settled material in the Canal is easily disturbed by boating in the Canal and shallow shoreline areas of the main lake. The type of turbidity which discharged to Bear Lake is common on construction sites with highly organic soils. It consists of extremely fine particles with a density near that of water which causes the particles to remain in suspension for long periods of time. It would generally take several years for the particles to settle naturally. Although the extremely turbid appearance of the water suggests a large mass loading of solids, the total volume of solids within the water from this type of turbidity is typically small. These particles are difficult to remove. An alum application will improve water appearance but will not remove the finest particles.

Figure 1-3.   Location of Construction Site on West Side of Bear Lake.

a. Temporary stormwater pond on construction site.

b. Turbid water discharging from construction site following 2.5-inch rainfall on 8/10/20

c. Water flowing through channel along powerline on 8/10/20

d. Turbid water discharging into Bear Lake

Figure 1-4. Photos of Construction Site Discharge into Bear Lake During June-September 2020.

The events described previously are the primary reason for the current study and feasibility evaluation for alum addition in Bear Lake. Although gradual declines in water quality and clarity had been observed in recent years, and there was interest among the BLPA to investigate these changes, the primary impetus for this study is to evaluate the water quality impacts from the turbid inflows.

1.7 Report Organization

This report has been divided into 4 separate sections for presentation of the work efforts performed by ERD. Section 1 contains an introduction to the report and provides a general overview of the work efforts performed by ERD, a summary of current conditions, and a discussion of recent polluting events. Current characteristics of Bear Lake are discussed in Section 2, including lake bathymetry, sediment accumulation and characteristics, and water quality. A discussion of a potential alum sediment inactivation project is given in Section 3. Appendices are also attached which contain technical data and analyses used to support the information contained within the report.

SECTION 2

PHYSICAL AND CHEMICAL CHARACTERISTICS OF BEAR LAKE

An overview of physical and chemical characteristics of Bear Lake is provided in this section, which includes bathymetry, sediment characterization, and a discussion of historical and current water quality characteristics. Bathymetric information provided in this section was generated during the 2010-11 evaluation conducted by ERD and is reproduced here since both area and volume data are used in subsequent sections to evaluate the feasibility and cost of sediment inactivation. The discussion on sediment characteristics includes data collected during both 2011 and 2021 as part of this current project.

2.1 Physical Characteristics

A general overview of Bear Lake is given on Figure 2-1. Bear Lake is irregular in shape and appears to have a shape similar to a bear, from which the name "Bear Lake" was derived.

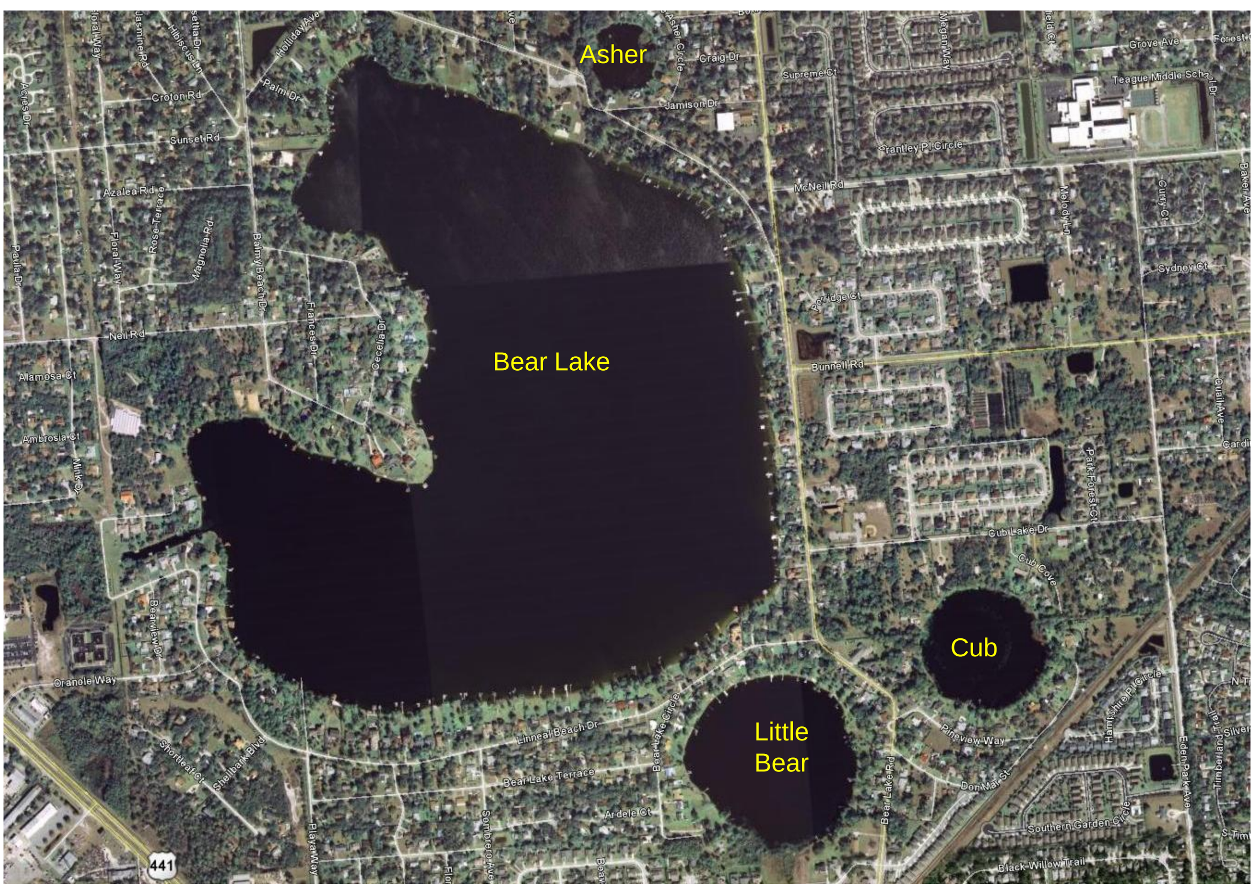

Figure 2-1. General Overview of Bear Lake.

A bathymetric survey of Bear Lake was conducted by ERD during September 2010 to evaluate water column depths as well as thickness of unconsolidated sediments within the lake. Measurements of water depth and sediment thickness were conducted at 208 individual sites in Bear Lake, and each of the data collection sites was identified in the field by longitude and latitude coordinates using a portable GPS device. The water level elevation in Bear Lake on September 9, 2010 was approximately 103.50 ft.

Water depth at each of the data collection sites was determined by lowering a 20-cm diameter Secchi disk attached to a graduated line until resistance from the sediment layer was encountered. The depth on the graduated line corresponding to the water surface was recorded in the field and is defined as the water depth at each site. After measurement of the water depth at each site, a 1.5-inch graduated aluminum pole was then lowered into the water column and forced into the sediments until a firm bottom material, typically sand or clay, was encountered. The depth corresponding to the water surface is defined as the depth to the firm lake bottom. The difference between the depth to the firm lake bottom and the water depth at each site is defined as the depth of unconsolidated sediments.

The generated field data was converted into bathymetric maps for both water depth and unconsolidated sediment depth in each of the lakes using AutoCAD 2007. Estimates of water volume and unconsolidated sediment volume for each lake were generated using the Autodesk Land Desktop 2007 Module.

A water depth contour map for Bear Lake, based on the field monitoring program conducted by ERD, is given on Figure 2-2. The bottom bathymetry is highly irregular, with much of the central portion of the lake exhibiting water depths ranging from approximately 10-15 ft. However, there are numerous “holes” within the bottom which appear to be remnants of small sinkholes where water depths extend from approximately 20-34 ft. The deeper areas are particularly apparent along the western side of the lake, with relatively steep shorelines in most areas. The slope of shoreline areas along the east side of the lake is more gradual compared with the west side.

Depth-area-volume relationships for Bear Lake are summarized on Table 2-1 based upon the bathymetric surveys conducted by ERD during September 2010. At the water surface elevation of 103.50 ft present in Bear Lake on September 9, 2010, the lake surface is approximately 302 acres. The lake volume at this surface area is 4,118 ac-ft which corresponds to a mean water depth of 13.6 ft. A summary of bathymetric characteristics of Bear Lake is given on Table 2-2.

A bathymetric contour map of the depth of unconsolidated organic sediments in Bear Lake is given in Figure 2-3. Significant accumulations of organic muck occur in multiple areas of the lake, with muck depths extending to approximately 8 ft or more. The areas containing the accumulated organic muck are likely deeper areas resulting from the original sinkhole activity that formed the lake that have subsequently become filled with muck deposits. The accumulated organic muck within the lake is comprised primarily of dead algal cells and other partially decomposed vegetation as well as solids which have entered the lake from the adjacent watershed areas. However, many areas of the lake, particularly in the eastern half of the lake, appear to have relatively little muck accumulation, with muck depths ranging from 0-1 ft.

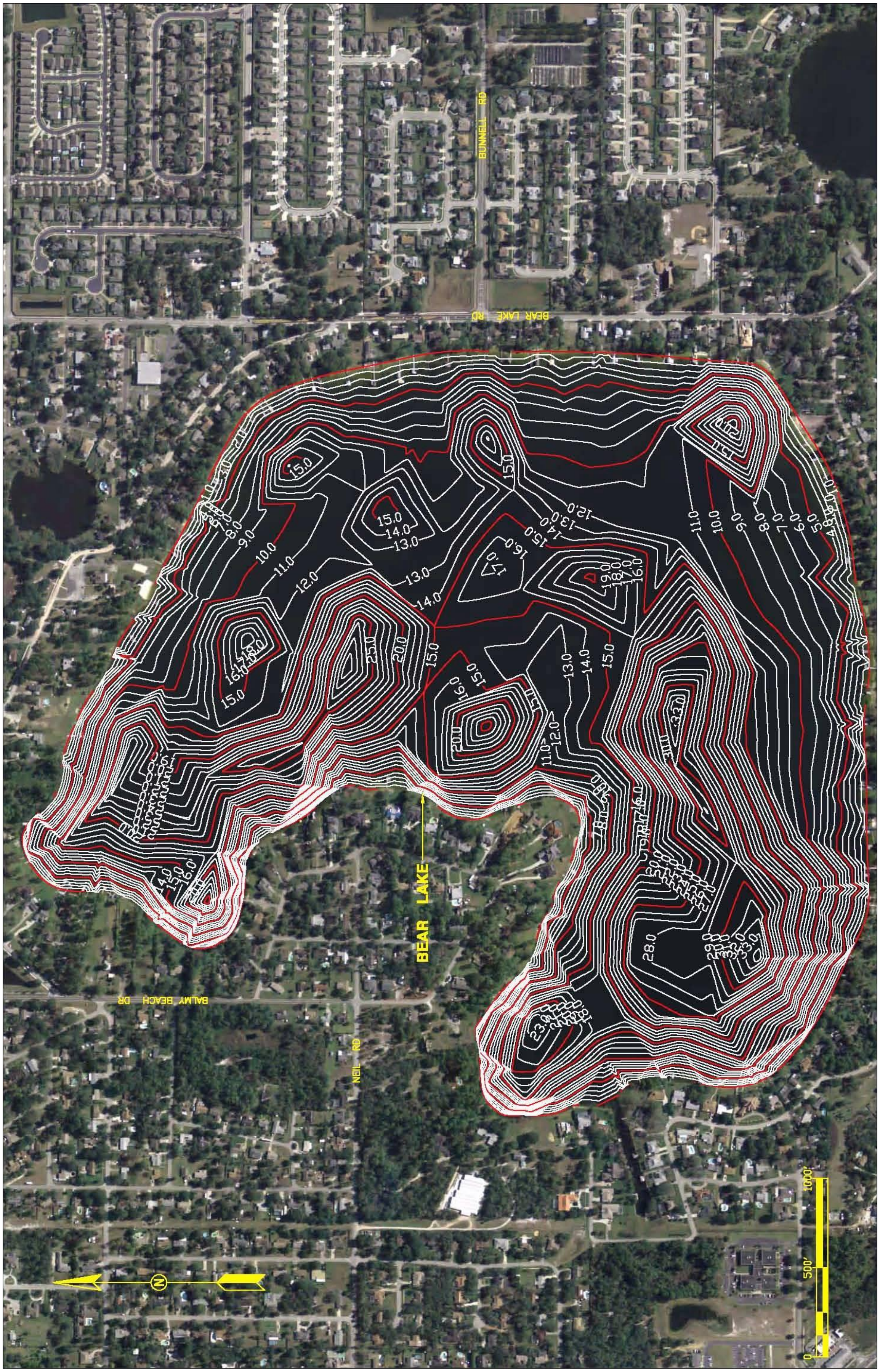

Figure 2-2. Water Depth Contour Map for Bear Lake on September 9, 2010.
(Water surface elevation = 103.50 ft)

TABLE 2-1

STAGE-AREA-VOLUME RELATIONSHIPS FOR BEAR LAKE
(Elevation 103.50 ft)

DEPTH (ft)	AREA (acres)	VOLUME (ac-ft)	DEPTH (ft)	AREA (acres)	VOLUME (ac-ft)
0	302	4,118	18	74.3	411
1	296	3,819	19	65.7	341
2	289	3,527	20	57.8	280
3	281	3,242	21	50.5	225
4	274	2,964	22	43.5	178
5	266	2,695	23	36.7	138
6	257	2,433	24	30.2	105
7	247	2,182	25	25.4	77.1
8	236	1,941	26	20.7	54.1
9	223	1,712	27	16.2	35.6
10	208	1,496	28	11.7	21.6
11	191	1,297	29	7.30	12.1
12	170	1,116	30	4.59	6.17
13	152	955	31	2.46	2.65
14	134	812	32	1.05	0.90
15	114	688	33	0.35	0.20
16	97.4	582	34	0.04	0.00
17	84.8	491			

Mean Depth = 13.6 ft

TABLE 2-2

BATHYMETRIC CHARACTERISTICS OF BEAR LAKE

AREA (acres)	VOLUME (ac-ft)	MEAN DEPTH (ft)	MAXIMUM DEPTH (ft)	SHORELINE LENGTH (ft)
302	4,118	13.6	34	17,411

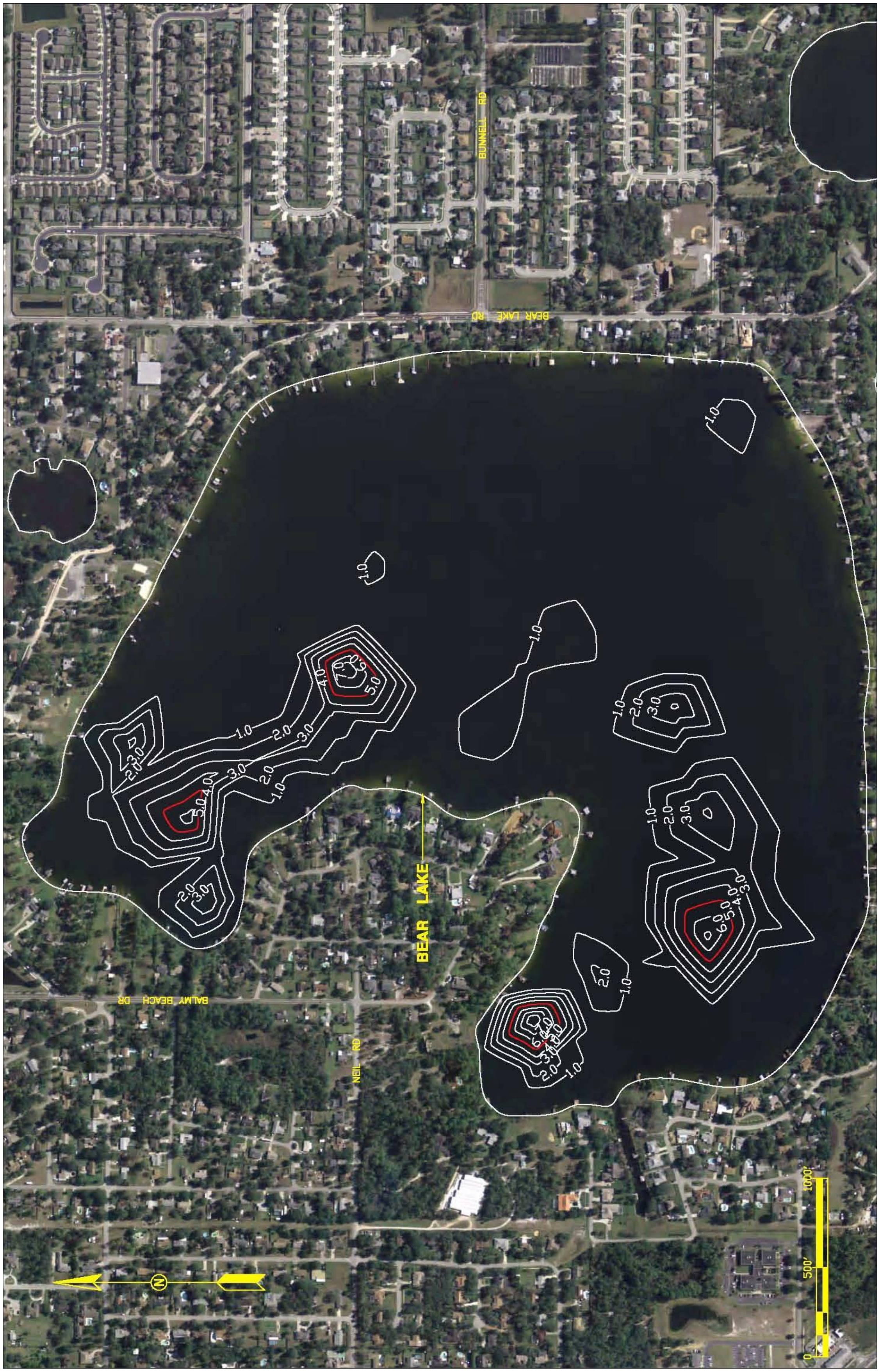

Figure 2-3. Muck Depth Contours (ft) in Bear Lake on September 9, 2010.

Estimates of area-volume relationships for organic muck accumulations in Bear Lake are given in Table 2-3. Bear Lake appears to have a relatively minimal accumulation of organic muck throughout much of the lake area. Approximately 79% of the lake area currently has muck accumulations ranging from 0-1 ft, with 10% of the lake area covered by muck depths ranging from 1-2 ft, 5% of the lake area covered by muck accumulations ranging from 2-3 ft, and 6% of the lake area covered by lake accumulations ranging from 3-8 ft. Overall, the volume of organic muck in Bear Lake is sufficient to cover the entire surface area of the lake to a depth of approximately 0.94 ft.

TABLE 2-3

DEPTH-AREA-VOLUME RELATIONSHIPS FOR ORGANIC MUCK IN BEAR LAKE

DEPTH (ft)	AREA (acres)	MUCK VOLUME (ac-ft)
0	302.11	283.7
1	64.37	100.5
2	34.28	51.1
3	18.17	24.9
4	8.95	11.3
5	4.57	4.58
6	1.79	1.40
7	0.47	0.27
8	0.08	0.00

Mean Thickness = 0.94 ft

2.2 Sediment Characteristics

Sediment core samples were collected in Bear Lake by ERD during October 2021 to evaluate the characteristics of existing sediments and potential impacts on water quality within the lake. Sediment core samples were collected at 37 separate locations in Bear Lake on October 21, 2021. Locations of the sediment monitoring sites in Bear Lake are shown on Figure 2-4. These are the same locations used for sediment collection conducted on December 17, 2010 which is described in the September 2012 report. Sediment samples were collected at a rate of 1 sample for every 8.1 acres of lake area. The 2010 sediment collection event was conducted several years after the limited alum application during 2008 (discussed in Section 1), and the sediment characteristics in sediments collected from deeper areas of the lake reflect the impacts from this addition.

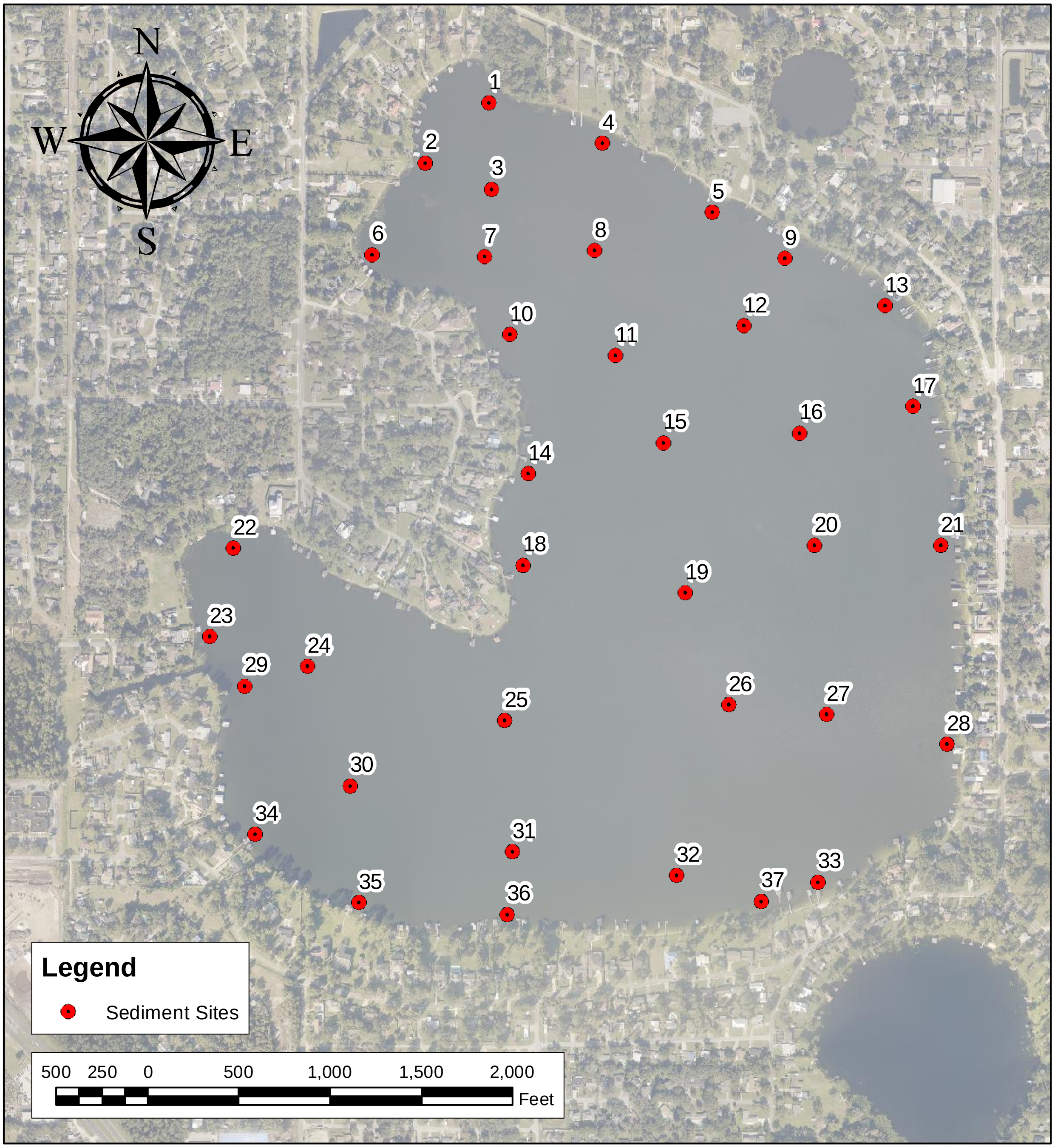

Figure 2-4. Locations of Sediment Sampling Sites in Bear Lake.

2.2.1 Sampling Techniques

Sediment samples were collected at each of the 37 monitoring sites during both the 2010 and 2021 events using a stainless steel split-spoon core device, which was penetrated into the sediments at each location to a minimum distance of approximately 0.5 m. After retrieval of the sediment sample, any overlying water was carefully decanted before the split-spoon device was opened to expose the collected sample. Visual characteristics of each sediment core sample were recorded, and the 0-10 cm layer was carefully sectioned off and placed into a polyethylene container for transport to the ERD laboratory. Duplicate core samples were collected at each site, and the 0-10 cm layers were combined together to form a single composite sample for each of the 37 monitoring sites. The polyethylene containers utilized for storage of the collected samples were filled completely to minimize air space in the storage container above the sediment sample. The collected samples were stored on ice and returned to the ERD laboratory for physical and chemical characterization.

2.2.2 Sediment Characterization and Speciation Techniques

Each of the 37 sediment core samples collected during 2010 and 2021 was analyzed for a variety of general parameters, including moisture content, organic content, sediment density, total nitrogen, and total phosphorus. Methodologies utilized for preparation and analysis of the sediment samples for these parameters are outlined in Table 2-4.

TABLE 2-4

ANALYTICAL METHODS FOR SEDIMENT ANALYSES

MEASUREMENT PARAMETER	SAMPLE PREPARATION	ANALYSIS REFERENCE	REFERENCE PREP./ANAL.*	METHOD DETECTION LIMITS (MDLs)
pH	EPA 9045	EPA 9045	3 / 3	0.01 pH units
Moisture Content	p. 3-54	p. 3-58	1 / 1	0.1%
Organic Content (Volatile Solids)	p. 3-52	pp. 3-52 to 3-53	1 / 1	0.1%
Total Phosphorus	pp. 3-227 to 3-228 (Method C)	EPA 365.4	1 / 2	0.005 mg/kg
Total Nitrogen	p. 3-201	pp. 3-201 to 3-204	1 / 1	0.010 mg/kg
Specific Gravity (Density)	p. 3-61	pp. 3-61 to 3-62	1 / 1	NA

*REFERENCES:

1. Procedures for Handling and Chemical Analysis of Sediments and Water Samples, EPA/Corps of Engineers, EPA/CE-81-1, 1981.

2. Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised March 1983.

3. Test Methods for Evaluating Solid Wastes, Physical-Chemical Methods, Third Edition, EPA-SW-846, Updated November 1990.

In addition to general sediment characterization, a fractionation procedure for inorganic soil phosphorus was conducted on each of the 37 collected sediment samples collected during 2010 and 2021. The modified Chang and Jackson Procedure, as proposed by Peterson and Corey (1966), was used for phosphorus fractionation. The Chang and Jackson Procedure allows the speciation of sediment phosphorus into saloid-bound phosphorus (defined as the sum of soluble plus easily exchangeable sediment phosphorus), iron-bound phosphorus, and aluminum-bound phosphorus. Although not used in this project, subsequent extractions of the Chang and Jackson procedure also provide calcium-bound and residual fractions.

Saloid-bound phosphorus is considered to be available under all conditions at all times. Iron-bound phosphorus is relatively stable under aerobic environments, generally characterized by redox potentials greater than 200 mv (E_h), while unstable under anoxic conditions, characterized by redox potential less than 200 mv. Aluminum-bound phosphorus is considered to be stable under all conditions of redox potential and natural pH conditions. A schematic of the Chang and Jackson Speciation Procedure for evaluating soil phosphorus bounding is given in Figure 2-5.

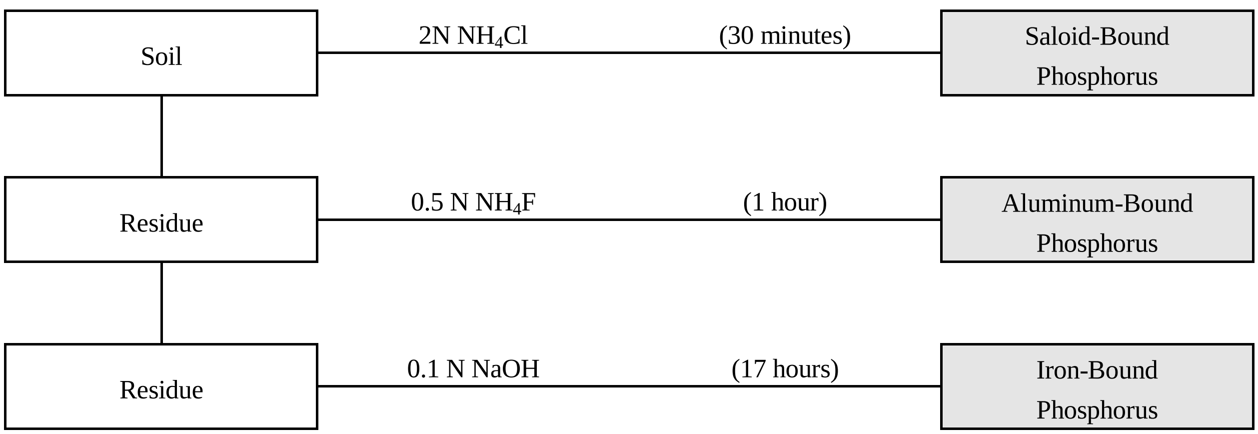

Figure 2-5. Schematic of Chang and Jackson Speciation Procedure for Evaluating Soil Phosphorus Bonding.

For purposes of evaluating release potential, ERD typically assumes that potentially available inorganic phosphorus in soils/sediments, particularly those which exhibit a significant potential to develop reduced conditions below the water-sediment interface, is represented by the sum of the soluble inorganic phosphorus and easily exchangeable phosphorus fractions (collectively termed saloid-bound phosphorus), plus iron-bound phosphorus which can become solubilized under reduced conditions. Aluminum-bound phosphorus is generally considered to be unavailable in the pH range of approximately 5.5-7.5 under a wide range of redox conditions.

2.2.3 Sediment Characteristics

2.2.3.1 Visual Characteristics

Visual characteristics of sediment core samples were recorded for each of the 37 sediment samples collected in Bear Lake during 2021. A summary of visual characteristics of sediment core samples is given in Table 2-5. In general, a surficial layer of unconsolidated organic muck was observed in Bear Lake at 17 of the 37 sediment monitoring sites, with thickness ranging from 1-15 cm. This unconsolidated surficial layer is comprised primarily of organic material (such as dead algal cells) and detritus which has accumulated onto the bottom of the lake. This organic material is easily disturbed by wind action or boating activities.

At many sites with thick muck deposits, the organic muck becomes more consolidated beneath the surficial layer, with a consistency similar to pudding. These layers, which reflect older organic deposits that are resistant to further degradation, are referred to as consolidated organic muck and typically do not resuspend into the water column except during relatively vigorous wind or disturbance by boat wakes or propellers. Measured depths of the consolidated organic muck layer ranged from 7 cm to greater than 65 cm. Shallow and shoreline areas of Bear Lake are characterized by various types of brown fine sand which is the parent soil layer which forms the original lake bottom.

Photographs of typical sediment characteristics in Bear Lake are given in Appendix A. A wide variety of sediment characteristics were observed in Bear Lake, ranging from fine sands to mixtures of sand and muck, fine sand overlying peat sediments, and areas with deep accumulations of loose organic muck. No distinct surficial layer of material contributed by the turbid inflows during 2020 was observed at any of the main lake sediment sites. The fine-grained materials from the inflows would likely be incorporated into the existing sediments with no distinct surficial layer.

2.2.3.2 General Sediment Characteristics

After return to the ERD Laboratory, the collected sediment core samples were evaluated for general sediment characteristics, including pH, moisture content, organic content, sediment density, total nitrogen, and total phosphorus. A summary of general characteristics measured in each of the 37 collected sediment core samples is given in Table 2-6. In general, sediments in Bear Lake were found to be slightly acidic to near-neutral in pH, with measured pH values ranging from 6.02-7.35 and an overall geometric mean of 6.71.

Isopleths of pH in the top 10 cm of sediments in Bear Lake are illustrated on Figure 2-6, based upon the information provided in Table 2-6. A pH isopleth map from the 2010 sediment collection event is also provided for comparison. Based on the current 2021 sediment monitoring event, the majority of areas within Bear Lake are characterized by pH values ranging from approximately 6.25-7.0. In general, pH values appear to be slightly lower in areas of accumulated organic muck and slightly higher in areas with primarily sandy sediments. A similar pattern was observed during 2010, although the trend is not as distinct as observed in 2021.

TABLE 2-5

VISUAL CHARACTERISTICS OF SEDIMENT CORE SAMPLES COLLECTED IN BEAR LAKE ON OCTOBER 21, 2021

SITE NO.	LAYER (cm)	VISUAL APPEARANCE
1	0 - >18	Brown fine sand with organics
2	0 – 2 2 - >30	Brown fine sand with organics Brown fine sand with organics
3	0 – 15 15 - >45	Dark brown unconsolidated organic muck Brown fine sand with organics
4	0 – 2 2 - >30	Dark brown unconsolidated organic muck Brown fine sand with organics
5	0 – 6 6 - >17	Brown fine sand with organics Brown fine sand with organics
6	0 – 6 6 – 13 13 - >26	Dark brown unconsolidated organic muck Dark brown consolidated organic muck Brown fine sand with organics
7	0 – 1 1 - >14	Dark brown unconsolidated organic muck Brown fine sand with organics
8	0 – 8 8 - >24	Brown fine sand with organics Brown fine sand with organics
9	0 – 4 4 - >23	Brown fine sand with organics Brown fine sand with organics
10	0 – 6 6 – 41 41 - >66	Brown unconsolidated organic muck Brown consolidated muck Brown fine sand with organics
11	0 – 9 9 - >57	Brown unconsolidated organic muck Brown consolidated muck
12	0 – 6 6 - >27	Brown fine sand with organics Brown fine sand with organics
13	0 – 3 3 – 8 8 - >27	Dark brown unconsolidated organic muck Brown fine sand with organics Brown fine sand with organics
14	0 – 5 5 - >21	Brown fine sand with organics Brown fine sand with organics
15	0 – 6 6 – 21 21 - >33	Brown unconsolidated organic muck Brown consolidated muck Brown fine sand with organics
16	0 - >22	Brown fine sand with organics
17	0 – 6 6 - >18	Brown fine sand with organics Brown fine sand with organics
18	0 – 7 7 - >23	Brown fine sand with organics Brown fine sand with organics
19	0 – 1 1 - >59	Dark brown unconsolidated organic muck Brown fine sand with organics
20	0 – 6 6 - >23	Brown fine sand with organics Brown fine sand with organics

TABLE 2-5 -- CONTINUED

VISUAL CHARACTERISTICS OF SEDIMENT CORE SAMPLES COLLECTED IN BEAR LAKE ON OCTOBER 21, 2021

SITE NO.	LAYER (cm)	VISUAL APPEARANCE
21	0 – 5	Light brown fine sand with green algae
	5 - >22	Brown fine sand with organics
22	0 – 3	Dark brown unconsolidated muck
	3 – 6	Brown fine sand with organics
	6 – 10	Brown fine sand with organics
	10 - >17	Brown fine sand with organics
23	0 – 3	Dark brown unconsolidated muck
	3 – 10	Brown fine sand with organics
	10 – 15	Brown fine sand with organics
	15 - >24	Brown fine sand with organics
24	0 – 3	Dark brown unconsolidated muck
	3 - >38	Brown fine sand with organics
25	0 – 11	Dark brown unconsolidated muck
	11 - >76	Dark brown consolidated muck
26	0 – 6	Light brown fine sand
	6 - >25	Brown fine sand with organics
27	0 – 5	Light brown fine sand
	5 - >18	Brown fine sand with organics
28	0 – 6	Light brown fine sand with light algae
	6 - >17	Brown fine sand with organics
29	0 – 2	Dark brown unconsolidated muck
	2 – 7	Brown fine sand with organics
	7 - >28	Black fine sand with organics
30	0 – 7	Dark brown unconsolidated muck
	7 – 38	Dark brown consolidated muck
	38 - >43	Dark gray consolidated muck
31	0 – 9	Brown fine sand with organics
	9 - >23	Brown fine sand with organics
32	0 – 6	Light brown fine sand
	6 - <17	Brown fine sand with organics
33	0 – 8	Light brown fine sand
	8 - >25	Brown fine sand with organics
34	0 – 3	Dark brown unconsolidated muck
	3 - >22	Brown fine sand with organics
35	0 – 6	Dark brown unconsolidated muck
	6 - >21	Brown fine sand with organics
36	0 – 5	Light brown sand with light algae
	5 - >21	Brown fine sand with organics
37	0 – 5	Light brown fine sand
	5 - >21	Brown fine sand with organics

TABLE 2-6

GENERAL CHARACTERISTICS OF SEDIMENT CORE SAMPLES COLLECTED IN BEAR LAKE ON OCTOBER 21, 2021

LAB I.D. (21-xx)	SITE	pH (s.u.)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	WET DENSITY (g/cm^3)
348	1	7.35	38.2	1.6	1.91
349	2	7.10	41.9	3.5	1.84
350	3	6.40	75.8	32.5	1.25
351	4	6.96	38.2	1.6	1.91
352	5	6.39	26.3	1.2	2.09
353	6	6.76	67.2	15.7	1.41
354	7	7.13	30.4	2.5	2.02
355	8	7.01	28.4	1.5	2.06
356	9	6.84	27.3	1.4	2.08
357	10	6.33	90.3	42.1	1.08
358	11	6.84	87.0	44.9	1.11
359	12	6.85	27.6	1.1	2.07
360	13	6.88	37.8	1.3	1.92
361	14	7.13	26.8	1.0	2.09
362	15	6.24	81.9	29.5	1.19
363	16	6.83	29.0	1.6	2.05
364	17	6.23	26.2	1.0	2.10
365	18	6.91	25.2	0.9	2.11
366	19	6.16	8.3	1.4	2.36
367	20	6.07	28.8	1.0	2.06
368	21	6.78	23.2	0.6	2.14
369	22	6.83	27.9	1.2	2.07
370	23	6.78	35.1	3.3	1.94
371	24	6.92	27.5	1.5	2.07
372	25	6.19	89.1	45.4	1.09
373	26	6.50	25.3	2.0	2.10
374	27	6.68	27.2	2.4	2.07
375	28	7.05	28.9	1.2	2.05
376	29	6.78	24.3	0.9	2.13
377	30	6.10	88.3	44.3	1.10
378	31	6.91	31.4	1.0	2.02
379	32	6.85	26.1	0.6	2.10
380	33	6.52	22.6	1.7	2.14
381	34	7.11	34.6	1.5	1.97
382	35	7.06	26.4	1.2	2.09
383	36	6.02	25.2	0.8	2.11
384	37	6.94	28.2	0.6	2.07
Minimum Value:		**6.02**	**8.3**	**0.6**	**1.08**
Maximum Value:		**7.35**	**90.3**	**45.4**	**2.36**
Geometric Mean:		**6.71**	**34.0**	**2.4**	**1.85**

2010 pH   2021 pH

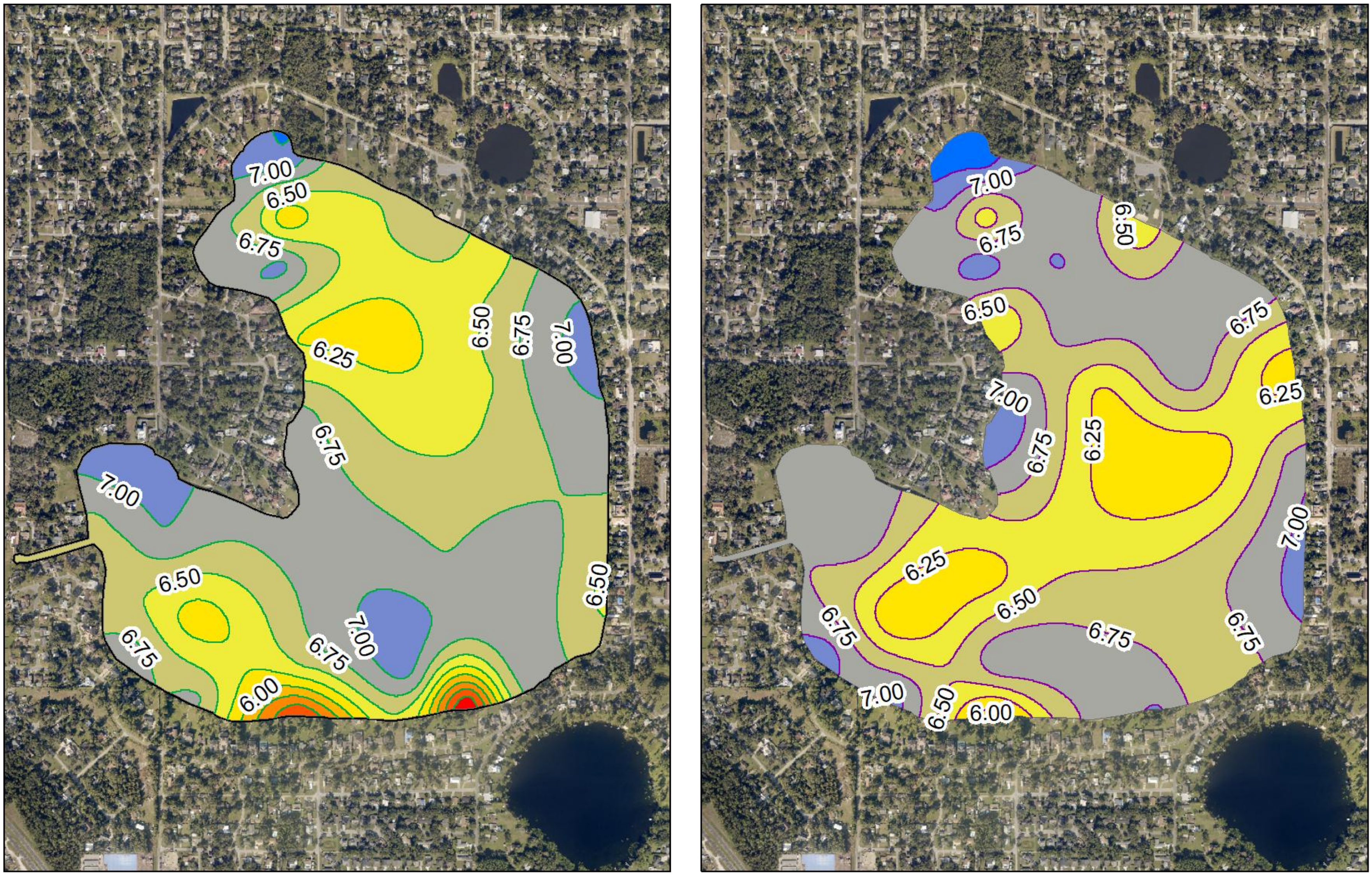

Figure 2-6. Isopleths of pH in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

Measurements of sediment moisture content in Bear Lake sediments were highly variable throughout the lake. Many of the collected sediment samples are characterized by elevated moisture contents, suggesting that these surficial sediments are comprised primarily of organic muck, while other sites have low moisture content suggesting sandy sediments. Measured sediment moisture contents in Bear Lake sediments during 2021 ranged from 8.3-90.3% with an overall geometric mean of 34.0%, reflecting moderate values.

Isopleths of sediment moisture content in Bear Lake are illustrated in Figure 2-7 based upon the information provided in Table 2-6. Areas of elevated moisture content are present throughout the lake, primarily in the areas with accumulated organic muck illustrated on Figure 2-3. The lowest sediment moisture contents were observed in the eastern half of the lake. Sediment moisture contents in excess of 50% are often indicative of highly organic sediments, while moisture contents less than 50% reflect mixtures of sand and muck. Based on these criteria, sediments in Bear Lake consist of a combination of sandy and highly organic materials. Sediment moisture contents appear to be similar between the 2010 and 2021 monitoring events.

Increases in sediment moisture content appear to have occurred in the southwest lobe of Bear Lake between the 2010 and 2021 sediment collection events while little, if any, change is apparent in the northwest lobe. The increase in moisture content in the southwest lobe may be related to the deposition of fine sediments from the construction site.

Isopleths of sediment organic content in Bear Lake are illustrated on Figure 2-8 based upon the information provided in Table 2-6. In general, sediment organic content values of 20% or more are indicative of organic muck type sediments, with values less than 20% representing either sand or mixtures of muck and sand. Based upon these criteria, areas of concentrated organic muck are apparent in western portions of the lake, with primarily sandy sediments in the eastern half. These areas of high organic content correspond relatively closely with the more significant areas of accumulated organic muck deposits illustrated on Figure 2-3. Measured sediment organic content within Bear Lake during 2021 ranges from 0.6-45.4%, with an overall geometric mean of 2.4% which is much lower than sediment organic contents measured by ERD in eutrophic urban lakes. The 2010 and 2021 plots of organic content are relatively similar, although sediment organic content appears to have increased slightly between the two events.

Measured sediment density values are also useful in evaluating the general characteristics of sediments within a lake. Sediments with calculated wet densities between 1.0 g/cm^3 and 1.25 g/cm^3 are indicative of highly organic muck type sediments, while sediment densities of approximately 2.0 or greater are indicative of sandy sediment conditions. Values between 1.25 g/cm^3 and 2.0 g/cm^3 indicate mixtures of sand muck. Measured sediment wet density values during 2021 in Bear Lake range from 1.08-2.36 g/cm^3, with an overall mean of 1.85 g/cm^3, indicating primarily sandy and low organic sediments.

Isopleths of wet density in Bear Lake sediments are given in Figure 2-9. Areas of low density sediments occur primarily in the west half of the lake. Higher sediment densities were observed in the east half of the lake. The 2010 and 2021 sediment density plots are similar with no significant change between the two dates.

Figure 2-7. Isopleths of Moisture Content (%) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

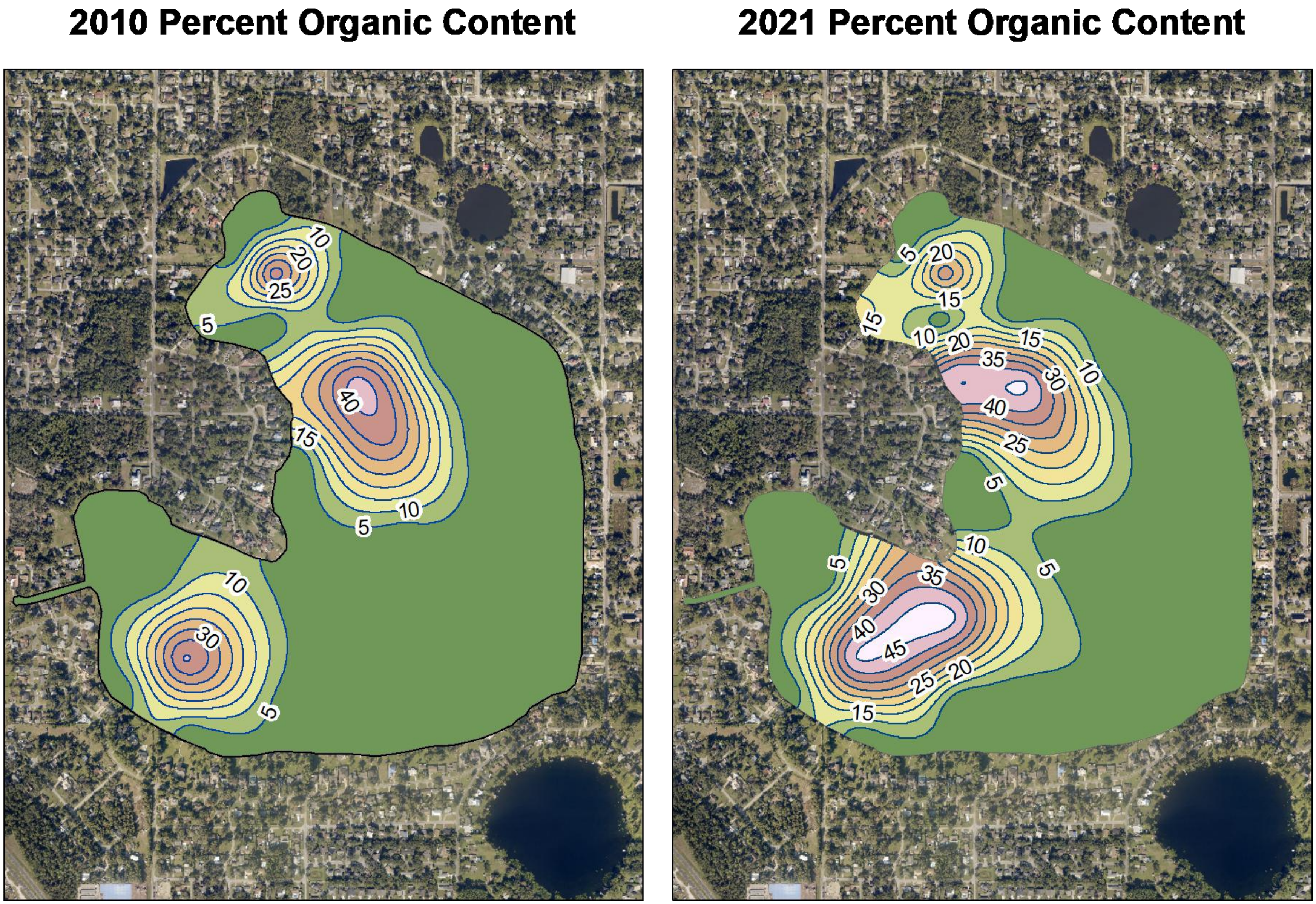

Figure 2-8. Isopleths of Organic Content (%) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

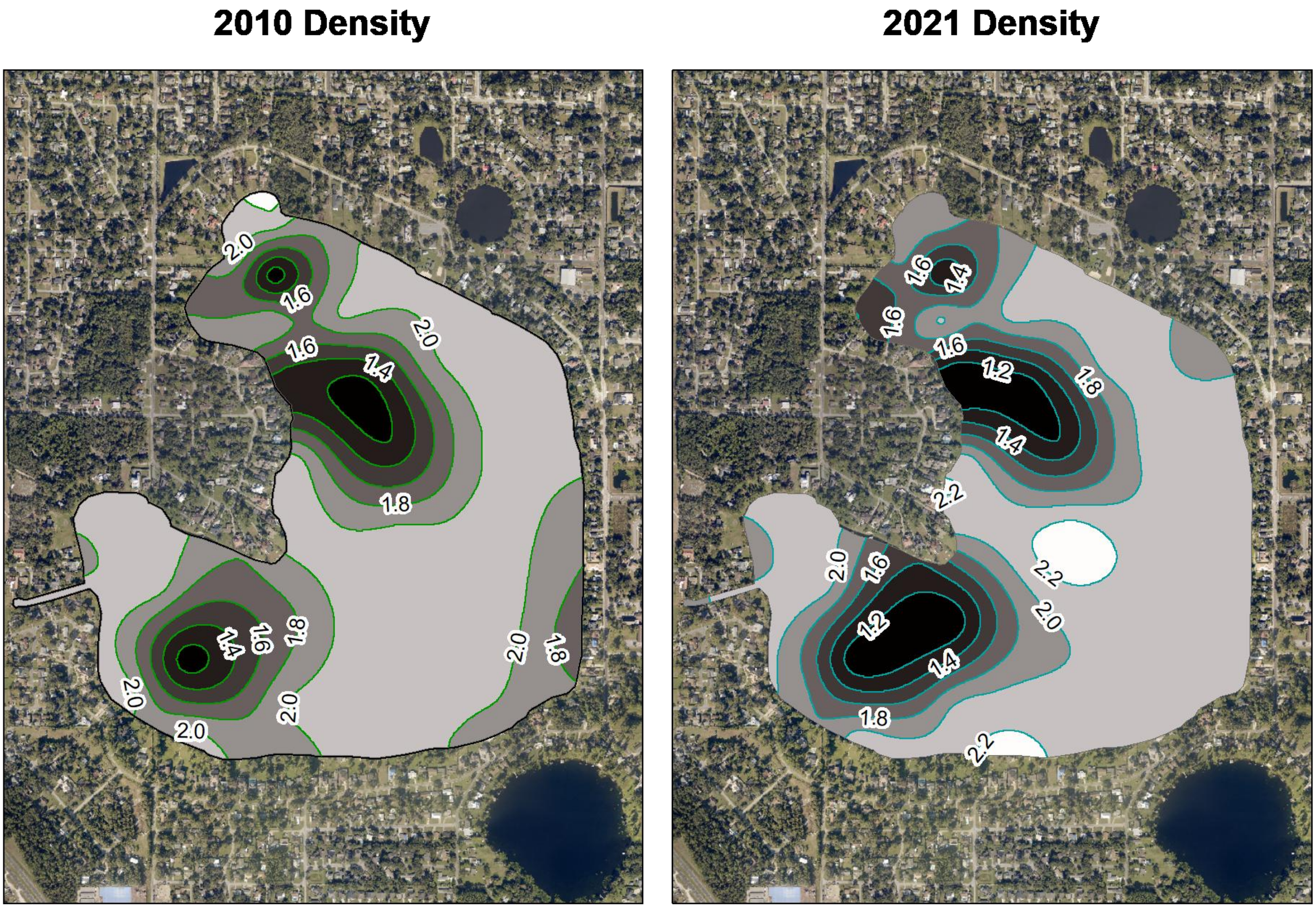

Figure 2-9. Isopleths of Wet Density (g/cm^3) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

2.2.3.3 <u>Nutrients</u>

A summary of sediment nutrient concentrations in Bear Lake sediments collected during 2021 is given in Table 2-7. Measured concentrations of total phosphorus in Bear Lake sediments were found to be low to moderate in value and highly variable throughout the lake, ranging from 42-673 $\mu g/cm^3$, with an overall mean of 138 $\mu g/cm^3$ which is on the lower end of sediment phosphorus values measured by ERD in lake sediments. In general, sandy sediments are often characterized by low total phosphorus concentrations, while highly organic muck type sediments are characterized by elevated total phosphorus concentrations. The mean sediment phosphorus concentration of 138 $\mu g/cm^3$ in Bear Lake is consistent with the physical sediment characteristics.

Isopleths of sediment phosphorus concentrations in Bear Lake are presented on Figure 2-10, based on information contained in Table 2-7. Areas of elevated sediment total phosphorus concentrations are present primarily in the western half of the lake in areas of accumulated organic muck, with lower concentrations in the eastern half. In general, overall total phosphorus concentrations observed in Bear Lake, particularly in the western half, are similar to values typically observed in urban lakes. No significant differences are apparent in sediment phosphorus concentrations between the 2010 and 2021 events.

Similar to the trends observed for sediment phosphorus concentrations, sediment total nitrogen concentrations are moderate in value. Measured sediment nitrogen concentrations in the lake range from 331-1,751 $\mu g/cm^3$, with an overall mean of 716 $\mu g/cm^3$, and appear to be on the low end of values normally observed in urban lakes. The relatively low sediment nitrogen concentrations in spite of continued nitrogen inputs may be due to nitrogen loss through denitrification. Isopleths of sediment nitrogen concentrations in Bear Lake are illustrated on Figure 2-11. In general, nitrogen sediment concentrations exhibit a trend similar to phosphorus, with elevated areas of sediment nitrogen concentrations located in the western half of the lake, with lower nitrogen concentrations in the eastern half.

The comparison of the 2010 and 2021 nitrogen concentrations suggests a decrease in sediment nitrogen concentrations in central and northwest portions of the lake compared with the 2010 measurements. Although nitrogen can be reduced through denitrification, it is unlikely that the observed decrease could occur within the short 11-year period between events.

2.2.3.4 <u>Phosphorus Speciation</u>

As discussed in Section 2.2.2, each of the collected sediment core samples was evaluated for phosphorus speciation based upon the modified Chang and Jackson speciation procedure developed by ERD. This procedure allows phosphorus within the sediments to be speciated with respect to bonding mechanisms which is useful in evaluating the stability of phosphorus in the sediments, the potential for release of phosphorus from the sediments under anaerobic or other conditions, and as a tool for estimating alum requirements for sediment inactivation.

TABLE 2-7

MEASURED CONCENTRATIONS OF NITROGEN AND PHOSPHORUS IN SEDIMENT CORE SAMPLES COLLECTED IN BEAR LAKE ON OCTOBER 21, 2021

LAB I.D. (21-xx)	SITE	TOTAL NITROGEN (µg/cm³)	TOTAL PHOSPHORUS (µg/cm³)
348	1	509	111
349	2	1,003	307
350	3	1,479	560
351	4	755	90
352	5	754	67
353	6	1,122	441
354	7	942	313
355	8	659	272
356	9	785	85
357	10	1,015	471
358	11	1,751	554
359	12	565	82
360	13	591	42
361	14	541	70
362	15	1,719	673
363	16	830	136
364	17	384	61
365	18	572	129
366	19	623	160
367	20	687	80
368	21	331	69
369	22	348	101
370	23	844	157
371	24	619	187
372	25	1,643	487
373	26	578	117
374	27	677	124
375	28	751	67
376	29	768	135
377	30	1,439	494
378	31	482	59
379	32	418	74
380	33	1,169	144
381	34	631	75
382	35	610	58
383	36	423	57
384	37	344	62
Minimum Value:		331	42
Maximum Value:		1,751	673
Geometric Mean:		716	138

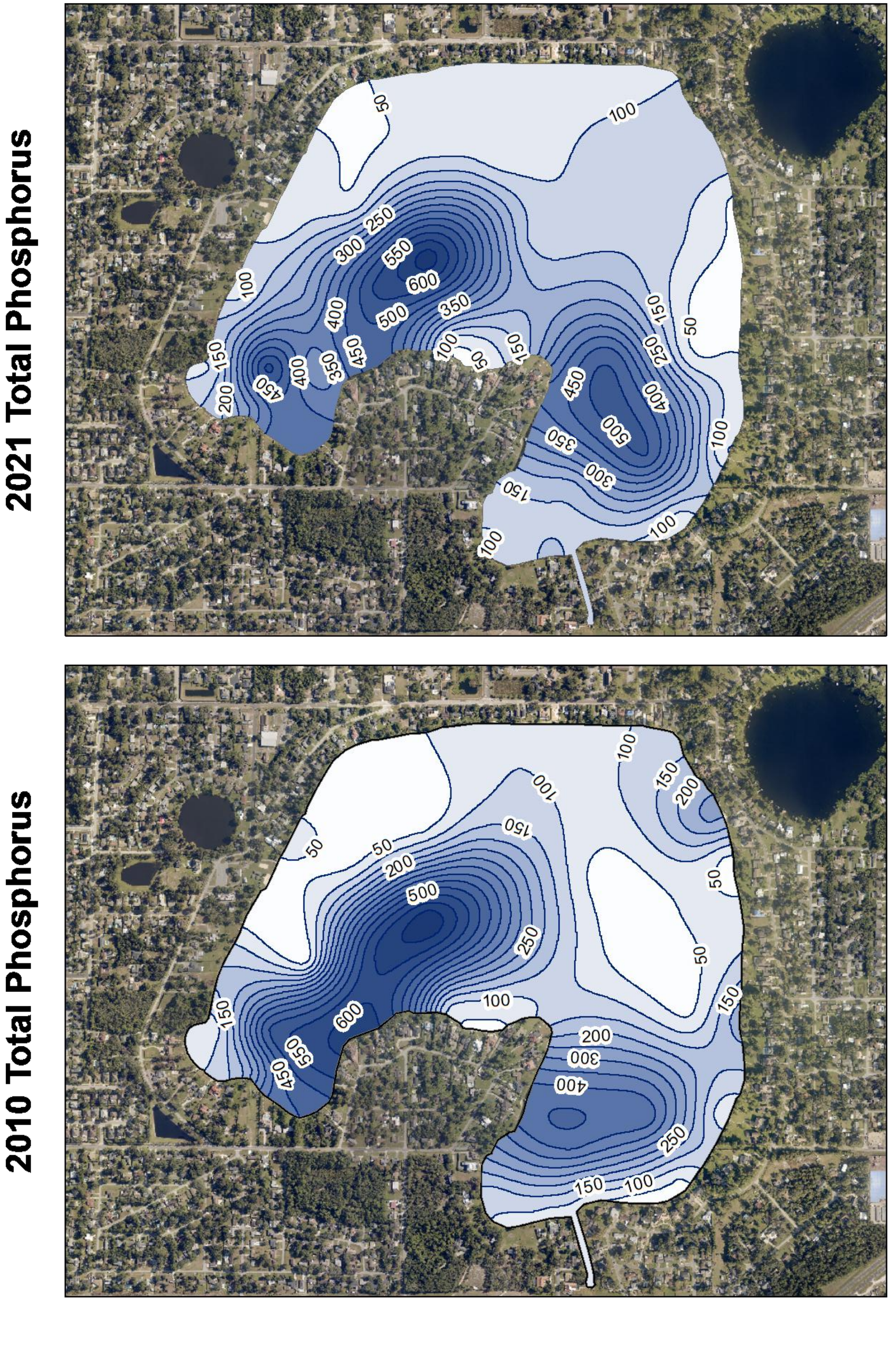

Figure 2-10. Isopleths of Total Phosphorus (µg/cm^3) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

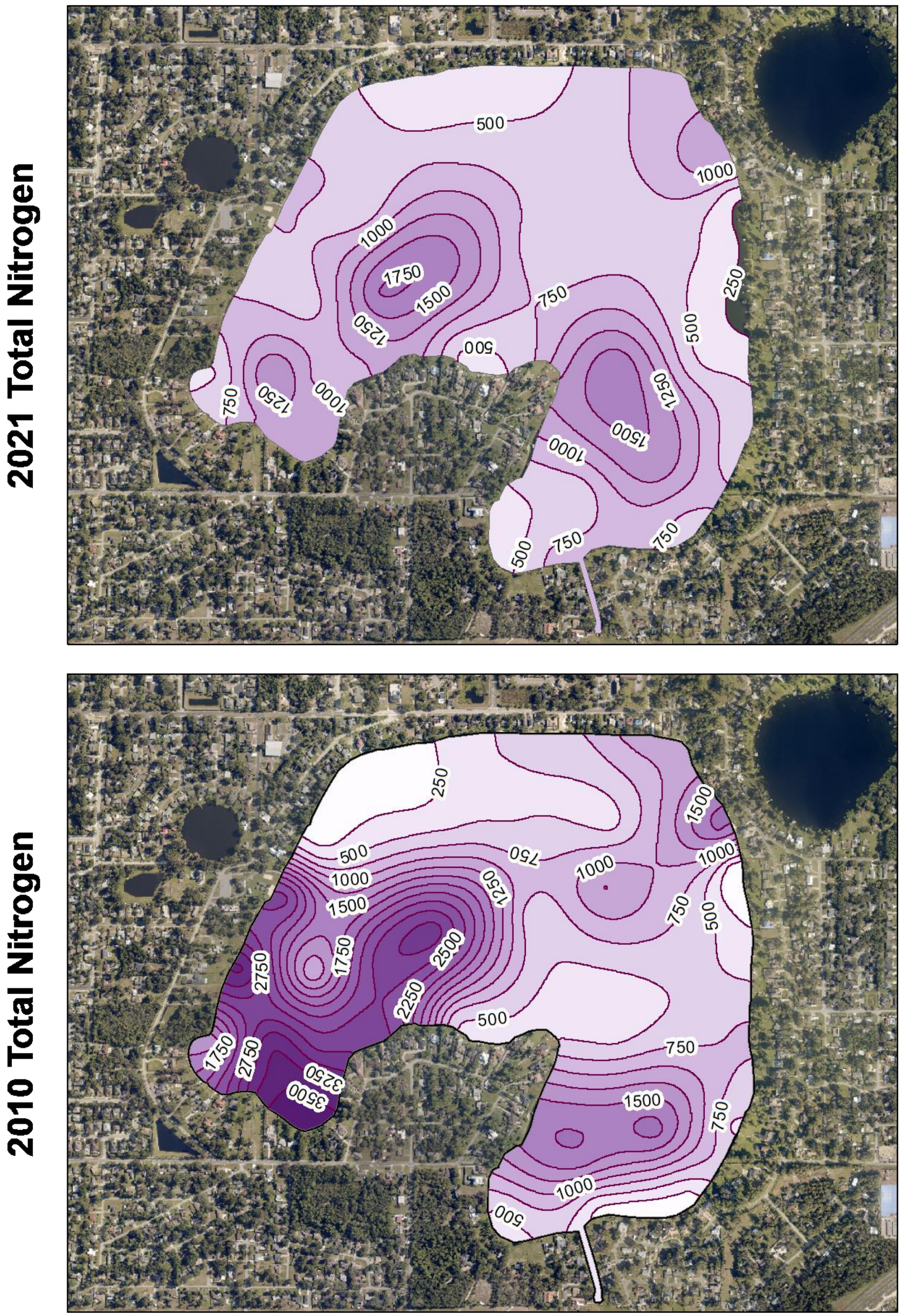

Figure 2-11. Isopleths of Total Nitrogen (µg/cm^3) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

A summary of phosphorus speciation in sediment core samples collected from Bear Lake during October 2021 is given in Table 2-8. Saloid-bound phosphorus represents sediment phosphorus which is either soluble or easily exchangeable and is typically considered to be readily available for release from the sediments into the overlying water column. As seen in Table 2-8, saloid-bound phosphorus concentrations appear to be fairly uniform and low in value throughout much of Bear Lake. Measured values for saloid-bound phosphorus range from 0.1-4.1 μg/cm^3, with an overall geomean of 0.8 μg/cm^3, reflecting low values.

Isopleths of saloid-bound phosphorus in the top 10 cm of sediments in Bear Lake during 2010 and 2021 are illustrated on Figure 2-12. Concentrations of saloid-bound phosphorus are low in value throughout the lake, with the most elevated values in the western and southeast portions of the lake. The comparison graphs for 2010 and 2021 suggest a decrease in saloid phosphorus in the northwest lobe from 2010 to 2021, but this difference is likely due to measurements collected at a single monitoring site. An increase in saloid-bound phosphorus is apparent near the discharge from Bear Lake Canal which could be related to the turbid water influx.

In general, iron-bound phosphorus associations in the sediments of Bear Lake appear to be low to elevated in value. Iron-bound phosphorus is relatively stable under oxidized conditions, but becomes unstable under a reduced environment, causing the iron-phosphorus bonds to separate, releasing the bound phosphorus directly into the water column. Iron-bound phosphorus concentrations in the sediments of Bear Lake during 2021 range from 0.7-143 μg/cm^3, with an overall geomean of 10 μg/cm^3. Since iron-bound phosphorus can be released under anaerobic conditions, portions of Bear Lake sediments may have conditions favorable for release of iron-bound sediment phosphorus into the water column throughout much of the year.

Isopleths of iron-bound phosphorus in the top 10 cm of sediments in Bear Lake during 2010 and 2021 are illustrated on Figure 2-13. Similar to the trends observed with other parameters, the majority of iron-bound sediment phosphorus is located in the western half of the lake. The plots suggest a decrease or redistribution of iron-bound phosphorus since decreases appear to have occurred in central portions of the lake combined with large increases in the northwest lobe.

Aluminum-bound phosphorus represents an unavailable species of phosphorus within the sediments. Phosphorus bound with aluminum is typically considered to be inert under a wide range of pH and redox conditions within the sediments. Aluminum-bound phosphorus concentrations in the 2021 Bear Lake sediments range from 5-250 μg/cm^3, with an overall geomean of 35 μg/cm^3, values which are much lower than aluminum-bound phosphorus concentrations commonly observed by ERD in urban lake systems. The geomean aluminum-bound phosphorus concentrations of 35 μg/cm^3 is approximately 25% of the overall total phosphorus sediment geomean concentration of 138 μg/cm^3, suggesting that approximately 25% of the existing phosphorus within the sediments is bound in sediment associations with aluminum which are considered to be inert and unavailable.

TABLE 2-8

PHOSPHORUS SPECIATION IN SEDIMENT CORE SAMPLES COLLECTED IN BEAR LAKE ON OCTOBER 21, 2021

LAB I.D. (21-xx)	SITE	SALOID-BOUND P (µg/cm^3 wet wt.)	IRON-BOUND P (µg/cm^3 wet wt.)	ALUMINUM-BOUND P (µg/cm^3 wet wt.)	RESIDUAL P (µg/cm^3 wet wt.)	TOTAL AVAILABLE P (g/cm^3)	PERCENT TOTAL AVAILABLE P (%)
348	1	1.3	11	42	4	13	11
349	2	2.4	31	112	21	38	12
350	3	0.1	143	234	73	158	28
351	4	2.5	8.4	26	10	13	14
352	5	0.2	2.8	13	16	6	9
353	6	3.0	125	182	2	128	29
354	7	0.2	45	91	19	49	16
355	8	0.2	26	79	27	32	12
356	9	0.2	6.8	18	16	10	12
357	10	1.8	87	119	227	134	29
358	11	0.6	99	176	225	145	26
359	12	0.2	4.6	19	15	8	10
360	13	1.1	0.7	7	12	4	10
361	14	1.1	2.3	20	10	5	8
362	15	1.4	108	250	206	150	22
363	16	1.0	15	44	7	17	13
364	17	0.2	1.2	7	21	5	9
365	18	2.8	7.1	38	13	12	10
366	19	0.2	21	36	11	23	15
367	20	0.9	5.1	21	12	8	10
368	21	1.2	2.1	5	24	8	12
369	22	4.1	5.6	30	9	11	11
370	23	1.4	18	55	6	21	13
371	24	2.4	21	52	15	26	14
372	25	0.1	85	165	198	125	26
373	26	0.2	19	29	7	21	18
374	27	3.8	17	37	3	21	17
375	28	1.8	2.1	9	20	8	12
376	29	2.7	1.7	19	40	12	9
377	30	0.8	66	166	217	110	22
378	31	1.6	4.6	16	7	8	13
379	32	1.3	4.0	19	10	7	10
380	33	0.2	33	31	4	34	23
381	34	1.5	1.6	27	8	5	6
382	35	1.8	2.1	10	14	7	11
383	36	0.9	2.4	20	4	4	7
384	37	0.9	2.1	15	12	5	9
Minimum Value:		0.1	0.7	5	2	4	6
Maximum Value:		4.1	143	250	227	158	29
Geometric Mean:		0.8	10	35	17	18	13

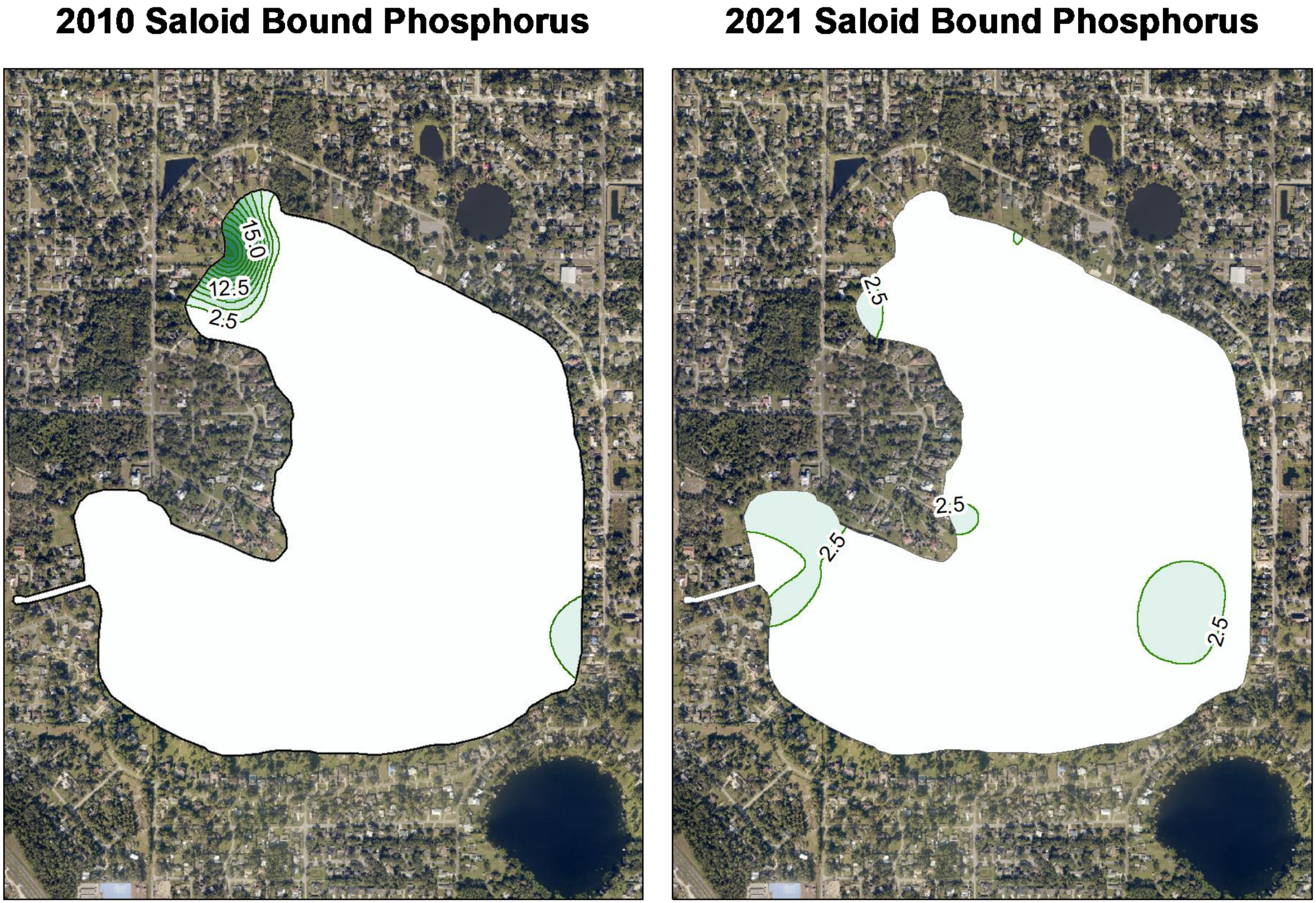

Figure 2-12. Isopleths of Saloid-Bound Phosphorus ($\mu g/cm^3$) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

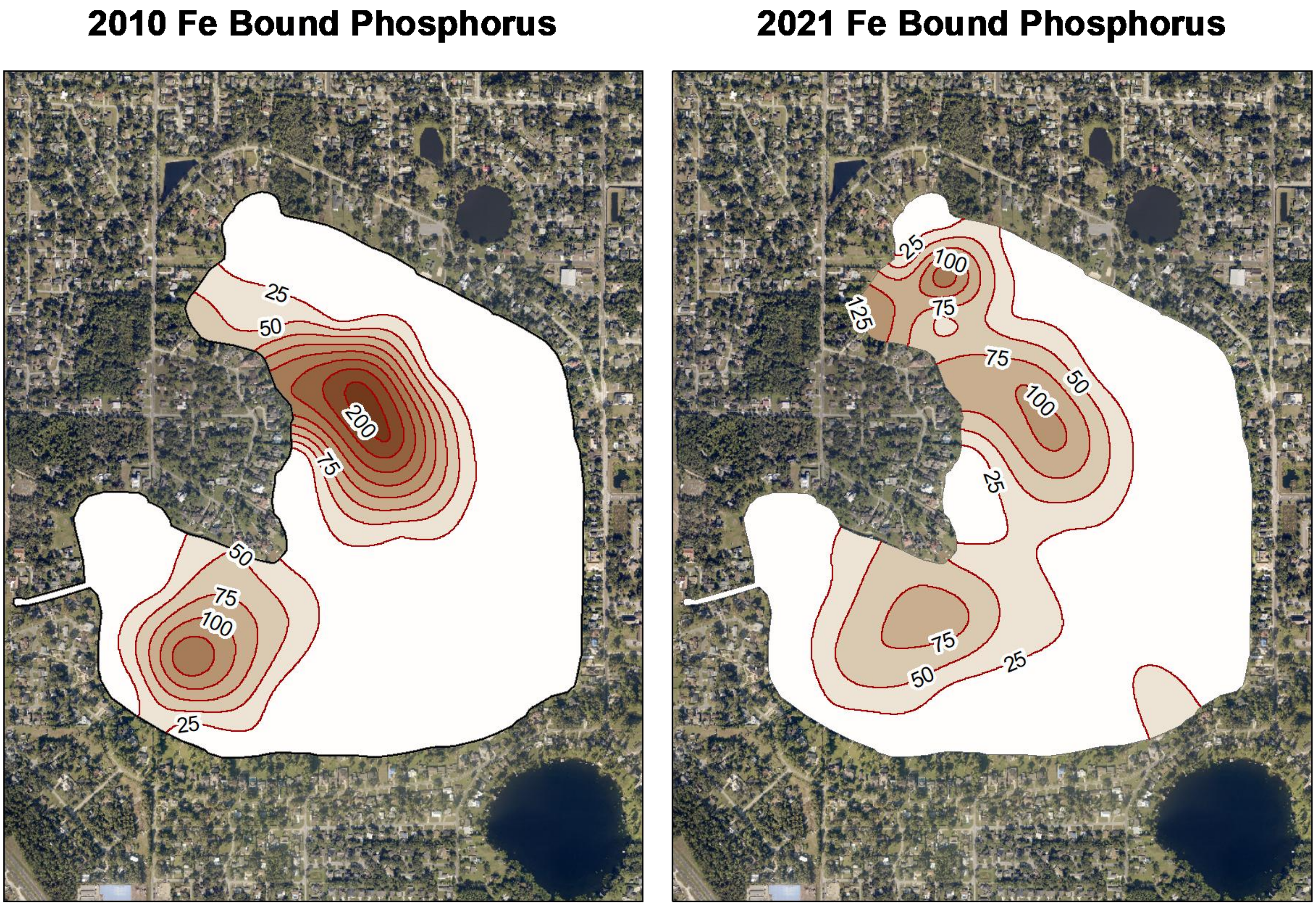

Figure 2-13. Isopleths of Iron-Bound Phosphorus (μg/cm^3) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

Isopleths of aluminum-bound phosphorus in Bear Lake sediments during 2010 and 2021 are provided in Figure 2-14. Similar to the previously discussed parameters, the most elevated aluminum-bound phosphorus concentrations are observed in the western half of the lake. However, unlike previous parameters which are similar between the two monitoring events, a large increase in aluminum-bound phosphorus appears to have occurred between 2010 and 2021. The magnitude of the difference is outside of normal sampling variability, and it appears that a large change in aluminum sediment bonding has occurred, although the mechanism for this change is not known.

Total available phosphorus represents the amount of sediment phosphorus which can potentially be released into the overlying water column, and for purposes of sediment inactivation, a period of 10-15 years is assumed. Typically, total available phosphorus is assumed to be the sum of the saloid-bound phosphorus and iron-bound phosphorus associations in each sediment core sample. Since the saloid-bound phosphorus is immediately available, and the iron-bound phosphorus is available under reduced conditions, the sum of these speciations has historically been used to represent the total phosphorus which is potentially available within the sediments. Phosphorus bounding mechanisms other than these were generally assumed to be insignificant.

Following the saloid-bound, iron-bound, and aluminum-bound extraction, the remaining sediment is primarily organic matter, much of which is recalcitrant, and phosphorus bound in this form has been considered to be relatively stable over the typical 10-12 year lifespan of alum sediment inactivation projects. This sediment fraction is referred to as residual since it reflects the sediments which remain following removal of the saloid-, iron-bound, and aluminum-bound fractions. However, some of the sediment, particularly new fresh organic matter from algae and plants, is capable of decomposing over the 10-12 year period. ERD assumes that 20% of this residual sediment will decompose and release phosphorus over a 10-12 year period. The residual sediment phosphorus concentrations are calculated as the total sediment phosphorus minus the saloid-, iron-, and aluminum-bound fractions, and 20% of this residual sediment concentration is considered to be available. Calculated residual phosphorus concentrations in Bear Lake sediments are provided in Table 2-8.

A summary of total available phosphorus in the Bear Lake sediment core samples is also given in Table 2-8. Total available phosphorus concentrations within the lake range from 4-158 $\mu g/cm^3$, with an overall geometric mean of 18 $\mu g/cm^3$. The mean sediment total available phosphorus in Bear Lake is much lower than the sediment available phosphorus concentrations commonly observed by ERD in urban lakes.

Isopleths of total available phosphorus (consisting of saloid-bound, iron-bound, and residual phosphorus) in the top 10 cm of sediments in Bear Lake are illustrated on Figure 2-15. Available phosphorus concentrations follow a pattern similar to those observed with other parameters, with the vast majority of total available phosphorus located in the west half of the lake. The isopleths presented on Figure 2-15 can be utilized directly as a guide for future sediment inactivation activities, if desired.

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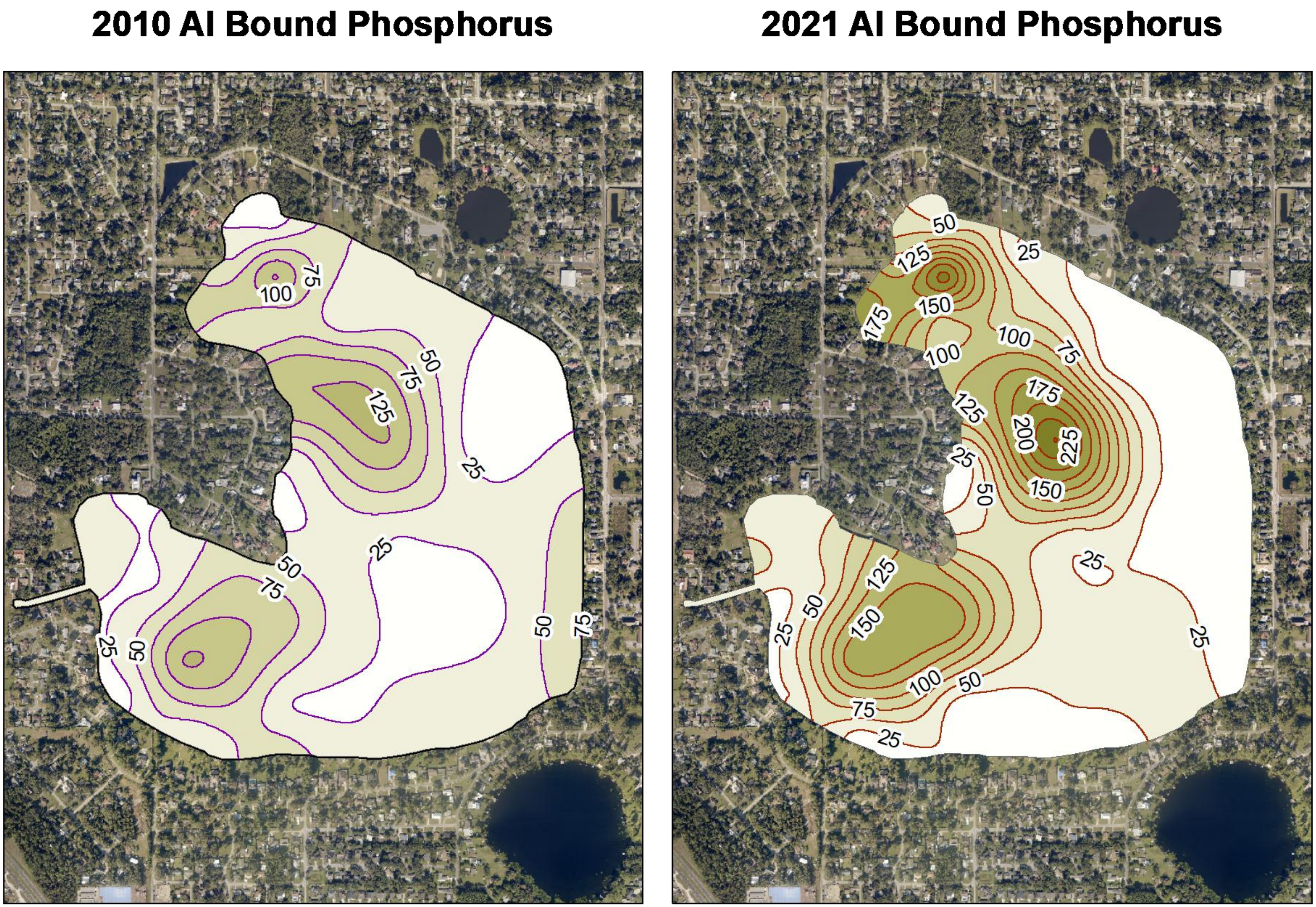


Figure 2-14. Isopleths of Aluminum-Bound Phosphorus ($\mu g/cm^3$) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

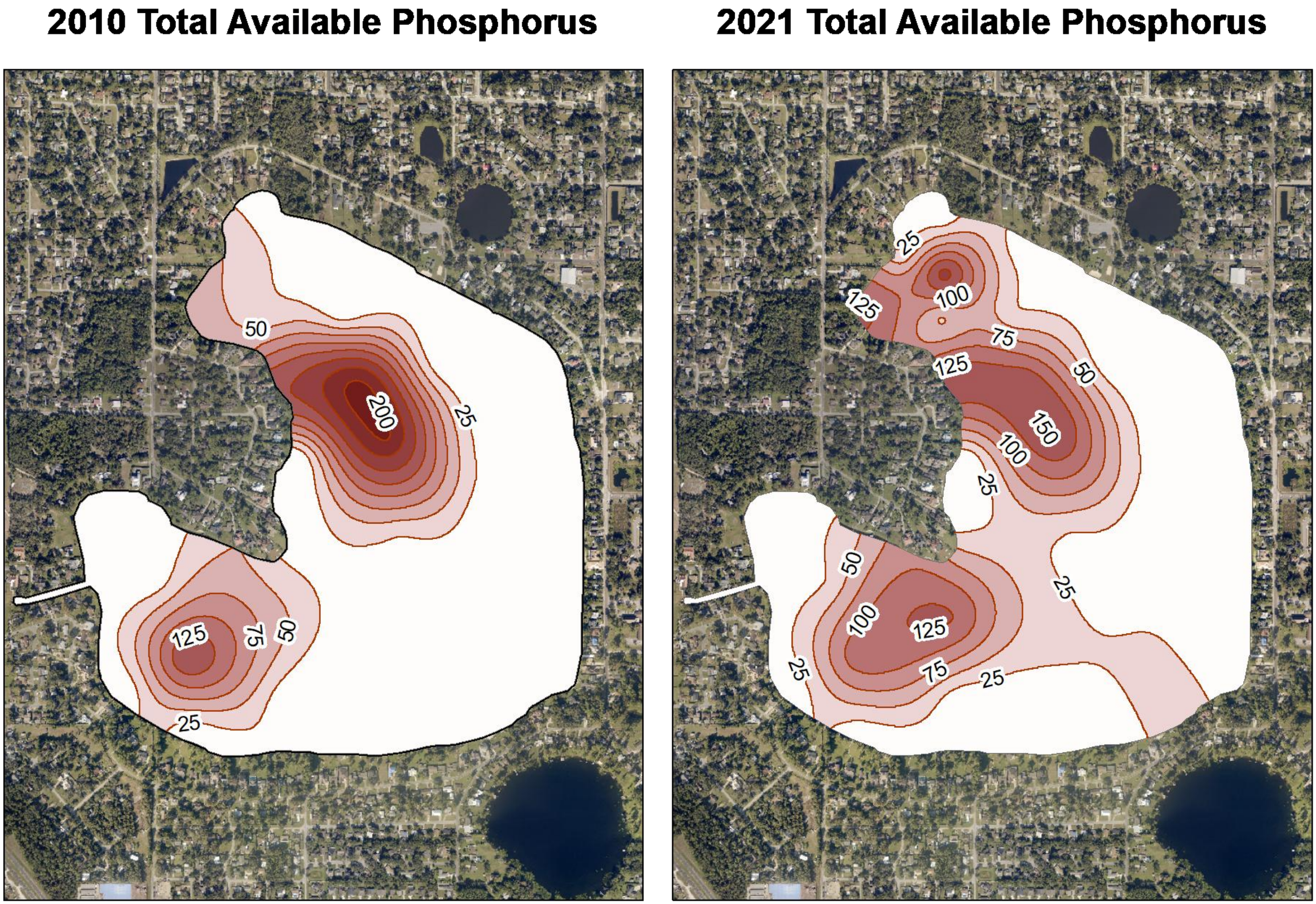


Figure 2-15. Isopleths of Total Available Phosphorus (μg/cm^3) in the Top 10 cm of Sediments in Bear Lake During 2010 and 2021.

Available sediment phosphorus is also expressed as a percentage of total phosphorus concentrations within the sediments. This value is calculated as the ratio of the total available phosphorus values listed for each site in Table 2-8 divided by the overall sediment phosphorus concentrations listed in Table 2-7. The percentage of available phosphorus within the sediments of Bear Lake ranges from approximately 6-29%, with an overall mean of 13%. This suggests that approximately 13% of the existing accumulation of phosphorus within the lake is potentially available for release into the overlying water column as a result of sediment agitation or anaerobic conditions.

2.2.4 Bear Lake Canal Sediments

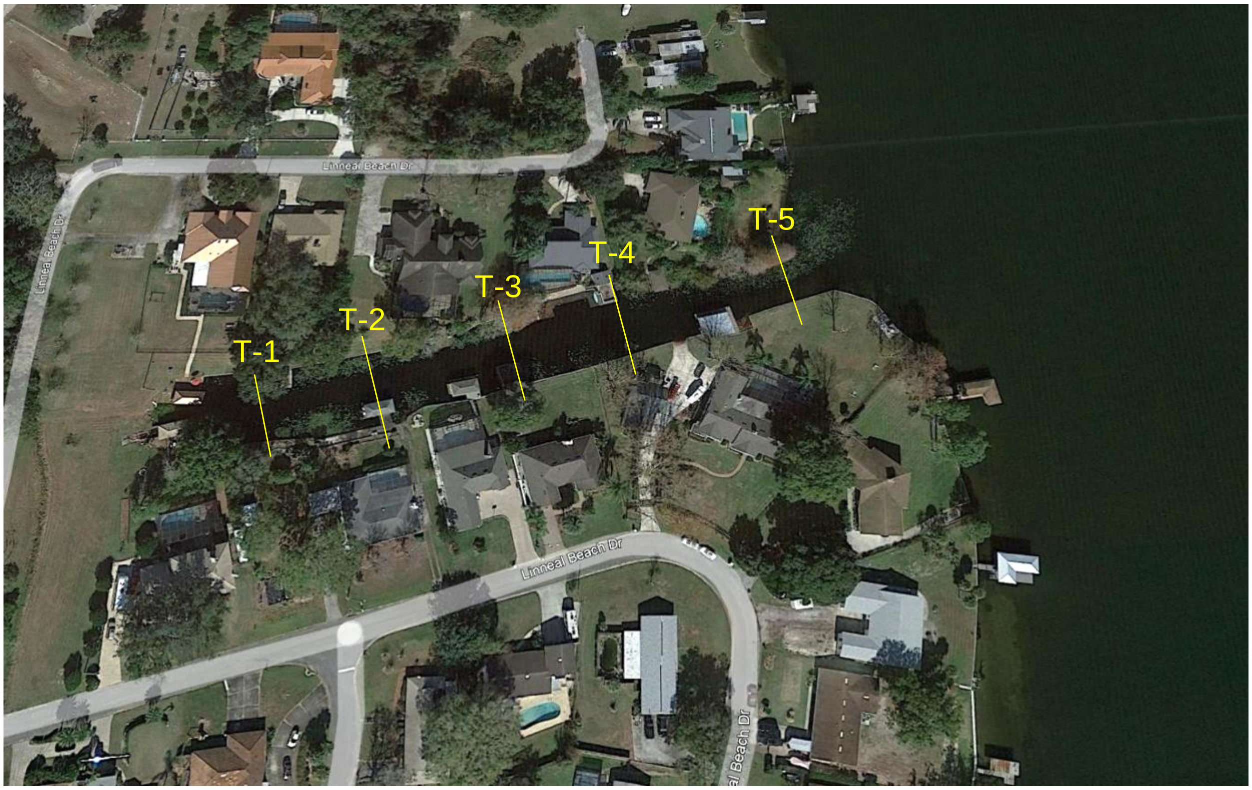
In addition to the sediment monitoring conducted in the main lake, ERD also collected sediment core samples along 5 transects in the Bear Lake Canal to evaluate residual evidence of accumulated dirt or fine particles which may have been deposited in the Canal by the turbid water inflow during 2020. Five separate transects were monitored, with 3 core samples collected along each transect at distances of 25%, 50%, and 75% of the channel width at each site, starting on the south side of the Canal. Photographs of the sediment collection transects and conditions in the Canal at the time of sediment collection are shown in Figure 2-16.

Photographs of the 15 sediment core samples collected along the Canal transects are provided in Appendix B. No visible surficial layer of accumulated particles was observed at any of the 15 sites. Any turbidity which settled onto the bottom of the Canal appears to have been incorporated into the existing sediments. The same phenomenon was also observed in sediment core samples collected in the main lake. As mentioned previously, the particles which created the turbidity during the 2020 event are extremely fine and could easily become incorporated into existing surficial sediments. If the inflow to the Canal had been comprised of sand or soil, the impacts would be clearly visible in the form of accumulated deltas.

2.3 Water Quality Characteristics of Bear Lake

2.3.1 Historical Water Quality Data Availability

A relatively large amount of historical water quality monitoring has been conducted in Bear Lake, with data collected by Seminole County, FDEP, and as part of the volunteer LakeWatch program. However, the most complete data set has been collected by the LakeWatch program, with monthly measurements beginning in 1991 and continuing to the present. Four separate monitoring sites are included with most events, and locations of the sites are indicated on Figure 2-17. Due to the extensive amount of continuous data available through LakeWatch, these data are used to evaluate historical and current water quality in Bear Lake.



a. Sediment monitoring transects in the Bear lake Canal

b. Canal conditions during sediment collection

Figure 2-16. Locations of Sediment Core Sample Transects in the Bear Lake Canal.

Figure 2-17.

Locations of LakeWatch Monitoring Sites in Bear Lake.

LakeWatch monitoring was initiated during 1991 with samples collected at the 4 separate locations indicated on Figure 2-17. Each of the sites was monitored on a monthly basis, with more than 375 events conducted at each site. Monitoring conducted by LakeWatch includes measurements of total nitrogen, total phosphorus, chlorophyll-a, and Secchi disk depth. Available LakeWatch data for the period of record from 11/30/91-9/28/21 were provided to ERD by Nancy Dunn and includes 1,431 individual water quality samples. A complete listing of the historical LakeWatch data is given in Appendix C, and a summary of annual geomean values for the LakeWatch parameters from 1992-2021 is given in Table 2-9, although the data for 2021 only include a portion of the year.

TABLE 2-9

ANNUAL GEOMETRIC MEAN VALUES FOR TOTAL NITROGEN, TOTAL PHOSPHORUS, CHLOROPHYLL-A, AND SECCHI DISK DEPTH IN BEAR LAKE FROM 1992-2021

YEAR	TOTAL NITROGEN (µg/l)	TOTAL PHOSPHORUS (µg/l)	CHLOROPHYLL-A (µg/l)	SECCHI DISK DEPTH (m)	TN/TP RATIO	TSI (Chyl-a)	TROPHIC STATE
1992	366	12	3.1	3.62	30	33	Oligotrophic
1993	388	12	2.8	3.29	32	30	Oligotrophic
1994	408	13	3.6	3.40	30	34	Oligotrophic
1995	365	14	2.6	3.92	26	30	Oligotrophic
1996	394	11	2.4	4.39	34	28	Oligotrophic
1997	373	11	1.9	5.47	33	25	Oligotrophic
1998	410	14	2.3	4.35	30	27	Oligotrophic
1999	436	14	3.6	3.66	31	34	Oligotrophic
2000	510	14	4.0	3.58	36	36	Oligotrophic
2001	532	14	5.2	3.01	38	40	Oligotrophic
2002	532	14	4.2	3.26	38	37	Oligotrophic
2003	480	13	3.6	3.78	37	35	Oligotrophic
2004	518	14	4.6	2.98	36	38	Oligotrophic
2005	484	15	6.1	2.58	31	42	Oligotrophic
2006	499	13	5.2	2.72	37	40	Oligotrophic
2007	538	12	5.3	2.59	44	41	Oligotrophic
2008	545	11	4.6	2.94	51	38	Oligotrophic
2009	631	11	3.4	3.22	58	33	Oligotrophic
2010	573	10	4.7	3.59	56	39	Oligotrophic
2011	583	9	4.0	3.66	64	36	Oligotrophic
2012	603	11	3.9	3.63	56	36	Oligotrophic
2013	560	11	4.5	3.51	53	38	Oligotrophic
2014	528	10	3.9	3.68	52	36	Oligotrophic
2015	572	12	4.0	3.35	48	36	Oligotrophic
2016	616	11	4.0	3.19	55	36	Oligotrophic
2017	596	12	7.3	2.59	49	45	Oligotrophic
2018	595	13	9.5	2.34	45	49	Oligotrophic
2019	548	14	8.9	2.41	40	48	Oligotrophic
2020	616	16	11.9	2.21	39	52	Mesotrophic
2021	671	17	11.6	1.88	39	52	Mesotrophic

2.3.1.1 Data Analysis Techniques

The historical LakeWatch data set for Bear Lake was used by ERD to evaluate general water quality characteristics and to conduct trend analyses for significant parameters over time. Due to the large amount of data available from LakeWatch, the historical data set covers a period of almost 30 years from 1991-2021.

A review of the historical water quality data was conducted by ERD to identify apparent data anomalies and inconsistent or impossible values. No significant data anomalies or impossible values were observed in the LakeWatch data. Secchi disk data provided in feet were converted to meters to be consistent with standard units for this parameter used in the scientific community. Multiple LakeWatch sites for the same date were averaged to obtain a single lake-wide value for each date.

Historical water quality characteristics in Bear Lake were evaluated by ERD based upon an examination of the results of individual monitoring events as well as mean annual concentrations for total phosphorus, total nitrogen, chlorophyll-a, Secchi disk depth, TN/TP ratio, and TSI. Line plots of concentration over time were developed for each evaluated historical parameter, and mean annual geometric mean values are superimposed over the historical data to provide a less cluttered view of potential water quality trends within the lake.

A linear regression line is also provided to assist in identifying significant water quality trends which is obtained using linear regression techniques on the annual geometric mean values. The calculated probability value (p value) is also provided which indicates the level of significance associated with each regression model. A model which is significant at a 95% confidence level would be associated with a p value of 0.05. However, lakes exhibit normal seasonal cyclic variations in water quality which can reduce the statistical significance of the regression model. Therefore, when evaluating water quality trends in lakes, a p value of 0.1 or less is generally considered to indicate a significant statistical trend, while p values greater than 0.1 suggest an insignificant trend.

2.3.1.2 Total Nitrogen

A graphical summary of historical trends in total nitrogen concentrations in Bear Lake from 1991-2021 is given in Figure 2-18 based on data collected by the LakeWatch program. Measured total nitrogen concentrations in Bear Lake have been low to moderate in value over the historical record from 1991-2021, although more elevated values have been observed at times. Typical total nitrogen concentrations in the lake have ranged from approximately 300-700 μg/l. Total nitrogen concentrations in Bear Lake have exhibited a low degree of variability over time which is less than typically observed by ERD in urban lakes.

The trend lines shown on Figure 2-18 suggest a trend of slightly increasing total nitrogen concentrations in Bear Lake over time due to the positive slope on the regression line, and the calculated p-value of <0.0001 indicates that the trend is statistically significant. Overall, the data suggest that total nitrogen concentrations in Bear Lake are increasing at a rate of 9 μg/l per year.

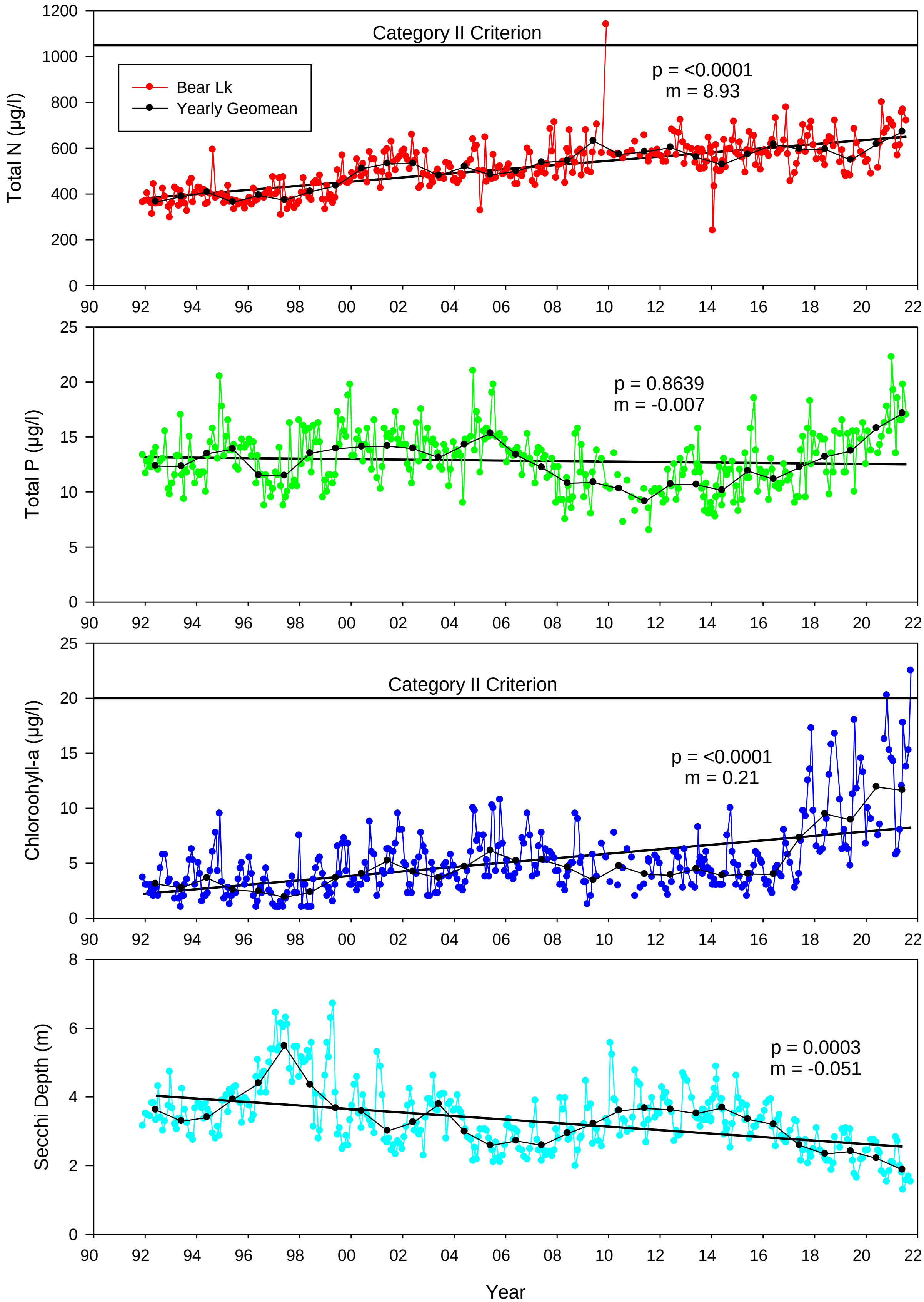


Figure 2-18. Summary of Trends in Total Nitrogen, Total Phosphorus, Chlorophyll-a, and Secchi Disk Depth in Bear Lake from 1991-2021.

Based on the Florida Numeric Nutrient Criteria (NNC), Bear Lake is a Category II lake since long-term color is less than 40 Pt-Co units and alkalinity exceeds 20 mg/l, and the NNC for total nitrogen is 1,050 μg/l which is indicated on Figure 2-17. None of the annual geometric mean total nitrogen concentrations have exceeded the applicable minimum Numeric Nutrient Criteria (NNC) of 1,050 μg/l throughout the period of available historical data from 1991-2020. Only one individual sample has exceeded a concentration of 1,050 μg/l over the historical period of data, and that value is likely an outlier.

2.3.1.3 Total Phosphorus

A graphical summary of historical trends in total phosphorus concentrations in Bear Lake from 1991-2021 is also given on Figure 2-18. Measured total phosphorus in Bear Lake has been variable over time, with generally low concentrations. Individual phosphorus measurements in the historical record have ranged from 4-22 μg/l, although the vast majority of measured values have occurred in the range of 10-15 μg/l.

Total phosphorus concentrations in Bear Lake have exhibited a high degree of variability throughout the field monitoring program. Unlike the trend observed for total nitrogen, annual geometric mean total phosphorus values in Bear Lake have exhibited a cyclic pattern, with the most elevated values occurring from 1998-2004 and from 2017 to the present. The trend line for geometric mean annual total phosphorus concentrations in Bear Lake from 1991-2021 exhibits a negative slope which suggests a trend of decreasing total phosphorus concentrations over time, but the p-value of 0.8639 indicates that the trend is not significant. A relatively rapid increase in total phosphorus appears to have occurred since 2017, with current total phosphorus values reaching historical highs by a factor of at least 2-3.

As indicated on Figure 2-18, annual geometric mean total phosphorus concentrations have been below the applicable NNC value of 30 μg/l throughout the entire historical water quality monitoring program, with no exceedances of the total phosphorus minimum NNC criterion observed at any time in the historical record.

The trend of increasing total phosphorus concentrations in Bear Lake in recent years suggests that loading sources of phosphorus have exceeded uptake mechanisms for total phosphorus in the lake during this period. Since the total phosphorus uptake mechanisms in Bear Lake are biologically driven through uptake by algae and aquatic plants, the variability in concentrations, assuming external inputs are relatively constant, are likely related to changes in plant biomass over time.

2.3.1.4 Chlorophyll-a

A graphical summary of measured concentrations of chlorophyll-a in Bear Lake from 1991-2021 is also given in Figure 2-18. In general, measured concentrations of chlorophyll-a in Bear Lake have been low to moderate in value over the available period of data. Chlorophyll-a concentrations <10 mg/m^3 are generally considered to reflect low values, with concentrations from 10-30 mg/m^3 reflecting moderate values, and concentrations >30 mg/m^3 representing elevated values.

Concentrations of chlorophyll-a in Bear Lake have ranged from 1-22 mg/m^3, although the vast majority of measured values have been approximately 10 mg/m^3 or less, particularly prior to 2017. The shape of the plot of annual geometric mean values for chlorophyll-a is somewhat similar to the plot for total phosphorus, with increases and decreases in chlorophyll-a corresponding to increases and decreases in phosphorus. The most elevated chlorophyll-a values in Bear Lake over the entire historical period have occurred since 2017.

The regression trend line for chlorophyll-a has a positive slope, suggesting a trend of increasing chlorophyll-a concentrations over time, and the calculated p-value of <0.0001 indicates that this trend is statistically significant. Overall, historical chlorophyll-a concentrations in Bear Lake have been indicative of oligotrophic conditions, with mesotrophic conditions on occasion since 2017. Over the available period of record from 1991-2021, the annual geometric mean chlorophyll-a concentration has not exceeded the NNC criterion of 20 mg/m^3 during any of the 29 years of historical record. However, substantial increases in total phosphorus have been recorded since 2017, with concentrations during several individual events exceeding 20 μg/l during 2020.

The pattern of annual geometric mean values for chlorophyll-a is somewhat similar to the pattern exhibited by total phosphorus. Several short-term patterns are apparent with a decreasing trend from 1992-2005, relatively consistent values from 2005-2016, and increasing values from 2017-2020.

2.3.1.5 Secchi Disk Depth

A graphical summary of measured Secchi disk depths in Bear Lake from 1991-2021 is also given on Figure 2-18. Recorded Secchi disk depths in Bear Lake have ranged from 2-7 m, although the majority of Secchi disk depths have ranged from 3-5 m. Secchi disk depths have been highly variable over the available period of record, with a lower degree of variability in recent years. The variability in Secchi disk depths illustrated on Figure 2-17 appears to be closely linked to changes in algal productivity since the chlorophyll-a and Secchi disk depth plots appear to exhibit inverse relationships. Due to the low color in Bear Lake, color does not appear to be a significant factor in determining Secchi disk depths.

The slope of the trend line for Secchi disk depth in Bear Lake is negative, suggesting a decrease in Secchi disk depth over time of 0.05 m per year, and the calculated p-value of 0.0003 indicates that the trend is highly significant. The Secchi disk depth data suggest that water clarity has been highly variable over time. The observed increases in total phosphorus and chlorophyll-a since 2017 are consistent with decreases in Secchi disk depth over the same period. The lowest Secchi disk values recorded in Bear Lake have been measured since 2017.

2.3.1.6 Nutrient Limitation

Nutrient limitation in a waterbody is often evaluated using the total nitrogen/total phosphorus (TN/TP) ratio. The calculated TN/TP ratio is a numerical ratio of the measured water column concentrations of total nitrogen and total phosphorus. This ratio can be useful in evaluating the relative significance of nitrogen and phosphorus in regulating primary productivity (algal growth) in a waterbody resulting from supplemental nutrient loadings. Measured TN/TP ratios less than 10 are considered to indicate nitrogen-limited conditions, suggesting that phosphorus is relatively abundant and nitrogen is the element which regulates primary productivity and the growth of algae within the lake system. Calculated TN/TP ratios between 10-30 indicate nutrient-balanced conditions, with both nitrogen and phosphorus considered important for limiting aquatic growth. Calculated TN/TP ratios in excess of 30 indicate phosphorus-limited conditions, which suggests that nitrogen is abundant within the system and algal growth is limited by the availability of phosphorus. This is the typical situation observed in many lakes in the Central Florida area. However, the concept of nutrient limitation is designed to address impacts from additional nutrient loadings to a waterbody and should not be confused with the process of reducing algal productivity by nutrient load reductions.

A graphical summary of calculated TN/TP ratios in Bear Lake from 1991-2021 is given on Figure 2-19. In general, nutrient ratios in Bear Lake have been highly variable over time, ranging from borderline nutrient-balanced to highly phosphorus-limited conditions. Bear Lake is currently highly phosphorus-limited which suggests that the lake is very susceptible to changes in algal productivity resulting from additional inputs of phosphorus. The trend line suggests increasing TN/TP ratios over time, and the calculated p-value of <0.0001 indicates that the trend is highly significant, suggesting that Bear Lake is becoming more sensitive to phosphorus inputs over time.

2.3.1.7 Trophic State Index (TSI)

Trophic State Index (TSI) values were also calculated for each monitoring event in Bear Lake over the available period of historical data. TSI is a summary statistic which incorporates measured concentrations of significant parameters in lake systems and is often considered the best overall indicator of the health of a lake system. Calculated TSI values less than 50 indicate oligotrophic conditions, representing lakes with low nutrient loadings and good to excellent water quality characteristics. Calculated TSI values from 50-60 indicate mesotrophic or fair water quality characteristics. Calculated TSI values between 60-70 indicate eutrophic or poor water quality characteristics, with hypereutrophic conditions, reflecting very poor water quality, indicated by TSI values in excess of 70.

The trophic state index was developed by Carlson (1977) as a relative measure of the degree of biological productivity in lakes and incorporates forcing functions such as nutrient supplies, light availability, seasonality, and other factors. Since the TSI value is intended to reflect the level of biological productivity, the best estimator for productivity is chlorophyll-a. Some calculations also include, perhaps incorrectly, concentrations of nutrients and Secchi disk depth in addition to chlorophyll-a.

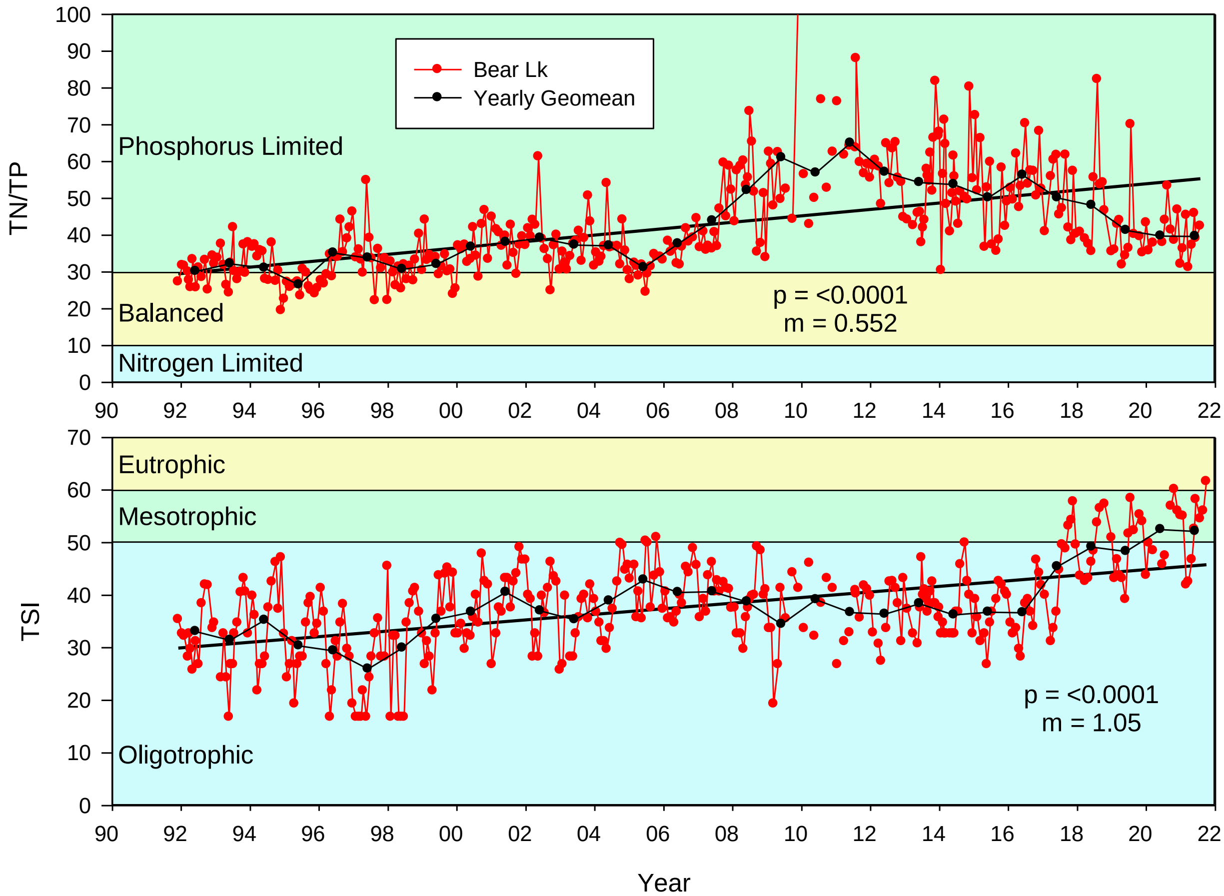


Figure 2-19. Summary of Trends in TN/TP Ratio and TSI in Bear Lake from 1991-2021.

However, including nutrients and Secchi disk depth with chlorophyll-a data in TSI calculations can lead to incorrect conclusions regarding trophic status, and these parameters should only be included as surrogates for biological productivity when chlorophyll data are not available, and TSI values calculated using nutrients and Secchi disk depth as surrogates should be flagged and used with caution. Since chlorophyll-a data for Bear Lake are available for the entire period of record, TSI calculations were conducted for Bear Lake using only measured concentrations of chlorophyll-a according to the following relationship:

$$\textit{TSI (chl-a)} \quad = \quad 16.8 + 14.4 \ln \textit{chl-a} \ (mg/m^3)$$

A graphical summary of calculated TSI values in Bear Lake from 1991-2021 is also given on Figure 2-19. Bear Lake exhibited oligotrophic characteristics over the available period of record until approximately 2017 when TSI values began to approach mesotrophic conditions. Measured TSI values for individual monitoring events in Bear Lake have ranged from approximately 17-63. Mesotrophic conditions were first recorded in Bear Lake during September 2017 and during 80 of the subsequent 164 samples collected since that time. Eutrophic conditions in Bear Lake were recorded for the first time during September 2021. The calculated trend line for TSI values in Bear Lake indicates a positive slope with increasing TSI values over time, and the calculated p-value of <0.0001 indicates that the trend is statistically significant. The trend suggests that TSI values in Bear Lake are increasing at a rate of 1.1 TSI units per year.

2.3.1.8 Seasonal Variability

Additional evaluations were performed to examine seasonal variations in water quality in Bear Lake. For purposes of this analysis, monthly total phosphorus concentrations were calculated by decades, which included the 1990s, 2000s, and 2010s as well as all data combined. A comparison of mean monthly concentrations of total phosphorus in Bear Lake from 1991-2020 is given in Figure 2-20.

Monthly concentrations of total phosphorus in Bear Lake appear to be relatively consistent throughout the year, which is a characteristic of an oligotrophic lake. During the 1990s, slightly higher total phosphorus concentrations (by approximately 10-15%) were observed during March and August-December which indicates impacts from both runoff and internal recycling. A similar pattern was observed during the 2000s with slightly higher total phosphorus concentrations from June-December, covering both wet and dry periods. During the 2010s, the most elevated total phosphorus concentrations were measured during May, June, and October, again reflecting a combination of wet and dry conditions.

The data summarized on Figure 2-20 indicate impacts from both runoff and internal recycling in regulating total phosphorus concentrations throughout the year. The impacts of internal recycling are evident, but small, at this time. The current impact is sufficient to maintain, and even increase, water column concentrations of total phosphorus during dry season conditions when runoff inputs are minimal in spite of continuous phosphorus removal through biological uptake.

2.3.1.9 Horizontal Variability

Horizontal water quality variability in Bear Lake was evaluated by comparing geometric mean concentrations of total nitrogen, total phosphorus, chlorophyll-a, and Secchi disk depth at each of the 4 LakeWatch monitoring sites over the available period of data from 1991-2021. Geometric mean values were calculated for each site by year, and the annual geomean values were averaged to obtain an overall mean value.

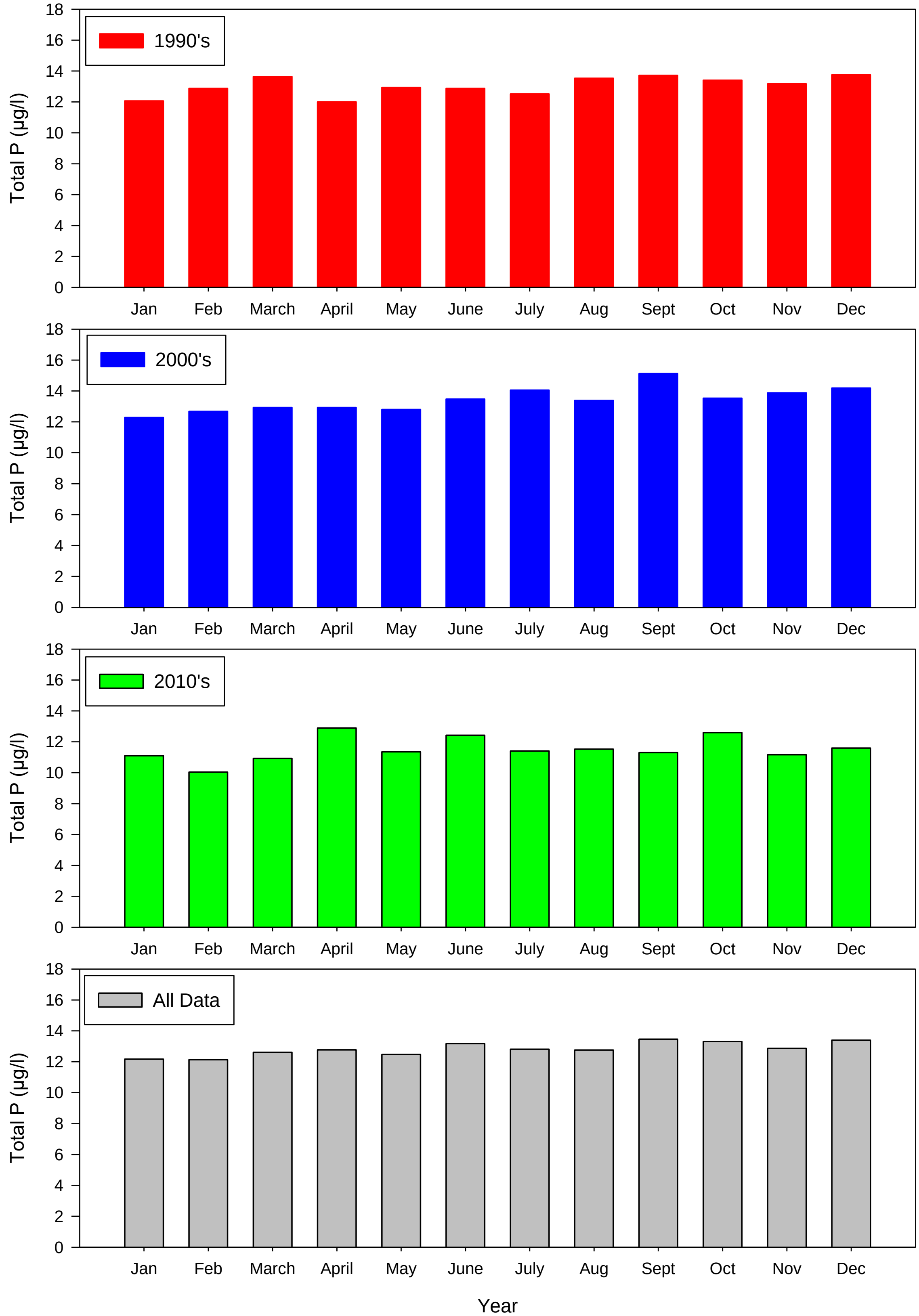


Figure 2-20. Monthly Plots of Total Phosphorus Concentrations in Bear Lake.

A summary of overall geomean values by site is given in Table 2-10. Mean values are virtually identical at each site for total nitrogen, total phosphorus, and chlorophyll-a, indicating no horizontal variability for these parameters in Bear Lake. A slight degree of horizontal variability was observed in Secchi disk depth at the 4 sites, with overall geomean values ranging from 3.07-3.14 m, with the highest values measured at the 2 central monitoring sites (Sites 1 and 2) and slightly lower values in the northwest and southwest lobes.

TABLE 2-10

GEOMETRIC MEAN VALUES FOR MEASURED LAKEWATCH PARAMETERS BY SITE IN BEAR LAKE

SITE	TOTAL NITROGEN (µg/l)	TOTAL PHOSPHORUS (µg/l)	CHLOROPHYLL-A (µg/l)	SECCHI DISK DEPTH (m)	TN/TP RATIO	TSI (Chyl-a)
1	487	12	4.7	3.13	39	35
2	482	12	4.5	3.14	39	35
3	480	12	4.6	3.08	39	35
4	489	12	4.5	3.07	39	35

2.3.1.10 Comparison with Other Florida Lakes

During 2012, ERD downloaded all available LakeWatch data for Florida lakes and developed frequency distribution diagrams for concentrations of significant water quality variables in Florida lakes. This evaluation included the available period of record for 1,198 Florida lakes, with a single overall geometric mean value calculated for total nitrogen, total phosphorus, and chlorophyll-a for each lake. A summary of this analysis is given on Figure 2-21, with overall geomean concentrations for total nitrogen, total phosphorus, chlorophyll-a, and TSI in Bear Lake superimposed over the frequency distribution curves to provide a comparison of water quality characteristics in Bear Lake with other Florida lakes. Mean water quality concentrations in Bear Lake were determined using the historical water quality data from 1991-2021. Mean concentrations of total nitrogen, total phosphorus, chlorophyll-a, and TSI in Bear Lake from 1991-2021 are indicated by **blue lines** on Figure 2-21 and used to estimate the frequency of Florida lakes with concentrations above and below historical values in Bear Lake.

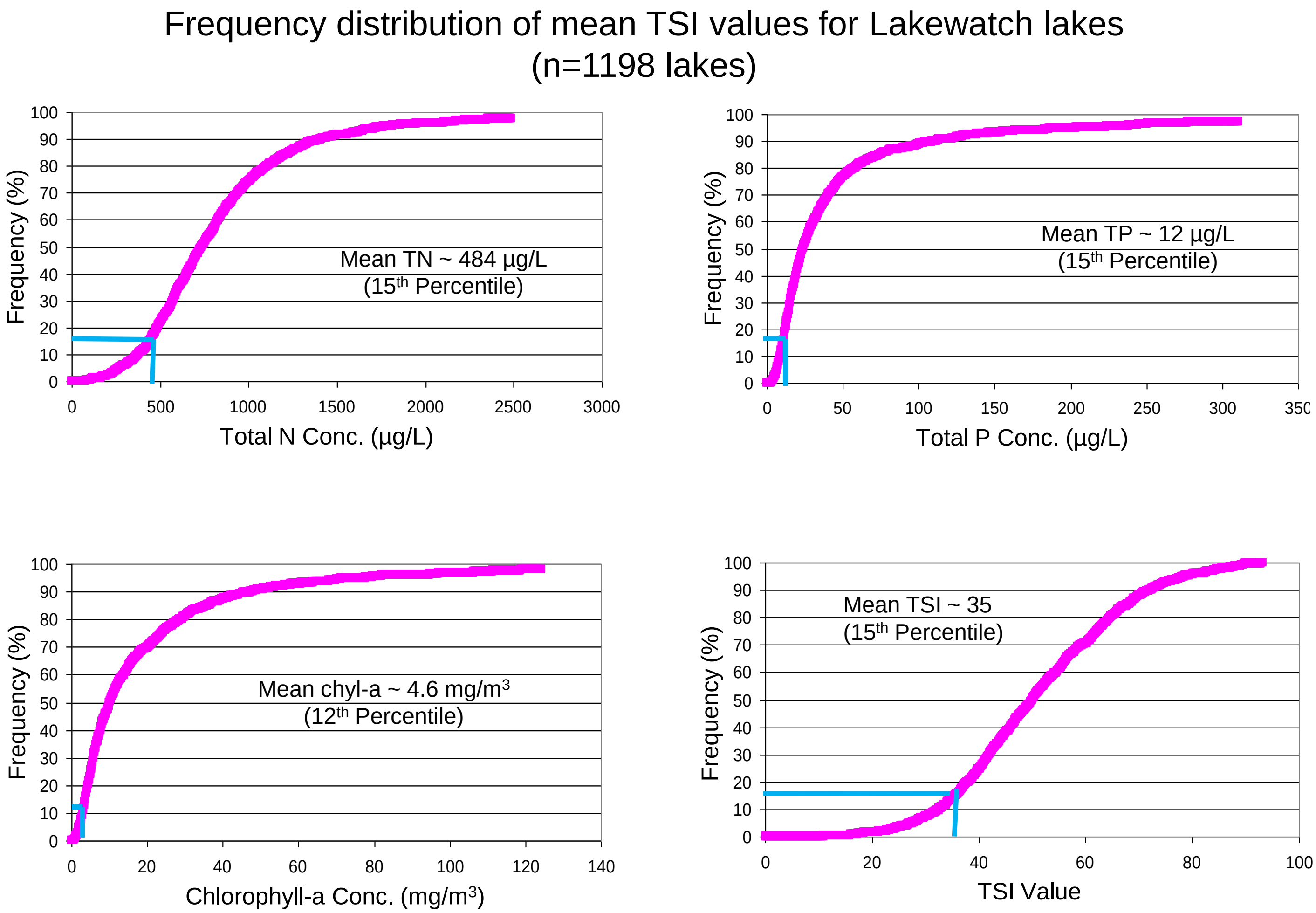


Figure 2-21. Comparison of Significant Water Quality Variables in Bear Lake with Florida LakeWatch Data.

During the period from 1991-2021, the average mean total nitrogen concentration in Bear Lake was approximately 484 µg/l which corresponds to the 15th percentile of waterbodies monitored by the LakeWatch program. The mean total phosphorus concentration of approximately 12 µg/l measured in Bear Lake from 1991-2021 also corresponds to the 15th percentile for Florida lakes, while the mean chlorophyll-a concentration of approximately 4.6 mg/m^3 in Bear Lake corresponds to the 12th percentile in comparison with other Florida lakes. The mean TSI value of approximately 35 in Bear Lake from 1991-2021 corresponds to the 15th percentile in comparison with other Florida lakes. The data suggest that current water quality characteristics in Bear Lake are much better than median values in comparison with other Florida lakes.

2.3.1.11 Summary

Overall, historical water quality in Bear Lake has been excellent, with low levels of nutrients and good water clarity which ranks among the top 15% of Florida waterbodies. However, beginning in late-2017, a distinct pattern of degrading water quality began with increases in concentrations of total phosphorus and chlorophyll-a and decreases in water clarity. These trends are clearly evident in the historical water quality data and appear to be increasing over time. It appears that an event occurred during 2017 that either added an additional influx of nutrients to the lake or eliminated some of the nutrient uptake mechanisms in the lake, or both. Bear Lake exhibited mesotrophic conditions for the first time in 2017, and the rapid upward trends for total phosphorus and chlorophyll-a and declining trend for Secchi disk depth suggest that this condition is worsening over time. If this trend continues, Bear Lake is headed for a transition from a macrophyte-dominated system to a planktonic system which typically results in eutrophic conditions. Lake residents should be very concerned about this trend.

2.4 Aquatic Vegetation

2.4.1 Shoreline Vegetation

Shoreline vegetation is an extremely important part of a healthy lake ecosystem. Emergent vegetation provides cover and habitat for many juvenile aquatic species. The stalks provide surface area for a wide variety of algae and aquatic organisms, many of which are an important part of the food-web for game fish. Shoreline vegetation also reduces erosion from wind and boats. Unfortunately, shoreline vegetation has been largely removed from developed parcels on Bear Lake, with many shoreline areas either totally or partially cleared with either sandy shorelines or lawn grass extending to the water's edge.

2.4.2 Submerged Vegetation

Over the past several decades, Bear Lake has maintained a healthy and abundant crop of submerged vegetation. However, prior to the 2017 grass carp stocking event, the growth of aquatic vegetation had accelerated, with vegetation in parts of Bear Lake extending throughout much of the water column. Many residents consider excess growth of aquatic vegetation to be the single-most significant issue within Bear Lake, although residents have periodically voiced concerns that the vegetation was excessive and interfered with recreational activities.

Vegetation control in the Bear Chain-of-Lakes has been conducted using a variety of mechanisms. Mechanical harvesting of vegetation using floating vegetation harvesters have been conducted on multiple occasions. However, mechanical harvesting is an expensive method of vegetation control when considering the cost of removal, stockpiling, and disposal of the vegetation. Chemical applications of herbicides have also been conducted to control both emergent and submerged vegetation. Biological control of vegetation has also been conducted using sterile grass carp fish which have been introduced into Bear, Little Bear, Asher, and Cub Lakes on multiple occasions, and this technique appears to be the preferred method at this time.

2.4.3 Grass Carp

Grass carp (*Ctenopharyngodon idella*), also known as white amur, are native to Asia and feed only on aquatic plants. They were first introduced to Florida in 1970 to control nuisance aquatic plant growth. In 1984, a method to sterilize grass carp was developed, which enabled the production of the triploid grass carp used today that have been genetically altered at hatcheries to prevent them from reproducing. Triploid grass carp are a biological and economical alternative for controlling particular aquatic weeds in waterbodies.

Grass carp live for at least 10 years and sometimes much longer in cooler waters. They grow rapidly in Florida conditions, reaching at least 10 pounds, with some fish exceeding 40 pounds. Grass carp are opportunistic herbivores that will consume a variety of aquatic plants. Their preference is based on vegetation taste and texture and not necessarily on plant availability. Grass carp generally only consume submerged vegetation that has soft/tender, non-fibrous stems and leaves. Some common plants they will readily consume are hydrilla, elodea, bladderwort, coontail, najas, milfoil, potamogeton spp. (pondweeds), chara, and nitella. They dislike and will not eat woody or hardy-stemmed plants such as cattails, lillypads, sedges, primrose, and many more. When desirable plant species have been eliminated, grass carp have been known to eat lawn grasses, particularly St. Augustine, along the water edge. A summary of grass carp feeding preferences for common aquatic plants is given in Table 2-11.

TABLE 2-11

GRASS CARP FEEDING PREFERENCE FOR COMMON AQUATIC PLANTS

PREFERENCE	SCIENTIFIC NAME	COMMON NAME
Highly Preferred	*Cabomba caroliniana* *Chara* spp. *Egeria densa* *Elodea canadensis* *Hydrilla verticillata* *Lemna* spp. and *Spirodela* spp. *Najas quadalupensis*	Fanwort Muskgrass Brazilian elodea Common elodea Hydrilla Duckweed Southern naiad
Moderately Preferred	*Azolla caroliniana* *Bacopa* spp. *Eleocharis* spp. *Potamogeton spp.* *Utricularia* spp.	Azolla or water-fern Water hyssop Slender spikerush Pondweeds Bladderworts
Non-Preferred	*Ceratophyllum demersum* *Myriophyllum* spp. *Brasenia schreberi* *Nuphar* spp. *Nymphaea* spp. *Vallisneria Americana* *Nelumbo luteum*	Coontail Milfoils Water shield Spatterdock Waterlillies Tapegrass or eelgrass Lotus

SOURCE: Sutton and Vandiver (1986), Miller and Decell (1984), Wiley et al. (1984)

Grass carp feed from the top of the plant down which minimizes broken floating vegetation and disturbance of bottom muds. They often avoid areas of heavy human activity and forage in deeper areas. Because of grass carp feeding habits, cut leaves of eelgrass observed in Bear Lake are more likely a result of boat props rather than grass carp. Photographs of grass carp are given on Figure 2-22.

a. Juvenile grass carp at time of stocking

b. Adult grass carp

Figure 2-22. Photographs of Grass Carp Used for Vegetation Control.

Grass carp are an inexpensive method of aquatic plant control, with costs ranging from $20-250/acre compared with $200-600/acre for chemical control, and provide a long-term control alternative to chemical applications. Grass carp are commonly used as part of an integrated plant management plan in combination with periodic, but limited, chemical applications.

Reported mortality rates for grass carp are highly variable, with values ranging from 2.5-40%/year, with the highest rates often associated with juveniles and the lowest rates for adults, although the most common range appears to be 25-40%/year. However, even with fish mortality, vegetation control often remains steady for multi-year periods due to increased consumption as the remaining fish increase in size.

Stocking rates for grass carp have also varied widely depending on the degree of aquatic infestation, type of vegetation, and climate. Literature stocking rates have varied from 1 to >50 fish/acre, with the higher stocking rates in colder climates where the fish metabolism decreases. Faculty in the Department of Fisheries at the University of Florida currently recommend a stocking rate of 2 fish/acre for hydrilla control in most lakes. A stocking rate in this range is intended to provide a slow steady decline in vegetation biomass over a period of years.

Grass carp are an intelligent fish species which live 20-30 years in their natural habitat. It is difficult to remove grass carp from a lake once the lake has been stocked. Several previous methods have been used to reduce grass carp populations in an overstocked lake which include chemical poisoning, spearing or bow fishing, and electroshock, all of which have yielded limited success. Removal of grass carp requires a permit from FWC. Mortality appears to be the main factor responsible for reduction in grass carp populations over time.

In some grass carp stocking projects, stakeholders have become frustrated with the slow initial response and stocked additional grass carp which has led to complete vegetation removal and transformation of the lake into a plankton-dominated system with frequent algal blooms and poor water quality. A minimum SAV coverage of 30-50% native vegetation is generally recommended to maintain a healthy lake. Once a lake becomes a plankton-dominated system, it is quite difficult to return the lake to a clear water, macrophyte-dominated system. It is much better to be conservative when estimating required stocking rates. More carp can always be added in a few years if desired control is not achieved. As the grass carp mature, it is hoped that vegetation control will be achieved primarily by the grass carp, and chemical control will be substantially reduced.

The number of grass carp fish which have been introduced into Bear Lake is difficult to estimate at this time since both permitted and non-permitted introductions of grass carp have occurred over the past several decades. During the mid-1990s, the growth of hydrilla became a concern in Bear Lake, and the BLPA put 3000 grass carp into the lake (USF, history narrative with Billy Long), but it is not known if this stocking was permitted or not.

A summary of known grass carp stocking into Bear Lake is given in Table 2-12 based upon information provided by the Florida Wildlife Commission (FWC) and Nancy Dunn. During 2009, the Florida Wildlife Commission (FWC) issued a permit to introduce grass carp into Bear Lake and Cub Lake for vegetation control, and approximately 3,100 grass carp were added to Bear Lake during 2 separate stocking events. The most recent stocking event during March 2017 introduced fish at a rate of 2 fish/acre which is the current recommended stocking rate. However, many fish from previous stocking events are likely still alive due to the longevity of the fish, and the current stocking rate for all grass carp combined well exceeds the recommended value.

TABLE 2-12

SUMMARY OF PERMITTED GRASS CARP STOCKING IN BEAR LAKE

DATES	NUMBER OF STOCKED CARP	STOCKING RATE (fish/acre)
1979	3,100	10.3
September 2009	1,600	5.3
December 2009	1,500	5.0
March 2017	600	2.0

Many of the stocking rates summarized in Table 2-12, particularly for stockings conducted prior to 2010, appear to be excessively high and are substantially in excess of the 1-2 fish/acre normally recommended by many limnologists and fish experts. Grass carp are commonly used for control of exotic or nuisance vegetation, such as hydrilla and Illinois pondweed. However, the dominant vegetation in Bear Lake appears to be eelgrass which is a native beneficial species that grass carp eat only when other more desirable vegetation is no longer present.

The explosion of aquatic vegetation in Bear Lake is a direct response to the increases in nutrient loadings entering the lakes as development occurs within the watershed. The primary reason why the Bear Chain-of-Lakes, particularly Bear Lake, has maintained excellent current water clarity is that the additional nutrients which enter the lake have been absorbed by the vegetation, limiting the availability of the additional nutrient loadings to algal species. If significant amounts of the existing vegetation are removed, the excess nutrient loadings will be manifested in the form of algae, resulting in an increase in chlorophyll-a, a decrease in water clarity, and a rapid increase in the rate of muck accumulation within the lake.

Seminole County currently conducts annual assessment of vegetation biomass in Bear Lake, and copies of the biobase maps for 2015, 2016, 2018, 2019, 2020, and 2021 are shown on Figure 2-23. The biobase maps show the locations, density, and distribution of vegetation in the lake. The colors on the map represent the ratio of submerged plant height to water depth. Data are collected through a combination of GPS and acoustic sonar instrumentation. Areas with no vegetation appear **blue**, while areas where the vegetation reaches the surface appear **red**.

During 2015-16, biomass is visible throughout the lake, concentrated primarily in perimeter areas. The **red** colors indicate that vegetation had reached the surface in some areas. Following the most recent grass carp stocking in 2017, the 2018 biobase map indicates a loss of vegetation in both central and shoreline areas of the lake, although **red** colors are still present, indicating vegetation extending to the surface. The biomass is further reduced during 2019 and 2020, with only limited patches of plants remaining. Biomass appears to have recovered in shoreline areas on the west side of the lake during 2021, although no vegetation is present in central portions of the lake. The reduction in diversity of submerged aquatic plant species occurs as the grass carp begin to consume and eliminate preferred plant species, such as hydrilla, southern naiad, and nitella, leaving eelgrass as a single species monoculture in portions of the lake. As the preferred plant species are eliminated, the eelgrass has no competition and expands into the available open spaces.

The final grass carp stocking event during 2017 resulted in a dramatic decrease in biomass within Bear Lake. As the biomass is consumed, the nutrients are released and stimulate algal growth. The current alarming declines in water quality are a result of over-stocking of grass carp. Although the influx of turbid water during 2020 also impacted overall water quality in Bear Lake, the declining trend since 2017 appears to be directly related to the final stocking event.

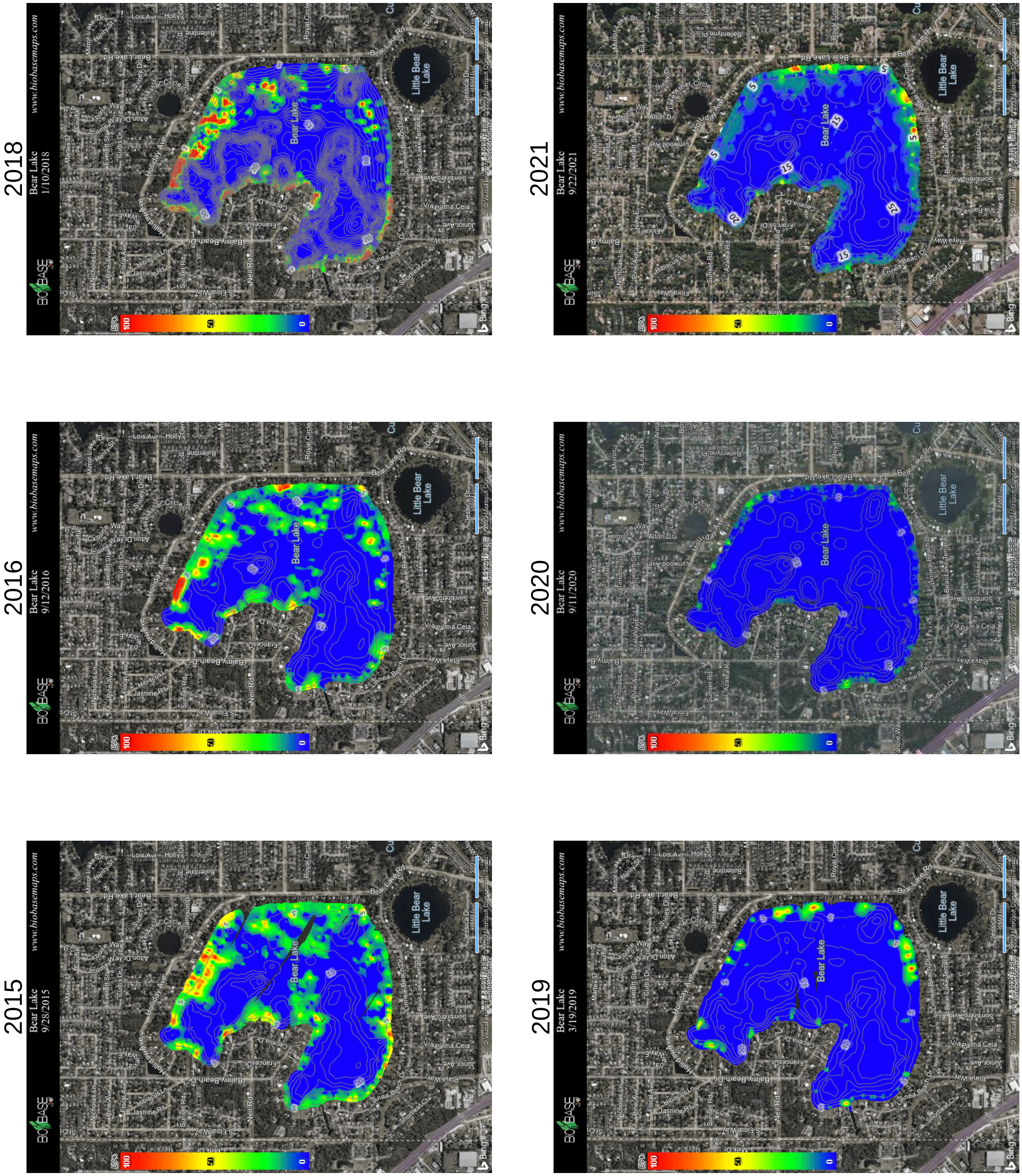


Figure 2-23. Available Biomass Maps for Bear Lake from 2015-2021. (Source: Seminole County)

2.4.4 Importance of Aquatic Vegetation in Bear Lake

Both shoreline and submerged aquatic vegetation in Bear Lake are extremely important in terms of maintaining the ecology and water quality characteristics within the lake. The existing submerged and shoreline vegetation provide a significant nutrient uptake mechanism which has maintained Bear Lake in an oligotrophic condition for several decades. Healthy lakes generally have SAV coverages of 30-50%.

If the existing vegetation continues to be eliminated, and is not allowed to re-establish, Bear Lake will quickly be converted into a plankton-dominated system which would exhibit eutrophic characteristics. Therefore, proper vegetation management is essential to maintaining on-going oligotrophic water quality characteristics in Bear Lake. The BLPA should consider removing some of the existing overpopulation of grass carp.

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SECTION 3

SEDIMENT INACTIVATION IN BEAR LAKE

This section provides a discussion of sediment inactivation in general and the feasibility, costs, and likely outcome for conducting sediment inactivation in Bear Lake.

3.1 Sediment Inactivation

3.1.1 Introduction

Sediment inactivation is a lake restoration technique which is designed to reduce sediment phosphorus release by combining available phosphorus in the sediments with a stable metal salt to form an insoluble inert precipitate, rendering the sediment phosphorus unavailable for release into the overlying water column. Although salts of aluminum, calcium, and iron have been used for sediment inactivation in previous projects, aluminum salts are the clear compounds of choice for this application. Inactivation of sediment phosphorus using aluminum is often a substantially less expensive option for reducing sediment phosphorus release since removal of the existing sediments is not required.

Sediment phosphorus inactivation is most often performed using aluminum sulfate, commonly called alum, which is applied at the surface in a liquid form using a boat or barge. Upon entering the water column, the alum forms an insoluble precipitate of aluminum hydroxide which attracts phosphorus, bacteria, algae, and suspended solids within the water column, settling these constituents into the bottom sediments. After reaching the bottom sediments, the residual aluminum binds tightly with phosphorus within the sediments (primarily saloid-bound and iron-bound associations), forming an inert precipitate which cannot be re-released under any conceivable condition of pH or redox potential which could occur in a natural lake system.

It is generally recognized that the top 10 cm layer of the sediments is the most active in terms of release of phosphorus under anoxic conditions, although the active layer may extend to 15 cm in highly fluid sediments. Therefore, the objective of a sediment inactivation project is to provide sufficient alum to bind the saloid- and iron-bound phosphorus associations in the top 10 cm of the sediments. More than 50 whole-lake sediment inactivation projects have been conducted within the State of Florida, all of which have been conducted by ERD, with the first large-scale application conducted during 1992 on Lake Conine in Polk County. Previous sediment inactivation projects have been effective from 7 to >25 years, although the normal lifespan is generally 10-15 years.

Due to differences in electronegativities, phosphorus preferentially attaches to iron in sediments before aluminum. The concept behind inactivating sediment phosphorus using aluminum is based upon increasing aluminum concentrations within the sediments to the point where phosphorus would preferentially bind with aluminum rather than in an unstable form with iron. The addition of aluminum to the sediments uses the principal of Le Chatelier that an increase in reactants (in this case aluminum) will drive the chemical reaction to increase the concentration of the products (aluminum-bound phosphorus). Previous sediment inactivation work conducted by ERD as well as other researchers has indicated that a molar Al:P ratio of 10:1 is typically sufficient to provide a driving force to allow aluminum to preferentially absorb phosphorus in sediments over iron. However, if the average available sediment phosphorus concentration is <50 mg/cm^3, the molar Al:P ratio is increased to 15:1 to provide sufficient driving force.

Estimates of chemical requirements for sediment inactivation projects are typically based upon the mass of total available phosphorus within the top 0-10 cm layer of the sediments. For sediment inactivation purposes, available phosphorus is defined as the sum of the saloid-bound phosphorus, defined as soluble plus easily exchangeable, and iron-bound phosphorus associations, plus approximately 20% of the residual organic phosphorus to address slow degradation of organic matter and subsequent release of phosphorus. Phosphorus bound to iron in the sediments is stable under aerobic conditions, but solubilizes under anoxic conditions and is subject to re-release from the sediments into the overlying water column.

Additional aluminum can be added to the sediments to create an active absorption mechanism for other phosphorus inputs into the water column as a result of groundwater seepage. Inputs of phosphorus from groundwater seepage into a lake can easily exceed inputs from internal recycling in only a few annual cycles. Carefully planned applications of alum can provide an abundance of aluminum which can intercept groundwater inputs of phosphorus, regardless of source, over a period of many years. As a result, alum applications can be used to eliminate phosphorus from the combined inputs from internal recycling as well as groundwater seepage.

3.1.2 Chemical Requirements

Calculation of sediment inactivation requirements are based on the mass of total available phosphorus which can potentially mobilize from the sediments to the overlying water column within the typical 10-12 year period of effectiveness for a sediment inactivation project. Estimates of the mass of total available phosphorus within the top 0-10 cm layer of the sediments in Bear Lake were generated by graphically integrating the isopleth map of total available phosphorus in the lake sediments (provided in Figure 2-15) for 2021. The top 0-10 cm layer of the sediments is considered to be the most active layer with respect to exchange of phosphorus between the sediments and the overlying water column, and inactivation of phosphorus within the 0-10 cm layer is typically sufficient to inactivate sediment release of phosphorus within a lake.

A summary of estimated total available phosphorus in the sediments of Bear Lake and alum requirements for sediment inactivation is given in Table 3-1. Based on the 2021 sediment collection event, the sediments of Bear Lake contain approximately 5,377 kg of available phosphorus in the top 10 cm which equates to approximately 173,445 moles of phosphorus to be inactivated as part of the sediment inactivation process. The measured quantity of available phosphorus in the top 10 cm of Bear Lake sediments during 2021 is 3 times greater than the available phosphorus mass of 1,862 kg total phosphorus measured during 2011 (September 2012 Report). This rapid increase in available phosphorus between 2010 and 2021 is due to additional sediment deposition resulting from the recent influx of turbid construction water and consumption and excretion of biomass by grass carp and enhanced algal blooms. The area weighted total available phosphorus in Bear Lake sediments increased from 14 $\mu g/cm^3$ in 2011 to 44 $\mu g/cm^3$ in 2021.

TABLE 3-1

BEAR LAKE SEDIMENT INACTIVATION REQUIREMENTS

AVAILABLE P CONTOUR INTERVAL ($\mu g/cm^3$)	CONTOUR INTERVAL MID-POINT ($\mu g/cm^3$)	CONTOUR AREA (acres)	AVAILABLE PHOSPHORUS		ALUM REQUIREMENTS (Al:P Ratio = 10:1)	
			kg	moles	moles Al	gallons alum
0 – 25	12.5	144.6	732	23,608	236,078	28,695
25-50	37.5	59.1	897	28,926	289,256	35,159
50-75	62.5	30.1	761	24,559	245,592	29,851
75-100	87.5	27.5	973	31,397	313,966	38,162
100-125	112.5	26.2	1,193	38,498	384,975	46,793
125-150	137.5	14.2	792	25,555	255,550	31,062
150-158	154	0.4	28	903	9,034	1,098
Overall Totals:		302	5,377	173,445	1,734,451	210,820

Areal Aluminum Dose: 38 g Al/m^2
Water Column Aluminum Dose: 9.2 mg Al/liter
Number of Tankers: 49

Using an Al:P ratio of 10:1, sediment inactivation in Bear Lake would require approximately 210,820 gallons of alum, equivalent to 49 tanker loads, containing 4,300 gallons each. The equivalent aerial aluminum dose for this application would be 38 g Al/m^2 on a whole-lake basis although the application would be targeted at areas with elevated available sediment phosphorus where the aerial aluminum doses would be much higher.

As mentioned previously, alum addition to sediments can also be used to control phosphorus loading from groundwater seepage. In the September 2012 ERD report, seepage influx to Bear Lake was estimated to be 0.024 kg/ac-yr or 7.1 kg/yr. For this analysis, the estimated value is assumed to reflect current seepage loadings.

A summary of alum requirements for control of phosphorus loading from groundwater seepage entering Bear Lake is given in Table 3-2. Based on the assumed phosphorus influx of 0.024 kg/ac-yr and a surface area of 302 acres, phosphorus influx to Bear Lake from groundwater seepage is estimated to be approximately 7.1 kg/yr. This analysis assumes that control of groundwater seepage is desired for a period of approximately 15 years. Therefore, the total mass of phosphorus from groundwater seepage which must be inactivated over the 15-year period is approximately 106 kg which equates to approximately 3,433 moles of total phosphorus. Assuming an Al:P ratio of 10:1 for adequate inactivation, control of 3,433 moles of total phosphorus will require approximately 34,327 moles of aluminum which equates to an alum volume of 4,180 gallons.

TABLE 3-2

ALUM REQUIREMENTS FOR CONTROL OF PHOSPHORUS LOADING FROM GROUNDWATER SEEPAGE TO BEAR LAKE

PARAMETER		UNITS	VALUE
Estimated Phosphorus Mass to be Controlled	Assumed Seepage Phosphorus Loading	g/m^2-yr	0.0058
	Annual Phosphorus Loading from Seepage	kg/yr	7.1
	Desired Length of Control	years	15
	Total Phosphorus Mass to be Inactivated	kg	106
	Moles of Phosphorus to be Inactivated	moles	3,433
Alum Requirements	Inactivation Al:P Ratio	--	15
	Moles of Aluminum Required	moles	34,327
	Alum Required	gallons	4,180
	Number of Tankers @4300 gallons/tanker	--	1.0
	Mean Water Column Dose	mg Al/liter	0.2

Previous alum surface applications performed for inactivation of sediment phosphorus release by ERD have indicated that the greatest degree of improvement in surface water characteristics and the highest degree of inactivation of sediment phosphorus release are achieved through multiple applications of aluminum to the waterbody spaced at intervals of approximately 4-12 months. Each subsequent application results in additional improvements in water column quality and additional aluminum floc added to the sediments for long-term inactivation of sediment phosphorus release.

If the proposed alum application to Bear Lake were to be divided into 4 treatments, the theoretical alum dose per treatment would be 2.4 mg Al/liter (9.6 mg Al/liter divided by 4 treatments). Surface water monitoring conducted in Bear Lake by ERD during 2010-2011 indicated a moderately buffered water column with typical values from 50-60 mg/l. Although pH responses to alum addition will need to be verified through jar testing, lakes with alkalinity in this range can typically accept an alum dose of 2.4 mg Al/liter without the need for an additional supplemental pH buffer. Alkalinity will recover naturally over time, and if the applications are spaced at 6-12 month intervals, supplemental lime additions for pH control will likely not be required.

A summary of proposed alum requirements to control internal recycling and groundwater seepage in Bear Lake is given in Table 3-3. It is recommended that the required alum volume be divided into 4 separate applications, with one-fourth of the required alum volume applied during each application based on the available phosphorus isopleths on Figure 2-15. Supplemental lime additions are not anticipated for Bear Lake. Each treatment would be applied using a boat or barge to spread the chemicals over the lake surface.

TABLE 3-3

SUMMARY OF ALUM REQUIREMENTS FOR CONTROL OF SEDIMENT PHOSPHORUS RELEASE AND GROUNDWATER SEEPAGE ENTERING BEAR LAKE

PARAMETER		UNITS	VALUE
Overall Alum Requirements	Alum	gallons	215,000
	Number of Tankers	--	47.8
	Water Column Dose	mg Al/liter	9.6
	Areal Dose	g Al/m^2	39.0
Chemical Requirements per Treatment	Number of Treatments	--	4
	Alum Required per Treatment	gallons tankers	55,900 13
	Dose per Treatment	mg Al/liter	2.4

Based on the assumed total alum volume of 215,000 gallons, the number of tankers required per application is 12.5. Since partial tankers are almost as expensive as full tankers due to constant shipping costs, the number of tankers per application is rounded up from 12.5 to 13.

3.1.3 Application Costs

A summary of estimated application costs for sediment inactivation and control of groundwater seepage in Bear Lake is given in Table 3-4. This estimate assumes an alum volume of 55,900 gallons (13 tankers) will be added during each of the 4 separate applications. It is assumed that the alum is purchased using the current Seminole County contract at the current contract price of $0.62/gallon. Planning and mobilization costs are estimated to be approximately $5,000 per application, which includes initial planning, mobilization of equipment to the site, demobilization at the completion of the application process, and clean-up. A unit application rate of $1,500/tanker is assumed which includes labor costs, daily water quality monitoring during the application, expenses, equipment rental, insurance, mileage, and application equipment fees.

TABLE 3-4

ESTIMATED APPLICATION COSTS FOR SEDIMENT INACTIVATION AND CONTROL OF GROUNDWATER SEEPAGE IN BEAR LAKE (Based on 4 separate applications)

PARAMETER		QUANTITY/ TREATMENT	UNITS	UNIT COST ($)	COST PER TREATMENT ($)	TOTAL COST ($)
Chemical Costs	Alum	55,900	gallons	0.62[1]	34,658	138,632
Labor Costs	Planning/Mobilization	1	each	5,000	5,000	20,000
	Chemical Application	13	each	1,500[2]	19,500	78,000
Monitoring/ Lab Testing	Field Monitoring	1	each	1,000	1,000	4,000
	Lab Analyses (pre/post)	8	samples	200	1,600	6,400
				TOTAL:	**$ 61,758**	**$ 247,032**

Total Alum Required:	223,600 gallons (52 tankers)
Alum Cost at County Contract Price:	$138,632 ($34,658/application)
Application Fee:	$108,400 ($27,100/application)

1. Assumed contract cost
2. Includes raw labor, water quality monitoring, insurance, expenses, application equipment, mileage, and rentals

A summary of costs per application is provided at the bottom of Table 3-4. The cost for each of the 4 applications will be $61,758, with $34,658 for alum and $27,100 for application and testing. The costs in Table 3-4 do not include a project summary report or post-treatment sediment monitoring, if desired. If applications are conducted once per year, the costs can be spread out over a 4-year period.

3.1.4 Anticipated Water Quality Impacts

Each alum application will result in immediate improvements in water quality in Bear Lake, and the initial application will remove most of the residual turbidity resulting from the influx of turbid water during 2020. Over time, as additional phosphorus loadings enter the lake from runoff and other sources, the water quality in the lake will reach a new equilibrium which reflects phosphorus inputs minus phosphorus loadings from internal recycling and groundwater seepage. The alum additions should be sufficient to clarify the water column and increase growth of aquatic plants in areas within the photic zone which will restore a primary nutrient uptake mechanism in the lake.

3.1.5 Longevity of Treatment

After initial application, the alum precipitate will form a visible floc layer on the surface of the sediments within the lake. This floc layer will continue to consolidate for approximately 30-90 days, reaching maximum consolidation during that time. Due to the unconsolidated nature of the sediments in areas of the lake where most of the alum will be applied, it is anticipated that a large portion of the floc will migrate into the existing sediments rather than accumulate on the surface as a distinct layer. This process is beneficial since it allows the floc to sorb soluble phosphorus during migration through the surficial sediments. Any floc remaining on the surface will provide a chemical barrier for adsorption of phosphorus which may be released from the sediments.

At least 50 previous sediment inactivation projects have been conducted by ERD in the State of Florida since 1992. Approximately half of these waterbodies have sufficient pre- and post-water quality data to evaluate the effectiveness of the alum sediment inactivation process. None of the 13 waterbodies for which water quality data are available have shown any signs of a decrease in the effectiveness of the sediment inactivation project, some of which were conducted more than 20 years ago. As a result, it appears that a properly planned and executed alum treatment project for Bear Lake would maintain a continuous level of effectiveness for a minimum of approximately 10-15 years or more.

3.2 Summary

Sediment core samples collected in Bear Lake during 2021 indicate a 3-fold increase in available phosphorus in the lake sediments from a combination of particles from the turbid water inflows, enhanced algal growth and deposition, and accumulation of residual plant biomass. The initial alum sediment inactivation project is more than 15 years old and appears to have lost most of the initial effectiveness. An additional sediment inactivation project appears warranted at this time to restore and maintain water quality in Bear Lake.

Since 2017, water column concentrations of total phosphorus and chlorophyll-a have increased substantially with a corresponding decrease in water clarity, and this timing correlates well with the 2017 grass carp stocking. The data suggest that vegetation removal has reduced a significant uptake mechanism in Bear Lake, leaving surplus nutrients which stimulate algal growth. Bear Lake is in danger of converting from a macrophytes-dominated system to a periphyton-dominated system, and this process is difficult to reverse once it becomes established. The number of grass carp currently in the lake appears to be excessive and ERD recommends that the BLPA consider reducing the number. The proposed alum sediment inactivation will reduce and improve light penetration which will allow return of some of the lost submerged vegetation.

APPENDICES

APPENDIX A

PHOTOGRAPHS OF SEDIMENT CORE SAMPLES COLLECTED IN BEAR LAKE ON OCTOBER 21, 2021

Bear Lake Sediment Photos – October 2021

Sites 1 - 4

Site 1

Site 2

Site 3

Site 4

Bear Lake Sediment Photos – October 2021

Sites 5 - 8

Site 5

Site 6

Site 7

Site 8

Bear Lake Sediment Photos – October 2021

Sites 9 - 12

Site 9

Site 10

Site 11

Site 12

Bear Lake Sediment Photos – October 2021
Sites 13 - 16

Site 13

Site 14

Site 15

Site 16

Bear Lake Sediment Photos – October 2021

Sites 17 - 20

Site 17

Site 18

Site 19

Site 20

Bear Lake Sediment Photos – October 2021

Sites 21 - 24

Site 21

Site 22

Site 23

Site 24

Bear Lake Sediment Photos – October 2021

Sites 25 - 28

Site 25

Site 26

Site 27

Site 28

Bear Lake Sediment Photos – October 2021

Sites 29 - 32

Site 29

Site 30

Site 31

Site 32

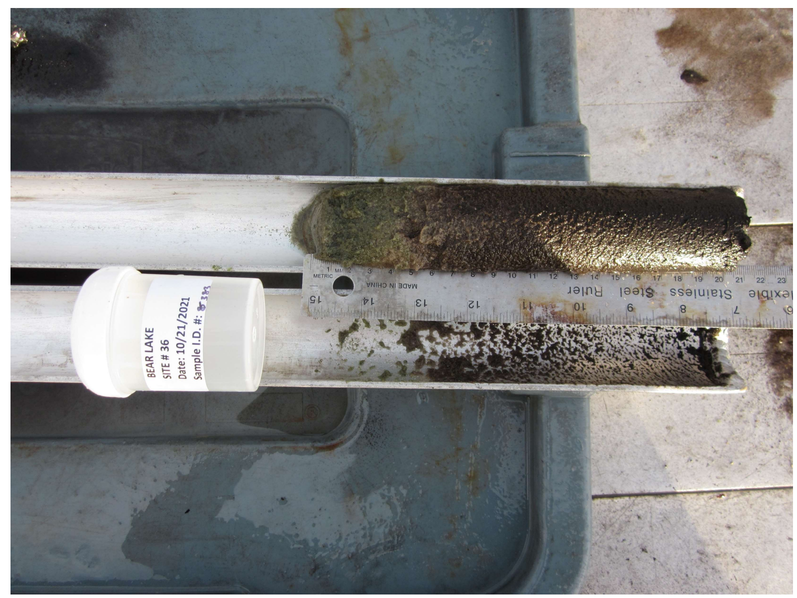
Bear Lake Sediment Photos – October 2021

Sites 33 - 36

Site 33

Site 34

Site 35



Site 36

Bear Lake Sediment Photos – October 2021

Site 37

Site 37

APPENDIX B

PHOTOGRAPHS OF SEDIMENT CORE SAMPLES COLLECTED IN THE BEAR LAKE CANAL

Photographs of Sediment Core Samples Collected Along Transect 1 in the Bear Lake Canal

Photographs of Sediment Core Samples Collected Along Transect 2 in the Bear Lake Canal

Photographs of Sediment Core Samples Collected Along Transect 3 in the Bear Lake Canal

Photographs of Sediment Core Samples Collected Along Transect 4 in the Bear Lake Canal

Photographs of Sediment Core Samples Collected Along Transect 5 in the Bear Lake Canal

APPENDIX C

HISTORICAL LAKEWATCH WATER QUALITY DATA FOR BEAR LAKE FROM 1991-2021

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	11/30/91	1	320	13	3	3.20	25	33	Oligotrophic
Bear	11/30/91	2	370	14	4	3.05	26	37	Oligotrophic
Bear	11/30/91	3	400	13	4	3.20	31	37	Oligotrophic
Bear	1/12/92	1	380	12	3	3.35	32	33	Oligotrophic
Bear	1/12/92	2	370	12	3	3.81	31	33	Oligotrophic
Bear	1/12/92	3	360	11	3	3.35	33	33	Oligotrophic
Bear	2/2/92	1	380	13	3	3.35	29	33	Oligotrophic
Bear	2/2/92	2	390	12	3	3.66	33	33	Oligotrophic
Bear	2/2/92	3	420	13	4	3.51	32	37	Oligotrophic
Bear	2/2/92	4	420	13	2	3.35	32	27	Oligotrophic
Bear	3/15/92	1	400	13	2	3.66	31	27	Oligotrophic
Bear	3/15/92	2	370	12	2	3.35	31	27	Oligotrophic
Bear	3/15/92	3	340	12	3	3.35	28	33	Oligotrophic
Bear	3/15/92	4	360	12	2	3.35	30	27	Oligotrophic
Bear	3/27/92	4	360	13	3		28	33	Oligotrophic
Bear	4/11/92	1	350	12	2	3.51	29	27	Oligotrophic
Bear	4/11/92	2	320	11	3	3.81	29	33	Oligotrophic
Bear	4/11/92	3	260	13	3	3.81	20	33	Oligotrophic
Bear	4/11/92	4	320	13	2	4.12	25	27	Oligotrophic
Bear	5/2/92	1	430	11	1	4.12	39	17	Oligotrophic
Bear	5/2/92	2	430	15	2	3.66	29	27	Oligotrophic
Bear	5/2/92	3	440	15	3	3.66	29	33	Oligotrophic
Bear	5/2/92	4	470	13	2	3.81	36	27	Oligotrophic
Bear	6/6/92	1	360	14	3	3.20	26	33	Oligotrophic
Bear	6/6/92	2	370	13	2	3.51	28	27	Oligotrophic
Bear	6/6/92	3	330	13	3	3.35	25	33	Oligotrophic
Bear	6/6/92	4	370	16	3	3.20	23	33	Oligotrophic
Bear	7/5/92	1	370	12	2	4.12	31	27	Oligotrophic
Bear	7/5/92	2	370	13	2	4.42	28	27	Oligotrophic
Bear	7/5/92	3	350	10	2	4.57	35	27	Oligotrophic
Bear	7/5/92	4	390	13	2	4.12	30	27	Oligotrophic
Bear	8/8/92	1	350	13	5	3.20	27	40	Oligotrophic
Bear	8/8/92	2	370	13	4	3.81	28	37	Oligotrophic
Bear	8/8/92	3	360	11	4	3.51	33	37	Oligotrophic
Bear	8/8/92	4	360	14	5	3.05	26	40	Oligotrophic
Bear	9/12/92	1	370	10	5	3.20	37	40	Oligotrophic
Bear	9/12/92	2	450	14	6	3.05	32	43	Oligotrophic
Bear	9/12/92	3	530	13	6	3.05	41	43	Oligotrophic
Bear	9/12/92	4	340	15	6	2.74	23	43	Oligotrophic
Bear	10/10/92	1	390	16	7	3.05	24	45	Oligotrophic
Bear	10/10/92	2	370	16	5	3.35	23	40	Oligotrophic
Bear	10/10/92	3	400	16	5	3.20	25	40	Oligotrophic
Bear	10/10/92	4	390	14	6	3.51	28	43	Oligotrophic
Bear	11/30/92	1	330	12	4	3.51	28	37	Oligotrophic
Bear	11/30/92	2	290	11	3	3.96	26	33	Oligotrophic
Bear	11/30/92	3	340	8	3	3.96	43	33	Oligotrophic
Bear	11/30/92	4	410	10	3	3.51	41	33	Oligotrophic
Bear	12/19/92	1	290	10	3	5.18	29	33	Oligotrophic
Bear	12/19/92	2	320	11	3	4.27	29	33	Oligotrophic
Bear	12/19/92	3	240	11	4	4.88	22	37	Oligotrophic
Bear	12/19/92	4	340	7	4	4.57	49	37	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/23/93	1	390	10		3.66	39	-	-
Bear	1/23/93	2	320	11		3.66	29	-	-
Bear	1/23/93	3	370	12		3.66	31	-	-
Bear	1/23/93	4	360	10		3.66	36	-	-
Bear	2/28/93	1	450	13	2	3.20	35	27	Oligotrophic
Bear	2/28/93	2	450	11	2	3.05	41	27	Oligotrophic
Bear	2/28/93	3	430	10	2	3.35	43	27	Oligotrophic
Bear	2/28/93	4	380	12	1	3.20	32	17	Oligotrophic
Bear	3/28/93	1	430	12	3	3.20	36	33	Oligotrophic
Bear	3/28/93	2	430	14	3	2.90	31	33	Oligotrophic
Bear	3/28/93	3	350	13	3	3.20	27	33	Oligotrophic
Bear	3/28/93	4	470	14	3	2.90	34	33	Oligotrophic
Bear	4/25/93	1	380	13	2	3.35	29	27	Oligotrophic
Bear	4/25/93	2	340	13	1	3.35	26	17	Oligotrophic
Bear	4/25/93	3	360	13	2	3.35	28	27	Oligotrophic
Bear	4/25/93	4	310	14	2	3.35	22	27	Oligotrophic
Bear	5/22/93	1	530	17	1	3.20	31	17	Oligotrophic
Bear	5/22/93	2	350	17	1	3.66	21	17	Oligotrophic
Bear	5/22/93	3	370	17	1	3.35	22	17	Oligotrophic
Bear	5/22/93	4	400	17	1	3.20	24	17	Oligotrophic
Bear	6/12/93	1	400	12	2	4.27	33	27	Oligotrophic
Bear	6/12/93	2	350	11	2	4.27	32	27	Oligotrophic
Bear	6/12/93	3	360	11	2	3.96	33	27	Oligotrophic
Bear	6/12/93	4	380	12	2	4.42	32	27	Oligotrophic
Bear	7/7/93	1	380	8	2		48	27	Oligotrophic
Bear	7/7/93	2	380	9	2		42	27	Oligotrophic
Bear	7/7/93	3	400	11	2		36	27	Oligotrophic
Bear	7/18/93	1	370	11	3	3.66	34	33	Oligotrophic
Bear	7/18/93	2	370	11	3	3.66	34	33	Oligotrophic
Bear	7/18/93	3	330	13	3	3.51	25	33	Oligotrophic
Bear	7/18/93	4	360	13	3	3.66	28	33	Oligotrophic
Bear	8/21/93	1	300	13	3	3.05	23	33	Oligotrophic
Bear	8/21/93	2	340	11	4	3.20	31	37	Oligotrophic
Bear	8/21/93	3	330	11	3	3.35	30	33	Oligotrophic
Bear	8/21/93	4	330	12	4	3.35	28	37	Oligotrophic
Bear	9/25/93	1	420	15	4	2.90	28	37	Oligotrophic
Bear	9/25/93	2	470	14	6	2.74	34	43	Oligotrophic
Bear	9/25/93	3	470	16	6	2.74	29	43	Oligotrophic
Bear	9/25/93	4	430	15	5	3.05	29	40	Oligotrophic
Bear	10/25/93	1	490	10	6	2.59	49	43	Oligotrophic
Bear	10/25/93	2	470	14	6	2.90	34	43	Oligotrophic
Bear	10/25/93	3	450	14	7	3.20	32	45	Oligotrophic
Bear	10/25/93	4	450	13	6	2.74	35	43	Oligotrophic
Bear	11/13/93	1	370	12	5	2.90	31	40	Oligotrophic
Bear	11/13/93	2	350	12	5	2.74	29	40	Oligotrophic
Bear	11/13/93	3	370	13	6	2.59	28	43	Oligotrophic
Bear	11/13/93	4	360	12	5	2.74	30	40	Oligotrophic
Bear	12/12/93	1	480	10	3	3.66	48	33	Oligotrophic
Bear	12/12/93	2	360	11	3	3.66	33	33	Oligotrophic
Bear	12/12/93	3	330	11	3	3.66	30	33	Oligotrophic
Bear	12/12/93	4	450	11	3	3.66	41	33	Oligotrophic

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Bear	1/28/94	1	410	11	5	3.81	37	40	Oligotrophic
Bear	1/28/94	2	390	11	4	3.81	35	37	Oligotrophic
Bear	1/28/94	3	460	11	6	3.66	42	43	Oligotrophic
Bear	1/28/94	4	450	14	5	3.96	32	40	Oligotrophic
Bear	2/20/94	1	420	10	3	3.81	42	33	Oligotrophic
Bear	2/20/94	2	420	13	4	3.66	32	37	Oligotrophic
Bear	2/20/94	3	470	13	6	3.66	36	43	Oligotrophic
Bear	2/20/94	4	390	10	3	3.96	39	33	Oligotrophic
Bear	3/20/94	1	380	11	1	3.81	35	17	Oligotrophic
Bear	3/20/94	2	410	12	2	3.66	34	27	Oligotrophic
Bear	3/20/94	3	380	11	2	3.66	35	27	Oligotrophic
Bear	3/20/94	4	430	13	1	3.51	33	17	Oligotrophic
Bear	4/17/94	1	430	13	2	3.51	33	27	Oligotrophic
Bear	4/17/94	2	400	10	2	3.51	40	27	Oligotrophic
Bear	4/17/94	3	420	12	2	3.20	35	27	Oligotrophic
Bear	4/17/94	4	420	12	2	3.20	35	27	Oligotrophic
Bear	5/15/94	1	380	10	2	3.81	38	27	Oligotrophic
Bear	5/15/94	2	370	10	2	3.96	37	27	Oligotrophic
Bear	5/15/94	3	300	10	2	3.66	30	27	Oligotrophic
Bear	5/15/94	4	370	10	2	3.81	37	27	Oligotrophic
Bear	6/11/94	1	390	15	2	3.66	26	27	Oligotrophic
Bear	6/11/94	2	320	14	2	3.81	23	27	Oligotrophic
Bear	6/11/94	3	380	10	2	3.51	38	27	Oligotrophic
Bear	6/11/94	4	350	14	3	3.51	25	33	Oligotrophic
Bear	7/16/94	1	410	15	5	3.35	27	40	Oligotrophic
Bear	7/16/94	2	370	15	4	3.66	25	37	Oligotrophic
Bear	7/16/94	3	430	15	4	3.51	29	37	Oligotrophic
Bear	7/16/94	4	390	13	4	3.35	30	37	Oligotrophic
Bear	8/20/94	1	610	15	6	3.05	41	43	Oligotrophic
Bear	8/20/94	2	600	15	6	3.20	40	43	Oligotrophic
Bear	8/20/94	3	570	15	5	2.74	38	40	Oligotrophic
Bear	8/20/94	4	590	18	7	2.74	33	45	Oligotrophic
Bear	9/29/94	1	410	13	7	2.74	32	45	Oligotrophic
Bear	9/29/94	2	380	14	8	2.74	27	47	Oligotrophic
Bear	9/29/94	3	340	14	9	2.74	24	48	Oligotrophic
Bear	9/29/94	4	400	15	7	2.90	27	45	Oligotrophic
Bear	10/29/94	1	360	14	4	3.20	26	37	Oligotrophic
Bear	10/29/94	2	410	12	3	3.20	34	33	Oligotrophic
Bear	10/29/94	3	390	12	5	3.20	33	40	Oligotrophic
Bear	10/29/94	4	400	14	5	2.90	29	40	Oligotrophic
Bear	11/25/94	1	360	19	5	3.05	19	40	Oligotrophic
Bear	11/25/94	2	390	20	8	3.05	20	47	Oligotrophic
Bear	11/25/94	3	430	25	19	2.29	17	59	Mesotrophic
Bear	11/25/94	4	400	18	6	3.05	22	43	Oligotrophic
Bear	12/28/94	1	400	17	2	4.27	24	27	Oligotrophic
Bear	12/28/94	2	380	19	4	3.96	20	37	Oligotrophic
Bear	12/28/94	3	460	18	5	3.51	26	40	Oligotrophic
Bear	12/28/94	4	360	17	2	3.81	21	27	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/29/95	1	360	14	2	3.96	26	27	Oligotrophic
Bear	1/29/95	2	370	13	2	3.96	28	27	Oligotrophic
Bear	1/29/95	3	370	13	2	3.66	28	27	Oligotrophic
Bear	1/29/95	4	340	13	1	3.96	26	17	Oligotrophic
Bear	2/28/95	1	360	13	2	3.96	28	27	Oligotrophic
Bear	2/28/95	2	370	14	2	3.96	26	27	Oligotrophic
Bear	2/28/95	3	440	17	2	3.96	26	27	Oligotrophic
Bear	2/28/95	4	370	16	2	4.27	23	27	Oligotrophic
Bear	3/26/95	1	470	16	3	3.66	29	33	Oligotrophic
Bear	3/26/95	2	400	16	2	3.66	25	27	Oligotrophic
Bear	3/26/95	3	400	17	3	3.35	24	33	Oligotrophic
Bear	3/26/95	4	470	17	3	3.51	28	33	Oligotrophic
Bear	4/16/95	1	350	14	1	4.12	25	17	Oligotrophic
Bear	4/16/95	2	340	14	1	4.57	24	17	Oligotrophic
Bear	4/16/95	3	370	14	2	3.96	26	27	Oligotrophic
Bear	4/16/95	4	400	13	1	4.12	31	17	Oligotrophic
Bear	5/20/95	1	380	14	2	3.96	27	27	Oligotrophic
Bear	5/20/95	2	370	15	2	4.57	25	27	Oligotrophic
Bear	5/20/95	3	370	12	2	3.96	31	27	Oligotrophic
Bear	5/20/95	4	370	14	2	3.96	26	27	Oligotrophic
Bear	6/18/95	1	360	16	2	4.12	23	27	Oligotrophic
Bear	6/18/95	2	310	12	2	4.57	26	27	Oligotrophic
Bear	6/18/95	3	340	15	3	4.27	23	33	Oligotrophic
Bear	6/18/95	4	320	14	2	4.12	23	27	Oligotrophic
Bear	7/15/95	1	360	13	2	4.42	28	27	Oligotrophic
Bear	7/15/95	2	370	12	2	4.27	31	27	Oligotrophic
Bear	7/15/95	3	380	14	3	4.27	27	33	Oligotrophic
Bear	7/15/95	4	370	10	2	4.27	37	27	Oligotrophic
Bear	8/19/95	1	350	12	4	3.96	29	37	Oligotrophic
Bear	8/19/95	2	330	10	3	3.96	33	33	Oligotrophic
Bear	8/19/95	3	340	14	4	3.96	24	37	Oligotrophic
Bear	8/19/95	4	390	12	3	3.81	33	33	Oligotrophic
Bear	9/16/95	1	380	13	4	3.66	29	37	Oligotrophic
Bear	9/16/95	2	370	14	5	4.12	26	40	Oligotrophic
Bear	9/16/95	3	350	14	4	3.81	25	37	Oligotrophic
Bear	9/16/95	4	350	15	5	3.66	23	40	Oligotrophic
Bear	10/7/95	1	370	16	5	3.35	23	40	Oligotrophic
Bear	10/7/95	2	360	11	4	3.20	33	37	Oligotrophic
Bear	10/7/95	3	330	14	4	3.35	24	37	Oligotrophic
Bear	10/7/95	4	370	18	7	3.05	21	45	Oligotrophic
Bear	11/19/95	1	310	14	3	3.96	22	33	Oligotrophic
Bear	11/19/95	2	360	13	3	4.12	28	33	Oligotrophic
Bear	11/19/95	3	330	14	3	4.12	24	33	Oligotrophic
Bear	11/19/95	4	340	15	3	3.66	23	33	Oligotrophic
Bear	12/16/95	1	360	14	3	3.66	26	33	Oligotrophic
Bear	12/16/95	2	380	14	5	3.96	27	40	Oligotrophic
Bear	12/16/95	3	350	15	3	3.96	23	33	Oligotrophic
Bear	12/16/95	4	360	14	3	3.96	26	33	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/21/96	1	350	9	5	3.96	39	40	Oligotrophic
Bear	1/21/96	2	400	16	6	3.51	25	43	Oligotrophic
Bear	1/21/96	3	390	19	6	3.51	21	43	Oligotrophic
Bear	1/21/96	4	390	15	5	3.96	26	40	Oligotrophic
Bear	2/25/96	1	350	12	4	3.35	29	37	Oligotrophic
Bear	2/25/96	2	350	13	4	3.35	27	37	Oligotrophic
Bear	2/25/96	3	350	14	4	3.20	25	37	Oligotrophic
Bear	2/25/96	4	360	14	4	3.35	26	37	Oligotrophic
Bear	3/23/96	1	400	14	2	3.60	29	27	Oligotrophic
Bear	3/23/96	2	450	14	2	3.35	32	27	Oligotrophic
Bear	3/23/96	3	420	14	2	3.51	30	27	Oligotrophic
Bear	3/23/96	4	420	16	2	3.35	26	27	Oligotrophic
Bear	4/28/96	1	360	11	1	4.57	33	17	Oligotrophic
Bear	4/28/96	2	380	10	1	4.57	38	17	Oligotrophic
Bear	4/28/96	3	380	10	1	4.57	38	17	Oligotrophic
Bear	4/28/96	4	360	12	1	4.57	30	17	Oligotrophic
Bear	5/19/96	1	390	11	1	5.03	35	17	Oligotrophic
Bear	5/19/96	2	340	13	2	5.18	26	27	Oligotrophic
Bear	5/19/96	3	380	14	2	4.88	27	27	Oligotrophic
Bear	5/19/96	4	390	15	1	5.18	26	17	Oligotrophic
Bear	6/30/96	1	420	12	2	4.27	35	27	Oligotrophic
Bear	6/30/96	2	420	12	3	4.27	35	33	Oligotrophic
Bear	6/30/96	3	330	12	3	3.96	28	33	Oligotrophic
Bear	6/30/96	4	390	10	3	3.96	39	33	Oligotrophic
Bear	7/20/96	1	340	11	2		31	27	Oligotrophic
Bear	7/20/96	2	410	11	2	4.57	37	27	Oligotrophic
Bear	7/20/96	3	440	11	2	4.57	40	27	Oligotrophic
Bear	7/20/96	4	360	13	3	4.73	28	33	Oligotrophic
Bear	8/18/96	1	380	9	3	4.73	42	33	Oligotrophic
Bear	8/18/96	2	460	8	3	4.73	58	33	Oligotrophic
Bear	8/18/96	3	350	9	4	4.73	39	37	Oligotrophic
Bear	8/18/96	4	340	9	4		38	37	Oligotrophic
Bear	9/14/96	1	390	13	4	4.27	30	37	Oligotrophic
Bear	9/14/96	2	360	11	6	4.57	33	43	Oligotrophic
Bear	9/14/96	3	420	11	4	3.96	38	37	Oligotrophic
Bear	9/14/96	4	440	11	4	3.66	40	37	Oligotrophic
Bear	10/29/96	1	450	10	2	5.03	45	27	Oligotrophic
Bear	10/29/96	2	490	11	3	4.88	45	33	Oligotrophic
Bear	10/29/96	3	350	11	3	4.88	32	33	Oligotrophic
Bear	10/29/96	4	380	11	2	5.18	35	27	Oligotrophic
Bear	11/23/96	1	360	9	2	5.34	40	27	Oligotrophic
Bear	11/23/96	2	450	10	2	5.49	45	27	Oligotrophic
Bear	11/23/96	3	440	9	3	5.18	49	33	Oligotrophic
Bear	11/23/96	4	340	10	2	5.49	34	27	Oligotrophic
Bear	12/22/96	1	500	10	1	5.34	50	17	Oligotrophic
Bear	12/22/96	2	430	11	1	5.34	39	17	Oligotrophic
Bear	12/22/96	3	530	10	2	5.49	53	27	Oligotrophic
Bear	12/22/96	4	430	10	1	5.34	43	17	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/28/97	1	450	12	1	5.95	38	17	Oligotrophic
Bear	1/28/97	2	410	12	1	5.95	34	17	Oligotrophic
Bear	1/28/97	3	360	11	1	7.32	33	17	Oligotrophic
Bear	1/28/97	4	370	12	1	6.55	31	17	Oligotrophic
Bear	2/28/97	1	410	12	1	5.18	34	17	Oligotrophic
Bear	2/28/97	2	400	10	1	5.49	40	17	Oligotrophic
Bear	2/28/97	3	390	10	1	5.49	39	17	Oligotrophic
Bear	2/28/97	4	430	14	1	5.18	31	17	Oligotrophic
Bear	3/23/97	1	560	16	1	5.34	35	17	Oligotrophic
Bear	3/23/97	2	370	13	1	5.64	28	17	Oligotrophic
Bear	3/23/97	3	430	13	1	5.49	33	17	Oligotrophic
Bear	3/23/97	4	510	14	1	5.34	36	17	Oligotrophic
Bear	4/13/97	1	230	11	2	5.64	21	27	Oligotrophic
Bear	4/13/97	2	250	11	2	6.40	23	27	Oligotrophic
Bear	4/13/97	3	400	10	1	6.10	40	17	Oligotrophic
Bear	4/13/97	4	350	10	1	6.40	35	17	Oligotrophic
Bear	5/17/97	1	480	8	1	5.79	60	17	Oligotrophic
Bear	5/17/97	2	420	10	1	6.71	42	17	Oligotrophic
Bear	5/17/97	3	530	8	1	5.79	66	17	Oligotrophic
Bear	5/17/97	4	460	9	1	5.79	51	17	Oligotrophic
Bear	6/21/97	1	320	9	1	6.25	36	17	Oligotrophic
Bear	6/21/97	2	400	10	2	6.40	40	27	Oligotrophic
Bear	6/21/97	3	420	10	2	6.25	42	27	Oligotrophic
Bear	6/21/97	4	350	9	2		39	27	Oligotrophic
Bear	7/12/97	1	300	11	3	6.40	27	33	Oligotrophic
Bear	7/12/97	2	330	10	2	6.10	33	27	Oligotrophic
Bear	7/12/97	3	360	9	2	5.79	40	27	Oligotrophic
Bear	7/12/97	4	340	10	2	6.10	34	27	Oligotrophic
Bear	8/17/97	1	330	12	3	5.18	28	33	Oligotrophic
Bear	8/17/97	2	370	17	3	5.18	22	33	Oligotrophic
Bear	8/17/97	3	350	16	3	4.57	22	33	Oligotrophic
Bear	8/17/97	4	350	20	3	4.27	18	33	Oligotrophic
Bear	9/21/97	1	390	9	3	4.57	43	33	Oligotrophic
Bear	9/21/97	2	340	10	4	4.57	34	37	Oligotrophic
Bear	9/21/97	3	370	12	5	4.57	31	40	Oligotrophic
Bear	9/21/97	4	400	11	3	3.96	36	33	Oligotrophic
Bear	10/21/97	1	400	11	2	5.49	36	27	Oligotrophic
Bear	10/21/97	2	300	11	3	5.79	27	33	Oligotrophic
Bear	10/21/97	3	340	10	2	5.34	34	27	Oligotrophic
Bear	10/21/97	4	310	12	2	5.18	26	27	Oligotrophic
Bear	11/29/97	1	360	11	2	5.18	33	27	Oligotrophic
Bear	11/29/97	2	350	10	2	5.64	35	27	Oligotrophic
Bear	11/29/97	3	350	11	3	5.49	32	33	Oligotrophic
Bear	11/29/97	4	350	10	2	5.49	35	27	Oligotrophic
Bear	12/28/97	1	390	19	9	4.42	21	48	Oligotrophic
Bear	12/28/97	2	400	17	8	4.57	24	47	Oligotrophic
Bear	12/28/97	3	340	16	8	4.88	21	47	Oligotrophic
Bear	12/28/97	4	330	14	5	4.42	24	40	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/31/98	1	390	11	1	5.18	35	17	Oligotrophic
Bear	1/31/98	2	400	13	1	5.18	31	17	Oligotrophic
Bear	1/31/98	3	370	14	1	5.18	26	17	Oligotrophic
Bear	1/31/98	4	460	12	1	5.03	38	17	Oligotrophic
Bear	2/28/98	1	470	15	2	5.79	31	27	Oligotrophic
Bear	2/28/98	2	520	15	3	5.03	35	33	Oligotrophic
Bear	2/28/98	3	420	14	3	4.88	30	33	Oligotrophic
Bear	2/28/98	4	460	20	4	4.27	23	37	Oligotrophic
Bear	3/25/98	1	420	13	2	4.88	32	27	Oligotrophic
Bear	3/25/98	2	340	16	3	5.49	21	33	Oligotrophic
Bear	3/25/98	3	390	16	4	4.88	24	37	Oligotrophic
Bear	3/25/98	4	460	17	3	4.88	27	33	Oligotrophic
Bear	4/25/98	1	430	13	1	5.18	33	17	Oligotrophic
Bear	4/25/98	2	460	13	1	5.79	35	17	Oligotrophic
Bear	4/25/98	3	380	13	1	5.34	29	17	Oligotrophic
Bear	4/25/98	4	360	13	1	5.03	28	17	Oligotrophic
Bear	5/23/98	1	370	13	1	5.49	28	17	Oligotrophic
Bear	5/23/98	2	440	23	1	5.18	19	17	Oligotrophic
Bear	5/23/98	3	360	12	1	5.03	30	17	Oligotrophic
Bear	5/23/98	4	360	15	1	4.88	24	17	Oligotrophic
Bear	6/21/98	1	420	11	1	5.64	38	17	Oligotrophic
Bear	6/21/98	2	390	13	1	5.64	30	17	Oligotrophic
Bear	6/21/98	3	370	11	1	5.49	34	17	Oligotrophic
Bear	6/21/98	4	310	12		5.49	26	-	-
Bear	7/19/98	1	460	17	3	3.05	27	33	Oligotrophic
Bear	7/19/98	2	450	15	4	3.20	30	37	Oligotrophic
Bear	7/19/98	3	430	16	3	3.20	27	33	Oligotrophic
Bear	7/19/98	4	440	16	4	3.05	28	37	Oligotrophic
Bear	8/22/98	1	390	15	4	3.96	26	37	Oligotrophic
Bear	8/22/98	2	500	14	5	4.12	36	40	Oligotrophic
Bear	8/22/98	3	440	15	5	4.12	29	40	Oligotrophic
Bear	8/22/98	4	490	14	4	4.12	35	37	Oligotrophic
Bear	9/27/98	1	460	17	5	2.90	27	40	Oligotrophic
Bear	9/27/98	2	480	15	5	2.74	32	40	Oligotrophic
Bear	9/27/98	3	350	16	5	2.74	22	40	Oligotrophic
Bear	9/27/98	4	500	17	6	2.74	29	43	Oligotrophic
Bear	10/18/98	1	510	14	5	3.05	36	40	Oligotrophic
Bear	10/18/98	2	490	15	6	3.05	33	43	Oligotrophic
Bear	10/18/98	3	420	15	5	3.05	28	40	Oligotrophic
Bear	10/18/98	4	500	14	6	2.90	36	43	Oligotrophic
Bear	11/29/98	1	400	10	4	3.96	40	37	Oligotrophic
Bear	11/29/98	2	360	8	4	3.96	45	37	Oligotrophic
Bear	11/29/98	3	310	11	4	4.12	28	37	Oligotrophic
Bear	11/29/98	4	430	9	4	3.96	48	37	Oligotrophic
Bear	12/31/98	1	350	12	3	4.57	29	33	Oligotrophic
Bear	12/31/98	2	260	11	3	4.73	24	33	Oligotrophic
Bear	12/31/98	3	360	10	3	4.57	36	33	Oligotrophic
Bear	12/31/98	4	360	11	3	4.57	33	33	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/28/99	1	440	9	2	5.64	49	27	Oligotrophic
Bear	1/28/99	2	460	9	2	5.49	51	27	Oligotrophic
Bear	1/28/99	3	380	10	2	5.49	38	27	Oligotrophic
Bear	1/28/99	4	460	12	2	5.64	38	27	Oligotrophic
Bear	2/21/99	1	380	12	3	5.18	32	33	Oligotrophic
Bear	2/21/99	2	400	10	3	5.34	40	33	Oligotrophic
Bear	2/21/99	3	370	12	3	4.88	31	33	Oligotrophic
Bear	2/21/99	4	360	12	2	5.18	30	27	Oligotrophic
Bear	3/20/99	1	420	11	3	6.25	38	33	Oligotrophic
Bear	3/20/99	2	360	12	2	6.40	30	27	Oligotrophic
Bear	3/20/99	3	390	11	2	6.25	35	27	Oligotrophic
Bear	3/20/99	4	410	12	2	6.25	34	27	Oligotrophic
Bear	4/20/99	1	390	11	2	6.86	35	27	Oligotrophic
Bear	4/20/99	2	350	10	1	6.55	35	17	Oligotrophic
Bear	4/20/99	3	390	11	2	6.71	35	27	Oligotrophic
Bear	4/20/99	4	310	11	1		28	17	Oligotrophic
Bear	5/23/99	1	450	10	3	4.42	45	33	Oligotrophic
Bear	5/23/99	2	380	13	3	4.27	29	33	Oligotrophic
Bear	5/23/99	3	330	10	3	4.12	33	33	Oligotrophic
Bear	5/23/99	4	370	13	3	3.66	28	33	Oligotrophic
Bear	6/26/99	1	500	17	6	3.05	29	43	Oligotrophic
Bear	6/26/99	2	510	19	7	2.74	27	45	Oligotrophic
Bear	6/26/99	3	510	16	7	2.74	32	45	Oligotrophic
Bear	6/26/99	4	490	17	6	3.05	29	43	Oligotrophic
Bear	7/24/99	1	410	14	4	3.05	29	37	Oligotrophic
Bear	7/24/99	2	470	15	4	3.20	31	37	Oligotrophic
Bear	7/24/99	3	410	13	4	3.05	32	37	Oligotrophic
Bear	7/24/99	4	500	15	4	3.05	33	37	Oligotrophic
Bear	8/31/99	1	550	16	6	2.44	34	43	Oligotrophic
Bear	8/31/99	2	570	14	5	2.59	41	40	Oligotrophic
Bear	8/31/99	3	460	17	8	2.44	27	47	Oligotrophic
Bear	8/31/99	4	690	19	8	2.44	36	47	Oligotrophic
Bear	9/25/99	1	480	16	7	2.44	30	45	Oligotrophic
Bear	9/25/99	2	500	17	6	2.74	29	43	Oligotrophic
Bear	9/25/99	3	420	14	9	2.59	30	48	Oligotrophic
Bear	9/25/99	4	460	15	7	2.44	31	45	Oligotrophic
Bear	10/27/99	1	460	12	4	2.90	38	37	Oligotrophic
Bear	10/27/99	2	470	16	5	2.90	29	40	Oligotrophic
Bear	10/27/99	3	470	16	4	2.90	29	37	Oligotrophic
Bear	10/27/99	4	400	16	4	2.74	25	37	Oligotrophic
Bear	11/23/99	1	470	18	7	2.59	26	45	Oligotrophic
Bear	11/23/99	2	400	19	6	2.59	21	43	Oligotrophic
Bear	11/23/99	3	440	19	6	2.68	23	43	Oligotrophic
Bear	11/23/99	4	480	19	8	2.44	25	47	Oligotrophic
Bear	12/19/99	1	360	23	3	3.51	16	33	Oligotrophic
Bear	12/19/99	2	480	27	3	3.20	18	33	Oligotrophic
Bear	12/19/99	3	470	13	3	3.35	36	33	Oligotrophic
Bear	12/19/99	4	510	16	3	3.20	32	33	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/16/00	1	450	14	3	3.66	32	33	Oligotrophic
Bear	1/16/00	2	480	13	3	3.66	37	33	Oligotrophic
Bear	1/16/00	3	510	13	3	3.66	39	33	Oligotrophic
Bear	1/16/00	4	520	13	3	3.96	40	33	Oligotrophic
Bear	2/19/00	1	470	13	3	4.27	36	33	Oligotrophic
Bear	2/19/00	2	390	13	3	4.57	30	33	Oligotrophic
Bear	2/19/00	3	480	12	3	4.57	40	33	Oligotrophic
Bear	2/19/00	4	570	15	5	3.96	38	40	Oligotrophic
Bear	3/26/00	1	530	14	3	4.57	38	33	Oligotrophic
Bear	3/26/00	2	520	15	2	4.57	35	27	Oligotrophic
Bear	3/26/00	3	540	15	3	4.57	36	33	Oligotrophic
Bear	3/26/00	4	610	15	2	4.57	41	27	Oligotrophic
Bear	4/23/00	1	530	16	3	3.35	33	33	Oligotrophic
Bear	4/23/00	2	490	15	3	3.66	33	33	Oligotrophic
Bear	4/23/00	3	490	14	3	3.66	35	33	Oligotrophic
Bear	4/23/00	4	500	17	3	3.35	29	33	Oligotrophic
Bear	5/27/00	1	480	14	3	3.05	34	33	Oligotrophic
Bear	5/27/00	2	470	14	2	3.20	34	27	Oligotrophic
Bear	5/27/00	3	460	15	4	3.05	31	37	Oligotrophic
Bear	5/27/00	4	490	14	3	3.05	35	33	Oligotrophic
Bear	6/24/00	1	480	14	4	4.12	34	37	Oligotrophic
Bear	6/24/00	2	480	11	4	3.96	44	37	Oligotrophic
Bear	6/24/00	3	620	12	3	4.12	52	33	Oligotrophic
Bear	6/24/00	4	540	14	4	3.96	39	37	Oligotrophic
Bear	7/23/00	1	420	14	5	3.66	30	40	Oligotrophic
Bear	7/23/00	2	610	15	5	3.66	41	40	Oligotrophic
Bear	7/23/00	3	480	14	5	3.66	34	40	Oligotrophic
Bear	7/23/00	4	450	14	5	3.35	32	40	Oligotrophic
Bear	8/20/00	1	400	16	3	3.51	25	33	Oligotrophic
Bear	8/20/00	2	450	15	4	3.66	30	37	Oligotrophic
Bear	8/20/00	3	480	16	3	3.35	30	33	Oligotrophic
Bear	8/20/00	4	470	16	4	3.35	29	37	Oligotrophic
Bear	9/23/00	1	520	15	11	3.35	35	51	Mesotrophic
Bear	9/23/00	2	660	12	7	3.35	55	45	Oligotrophic
Bear	9/23/00	3	510	13	9	3.51	39	48	Oligotrophic
Bear	9/23/00	4	640	15	8	3.05	43	47	Oligotrophic
Bear	10/22/00	1	480	14	6	3.20	34	43	Oligotrophic
Bear	10/22/00	2	650	12	6	3.20	54	43	Oligotrophic
Bear	10/22/00	3	520	12	6	3.20	43	43	Oligotrophic
Bear	10/22/00	4	550	10	6	3.05	55	43	Oligotrophic
Bear	11/28/00	1	530	16	6	3.05	33	43	Oligotrophic
Bear	11/28/00	2	510	17	6	2.90	30	43	Oligotrophic
Bear	11/28/00	3	550	17	6	2.90	32	43	Oligotrophic
Bear	11/28/00	4	610	16	5	2.90	38	40	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/7/01	1	490	11	2	5.18	45	27	Oligotrophic
Bear	1/7/01	2	520	11	2	5.18	47	27	Oligotrophic
Bear	1/7/01	3	490	13	2	5.34	38	27	Oligotrophic
Bear	1/7/01	4	500	10	2	5.49	50	27	Oligotrophic
Bear	2/25/01	1	520	10	3	4.88	52	33	Oligotrophic
Bear	2/25/01	2	380	10	3	4.88	38	33	Oligotrophic
Bear	2/25/01	3	340	10	3	4.88	34	33	Oligotrophic
Bear	2/25/01	4	460	11	3	4.88	42	33	Oligotrophic
Bear	3/24/01	1	550	12	5	4.12	46	40	Oligotrophic
Bear	3/24/01	2	480	11	4	3.96	44	37	Oligotrophic
Bear	3/24/01	3	570	13	4	4.12	44	37	Oligotrophic
Bear	3/24/01	4	380	13	4	3.96	29	37	Oligotrophic
Bear	4/22/01	1	570	16	4	2.74	36	37	Oligotrophic
Bear	4/22/01	2	600	16	4	2.74	38	37	Oligotrophic
Bear	4/22/01	3	620	16	4	2.74	39	37	Oligotrophic
Bear	4/22/01	4	540	15	4	2.74	36	37	Oligotrophic
Bear	5/29/01	1	620	15	6	2.74	41	43	Oligotrophic
Bear	5/29/01	2	570	14	6	2.74	41	43	Oligotrophic
Bear	5/29/01	3	590	16	6	2.59	37	43	Oligotrophic
Bear	5/29/01	4	600	15	7	2.59	40	45	Oligotrophic
Bear	6/24/01	1	480	15	6	2.74	32	43	Oligotrophic
Bear	6/24/01	2	460	14	6	2.90	33	43	Oligotrophic
Bear	6/24/01	3	490	15	7	2.74	33	45	Oligotrophic
Bear	6/24/01	4	490	17	6	2.74	29	43	Oligotrophic
Bear	7/29/01	1	620	14	4	2.44	44	37	Oligotrophic
Bear	7/29/01	2	640	14	4	2.44	46	37	Oligotrophic
Bear	7/29/01	3	610	15	4	2.44	41	37	Oligotrophic
Bear	7/29/01	4	640	16	5	2.44	40	40	Oligotrophic
Bear	8/26/01	1	470	16	7	2.59	29	45	Oligotrophic
Bear	8/26/01	2	500	17	6	2.59	29	43	Oligotrophic
Bear	8/26/01	3	550	14	5	2.74	39	40	Oligotrophic
Bear	8/26/01	4	630	15	6	2.44	42	43	Oligotrophic
Bear	9/24/01	1	490	15	8	2.44	33	47	Oligotrophic
Bear	9/24/01	2	550	17	7	2.44	32	45	Oligotrophic
Bear	9/24/01	3	520	19	5	2.29	27	40	Oligotrophic
Bear	9/24/01	4	450	18	7	2.13	25	45	Oligotrophic
Bear	10/28/01	1	600	15	11	2.74	40	51	Mesotrophic
Bear	10/28/01	2	570	15	8	2.74	38	47	Oligotrophic
Bear	10/28/01	3	520	15	11	2.74	35	51	Mesotrophic
Bear	10/28/01	4	510	14	8	2.59	36	47	Oligotrophic
Bear	11/25/01	1	580	15	8	2.74	39	47	Oligotrophic
Bear	11/25/01	2	540	14	7	2.74	39	45	Oligotrophic
Bear	11/25/01	3	530	13	8	2.59	41	47	Oligotrophic
Bear	11/25/01	4	600	15	9	2.44	40	48	Oligotrophic
Bear	12/30/01	1	600	17	8	2.44	35	47	Oligotrophic
Bear	12/30/01	2	530	15	9	2.44	35	48	Oligotrophic
Bear	12/30/01	3	570	15	8	2.44	38	47	Oligotrophic
Bear	12/30/01	4	640	16	7	2.59	40	45	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/27/02	1	690	14	5	2.74	49	40	Oligotrophic
Bear	1/27/02	2	490	15	5	2.90	33	40	Oligotrophic
Bear	1/27/02	3	630	14	5	2.90	45	40	Oligotrophic
Bear	1/27/02	4	560	14	5	2.74	40	40	Oligotrophic
Bear	2/24/02	1	580	14	5	3.05	41	40	Oligotrophic
Bear	2/24/02	2	540	14	5	3.20	39	40	Oligotrophic
Bear	2/24/02	3	590	14	4	3.20	42	37	Oligotrophic
Bear	2/24/02	4	540	15	5	3.05	36	40	Oligotrophic
Bear	3/17/02	1	540	12	3	3.81	45	33	Oligotrophic
Bear	3/17/02	2	460	13	2	3.81	35	27	Oligotrophic
Bear	3/17/02	3	550	13	2	3.66	42	27	Oligotrophic
Bear	3/17/02	4	640	12	2	3.66	53	27	Oligotrophic
Bear	4/14/02	1	540	12	3	4.27	45	33	Oligotrophic
Bear	4/14/02	2	520	12	3	4.27	43	33	Oligotrophic
Bear	4/14/02	3	410	13	3	4.12	32	33	Oligotrophic
Bear	4/14/02	4	560	11	3	4.27	51	33	Oligotrophic
Bear	5/15/02	1	670	10	2	3.81	67	27	Oligotrophic
Bear	5/15/02	2	650	11	3	3.81	59	33	Oligotrophic
Bear	5/15/02	3	660	11	2	3.81	60	27	Oligotrophic
Bear	5/15/02	4	650	11	2	3.81	59	27	Oligotrophic
Bear	6/23/02	1	520	13	5	3.35	40	40	Oligotrophic
Bear	6/23/02	2	490	13	4	3.05	38	37	Oligotrophic
Bear	6/23/02	3	550	16	5	2.90	34	40	Oligotrophic
Bear	6/23/02	4	610	14	6	2.74	44	43	Oligotrophic
Bear	7/21/02	1	500	15	4	3.35	33	37	Oligotrophic
Bear	7/21/02	2	620	16	3	3.35	39	33	Oligotrophic
Bear	7/21/02	3	680	15	4	3.20	45	37	Oligotrophic
Bear	7/21/02	4	510	19	5	3.05	27	40	Oligotrophic
Bear	8/25/02	1	460	13	6	2.90	35	43	Oligotrophic
Bear	8/25/02	2	390	12	5	3.05	33	40	Oligotrophic
Bear	8/25/02	3	440	13	5	2.74	34	40	Oligotrophic
Bear	8/25/02	4	410	13	6	2.90	32	43	Oligotrophic
Bear	9/22/02	1	440	16	8	3.05	28	47	Oligotrophic
Bear	9/22/02	2	400	17	8	3.05	24	47	Oligotrophic
Bear	9/22/02	3	390	18	8	2.90	22	47	Oligotrophic
Bear	9/22/02	4	510	19	7	3.05	27	45	Oligotrophic
Bear	10/27/02	1	530	13	8	2.13	41	47	Oligotrophic
Bear	10/27/02	2	530	12	6	2.44	44	43	Oligotrophic
Bear	10/27/02	3	450	14	7	2.44	32	45	Oligotrophic
Bear	10/27/02	4	440	14	5	2.13	31	40	Oligotrophic
Bear	11/24/02	1	560	15	7	3.51	37	45	Oligotrophic
Bear	11/24/02	2	510	15	6	3.35	34	43	Oligotrophic
Bear	11/24/02	3	620	15	6	3.20	41	43	Oligotrophic
Bear	11/24/02	4	660	14	5	3.51	47	40	Oligotrophic
Bear	12/29/02	1	450	16	2	3.96	28	27	Oligotrophic
Bear	12/29/02	2	490	15	2	3.96	33	27	Oligotrophic
Bear	12/29/02	3	490	16	3	3.66	31	33	Oligotrophic
Bear	12/29/02	4	490	16	1	4.12	31	17	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/26/03	1	460	12	2	3.96	38	27	Oligotrophic
Bear	1/26/03	2	390	12	2	4.12	33	27	Oligotrophic
Bear	1/26/03	3	420	13	2	3.66	32	27	Oligotrophic
Bear	1/26/03	4	460	12	2	3.96	38	27	Oligotrophic
Bear	2/23/03	1	510	14	6	3.66	36	43	Oligotrophic
Bear	2/23/03	2	420	15	5	3.81	28	40	Oligotrophic
Bear	2/23/03	3	540	14	4	3.96	39	37	Oligotrophic
Bear	2/23/03	4	400	15	5	3.66	27	40	Oligotrophic
Bear	3/15/03	1	450	14		4.73	32	=	-
Bear	3/15/03	2	460	15	5	4.57	31	40	Oligotrophic
Bear	3/15/03	3	410	15	3	4.42	27	33	Oligotrophic
Bear	3/15/03	4	480	15	5	4.73	32	40	Oligotrophic
Bear	4/19/03	1	480	15	2	3.66	32	27	Oligotrophic
Bear	4/19/03	2	450	15	3	3.66	30	33	Oligotrophic
Bear	4/19/03	3	450	13	2	3.51	35	27	Oligotrophic
Bear	4/19/03	4	560	14	2	3.66	40	27	Oligotrophic
Bear	5/19/03	1	560	13	2	3.66	43	27	Oligotrophic
Bear	5/19/03	2	520	14	2	3.51	37	27	Oligotrophic
Bear	5/19/03	3	510	13	2	3.66	39	27	Oligotrophic
Bear	5/19/03	4	430	14	3	3.51	31	33	Oligotrophic
Bear	6/15/03	1	520	12	3	3.96	43	33	Oligotrophic
Bear	6/15/03	2	470	12	3	4.27	39	33	Oligotrophic
Bear	6/15/03	3	460	12	3	3.96	38	33	Oligotrophic
Bear	6/15/03	4	420	13	3	3.96	32	33	Oligotrophic
Bear	7/19/03	1	490	9	3	4.12	54	33	Oligotrophic
Bear	7/19/03	2	470	13	4	4.12	36	37	Oligotrophic
Bear	7/19/03	3	470	12	4	3.96	39	37	Oligotrophic
Bear	7/19/03	4	480	14	4	4.12	34	37	Oligotrophic
Bear	8/17/03	1	530	14	5	4.12	38	40	Oligotrophic
Bear	8/17/03	2	480	15	4	4.12	32	37	Oligotrophic
Bear	8/17/03	3	370	15	5	3.96	25	40	Oligotrophic
Bear	8/17/03	4	480	13	5	4.12	37	40	Oligotrophic
Bear	9/14/03	1	580	15	5	2.74	39	40	Oligotrophic
Bear	9/14/03	2	530	14	5	2.74	38	40	Oligotrophic
Bear	9/14/03	3	510	14	5	2.90	36	40	Oligotrophic
Bear	9/14/03	4	520	12	5	2.74	43	40	Oligotrophic
Bear	10/25/03	1	490	11	4	3.66	45	37	Oligotrophic
Bear	10/25/03	2	530	10	3	3.81	53	33	Oligotrophic
Bear	10/25/03	3	550	10	3	3.81	55	33	Oligotrophic
Bear	10/25/03	4	550	11	5	3.81	50	40	Oligotrophic
Bear	11/16/03	1	500	14	6	3.81	36	43	Oligotrophic
Bear	11/16/03	2	500	12	6	3.81	42	43	Oligotrophic
Bear	11/16/03	3	510	10	5	3.81	51	40	Oligotrophic
Bear	11/16/03	4	550	12	6	3.96	46	43	Oligotrophic
Bear	12/27/03	1	520	14	5	3.66	37	40	Oligotrophic
Bear	12/27/03	2	390	14	5	3.66	28	40	Oligotrophic
Bear	12/27/03	3	440	15	5	3.51	29	40	Oligotrophic
Bear	12/27/03	4	480	15	4	3.51	32	37	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/19/04	1	470	13	4	3.66	36	37	Oligotrophic
Bear	1/19/04	2	470	13	4	3.66	36	37	Oligotrophic
Bear	1/19/04	3	470	13	4	3.51	36	37	Oligotrophic
Bear	1/19/04	4	450	14	4	3.66	32	37	Oligotrophic
Bear	2/22/04	1	520	16	4	4.12	33	37	Oligotrophic
Bear	2/22/04	2	420	14	3	4.12	30	33	Oligotrophic
Bear	2/22/04	3	410	12	3	3.96	34	33	Oligotrophic
Bear	2/22/04	4	440	13	4	3.96	34	37	Oligotrophic
Bear	3/14/04	1	480	13	3	3.66	37	33	Oligotrophic
Bear	3/14/04	2	450	13	2	3.66	35	27	Oligotrophic
Bear	3/14/04	3	450	14	3	3.66	32	33	Oligotrophic
Bear	3/14/04	4	450	14	3	3.51	32	33	Oligotrophic
Bear	4/10/04	1	460	14	3	3.51	33	33	Oligotrophic
Bear	4/10/04	2	490	13	2	3.51	38	27	Oligotrophic
Bear	4/10/04	3	510	13	3	3.66	39	33	Oligotrophic
Bear	4/10/04	4	490	13	3	3.51	38	33	Oligotrophic
Bear	5/8/04	1	510	10	3	3.51	51	33	Oligotrophic
Bear	5/8/04	2	490	10	3	3.35	49	33	Oligotrophic
Bear	5/8/04	3	440	9	2	3.51	49	27	Oligotrophic
Bear	5/8/04	4	470	7	2	3.20	67	27	Oligotrophic
Bear	6/12/04	1	560	15	3	3.05	37	33	Oligotrophic
Bear	6/12/04	2	470	18	3	3.05	26	33	Oligotrophic
Bear	6/12/04	3	520	11	3	3.05	47	33	Oligotrophic
Bear	6/12/04	4	530	15	4	3.05	35	37	Oligotrophic
Bear	7/11/04	1	520	15	5	2.74	35	40	Oligotrophic
Bear	7/11/04	2	570	15	5	2.74	38	40	Oligotrophic
Bear	7/11/04	3	560	13	3	2.74	43	33	Oligotrophic
Bear	7/11/04	4	470	15	4	3.05	31	37	Oligotrophic
Bear	8/29/04	1	580	16	6	2.74	36	43	Oligotrophic
Bear	8/29/04	2	510	13	5	2.74	39	40	Oligotrophic
Bear	8/29/04	3	590	14	6	2.74	42	43	Oligotrophic
Bear	8/29/04	4	510	17	7	2.74	30	45	Oligotrophic
Bear	9/30/04	1	760	16	10	2.13	48	50	Oligotrophic
Bear	9/30/04	2	600	25	9	2.13	24	48	Oligotrophic
Bear	9/30/04	3	590	24	12	2.13	25	53	Mesotrophic
Bear	9/30/04	4	600	19	9	2.13	32	48	Oligotrophic
Bear	10/23/04	1	590	15	11	2.59	39	51	Mesotrophic
Bear	10/23/04	2	710	16	9	2.59	44	48	Oligotrophic
Bear	10/23/04	3	550	10	8	2.44	55	47	Oligotrophic
Bear	10/23/04	4	530	14	11	2.44	38	51	Mesotrophic
Bear	11/21/04	1	550	15	6	2.13	37	43	Oligotrophic
Bear	11/21/04	2	650	16	8	2.13	41	47	Oligotrophic
Bear	11/21/04	3	630	20	7	2.13	32	45	Oligotrophic
Bear	11/21/04	4	610	18	7	2.29	34	45	Oligotrophic
Bear	12/18/04	1	480	17	8	2.90	28	47	Oligotrophic
Bear	12/18/04	2	520	16	8	2.90	33	47	Oligotrophic
Bear	12/18/04	3	500	17	8	2.74	29	47	Oligotrophic
Bear	12/18/04	4	500	16	6	2.74	31	43	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/9/05	1	360	12	7	3.05	30	45	Oligotrophic
Bear	1/9/05	2	300	11	5	3.05	27	40	Oligotrophic
Bear	1/9/05	3	320	12	6	3.05	27	43	Oligotrophic
Bear	1/9/05	4	330	12	7	3.05	28	45	Oligotrophic
Bear	2/26/05	1	490	14	8	3.05	35	47	Oligotrophic
Bear	2/26/05	2	530	17	8	3.05	31	47	Oligotrophic
Bear	2/26/05	3	500	16	8	3.05	31	47	Oligotrophic
Bear	2/26/05	4	480	15	6	3.05	32	43	Oligotrophic
Bear	3/20/05	1		13	4	3.05	0	37	Oligotrophic
Bear	3/20/05	2	500	15	4	3.05	33	37	Oligotrophic
Bear	3/20/05	3	670	15	4	3.05	45	37	Oligotrophic
Bear	3/20/05	4	770	16	3	3.05	48	33	Oligotrophic
Bear	4/10/05	1	470	15	6	2.90	31	43	Oligotrophic
Bear	4/10/05	2	460	15	5	3.05	31	40	Oligotrophic
Bear	4/10/05	3	420	15	5	3.05	28	40	Oligotrophic
Bear	4/10/05	4	460	18	5	3.05	26	40	Oligotrophic
Bear	5/15/05	1	450	15	5	2.74	30	40	Oligotrophic
Bear	5/15/05	2	430	13	3	2.74	33	33	Oligotrophic
Bear	5/15/05	3	430	16	3	2.74	27	33	Oligotrophic
Bear	5/15/05	4	600	16	4	2.90	38	37	Oligotrophic
Bear	6/26/05	1	460	18	11	2.44	26	51	Mesotrophic
Bear	6/26/05	2	460	20	9	2.44	23	48	Oligotrophic
Bear	6/26/05	3	430	18	10	2.44	24	50	Oligotrophic
Bear	6/26/05	4	510	20	11	2.44	26	51	Mesotrophic
Bear	7/15/05	1	550	17	10	2.13	32	50	Oligotrophic
Bear	7/15/05	2	540	18	9	2.13	30	48	Oligotrophic
Bear	7/15/05	3	560	18	11	2.13	31	51	Mesotrophic
Bear	7/15/05	4	630	26	10	1.98	24	50	Oligotrophic
Bear	8/19/05	1	490	16	4	2.74	31	37	Oligotrophic
Bear	8/19/05	2	460	14	4	2.74	33	37	Oligotrophic
Bear	8/19/05	3	450	15	4	2.59	30	37	Oligotrophic
Bear	8/19/05	4	480	15	5	2.59	32	40	Oligotrophic
Bear	9/25/05	1	500	14	8	2.29	36	47	Oligotrophic
Bear	9/25/05	2	500	15	6	2.29	33	43	Oligotrophic
Bear	9/25/05	3	470	17	6	2.13	28	43	Oligotrophic
Bear	9/25/05	4	590	14	6	2.13	42	43	Oligotrophic
Bear	10/16/05	1	520	15	11	2.13	35	51	Mesotrophic
Bear	10/16/05	2	540	15	11	2.13	36	51	Mesotrophic
Bear	10/16/05	3	500	16	10	1.98	31	50	Oligotrophic
Bear	10/16/05	4	520	15	11	2.13	35	51	Mesotrophic
Bear	11/25/05	1	430	14	7	2.29	31	45	Oligotrophic
Bear	11/25/05	2	510	14	7	2.29	36	45	Oligotrophic
Bear	11/25/05	3	500	15	6	2.29	33	43	Oligotrophic
Bear	11/25/05	4	500	14	7	2.29	36	45	Oligotrophic
Bear	12/24/05	1	460	14	3	2.74	33	33	Oligotrophic
Bear	12/24/05	2	480	15	5	2.59	32	40	Oligotrophic
Bear	12/24/05	3	490	15	4	2.44	33	37	Oligotrophic
Bear	12/24/05	4	530	15	5	2.59	35	40	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/22/06	1			5	3.20	-	40	Oligotrophic
Bear	1/22/06	2	510	13	6	3.20	39	43	Oligotrophic
Bear	1/22/06	3	470	12	5	3.20	39	40	Oligotrophic
Bear	1/22/06	4	540	13	5	3.05	42	40	Oligotrophic
Bear	2/17/06	1	520	14	4	3.35	37	37	Oligotrophic
Bear	2/17/06	2	480	13	3	3.35	37	33	Oligotrophic
Bear	2/17/06	3	540	14	5	3.35	39	40	Oligotrophic
Bear	2/17/06	4	570	14	3	3.35	41	33	Oligotrophic
Bear	3/19/06	1	460	14	4	3.05	33	37	Oligotrophic
Bear	3/19/06	2	490	14	4	3.20	35	37	Oligotrophic
Bear	3/19/06	3	480	14	4	3.05	34	37	Oligotrophic
Bear	3/19/06	4	470	12	3	3.05	39	33	Oligotrophic
Bear	4/24/06	1	480	13	4	2.74	37	37	Oligotrophic
Bear	4/24/06	2	470	13	3	2.74	36	33	Oligotrophic
Bear	4/24/06	3	500	14	3	2.74	36	33	Oligotrophic
Bear	4/24/06	4	490	13	4	2.74	38	37	Oligotrophic
Bear	5/21/06	1	450	13	4	3.05	35	37	Oligotrophic
Bear	5/21/06	2	430	14	4	3.05	31	37	Oligotrophic
Bear	5/21/06	3	480	15	4	3.05	32	37	Oligotrophic
Bear	5/21/06	4	410	13	4	3.05	32	37	Oligotrophic
Bear	6/23/06	1	470	14	5	3.05	34	40	Oligotrophic
Bear	6/23/06	2	460	15	5	2.90	31	40	Oligotrophic
Bear	6/23/06	3	430	12	5	2.90	36	40	Oligotrophic
Bear	6/23/06	4	410	15	5	3.05	27	40	Oligotrophic
Bear	7/16/06	1	480	13	5	2.44	37	40	Oligotrophic
Bear	7/16/06	2	450	17	4	2.59	26	37	Oligotrophic
Bear	7/16/06	3	420	11	5	2.44	38	40	Oligotrophic
Bear	7/16/06	4	590	13	4	2.44	45	37	Oligotrophic
Bear	8/27/06	1	490	12	7	2.44	41	45	Oligotrophic
Bear	8/27/06	2	470	12	8	2.44	39	47	Oligotrophic
Bear	8/27/06	3	460	10	7	2.44	46	45	Oligotrophic
Bear	8/27/06	4	490	12	7	2.44	41	45	Oligotrophic
Bear	9/24/06	1	500	12	7	2.29	42	45	Oligotrophic
Bear	9/24/06	2	510	13	7	2.29	39	45	Oligotrophic
Bear	9/24/06	3	490	13	6	2.13	38	43	Oligotrophic
Bear	9/24/06	4	510	15	7	2.29	34	45	Oligotrophic
Bear	11/10/06	1	610	16	11	2.13	38	51	Mesotrophic
Bear	11/10/06	2	560	14	8	2.13	40	47	Oligotrophic
Bear	11/10/06	3	630	15	7	2.29	42	45	Oligotrophic
Bear	11/10/06	4	590	16	12	2.13	37	53	Mesotrophic
Bear	12/17/06	1	710	14	9	2.44	51	48	Oligotrophic
Bear	12/17/06	2	530	12	6	2.59	44	43	Oligotrophic
Bear	12/17/06	3	540	13	7	2.44	42	45	Oligotrophic
Bear	12/17/06	4	540	13	8	2.44	42	47	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/21/07	1	430	13	4	3.20	33	37	Oligotrophic
Bear	1/21/07	2	440	11	4	3.20	40	37	Oligotrophic
Bear	1/21/07	3	450	12	4	3.20	38	37	Oligotrophic
Bear	1/21/07	4	500	14	3	3.05	36	33	Oligotrophic
Bear	2/28/07	1	410	12	5	3.96	34	40	Oligotrophic
Bear	2/28/07	2	510	11	4	3.81	46	37	Oligotrophic
Bear	2/28/07	3	420	10	5	3.81	42	40	Oligotrophic
Bear	2/28/07	4	410	10	5	3.96	41	40	Oligotrophic
Bear	3/27/07	1	500	14	4	2.74	36	37	Oligotrophic
Bear	3/27/07	2	560	14	4	2.74	40	37	Oligotrophic
Bear	3/27/07	3	440	13	4	2.74	34	37	Oligotrophic
Bear	3/27/07	4	440	13	4	2.74	34	37	Oligotrophic
Bear	4/18/07	1	480	14	7	2.44	34	45	Oligotrophic
Bear	4/18/07	2	490	14	6	2.44	35	43	Oligotrophic
Bear	4/18/07	3	540	14	6	2.44	39	43	Oligotrophic
Bear	4/18/07	4	560	14	7	2.44	40	45	Oligotrophic
Bear	5/29/07	1	510	14	9	2.13	36	48	Oligotrophic
Bear	5/29/07	2	480	12	7	2.13	40	45	Oligotrophic
Bear	5/29/07	3	450	15	8	2.13	30	47	Oligotrophic
Bear	5/29/07	4	540	14	7	2.13	39	45	Oligotrophic
Bear	6/25/07	1	530	15	6	2.44	35	43	Oligotrophic
Bear	6/25/07	2	530	12	5	2.44	44	40	Oligotrophic
Bear	6/25/07	3	530	13	5	2.44	41	40	Oligotrophic
Bear	6/25/07	4	510	12	5	2.44	43	40	Oligotrophic
Bear	7/22/07	1	490	14	9	2.13	35	48	Oligotrophic
Bear	7/22/07	2	510	14	5	2.29	36	40	Oligotrophic
Bear	7/22/07	3	460	12	5	2.29	38	40	Oligotrophic
Bear	7/22/07	4	490	13	6	2.44	38	43	Oligotrophic
Bear	8/18/07	1	510	11	6	2.44	46	43	Oligotrophic
Bear	8/18/07	2	540	11	5	2.44	49	40	Oligotrophic
Bear	8/18/07	3	490	11	5	2.29	45	40	Oligotrophic
Bear	8/18/07	4	580	12	5	2.44	48	40	Oligotrophic
Bear	9/29/07	1	700	13	7	2.44	54	45	Oligotrophic
Bear	9/29/07	2	720	11	5	2.44	65	40	Oligotrophic
Bear	9/29/07	3	620	11	5	2.44	56	40	Oligotrophic
Bear	9/29/07	4	690	11	7	2.29	63	45	Oligotrophic
Bear	10/27/07	1	600	13	9	2.29	46	48	Oligotrophic
Bear	10/27/07	2	580	13	5	2.29	45	40	Oligotrophic
Bear	10/27/07	3	570	13	5	2.23	44	40	Oligotrophic
Bear	10/27/07	4	590	13	4	2.29	45	37	Oligotrophic
Bear	11/27/07	1	760	14	5.8	2.44	54	42	Oligotrophic
Bear	11/27/07	2	670	13	5.5	2.44	52	41	Oligotrophic
Bear	11/27/07	3	650	11	5.5	2.44	59	41	Oligotrophic
Bear	11/27/07	4	770	11	4.9	2.44	70	40	Oligotrophic
Bear	12/19/07	1	440	9	4.7	3.05	49	39	Oligotrophic
Bear	12/19/07	2	490	9	4.1	3.20	54	37	Oligotrophic
Bear	12/19/07	3	480	9	3.8	2.90	53	36	Oligotrophic
Bear	12/19/07	4	470	9	4.3	3.05	52	38	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/23/08	1	540	10	4	2.74	54	37	Oligotrophic
Bear	1/23/08	2	520	12	5	2.74	43	40	Oligotrophic
Bear	1/23/08	3	520	13	4	2.74	40	37	Oligotrophic
Bear	1/23/08	4	520	14	4	2.90	37	37	Oligotrophic
Bear	2/16/08	1	500	8	3	3.96	63	33	Oligotrophic
Bear	2/16/08	2	510	10	3	3.96	51	33	Oligotrophic
Bear	2/16/08	3	520	10	3	3.96	52	33	Oligotrophic
Bear	2/16/08	4	580	9	3	3.96	64	33	Oligotrophic
Bear	3/27/08	1	550	9	3	3.66	61	33	Oligotrophic
Bear	3/27/08	2	500	8	3	3.66	63	33	Oligotrophic
Bear	3/27/08	3	570	10	3	3.66	57	33	Oligotrophic
Bear	3/27/08	4	540	10	3	3.51	54	33	Oligotrophic
Bear	4/27/08	1	500	7	2	3.96	71	27	Oligotrophic
Bear	4/27/08	2	440	7	3	3.96	63	33	Oligotrophic
Bear	4/27/08	3	410	8	2	3.96	51	27	Oligotrophic
Bear	4/27/08	4	440	8	3	3.96	55	33	Oligotrophic
Bear	5/23/08	1	630	13	4	3.05	48	37	Oligotrophic
Bear	5/23/08	2	590	10	4	3.05	59	37	Oligotrophic
Bear	5/23/08	3	590	10	3	2.90	59	33	Oligotrophic
Bear	5/23/08	4	570	12	4	2.74	48	37	Oligotrophic
Bear	6/14/08	1	600	10	5	2.74	60	40	Oligotrophic
Bear	6/14/08	2	580	11	4	2.74	53	37	Oligotrophic
Bear	6/14/08	3	540	10	4	2.74	54	37	Oligotrophic
Bear	6/14/08	4	610	11	4	2.74	55	37	Oligotrophic
Bear	6/29/08	1	610	10	6	2.74	61	43	Oligotrophic
Bear	6/29/08	2	670	9	4	2.74	74	37	Oligotrophic
Bear	6/29/08	3	730	9	5	2.74	81	40	Oligotrophic
Bear	6/29/08	4	700	9	4	2.90	78	37	Oligotrophic
Bear	7/27/08	1	550	9	5	3.05	61	40	Oligotrophic
Bear	7/27/08	2	580	8	4	3.05	73	37	Oligotrophic
Bear	7/27/08	3	540	9	5	3.05	60	40	Oligotrophic
Bear	7/27/08	4	540	8	6	3.05	68	43	Oligotrophic
Bear	8/17/08	1	500	9	5	2.90	56	40	Oligotrophic
Bear	8/17/08	2	460	10	5	3.05	46	40	Oligotrophic
Bear	8/17/08	3	540	10	5	2.90	54	40	Oligotrophic
Bear	8/17/08	4	460	9	5	3.05	51	40	Oligotrophic
Bear	9/18/08	1	540	14	10	1.98	39	50	Oligotrophic
Bear	9/18/08	2	540	15	9	1.98	36	48	Oligotrophic
Bear	9/18/08	3	510	14	9	1.98	36	48	Oligotrophic
Bear	9/18/08	4	550	18	10	1.98	31	50	Oligotrophic
Bear	10/26/08	1	540	14	9	2.44	39	48	Oligotrophic
Bear	10/26/08	2	650	15	9	2.44	43	48	Oligotrophic
Bear	10/26/08	3	560	14	9	2.44	40	48	Oligotrophic
Bear	10/26/08	4	580	20	9	2.44	29	48	Oligotrophic
Bear	11/28/08	1	570	12	5	2.90	48	40	Oligotrophic
Bear	11/28/08	2	590	14	5	2.74	42	40	Oligotrophic
Bear	11/28/08	3	590	10	5	2.74	59	40	Oligotrophic
Bear	11/28/08	4	620	11	5	2.74	56	40	Oligotrophic
Bear	12/17/08	1	470	13	4	2.84	36	37	Oligotrophic
Bear	12/17/08	2	470	13	6	2.90	36	43	Oligotrophic
Bear	12/17/08	3	490	15	7	2.74	33	45	Oligotrophic
Bear	12/17/08	4	490	16	5	2.90	31	40	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/23/09	1	580	7	3	3.20	83	33	Oligotrophic
Bear	1/23/09	2	530	11	3	3.20	48	33	Oligotrophic
Bear	1/23/09	3	570	10	4	3.20	57	37	Oligotrophic
Bear	1/23/09	4	620	10	3	3.20	62	33	Oligotrophic
Bear	2/14/09	1	660	10	4	4.57	66	37	Oligotrophic
Bear	2/14/09	2	730	12	3	4.42	61	33	Oligotrophic
Bear	2/14/09	3	680	12	3	4.42	57	33	Oligotrophic
Bear	2/14/09	4	640	12	3	4.42	53	33	Oligotrophic
Bear	3/9/09	1	530	11	2	3.66	48	27	Oligotrophic
Bear	3/9/09	2	490	11	1	3.66	45	17	Oligotrophic
Bear	3/9/09	3	490	11	1	3.66	45	17	Oligotrophic
Bear	3/9/09	4	490	9	1	3.66	54	17	Oligotrophic
Bear	4/28/09	1	510	9	2	3.81	57	27	Oligotrophic
Bear	4/28/09	2	500	7	2	3.96	71	27	Oligotrophic
Bear	4/28/09	3	470	7	2	3.66	67	27	Oligotrophic
Bear	4/28/09	4	490	9	2	3.66	54	27	Oligotrophic
Bear	5/24/09	1	650	11	5	2.74	59	40	Oligotrophic
Bear	5/24/09	2	540	11	4	2.74	49	37	Oligotrophic
Bear	5/24/09	3	550	12	5	2.59	46	40	Oligotrophic
Bear	5/24/09	4	580	13	9	2.44	45	48	Oligotrophic
Bear	7/21/09	1	700	14	5	3.05	50	40	Oligotrophic
Bear	7/21/09	2	650	17	3	3.05	38	33	Oligotrophic
Bear	7/21/09	3	820	12	4	3.05	68	37	Oligotrophic
Bear	7/21/09	4	640	12	3	3.05	53	33	Oligotrophic
Bear	8/19/09	1				2.74	-	-	-
Bear	8/19/09	2				2.74	-	-	-
Bear	8/19/09	3				2.59	-	-	-
Bear	8/19/09	4				2.74	-	-	-
Bear	9/28/09	1	590	12	7	2.59	49	45	Oligotrophic
Bear	9/28/09	2	620	14	6	2.59	44	43	Oligotrophic
Bear	9/28/09	3	430	12	7	2.44	36	45	Oligotrophic
Bear	9/28/09	4	670	14	7	2.59	48	45	Oligotrophic
Bear	11/29/09	1	1150	11	5	3.20	105	40	Oligotrophic
Bear	11/29/09	2	1180	9	6	3.51	131	43	Oligotrophic
Bear	11/29/09	3	1120	11	6	3.35	102	43	Oligotrophic
Bear	11/29/09	4	1110	11	5	3.35	101	40	Oligotrophic
Bear	12/31/09	1				3.20	-	-	-
Bear	12/31/09	2				3.35	-	-	-
Bear	12/31/09	3				3.20	-	-	-
Bear	12/31/09	4				3.20	-	-	-

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/28/10	1	620	10	3	5.49	62	33	Oligotrophic
Bear	1/28/10	2	570	10	3	5.49	57	33	Oligotrophic
Bear	1/28/10	3	530	10	3	5.79	53	33	Oligotrophic
Bear	1/28/10	4	590	11	4	5.49	54	37	Oligotrophic
Bear	2/22/10	1				5.03	-	-	-
Bear	2/22/10	2				5.49	-	-	-
Bear	2/22/10	3				5.34	-	-	-
Bear	2/22/10	4				5.03	-	-	-
Bear	3/24/10	1	580	12	6	3.81	48	43	Oligotrophic
Bear	3/24/10	2	570	17	9	3.96	34	48	Oligotrophic
Bear	3/24/10	3	570	13	9	3.96	44	48	Oligotrophic
Bear	3/24/10	4	550	12	7	3.96	46	45	Oligotrophic
Bear	4/9/10	1				3.81	-	-	-
Bear	4/9/10	2				3.96	-	-	-
Bear	4/9/10	3				3.96	-	-	-
Bear	4/9/10	4				3.81	-	-	-
Bear	5/19/10	1	600	11	3.6	3.51	55	35	Oligotrophic
Bear	5/19/10	2	590	12	3	3.66	49	33	Oligotrophic
Bear	5/19/10	3	500	11	2.9	3.66	45	32	Oligotrophic
Bear	5/19/10	4	610	12	2.3	3.51	51	29	Oligotrophic
Bear	6/15/10	1				3.05	-	-	-
Bear	6/15/10	2				2.90	-	-	-
Bear	6/15/10	3				2.74	-	-	-
Bear	6/15/10	4				2.74	-	-	-
Bear	7/29/10	1	550	7	4.6	3.29	79	39	Oligotrophic
Bear	7/29/10	2	580	7	4.2	3.35	83	37	Oligotrophic
Bear	7/29/10	3	530	7	4.3	3.35	76	38	Oligotrophic
Bear	7/29/10	4	560	8	4.9	3.35	70	40	Oligotrophic
Bear	8/26/10	1				3.35	-	-	-
Bear	8/26/10	2				3.20	-	-	-
Bear	8/26/10	3				3.20	-	-	-
Bear	8/26/10	4				3.35	-	-	-
Bear	9/28/10	1	580	10	7	3.05	58	45	Oligotrophic
Bear	9/28/10	2	600	12	6	3.05	50	43	Oligotrophic
Bear	9/28/10	3	610	12	6	2.74	51	43	Oligotrophic
Bear	9/28/10	4	520	10	6	3.05	52	43	Oligotrophic
Bear	10/28/10	1				3.05	-	-	-
Bear	10/28/10	2				3.05	-	-	-
Bear	10/28/10	3				3.05	-	-	-
Bear	10/28/10	4				3.05	-	-	-
Bear	11/30/10	1	610	11	6	3.05	55	43	Oligotrophic
Bear	11/30/10	2	590	10	5	3.05	59	40	Oligotrophic
Bear	11/30/10	3	590	9	6	3.05	66	43	Oligotrophic
Bear	11/30/10	4	560	8	5	3.05	70	40	Oligotrophic
Bear	12/15/10	1				3.51	-	-	-
Bear	12/15/10	2				3.51	-	-	-
Bear	12/15/10	3				3.20	-	-	-
Bear	12/15/10	4				3.35	-	-	-

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/15/11	1	620	8	2	4.88	78	27	Oligotrophic
Bear	1/15/11	2	640	9	2	4.73	71	27	Oligotrophic
Bear	1/15/11	3	640	8	2	4.73	80	27	Oligotrophic
Bear	1/15/11	4	610	8	2	4.73	76	27	Oligotrophic
Bear	2/20/11	1				4.57	-	-	-
Bear	2/20/11	2				4.42	-	-	-
Bear	2/20/11	3				4.27	-	-	-
Bear	2/20/11	4				4.42	-	-	-
Bear	3/29/11	1	570	10	3	4.42	57	33	Oligotrophic
Bear	3/29/11	2	550	9	2	4.27	61	27	Oligotrophic
Bear	3/29/11	3	550	8	3	4.42	69	33	Oligotrophic
Bear	3/29/11	4	600	10	3	4.27	60	33	Oligotrophic
Bear	4/8/11	1				3.81	-	-	-
Bear	4/8/11	2				3.66	-	-	-
Bear	4/8/11	3				3.66	-	-	-
Bear	4/8/11	4				3.66	-	-	-
Bear	5/26/11	1	630	10	2.9	3.20	63	32	Oligotrophic
Bear	5/26/11	2	680	10	3.3	3.20	68	34	Oligotrophic
Bear	5/26/11	3	720	10	3.1	3.14	72	33	Oligotrophic
Bear	5/26/11	4	590	11	2.9	3.20	54	32	Oligotrophic
Bear	6/21/11	1				2.74	-	-	-
Bear	6/21/11	2				2.74	-	-	-
Bear	6/21/11	3				2.59	-	-	-
Bear	6/21/11	4				2.59	-	-	-
Bear	7/27/11	1	580	9	6	3.35	64	43	Oligotrophic
Bear	7/27/11	2	550	8	4.7	3.35	69	39	Oligotrophic
Bear	7/27/11	3	510	9	5.6	3.35	57	42	Oligotrophic
Bear	7/27/11	4	520	8	5.1	3.20	65	40	Oligotrophic
Bear	8/2/11	1	560	5	5.4	3.81	112	41	Oligotrophic
Bear	8/2/11	2	530	7	5.2	3.66	76	41	Oligotrophic
Bear	8/2/11	3	590	7	4.5	3.51	84	38	Oligotrophic
Bear	8/2/11	4	560	7	5.3	3.66	80	41	Oligotrophic
Bear	9/12/11	1	620	13	4	3.96	48	37	Oligotrophic
Bear	9/12/11	2	570	9	3.3	3.96	63	34	Oligotrophic
Bear	9/12/11	3	600	9	3.4	3.96	67	34	Oligotrophic
Bear	9/12/11	4	550	9	4.2	3.96	61	37	Oligotrophic
Bear	10/27/11	1	550	9	6	3.51	61	43	Oligotrophic
Bear	10/27/11	2	590	9	5.3	3.35	66	41	Oligotrophic
Bear	10/27/11	3	590	12	6	3.35	49	43	Oligotrophic
Bear	10/27/11	4	560	11	5.4	3.35	51	41	Oligotrophic
Bear	11/28/11	1	560	10	5.5	3.51	56	41	Oligotrophic
Bear	11/28/11	2	580	10	5.4	3.66	58	41	Oligotrophic
Bear	11/28/11	3	640	10	4.9	3.51	64	40	Oligotrophic
Bear	11/28/11	4	590	10	5.8	3.51	59	42	Oligotrophic
Bear	12/30/11	1	530	10	4.9	3.35	53	40	Oligotrophic
Bear	12/30/11	2	690	11	5.3	3.66	63	41	Oligotrophic
Bear	12/30/11	3	530	9	4.9	3.51	59	40	Oligotrophic
Bear	12/30/11	4	520	11	4.7	3.51	47	39	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/30/12	1	580	11	3.3	4.27	53	34	Oligotrophic
Bear	1/30/12	2	580	9	3.1	4.27	64	33	Oligotrophic
Bear	1/30/12	3	540	11	3.1	4.27	49	33	Oligotrophic
Bear	1/30/12	4	550	8	2.7	4.27	69	31	Oligotrophic
Bear	2/21/12	1	540	9		3.96	60	-	-
Bear	2/21/12	2	500	9		3.96	56	-	-
Bear	2/21/12	3	550	8		3.96	69	-	-
Bear	2/21/12	4	570	10		3.96	57	-	-
Bear	3/31/12	1	530	10	2.7	4.27	53	31	Oligotrophic
Bear	3/31/12	2	560	9	2.7	4.12	62	31	Oligotrophic
Bear	3/31/12	3	520	9	2.7	3.96	58	31	Oligotrophic
Bear	3/31/12	4	550	9	2.4	4.12	61	29	Oligotrophic
Bear	4/25/12	1	600	12	2.4	3.96	50	29	Oligotrophic
Bear	4/25/12	2	560	13	2	3.81	43	27	Oligotrophic
Bear	4/25/12	3	580	12	2	3.66	48	27	Oligotrophic
Bear	4/25/12	4	570	11	2	3.81	52	27	Oligotrophic
Bear	5/20/12	1				3.96	-	-	-
Bear	5/20/12	2				3.81	-	-	-
Bear	5/20/12	3				3.66	-	-	-
Bear	5/20/12	4				3.81	-	-	-
Bear	6/18/12	1	680	10	4	3.66	68	37	Oligotrophic
Bear	6/18/12	2	640	10	3	3.51	64	33	Oligotrophic
Bear	6/18/12	3	640	10	3	3.51	64	33	Oligotrophic
Bear	6/18/12	4	760	12	3	3.51	63	33	Oligotrophic
Bear	7/24/12	1	690	13	7	2.90	53	45	Oligotrophic
Bear	7/24/12	2	720	12	6	2.74	60	43	Oligotrophic
Bear	7/24/12	3	680	12	5	2.59	57	40	Oligotrophic
Bear	7/24/12	4	600	13	6	2.59	46	43	Oligotrophic
Bear	8/23/12	1	570	8	6	3.05	71	43	Oligotrophic
Bear	8/23/12	2	580	8	6	3.05	73	43	Oligotrophic
Bear	8/23/12	3	570	9	6	2.90	63	43	Oligotrophic
Bear	8/23/12	4	560	12	6	3.05	47	43	Oligotrophic
Bear	9/26/12	1	620	10	6	2.74	62	43	Oligotrophic
Bear	9/26/12	2	840	10	6	2.90	84	43	Oligotrophic
Bear	9/26/12	3	600	10	5	2.90	60	40	Oligotrophic
Bear	9/26/12	4	600	11	5	2.90	55	40	Oligotrophic
Bear	10/19/12	1	680	13	4	2.90	52	37	Oligotrophic
Bear	10/19/12	2	640	12	4	3.05	53	37	Oligotrophic
Bear	10/19/12	3	870	15	5	2.90	58	40	Oligotrophic
Bear	10/19/12	4	700	12	5	2.74	58	40	Oligotrophic
Bear	11/25/12	1	630	11	3	4.73	57	33	Oligotrophic
Bear	11/25/12	2	710	13	3	4.73	55	33	Oligotrophic
Bear	11/25/12	3	580	11	3	4.73	53	33	Oligotrophic
Bear	11/25/12	4	580	11	2	4.57	53	27	Oligotrophic
Bear	12/16/12	1	550	10	6	4.73	55	43	Oligotrophic
Bear	12/16/12	2	530	12	6	4.73	44	43	Oligotrophic
Bear	12/16/12	3	510	13	6	4.57	39	43	Oligotrophic
Bear	12/16/12	4	530	13	7	4.27	41	45	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/27/13	1	680	13	4	4.57	52	37	Oligotrophic
Bear	1/27/13	2	510	13	5	4.42	39	40	Oligotrophic
Bear	1/27/13	3	600	15	5	4.57	40	40	Oligotrophic
Bear	1/27/13	4	630	14	3	4.27	45	33	Oligotrophic
Bear	3/29/13	1	600	13	3	3.96	46	33	Oligotrophic
Bear	3/29/13	2	630	14	3	3.96	45	33	Oligotrophic
Bear	3/29/13	3	620	15	3	3.96	41	33	Oligotrophic
Bear	3/29/13	4	530	14	3	3.96	38	33	Oligotrophic
Bear	5/18/13	1	550	13	3	3.51	42	33	Oligotrophic
Bear	5/18/13	2	510	12	2	3.51	43	27	Oligotrophic
Bear	5/18/13	3	530	10	4	3.35	53	37	Oligotrophic
Bear	5/18/13	4	550	12	2	3.35	46	27	Oligotrophic
Bear	6/12/13	1	520	13	5	3.51	40	40	Oligotrophic
Bear	6/12/13	2	600	11	4	3.35	55	37	Oligotrophic
Bear	6/12/13	3	560	12	4	3.29	47	37	Oligotrophic
Bear	6/12/13	4	610	14	4	3.35	44	37	Oligotrophic
Bear	6/26/13	1	620	15	9	3.35	41	48	Oligotrophic
Bear	6/26/13	2	560	17	7	3.35	33	45	Oligotrophic
Bear	6/26/13	3	640	16	8	3.35	40	47	Oligotrophic
Bear	6/26/13	4	560	15	9	3.35	37	48	Oligotrophic
Bear	7/12/13	1	450	12	5	3.35	38	40	Oligotrophic
Bear	7/12/13	2	490	13	5	3.35	38	40	Oligotrophic
Bear	7/12/13	3	450	12	5	3.35	38	40	Oligotrophic
Bear	7/12/13	4	660	12	5	3.35	55	40	Oligotrophic
Bear	7/29/13	1	450	11	7	3.20	41	45	Oligotrophic
Bear	7/29/13	2	470	13	5	3.05	36	40	Oligotrophic
Bear	7/29/13	3	590	10	4	3.05	59	37	Oligotrophic
Bear	7/29/13	4	520	13	6	3.20	40	43	Oligotrophic
Bear	8/20/13	1	560	10	5	3.66	56	40	Oligotrophic
Bear	8/20/13	2	620	10	5	3.51	62	40	Oligotrophic
Bear	8/20/13	3	600	11	4	3.51	55	37	Oligotrophic
Bear	8/20/13	4	590	10	5	3.51	59	40	Oligotrophic
Bear	8/31/13	1	580	11	4	3.66	53	37	Oligotrophic
Bear	8/31/13	2	600	10	4	3.66	60	37	Oligotrophic
Bear	8/31/13	3	560	9	4	3.66	62	37	Oligotrophic
Bear	8/31/13	4	590	12	4	3.51	49	37	Oligotrophic
Bear	9/15/13	1	640	11	4	3.66	58	37	Oligotrophic
Bear	9/15/13	2	510	11	5	3.66	46	40	Oligotrophic
Bear	9/15/13	3	470	7	5	3.66	67	40	Oligotrophic
Bear	9/15/13	4	420	9	4	3.51	47	37	Oligotrophic
Bear	9/29/13	1	460	8	6	3.35	58	43	Oligotrophic
Bear	9/29/13	2	470	7	5	3.35	67	40	Oligotrophic
Bear	9/29/13	3	670	9	5	3.20	74	40	Oligotrophic
Bear	9/29/13	4	450	9	5	3.35	50	40	Oligotrophic
Bear	10/19/13	1	450	11	6	3.35	41	43	Oligotrophic
Bear	10/19/13	2	590	11	5	3.35	54	40	Oligotrophic
Bear	10/19/13	3	560	8	6	3.20	70	43	Oligotrophic
Bear	10/19/13	4	560	13	7	3.35	43	45	Oligotrophic
Bear	10/31/13	1	610	8	5	3.51	76	40	Oligotrophic
Bear	10/31/13	2	510	9	4	3.51	57	37	Oligotrophic
Bear	10/31/13	3	510	9	5	3.35	57	40	Oligotrophic
Bear	10/31/13	4	530	7	4	3.35	76	37	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	11/21/13	1	670	8	4	3.96	84	37	Oligotrophic
Bear	11/21/13	2	700	7	4	3.81	100	37	Oligotrophic
Bear	11/21/13	3	640	8	5	3.66	80	40	Oligotrophic
Bear	11/21/13	4	570	9	5	3.81	63	40	Oligotrophic
Bear	12/26/13	1	540	9	4	3.35	60	37	Oligotrophic
Bear	12/26/13	2	540	8	4	3.20	68	37	Oligotrophic
Bear	12/26/13	3	650	9	3	3.35	72	33	Oligotrophic
Bear	12/26/13	4	680	10	4	3.20	68	37	Oligotrophic
Bear	12/31/13	1	550	9	4	3.35	61	37	Oligotrophic
Bear	12/31/13	2	570	8	5	3.35	71	40	Oligotrophic
Bear	12/31/13	3	520	8	4	3.35	65	37	Oligotrophic
Bear	12/31/13	4	670	9	4	3.35	74	37	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/19/14	1	290	8	3	3.96	36	33	Oligotrophic
Bear	1/19/14	2	250	7	3	3.96	36	33	Oligotrophic
Bear	1/19/14	3	200	8	3	3.96	25	33	Oligotrophic
Bear	1/19/14	4	220	9	3	3.81	24	33	Oligotrophic
Bear	2/9/14	1	450	9	3	4.27	50	33	Oligotrophic
Bear	2/9/14	2	460	9	4	4.27	51	37	Oligotrophic
Bear	2/9/14	3	440	9	4	4.27	49	37	Oligotrophic
Bear	2/9/14	4	380	5	3	4.12	76	33	Oligotrophic
Bear	2/23/14	1	510	8	3	4.12	64	33	Oligotrophic
Bear	2/23/14	2	620	7	3	4.12	89	33	Oligotrophic
Bear	2/23/14	3	530	8	3	3.96	66	33	Oligotrophic
Bear	2/23/14	4	530	8	3	3.96	66	33	Oligotrophic
Bear	3/8/14	1	640	10	3	4.88	64	33	Oligotrophic
Bear	3/8/14	2	590	10	3	4.88	59	33	Oligotrophic
Bear	3/8/14	3	670	9	3	4.88	74	33	Oligotrophic
Bear	3/8/14	4	550	9	3	4.88	61	33	Oligotrophic
Bear	3/15/14	1	530	10	3	4.88	53	33	Oligotrophic
Bear	3/15/14	2	490	10	3	4.57	49	33	Oligotrophic
Bear	3/15/14	3	520	12	3	4.12	43	33	Oligotrophic
Bear	3/15/14	4	480	10	3	4.42	48	33	Oligotrophic
Bear	4/25/14	1	560	14	3	3.66	40	33	Oligotrophic
Bear	4/25/14	2	560	11	3	3.81	51	33	Oligotrophic
Bear	4/25/14	3	440	12	3	3.66	37	33	Oligotrophic
Bear	4/25/14	4	430	12	3	3.66	36	33	Oligotrophic
Bear	5/21/14	1	490	10	3	3.96	49	33	Oligotrophic
Bear	5/21/14	2	490	10	3	3.96	49	33	Oligotrophic
Bear	5/21/14	3	560	10	3	3.81	56	33	Oligotrophic
Bear	5/21/14	4	460	9	3	3.96	51	33	Oligotrophic
Bear	5/31/14	1	510	8	3	3.96	64	33	Oligotrophic
Bear	5/31/14	2	540	10	3	3.96	54	33	Oligotrophic
Bear	5/31/14	3	510	8	3	3.81	64	33	Oligotrophic
Bear	5/31/14	4	580	9	3	3.96	64	33	Oligotrophic
Bear	6/10/14	1	570	10	3	3.66	57	33	Oligotrophic
Bear	6/10/14	2	490	10	3	3.81	49	33	Oligotrophic
Bear	6/10/14	3	560	9	3	3.66	62	33	Oligotrophic
Bear	6/10/14	4	550	10	3	3.35	55	33	Oligotrophic
Bear	6/28/14	1	590	14	4	2.74	42	37	Oligotrophic
Bear	6/28/14	2	580	12	4	2.90	48	37	Oligotrophic
Bear	6/28/14	3	540	13	4	2.90	42	37	Oligotrophic
Bear	6/28/14	4	830	13	4	3.05	64	37	Oligotrophic
Bear	7/22/14	1	480	12	4	3.35	40	37	Oligotrophic
Bear	7/22/14	2	590	12	4	3.35	49	37	Oligotrophic
Bear	7/22/14	3	460	11	4	3.05	42	37	Oligotrophic
Bear	7/22/14	4	530	13	4	3.20	41	37	Oligotrophic
Bear	8/12/14	1	550	12	8	3.05	46	47	Oligotrophic
Bear	8/12/14	2	700	12	7	3.05	58	45	Oligotrophic
Bear	8/12/14	3	560	10	8	3.05	56	47	Oligotrophic
Bear	8/12/14	4	560	12	7	3.05	47	45	Oligotrophic
Bear	9/27/14	1	570	10	9	2.74	57	48	Oligotrophic
Bear	9/27/14	2	590	12	11	2.44	49	51	Mesotrophic
Bear	9/27/14	3	600	12	10	2.44	50	50	Oligotrophic
Bear	9/27/14	4	630	14	10	2.44	45	50	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	10/25/14	1	590	12	6	3.35	49	43	Oligotrophic
Bear	10/25/14	2	680	13	6	3.35	52	43	Oligotrophic
Bear	10/25/14	3	630	13	6	3.05	48	43	Oligotrophic
Bear	10/25/14	4	630	13	6	3.05	48	43	Oligotrophic
Bear	11/16/14	1	660	9	5	3.66	73	40	Oligotrophic
Bear	11/16/14	2	740	8	5	3.66	93	40	Oligotrophic
Bear	11/16/14	3	650	10	5	3.35	65	40	Oligotrophic
Bear	11/16/14	4	810	9	5	3.35	90	40	Oligotrophic
Bear	12/20/14	1	630	10	3	4.57	63	33	Oligotrophic
Bear	12/20/14	2	560	10	3	4.57	56	33	Oligotrophic
Bear	12/20/14	3	580	12	3	4.57	48	33	Oligotrophic
Bear	12/20/14	4	540	10	3	4.73	54	33	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/17/15	1	560	9	5	4.12	62	40	Oligotrophic
Bear	1/17/15	2	520	9	5	3.81	58	40	Oligotrophic
Bear	1/17/15	3	540	9	4	3.96	60	37	Oligotrophic
Bear	1/17/15	4	660	6	5	3.96	110	40	Oligotrophic
Bear	2/8/15	1	770	13	4	3.51	59	37	Oligotrophic
Bear	2/8/15	2	530	10	4	3.66	53	37	Oligotrophic
Bear	2/8/15	3	570	12	3	3.66	48	33	Oligotrophic
Bear	2/8/15	4	630	13	4	3.66	48	37	Oligotrophic
Bear	3/15/15	1	500	10	3	3.96	50	33	Oligotrophic
Bear	3/15/15	2	510	5	2	3.66	102	27	Oligotrophic
Bear	3/15/15	3	560	9	3	3.96	62	33	Oligotrophic
Bear	3/15/15	4	660	13	3	3.66	51	33	Oligotrophic
Bear	4/26/15	1	580	16	3	3.51	36	33	Oligotrophic
Bear	4/26/15	2	520	13	3	3.35	40	33	Oligotrophic
Bear	4/26/15	3	440	14	3	3.20	31	33	Oligotrophic
Bear	4/26/15	4	430	11	3	3.20	39	33	Oligotrophic
Bear	5/19/15	1	510	12	2	3.81	43	27	Oligotrophic
Bear	5/19/15	2	510	11	2	3.81	46	27	Oligotrophic
Bear	5/19/15	3	650	10	2	3.66	65	27	Oligotrophic
Bear	5/19/15	4	690	12	2	3.66	58	27	Oligotrophic
Bear	6/23/15	1	740	12	3	2.90	62	33	Oligotrophic
Bear	6/23/15	2	650	10	4	2.74	65	37	Oligotrophic
Bear	6/23/15	3	640	11	3	3.05	58	33	Oligotrophic
Bear	6/23/15	4	650	12	4	2.44	54	37	Oligotrophic
Bear	7/14/15	1	640	17	4	3.05	38	37	Oligotrophic
Bear	7/14/15	2	530	15	4	2.74	35	37	Oligotrophic
Bear	7/14/15	3	600	15	4	2.74	40	37	Oligotrophic
Bear	7/14/15	4	580	16	4	3.05	36	37	Oligotrophic
Bear	8/29/15	1	610	21	5	3.05	29	40	Oligotrophic
Bear	8/29/15	2	670	18	5	3.20	37	40	Oligotrophic
Bear	8/29/15	3	640	17	4	3.20	38	37	Oligotrophic
Bear	8/29/15	4	690	18	5	3.05	38	40	Oligotrophic
Bear	9/24/15	1	470	15	6	3.05	31	43	Oligotrophic
Bear	9/24/15	2	530	14	6	3.20	38	43	Oligotrophic
Bear	9/24/15	3	510	14	6	3.05	36	43	Oligotrophic
Bear	9/24/15	4	590	12	6	3.20	49	43	Oligotrophic
Bear	10/25/15	1	560	9	6	3.35	62	43	Oligotrophic
Bear	10/25/15	2	580	11	5	3.05	53	40	Oligotrophic
Bear	10/25/15	3	610	10	6	3.35	61	43	Oligotrophic
Bear	10/25/15	4	570	10	6	3.35	57	43	Oligotrophic
Bear	11/30/15	1	540	12	6	3.51	45	43	Oligotrophic
Bear	11/30/15	2	520	12	5	3.35	43	40	Oligotrophic
Bear	11/30/15	3	520	11	5	3.35	47	40	Oligotrophic
Bear	11/30/15	4	440	13	5	3.35	34	40	Oligotrophic
Bear	12/20/15	1	480	10	5	3.35	48	40	Oligotrophic
Bear	12/20/15	2	530	11	5	3.35	48	40	Oligotrophic
Bear	12/20/15	3	770	13	5	3.35	59	40	Oligotrophic
Bear	12/20/15	4	530	13	5	3.35	41	40	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/26/16	1	660	11	3	3.66	60	33	Oligotrophic
Bear	1/26/16	2	590	11	4	3.51	54	37	Oligotrophic
Bear	1/26/16	3	470	12	4	3.51	39	37	Oligotrophic
Bear	1/26/16	4	640	11	3	3.66	58	33	Oligotrophic
Bear	2/21/16	1	570	13	3	3.81	44	33	Oligotrophic
Bear	2/21/16	2	550	11	3	3.66	50	33	Oligotrophic
Bear	2/21/16	3	550	11	3	3.81	50	33	Oligotrophic
Bear	2/21/16	4	650	12	3	3.96	54	33	Oligotrophic
Bear	3/26/16	1	550	8	3	3.96	69	33	Oligotrophic
Bear	3/26/16	2	560	10	3	3.96	56	33	Oligotrophic
Bear	3/26/16	3	550	8	3	3.96	69	33	Oligotrophic
Bear	3/26/16	4	600	11	4	3.66	55	37	Oligotrophic
Bear	4/26/16	1	580	13	2	3.96	45	27	Oligotrophic
Bear	4/26/16	2	540	13	3	3.96	42	33	Oligotrophic
Bear	4/26/16	3	690	13	3	3.96	53	33	Oligotrophic
Bear	4/26/16	4	660	13	2	3.81	51	27	Oligotrophic
Bear	5/14/16	1	590	12	3	3.05	49	33	Oligotrophic
Bear	5/14/16	2	630	12	2	3.20	53	27	Oligotrophic
Bear	5/14/16	3	630	13	2	3.05	48	27	Oligotrophic
Bear	5/14/16	4	690	11	2	3.20	63	27	Oligotrophic
Bear	6/30/16	1	700	9	4	2.74	78	37	Oligotrophic
Bear	6/30/16	2	790	10	5	2.44	79	40	Oligotrophic
Bear	6/30/16	3	740	12	5	2.44	62	40	Oligotrophic
Bear	6/30/16	4	690	11	4	2.59	63	37	Oligotrophic
Bear	7/28/16	1	560	11	5	3.35	51	40	Oligotrophic
Bear	7/28/16	2	580	12	5	3.35	48	40	Oligotrophic
Bear	7/28/16	3	580	10	4	3.35	58	37	Oligotrophic
Bear	7/28/16	4	580	10	5	3.20	58	40	Oligotrophic
Bear	8/24/16	1	570	10	4	3.51	57	37	Oligotrophic
Bear	8/24/16	2	600	10	4	3.51	60	37	Oligotrophic
Bear	8/24/16	3	590	10	4	3.35	59	37	Oligotrophic
Bear	8/24/16	4	590	11	4	3.51	54	37	Oligotrophic
Bear	9/23/16	1	580	10	6	2.90	58	43	Oligotrophic
Bear	9/23/16	2	600	11	5	2.90	55	40	Oligotrophic
Bear	9/23/16	3	580	8	2	2.90	73	27	Oligotrophic
Bear	9/23/16	4	620	14	2	2.74	44	27	Oligotrophic
Bear	10/25/16	1	610	12	8	2.74	51	47	Oligotrophic
Bear	10/25/16	2	650	13	9	2.74	50	48	Oligotrophic
Bear	10/25/16	3	640	13	7	2.74	49	45	Oligotrophic
Bear	10/25/16	4	630	12	8	2.74	53	47	Oligotrophic
Bear	11/24/16	1	550	12	8	2.74	46	47	Oligotrophic
Bear	11/24/16	2	1060	10	7	2.74	106	45	Oligotrophic
Bear	11/24/16	3	650	13	6	2.59	50	43	Oligotrophic
Bear	11/24/16	4	850	12	6	2.59	71	43	Oligotrophic
Bear	12/19/16	1	580	11	6	2.90	53	43	Oligotrophic
Bear	12/19/16	2	550	10	5	2.90	55	40	Oligotrophic
Bear	12/19/16	3	560	10	7	2.74	56	45	Oligotrophic
Bear	12/19/16	4	600	13	5	2.74	46	40	Oligotrophic

LakeWatch Data for Bear Lake from 1991 - 2021

Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/25/17	1	530	14	5	3.05	38	40	Oligotrophic
Bear	1/25/17	2	440	8	5	3.05	55	40	Oligotrophic
Bear	1/25/17	3	440	12	5	3.05	37	40	Oligotrophic
Bear	1/25/17	4	410	12	5	2.90	34	40	Oligotrophic
Bear	3/30/17	1	420	9	3	3.35	47	33	Oligotrophic
Bear	3/30/17	2	460	11	3	3.35	42	33	Oligotrophic
Bear	3/30/17	3	500	8	3	3.20	63	33	Oligotrophic
Bear	3/30/17	4	580	8	2	3.35	73	27	Oligotrophic
Bear	4/26/17	1	520	9	3	3.35	58	33	Oligotrophic
Bear	4/26/17	2	590	7	4	3.35	84	37	Oligotrophic
Bear	4/26/17	3	510	8	3	3.20	64	33	Oligotrophic
Bear	4/26/17	4	500	14	3	3.20	36	33	Oligotrophic
Bear	5/27/17	1	580	10	4	2.74	58	37	Oligotrophic
Bear	5/27/17	2	610	10	4	2.74	61	37	Oligotrophic
Bear	5/27/17	3	570	9	4	2.74	63	37	Oligotrophic
Bear	5/27/17	4	580	9	4	2.74	64	37	Oligotrophic
Bear	6/25/17	1	530	12	7	2.13	44	45	Oligotrophic
Bear	6/25/17	2	580	12	6	2.13	48	43	Oligotrophic
Bear	6/25/17	3	760	16	7	2.13	48	45	Oligotrophic
Bear	6/25/17	4	630	15	8	2.13	42	47	Oligotrophic
Bear	7/24/17	1	650	15	10	2.44	43	50	Oligotrophic
Bear	7/24/17	2	730	13	10	2.44	56	50	Oligotrophic
Bear	7/24/17	3	650	14	9	2.44	46	48	Oligotrophic
Bear	7/24/17	4	770	18	10	2.44	43	50	Oligotrophic
Bear	8/30/17	1	620	9	9	2.74	69	48	Oligotrophic
Bear	8/30/17	2	590	11	9	2.74	54	48	Oligotrophic
Bear	8/30/17	3	570	9	10	2.74	63	50	Oligotrophic
Bear	8/30/17	4	550	9	9	2.74	61	48	Oligotrophic
Bear	9/30/17	1	660	16	13	2.13	41	54	Mesotrophic
Bear	9/30/17	2	660	17	12	2.13	39	53	Mesotrophic
Bear	9/30/17	3	650	13	13	1.98	50	54	Mesotrophic
Bear	9/30/17	4	640	17	12	1.98	38	53	Mesotrophic
Bear	10/31/17	1	710	23	14	2.44	31	55	Mesotrophic
Bear	10/31/17	2	690	17	14	2.44	41	55	Mesotrophic
Bear	10/31/17	3	680	18	14	2.29	38	55	Mesotrophic
Bear	10/31/17	4	670	15	12	2.44	45	53	Mesotrophic
Bear	11/18/17	1	710	13	18	2.29	55	58	Mesotrophic
Bear	11/18/17	2	730	12	18	2.29	61	58	Mesotrophic
Bear	11/18/17	3	710	12	18	2.13	59	58	Mesotrophic
Bear	11/18/17	4	710	13	15	2.29	55	56	Mesotrophic
Bear	12/17/17	1	600	15	9	2.59	40	48	Oligotrophic
Bear	12/17/17	2	640	16	10	2.44	40	50	Oligotrophic
Bear	12/17/17	3	620	16	11	2.44	39	51	Mesotrophic
Bear	12/17/17	4	590	14	9	2.44	42	48	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/31/18	1	550	14	6	3.35	39	43	Oligotrophic
Bear	1/31/18	2	550	13	6	3.05	42	43	Oligotrophic
Bear	1/31/18	3	560	14	8	2.90	40	47	Oligotrophic
Bear	1/31/18	4	540	13	6	3.05	42	43	Oligotrophic
Bear	3/24/18	1	590	15	6	2.44	39	43	Oligotrophic
Bear	3/24/18	2	580	15	6	2.44	39	43	Oligotrophic
Bear	3/24/18	3	580	15	6	2.44	39	43	Oligotrophic
Bear	3/24/18	4	590	15	6	2.44	39	43	Oligotrophic
Bear	4/29/18	1	550	15	6	2.44	37	43	Oligotrophic
Bear	4/29/18	2	580	14	7	2.29	41	45	Oligotrophic
Bear	4/29/18	3	590	15	6	2.44	39	43	Oligotrophic
Bear	4/29/18	4	490	15	6	2.29	33	43	Oligotrophic
Bear	5/31/18	1	540	15	8	2.29	36	47	Oligotrophic
Bear	5/31/18	2	560	15	8	2.29	37	47	Oligotrophic
Bear	5/31/18	3	440	14	7	2.13	31	45	Oligotrophic
Bear	5/31/18	4	560	15	8	2.13	37	47	Oligotrophic
Bear	6/24/18	1	640	16	9	2.13	40	48	Oligotrophic
Bear	6/24/18	2	630	12	9	2.13	53	48	Oligotrophic
Bear	6/24/18	3	620	9	8	2.13	69	47	Oligotrophic
Bear	6/24/18	4	610	10	10	2.13	61	50	Oligotrophic
Bear	7/31/18	1	640	12	13	2.13	53	54	Mesotrophic
Bear	7/31/18	2	650	4	13	2.13	163	54	Mesotrophic
Bear	7/31/18	3	640	12	13	2.13	53	54	Mesotrophic
Bear	7/31/18	4	660	11	13	2.13	60	54	Mesotrophic
Bear	8/29/18	1	630	18	15	1.83	35	56	Mesotrophic
Bear	8/29/18	2	650	15	15	1.83	43	56	Mesotrophic
Bear	8/29/18	3	650	14	16	1.83	46	57	Mesotrophic
Bear	8/29/18	4	630	7	17	1.98	90	58	Mesotrophic
Bear	9/30/18	1	610	13		2.13	47	-	-
Bear	9/30/18	2	600	14		1.98	43	-	-
Bear	9/30/18	3	610	12		2.13	51	-	-
Bear	9/30/18	4	610	8		1.98	76	-	-
Bear	10/17/18	1	720	15	18	2.90	48	58	Mesotrophic
Bear	10/17/18	2	710	16	15	2.90	44	56	Mesotrophic
Bear	10/17/18	3	700	14	15	2.74	50	56	Mesotrophic
Bear	10/17/18	4	750	17	19	2.74	44	59	Mesotrophic
Bear	12/30/18	1	360	15	11	2.59	24	51	Mesotrophic
Bear	12/30/18	2	570	14	11	2.44	41	51	Mesotrophic
Bear	12/30/18	3	590	14	9	2.44	42	48	Oligotrophic
Bear	12/30/18	4	630	18	12	2.59	35	53	Mesotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/31/19	1	580	15	6	3.20	39	43	Oligotrophic
Bear	1/31/19	2	590	18	6	3.05	33	43	Oligotrophic
Bear	1/31/19	3	590	17	7	2.90	35	45	Oligotrophic
Bear	1/31/19	4	600	16	6	3.05	38	43	Oligotrophic
Bear	2/28/19	1	470	12	8	3.05	39	47	Oligotrophic
Bear	2/28/19	2	500	13	8	2.90	38	47	Oligotrophic
Bear	2/28/19	3	500	13	8	3.05	38	47	Oligotrophic
Bear	2/28/19	4	500	9	8	2.74	56	47	Oligotrophic
Bear	3/25/19	1	490	13	6	3.20	38	43	Oligotrophic
Bear	3/25/19	2	470	14	6	3.05	34	43	Oligotrophic
Bear	3/25/19	3	470	13	7	3.05	36	45	Oligotrophic
Bear	3/25/19	4	480	7	7	3.05	69	45	Oligotrophic
Bear	4/21/19	1	470	15	6	2.74	31	43	Oligotrophic
Bear	4/21/19	2	480	14	6	2.74	34	43	Oligotrophic
Bear	4/21/19	3	500	16	6	2.74	31	43	Oligotrophic
Bear	4/21/19	4	490	16	7	2.74	31	45	Oligotrophic
Bear	5/26/19	1	480	15	5	3.05	32	40	Oligotrophic
Bear	5/26/19	2	460	14	5	3.05	33	40	Oligotrophic
Bear	5/26/19	3	490	14	5	3.05	35	40	Oligotrophic
Bear	5/26/19	4	490	13	4	3.05	38	37	Oligotrophic
Bear	6/30/19	1	550	16	12	2.13	34	53	Mesotrophic
Bear	6/30/19	2	550	18	11	2.13	31	51	Mesotrophic
Bear	6/30/19	3	540	12	11	2.13	45	51	Mesotrophic
Bear	6/30/19	4	570	16	11	2.13	36	51	Mesotrophic
Bear	7/21/19	1	640	11	18	1.83	58	58	Mesotrophic
Bear	7/21/19	2	680	8	18	1.68	85	58	Mesotrophic
Bear	7/21/19	3	700	9	17	1.83	78	58	Mesotrophic
Bear	7/21/19	4	710	12	19	1.68	59	59	Mesotrophic
Bear	8/25/19	1	630	17	12	1.22	37	53	Mesotrophic
Bear	8/25/19	2	610	14	11	1.22	44	51	Mesotrophic
Bear	8/25/19	3	630	15	12	1.98	42	53	Mesotrophic
Bear	8/25/19	4	610	16	12	2.13	38	53	Mesotrophic
Bear	10/24/19	1	570	14	15	2.29	41	56	Mesotrophic
Bear	10/24/19	2	580	15	14	2.13	39	55	Mesotrophic
Bear	10/24/19	3	590	16	14	2.13	37	55	Mesotrophic
Bear	10/24/19	4	590	14	15	2.13	42	56	Mesotrophic
Bear	11/22/19	1	580	15	14	2.29	39	55	Mesotrophic
Bear	11/22/19	2	570	17	14	2.13	34	55	Mesotrophic
Bear	11/22/19	3	550	17	13	2.13	32	54	Mesotrophic
Bear	11/22/19	4	580	16	12	2.29	36	53	Mesotrophic
Bear	12/31/19	1	560	14	7	2.44	40	45	Oligotrophic
Bear	12/31/19	2	520	12	8	2.44	43	47	Oligotrophic
Bear	12/31/19	3	520	13	8	2.44	40	47	Oligotrophic
Bear	12/31/19	4	550	11	4	2.44	50	37	Oligotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/27/20	1	570	17	10	2.44	34	50	Oligotrophic
Bear	1/27/20	2	550	13	10	2.44	42	50	Oligotrophic
Bear	1/27/20	3	530	15	9	2.44	35	48	Oligotrophic
Bear	1/27/20	4	540	17	11	2.44	32	51	Mesotrophic
Bear	3/15/20	1	530	11	9	2.74	48	48	Oligotrophic
Bear	3/15/20	2	390	19	9	2.74	21	48	Oligotrophic
Bear	3/15/20	3	500	13	9	2.74	38	48	Oligotrophic
Bear	3/15/20	4	530	12	9	2.74	44	48	Oligotrophic
Bear	4/25/20	1				2.74	-	-	-
Bear	4/25/20	2				2.74	-	-	-
Bear	4/25/20	3				2.74	-	-	-
Bear	4/25/20	4				2.74	-	-	-
Bear	5/30/20	1				2.59	-	-	-
Bear	5/30/20	2				2.59	-	-	-
Bear	5/30/20	3				2.74	-	-	-
Bear	5/30/20	4				2.74	-	-	-
Bear	6/21/20	1	510	13	7	2.44	39	45	Oligotrophic
Bear	6/21/20	2	500	13	7	2.44	38	45	Oligotrophic
Bear	6/21/20	3	520	14	8	2.44	37	47	Oligotrophic
Bear	6/21/20	4	520	14	8	2.44	37	47	Oligotrophic
Bear	7/20/20	1	610	12	10	2.44	51	50	Oligotrophic
Bear	7/20/20	2	600	14	7	2.44	43	45	Oligotrophic
Bear	7/20/20	3	660	17	8	2.29	39	47	Oligotrophic
Bear	7/20/20	4	610	14	9	2.29	44	48	Oligotrophic
Bear	8/14/20	3	800	15		1.83	53	-	Hypereutrophic
Bear	9/19/20	1	760	19	16	1.83	40	57	Mesotrophic
Bear	9/19/20	2	620	14	15	1.83	44	56	Mesotrophic
Bear	9/19/20	3	640	14	16	1.52	46	57	Mesotrophic
Bear	9/19/20	4	640	18	18	1.83	36	58	Mesotrophic
Bear	10/25/20	1	690	17	20	1.52	41	60	Mesotrophic
Bear	10/25/20	2	630	19	19	1.52	33	59	Mesotrophic
Bear	10/25/20	3	670	17	22	1.52	39	61	Eutrophic
Bear	10/25/20	4	740	18	20	1.52	41	60	Mesotrophic
Bear	11/29/20	1	720	15	15	1.83	48	56	Mesotrophic
Bear	11/29/20	2	720	16	16	1.83	45	57	Mesotrophic
Bear	11/29/20	3	710	14	15	1.83	51	56	Mesotrophic
Bear	11/29/20	4	740	17	15	1.83	44	56	Mesotrophic
Bear	12/29/20	1	700	22	13	2.13	32	54	Mesotrophic
Bear	12/29/20	2	700	21	15	2.29	33	56	Mesotrophic
Bear	12/29/20	3	740	24	18	1.83	31	58	Mesotrophic
Bear	12/29/20	4	710	22	12	2.13	32	53	Mesotrophic

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Lake	Date	Station	Total N (µg/L)	Total P (µg/L)	Chyl-a (µg/L)	Secchi Depth (m)	TN/TP Ratio	TSI (chyl-a)	Trophic State
Bear	1/24/21	1	670	18	13	2.13	37	54	Mesotrophic
Bear	1/24/21	2	700	19	15	2.13	37	56	Mesotrophic
Bear	1/24/21	3	710	20	15	1.83	36	56	Mesotrophic
Bear	1/24/21	4	710	20	14	2.13	36	55	Mesotrophic
Bear	2/28/21	1	610	12	6	2.74	51	43	Oligotrophic
Bear	2/28/21	2	590	15	6	2.90	39	43	Oligotrophic
Bear	2/28/21	3	620	13	5	2.90	48	40	Oligotrophic
Bear	2/28/21	4	610	14	6	2.74	44	43	Oligotrophic
Bear	3/23/21	1	560	20	7	2.74	28	45	Oligotrophic
Bear	3/23/21	2	570	21	6	2.59	27	43	Oligotrophic
Bear	3/23/21	3	580	18	6	2.74	32	43	Oligotrophic
Bear	3/23/21	4	560	15	5	2.74	37	40	Oligotrophic
Bear	4/30/21	1	610	15	8	1.98	41	47	Oligotrophic
Bear	4/30/21	2	640	17	8	1.98	38	47	Oligotrophic
Bear	4/30/21	3	610	17	8	1.98	36	47	Oligotrophic
Bear	4/30/21	4	590	17	8	1.98	35	47	Oligotrophic
Bear	5/24/21	1	730	16	12	1.83	46	53	Mesotrophic
Bear	5/24/21	2	770	16	12	1.83	48	53	Mesotrophic
Bear	5/24/21	3	770	18	13	1.68	43	54	Mesotrophic
Bear	5/24/21	4	750	16	11	1.83	47	51	Mesotrophic
Bear	6/9/21	1	760	21	18	1.37	36	58	Mesotrophic
Bear	6/9/21	2	750	18	17	1.37	42	58	Mesotrophic
Bear	6/9/21	3	740	18	16	1.22	41	57	Mesotrophic
Bear	6/9/21	4	820	22	20	1.22	37	60	Mesotrophic
Bear	7/26/21	1	730	17	14	1.52	43	55	Mesotrophic
Bear	7/26/21	2	710	17	13	1.52	42	54	Mesotrophic
Bear	7/26/21	3	720	16	15	1.68	45	56	Mesotrophic
Bear	7/26/21	4	720	18	13	1.52	40	54	Mesotrophic
Bear	8/29/21	1			16	1.68		57	Mesotrophic
Bear	8/29/21	2			15	1.68		56	Mesotrophic
Bear	8/29/21	3			14	1.68		55	Mesotrophic
Bear	8/29/21	4			16	1.68		57	Mesotrophic
Bear	9/28/21	1			22	1.52		61	Eutrophic
Bear	9/28/21	2			22	1.52		61	Eutrophic
Bear	9/28/21	3			24	1.52		63	Eutrophic
Bear	9/28/21	4			22	1.52		61	Eutrophic