2022 Environmental Monitoring for Treasure Lake and Bimini Lake

Prepared for:

Treasure Lake P.O.A.

Dubois, PA 15801-9099

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Sampling Procedures and Analytical Methodology

Water samples and water quality data were collected on July 26 and August 22, 2022. The parameters that were used for the monitoring are listed in Table 1 below. The sampling location in the lake was what is believed to be the deepest point. Only one sampling site for the lake was selected. Due to the size of the lake, one site was sufficient to obtain a representative sample of the water quality for the lake.

Table 1 – Water Quality Parameters Measured for 2022

Dissolved Oxygen (DO)	Total Phosphorus
Dissolved Oxygen Saturation (%)	Secchi Disk Transparency
Temperature	Chlorophyll *a*
pH	Phytoplankton
Conductivity	Zooplankton

The parameters in Table 1 are indicators of the health of a water body and the ability to support aquatic life. These parameters also help to determine a lake's trophic state and relate interactions between the chemical and biological components of a lake and the ecosystem. The analyses performed during the monitoring process were conducted in accordance with Standard Methods, 1995. Dissolved oxygen and temperature were measured using a YSI Model 57 meter at half meter depths to the deepest point on the lake. Conductivity and pH were measured at one-meter depths using a YSI ProPlus multi meter. Water samples taken from incremental depths were collected with a Wildco beta plus horizontal water sampler equipped with a stainless-steel messenger.

Total phosphorous concentration was measured from composite samples. Water samples for total phosphorous were placed in sample bottles containing preservative and then stored on ice while in the field. The samples were delivered to the lab for analysis the day of sampling. The samples were analyzed using the colorimetric ascorbic acid method (Standard Methods, 1992, Method 4500-P E).

Biological characteristics of the lake will be ascertained through the analysis of chlorophyll *a* and the identification of major species of phytoplankton and zooplankton. The composite water taken for the total phosphorous sample was also used to take samples for the chlorophyll *a* and phytoplankton analyses. A determined volume of water was filtered in the field for chlorophyll *a* analysis. The filter papers were then placed in glass vials and stored on ice while in the field until they could be frozen. Once frozen, the samples were shipped to Dr. Gregory Boyer of the Biochemistry Department, SUNY-ESF for analysis using the Welschmeyer fluorometric method.

Samples for the identification of Phytoplankton and zooplankton populations were collected following Standard Methods (Method 10200 B). The composite phytoplankton sample was preserved with two percent by volume M3 and stored in a cool, dark location until it was sent to Dr. Ken Wagner at Water Resource Services, Inc. for identification and enumeration. Phytoplankton will be identified to the lowest practical taxon and counted using a Sedgewick-Rafter chamber and a microscope equipped with a Whipple grid. The Zooplankton sample was collected over a 30-meter net tow from the entire water column using a 60 µm mesh plankton net. The Zooplankton sample was preserved with fifteen percent by volume buffered formalin solution (Lind, 1979). The zooplankton sample will also be identified and enumerated by Dr. Ken Wagner.

Parameters Measured During the 2022 Water Quality sampling

Dissolved Oxygen (DO)

The amount of oxygen present in the water and the profile of this oxygen throughout the water column are important indicators as to the health of a lake. By studying this one parameter, a large amount of information can be determined. The DO content of water results from photosynthesis, diffusion at the air-water interface and distribution by wind-driven mixing. The amount of oxygen produced through photosynthesis is related to the amount of plant and algal life and thus the productivity of the lake. The profile of the DO in the water column can give insight into the mixing patterns and effectiveness of mixing processes in a lake. The DO will fluctuate with changes in temperature and changes in photosynthetic activity and diffusion. Surface waters are often supersaturated with DO during daylight hours. Oxygen is used continuously by the pond biota in respiration, but during the day photosynthesis normally produces oxygen faster than it is used in respiration so that DO concentrations remain high. Phytoplankton die-offs and sudden destratification of the water body can cause rapid oxygen depletion. If the DO falls below 4.0 mg/L, most desirable aquatic organisms will be stressed and may even die.

Dissolved Oxygen Saturation

Water containing the amount of DO which it should theoretically hold at a given temperature, pressure, and salinity is said to be saturated with oxygen. Likewise, waters containing less than or more than the theoretical concentration are said to be under saturated or supersaturated with oxygen, respectively. The degree of oxygen saturation of water is expressed as percent saturation and water that is saturated with oxygen is at 100 percent. The amount of oxygen that can dissolve in water decreases with increasing temperature and salinity and with increased dissolved solids, therefore, dissolved oxygen saturation provides a better means of comparing oxygen concentrations from different sampling dates and depths in the water column.

Temperature

Sufficient and accurate temperature data are important. Temperature directly and indirectly exerts many fundamental effects on limnological phenomena such as lake stability, gas solubility and biotic metabolism. One of the most important relations of the temperature to water is the decrease in the solubility of oxygen in water as the temperature increases. Temperatures in a lake are a function of ambient air temperatures and the physical characteristics of the water itself. The turbidity of a water body can inhibit light from passing through the water column and warming the water. Light energy or the heat generated from the light is absorbed exponentially with depth, so most heat is absorbed within the upper layer of water. Since heat is absorbed more rapidly near the surface of a water body and the warm upper waters are less dense than cool lower water, bodies of water may stratify thermally. This occurs when differences in density of upper and lower strata become so great that the two cannot be mixed by wind action.

pH

The pH of a solution is a measure of its hydrogen ion activity and is expressed as the logarithm of the reciprocal of the hydrogen ion concentration. It is important to remember that a change of one pH unit represents a tenfold change in hydrogen ion concentration. The pH scale ranges from 1.0 to 14.0 standard units. A pH of 7.0 indicates neutral conditions, while waters with a pH less than 7.0 are said to be acidic and those with a pH greater than 7.0 are said to be basic. The pH of most natural waters falls in the range of 4.0 to 9.0, and much more often in the range of 6.0 to 8.0. The desirable range for fish production is 6.5 to 9.0. The acid death point for fish is around 4.0 or less. In water bodies, deviation from the neutral pH 7.0 is primarily due to the hydrolysis of salts of acids and bases. Dissolved gases such as CO_2, H_2S, and NH_3 also have a significant effect on pH values. The majority of natural water bodies have a somewhat alkaline or basic pH due to the presence of carbonates. Values for pH and the changes in these values are important, since they may reflect biological activity and changes in natural chemistry of waters, as well as pollution.

Conductivity

Conductivity or specific conductance is a measure of water's capacity to conduct an electric current. Conductivity is the reciprocal of resistance for which the standard unit is an ohm. Since conductivity is the inverse of resistance, the standard unit for conductivity is the *mho*. In low-conductivity natural waters, the standard unit is the *micromho*. Because the measurement is made using two electrodes that are one centimeter apart, conductivity is generally reported as micromhos per centimeter (µmhos/cm). Different ions vary in their ability to conduct electricity, but, in general, the greater the concentration of ions in natural water, the higher the conductivity. Temperature also affects conductivity. Conductivity will generally increase two to three percent per degree Celsius. For comparison of values, conductivity is usually corrected to one standard temperature which is most often 25°C. The most useful information that can be gathered from conductivity readings is the estimation of the total concentration of dissolved ionic matter in the water, which in turn relates to water fertility.

Total Phosphorus

Phosphorous is a key metabolic nutrient and the supply of this element often regulates the productivity of natural waters. Total phosphorous is the sum of all forms of phosphorous present. Phosphorous is present in water in several soluble and particulate forms, including organically bound phosphorous, inorganic polyphosphates and inorganic orthophosphates. Orthophosphates, which are ionized forms of orthophosphoric acid (H_3PO_4), are the simplest forms of phosphorous present. The pH of the water will affect the degree of ionization and thus the amount of orthophosphates present. The natural source of phosphorous to waters is from leaching of phosphate containing rocks and from organic matter decomposition. Additional sources are found in manmade fertilizers, domestic sewage and detergents. Inorganic and organic phosphates may reach waters through effluent and runoff. Phosphorous is lost from the water by chemical precipitation to sediment and by adsorption on clays or sediment with high pH and carbonate levels. Phosphorous is usually found in low concentration in natural waters, but is used readily by plants for growth. The element present in the lowest concentration relative to demand is the element limiting the process at a given time. This is why phosphorous is usually said to be the limiting factor of plant and algal growth and if found in excess is most likely to cause excessive plant growth or algal "blooms".

Secchi Disk Transparency

Visibility is a measure of the depth to which one can see into the water. The Secchi disk is a simple device used to estimate this depth. The disk is a weighted circular plate, 20 cm in diameter, with a painted surface consisting of alternate opposing black and white quarters. The disk is attached to a depth-calibrated chord attached to a ring in the center of the disk, so the disk is horizontal when lowered into the water. To determine the Secchi disk visibility, the disk is lowered into the water until the disk disappears and the depth is noted. The disk is lowered further then slowly raised until it is visible again and this depth is noted. The final Secchi depth is the average of these two readings. Secchi depth corresponds to the depth where light penetration is ten percent or less and approximates the lower level of photosynthetic activity. The transparency is based on the transmission of light through the water and is related to the amount of natural light, amount of inorganic suspended solids and the amount of organic suspended solids. The Secchi disk measures the turbidity of water. Plankton is usually the major source of turbidity, so Secchi depth can give an estimate of plankton density. When compared with data on chlorophyll *a*, particulate organic matter and phytoplankton counts, Secchi depth correlates most with particulate organic matter. Particulate organic matter is a measurement which includes living zooplankton and phytoplankton as well as dead organic particles. For northern lakes, a Secchi depth of greater than 30 feet is considered oligotrophic while the eutrophic lakes may have a reading of 3 to 4 feet or less during summer algal blooms (Moore, 1988). Secchi depths of less than two meters are usually considered undesirable for recreational lake uses and even lower values may indicate the onset of an algal bloom.

Chlorophyll *a*

Chlorophyll is a green pigment in algae and other green plants that is essential for the conversion of sunlight, carbon dioxide and water to sugar that may then be used as food. Chlorophyll *a* is a type of chlorophyll present in all types of algae, sometimes in direct proportion to the biomass of the algae. The values may also be used to characterize the age, structure, quantification of the phytoplankton and photosynthetic rates.

Phytoplankton

Phytoplankton are microscopic algae and microbes that float freely in open water. Phytoplankton occurring in lakes include members belonging to one of the following taxonomic divisions: green algae (Chlrorophyta), blue-green algae (Cyanophyta), diatoms (Bacillariophyta), yellow-green and golden-brown algae (Chrysophyta) and dinoflagellates (Pyrrhophyta).

The chlorophyta or green algae do not compose, for the most part, a significant portion of food chains nor do they affect other organisms positively or negatively. These organisms have not been found to kill fish or edible invertebrates and therefore do not receive much public notice. They are primarily fed upon by rotifers and protozoa, but usually environmental constraints can keep their populations in check. Nitella, Chara and Spirogyra are some species from this division commonly found in North American lakes. A bloom of a species from this division is not as common as other taxonomic groups such as the blue-green algae. There are however some species that may cause a green bloom such as *Hydrodictyon*, *Volvox*, *Pandorina* and *Volvulina*.

Cyanophyta or cyanobacteria are commonly referred to as the blue-green algae because they are a group of bacteria that can photosynthesize and thus produce their own food. This division also has an advantage over other groups because the blue-greens have the ability to fix nitrogen, meaning they can utilize atmospheric nitrogen and store it and therefore exist even if levels of nitrogen in the water are low. The blue-green algae are probably the most commonly known group of phytoplankton known by the public due to the problems they may cause. Blue-green blooms have been associated with off-flavor in fish, toxic substances, shallow chemical and thermal stratification, taste and odor in drinking water, phytoplankton die-offs and unsightly appearance on the water surface. The two most serious problems associated with excessive blue-green blooms are foul odor or taste of the fish or water and sudden, massive phytoplankton die-offs. Buoyant blue-green algae often accumulate at the surface of a water body and form a “green scum”. If the scum is heavy or thick and dies of suddenly, fish kills may result from the depletion of oxygen following decay of the dead algae. Blue-green blooms are associated with high concentrations of nitrogen and phosphorous but not all water bodies with these characteristics may have a bloom. Some other associated reasons may be: 1. High concentrations of organic matter, 2. High concentrations of nitrogen and phosphorous at low CO_2 levels and high pH and 3. Excretion of antibiotics by blue-green algae which inhibit other algae and favor blue-greens (Boyd, 1981). Some blue-green algae associated with taste and odor changes in water are

Anabaena, *Microcystis*, and *Aphanizomenon*. One other species of blue-green known as *Lyngbya* is responsible for one of the skin irritations commonly known as "swimmer's itch."

The Bacillariophyta are the diatoms. This group look like glass structures when viewed under a microscope due to their silica shells. Diatoms are among some of the most important aquatic microorganisms today. They are abundant in both the plankton and sediments in freshwater ecosystems and are an important food source. This group will usually be more prevalent during the spring and will taper off as the water warms. Some species associated with blooms that could cause taste or odor problems are *Synedra, Tabellaria, Asterionella* and *Gomphonema*.

Chrysophytes are considered the golden-brown algae. Most species of chrysophyta are single-celled flagellates. Some species are colorless, but the majority are photosynthetic. Toxic blooms can be produced by several species. This group also is more prevalent in the spring when the water is cooler, and may move to the hypolimnetic water during the summer months. Some species may produce taste and odor problems but do not usually cause health problems. Some of the species that may cause problems are *Dinobyron, Synura, Mallomonas,* and *Uroglenopsis*.

The last group, dinoflagellates, is one of the most important constituents of the marine and freshwater phytoplankton. The dinoflagellates are microscopic, usually unicellular, flagellated, often photosynthetic protists commonly regarded as algae. Besides being important primary producers dinoflagellates are known for producing high levels of toxins, especially when they occur in large numbers. When these large numbers occur they are called "red tides." The red tides can introduce non-fatal or fatal amounts of toxins into animals, especially shellfish, which can then be eaten by humans who are affected by the toxins. Many of these toxins are quite potent and if not fatal, can still cause neurological damage. These deadly blooms usually do not occur in freshwater, however, two species – *Peridinium* and *Ceratium* have been know to cause fish kills in fresh water. The red tides appear to be more common in recent years and it is suspected that human input of phosphates to water bodies and warmer global temperatures may be adding to the increased frequency.

As the growing season proceeds, a succession of algal communities typically occurs in a lake. A typical seasonal succession of lake phytoplankton would be: Diatoms dominate in the spring and autumn, green algae in mid-summer, and blue-green algae in late summer. Within a season there may be a shift from dominance by bloom forming blue-green algae to one by diatoms or green algae. This shift may be due to changes in 1. CO_2 and pH, 2. Distribution of buoyant cells, and 3. Grazing by zooplankton (Cooke et al, 1993). Phytoplankton biomass usually tends to be high in the spring and early summer due to increasing water temperature and light availability, relatively high nutrient availability, and low losses to zooplankton grazing. As grazing pressure increases and nutrient availability declines from early to midsummer, algal biomass will usually decline. In the late summer and fall when the water column begins mixing and nutrient levels increase, the algal biomass may again increase.

When looking at data for algal biomass versus total algal numbers sometimes the numbers have a high correlation, while other times they may not. This discrepancy may be due to algal communities that are composed of extremely high numbers of small algal cells or low numbers of extremely large algal cells. The size difference between species of algal cells can be quite large and these size differences may explain some of the discrepancies seen in the seasonal algal data for the monitoring program of the lakes. Another discrepancy that occurs is when comparing chlorophyll *a* to algal biomass. Chlorophyll *a* is present in all algae and therefore seems that there should be a direct correlation between the amount of Chlorophyll *a* sampled and the biomass of the algae. There are circumstances that cause this relation not to be a direct one. Not all algae cells may possess the same percentage of Chlorophyll *a* to dry algal biomass. Also, different species will produce different amounts of Chlorophyll *a* under the same conditions and certain environmental conditions may cause algal cells to produce more chlorophyll but not increase their numbers (of actual cells). Algal cells have also adapted themselves to be able to rapidly increase the amount of chlorophyll due to light conditions, so even in the same day (within hours) two samplings could produce different results if a storm event were to occur and decrease light levels directly or indirectly through more turbid water. This adaptation allows cells to have more available chlorophyll to utilize the decreased light. All these variations in levels of chlorophyll production could cause an apparent discrepancy between chlorophyll levels and biomass of the phytoplankton communities.

Zooplankton

Zooplankton are microscopic, crustacean animals which free float and could filter nearly the entire epilimnion in lake water grazing on detritus particles, bacteria and algae. In some lakes or reservoirs, the amount of algae in the open water may be controlled as much by zooplankton grazing as by the quantity of nutrients. The zooplankton feed on the algae or phytoplankton as well as on other smaller zooplankters. The most efficient grazers, which remove more particles, are the largest sized zooplankton species. These large zooplankton, however, are selectively eaten by fish, including the fry of most every fish species and the adults of planktivorous species such as shad, bluegill, pumpkinseed, perch and alewives. The zooplankton that feed on the algae are part of several orders including the Cladocera, Copepoda and Ostracoda. These are the small creatures commonly called waterfleas. There are several types of protozoans, rotifers and crustaceans that belong to those orders. Zooplankton populations will vary in a lake depending on temperature, food supply and level of predation by fish. The level of oxygen in the hypolimnion will directly affect the rate at which the zooplankton are consumed. If the DO is low in the hypolimnion, the zooplankton cannot migrate to the lower waters and are forced to stay in the upper (epilimnion) waters where they are more readily accessible to fish predation. Just as the phytoplankton populations may vary within any given time period, so may the zooplankton populations.

Trophic State Indices

The trophic state of a lake is a relative expression of the biological productivity of the lake. The Trophic State Index (TSI) developed by Carlson (1977) is among the most commonly used indicators of lake trophic state. This index is actually composed of three separate indices based on concentrations of total phosphorous, chlorophyll *a* and the Secchi depth readings from a variety of lakes.

Mean values of total phosphorous, chlorophyll *a*, and Secchi depth for an individual lake are logarithmically converted to a scale of relative trophic state ranging from 1 to 100. A TSI of less than 35 indicates oligotrophic conditions, a TSI between 35 and 50 indicates mesotrophic conditions and a TSI greater than 50 indicates eutrophic conditions. Oligotrophic comes from the Greek for “poorly nourished” and describes a lake of low plant productivity and high transparency. Mesotrophic comes from the Greek for “moderately nourished” and describes a lake of moderate photosynthetic activity and transparency. Eutrophic comes from the Greek for “well-nourished” and describes a lake of high photosynthetic activity and low transparency. Hypereutrophic, or excessively productive lakes, have TSI values greater than 70. Higher numbers are associated with increased probabilities of encountering nuisance conditions such as aesthetic problems i.e. algal scums.

Treasure Lake Monitoring Data

Date: 7-26-22 Location: Dam Weather: Sunny, East 0-5mph

Observer: KL Secchi Depth: 3.0 m Time: 8:45 AM

Depth (m)	Dissolved Oxygen (mg/L)	Dissolved Oxygen %Saturation	Temperature (ºC)	pH	Conductivity (µmhos/cm @25ºC)
0.0	7.8	97.50	25.9	7.6	150.2
1.0	7.8	97.62	26.0	7.6	150.1
2.0	7.7	96.37	26.0	7.6	150.2
3.0	7.6	95.00	25.9	7.6	150.1
4.0	7.6	95.00	25.9	7.6	150.2
5.0	6.7	82.61	25.0	7.5	148.3
6.0	5.6	64.59	21.1	7.4	139.1
7.0	2.3	24.49	16.9	7.2	129.8
8.0	1.4	14.06	14.1	6.9	121.4
9.0	1.2	11.53	12.1	6.6	116.8
10.0	0.9	8.45	11.1	6.5	114.3
11.0	0.8	7.41	10.5	6.5	114.4
12.0	1.3	11.93	10.1	6.5	114.2
13.0	1.3	11.90	10.0	6.5	113.8
14.0	1.2	10.85	9.5	6.5	116.1
15.0	1.0	8.98	9.2	6.6	118.6
16.0	0.9	8.06	9.1	6.7	119.6

Chlorophyll *a*: 2.41 µg/l

Total Phosphorus: 0.008 mg/L

Treasure Lake Monitoring Data

Date: 8-22-22 Location: Dam Weather: Cloudy

Observer: JP Secchi Depth: 6.0 m Time: 10:15 AM

Depth (m)	Dissolved Oxygen (mg/L)	Dissolved Oxygen %Saturation	Temperature (ºC)	pH	Conductivity (µmhos/cm @25ºC)
0.0	7.9	95.76	24.0	7.1	142.6
1.0	7.8	94.45	24.0	7.3	142.0
2.0	7.5	90.90	24.0	7.4	141.9
3.0	7.5	90.90	24.0	7.4	141.8
4.0	6.7	81.11	23.9	7.4	142.3
5.0	6.3	75.45	23.2	7.2	140.9
6.0	5.2	61.39	22.4	7.0	140.1
7.0	1.8	20.36	20.0	6.7	134.2
8.0	1.0	10.74	17.3	6.4	127.2
9.0	0.8	8.16	14.8	6.3	125.8
10.0	0.8	7.71	12.2	6.3	121.6
11.0	0.7	6.57	11.1	6.3	120.4
12.0	0.7	6.44	10.2	6.3	119.7
13.0	0.5	4.58	10.0	6.3	120.2
14.0	0.5	4.58	10.0	6.4	121.6
15.0	0.5	4.57	9.9	6.6	127.4
16.0	0.5	4.56	9.8	6.7	134.4

Chlorophyll *a*: 2.56 µg/l

Total Phosphorus: 0.009 mg/L

Figure 1-Treasure Lake Dissolved Oxygen July

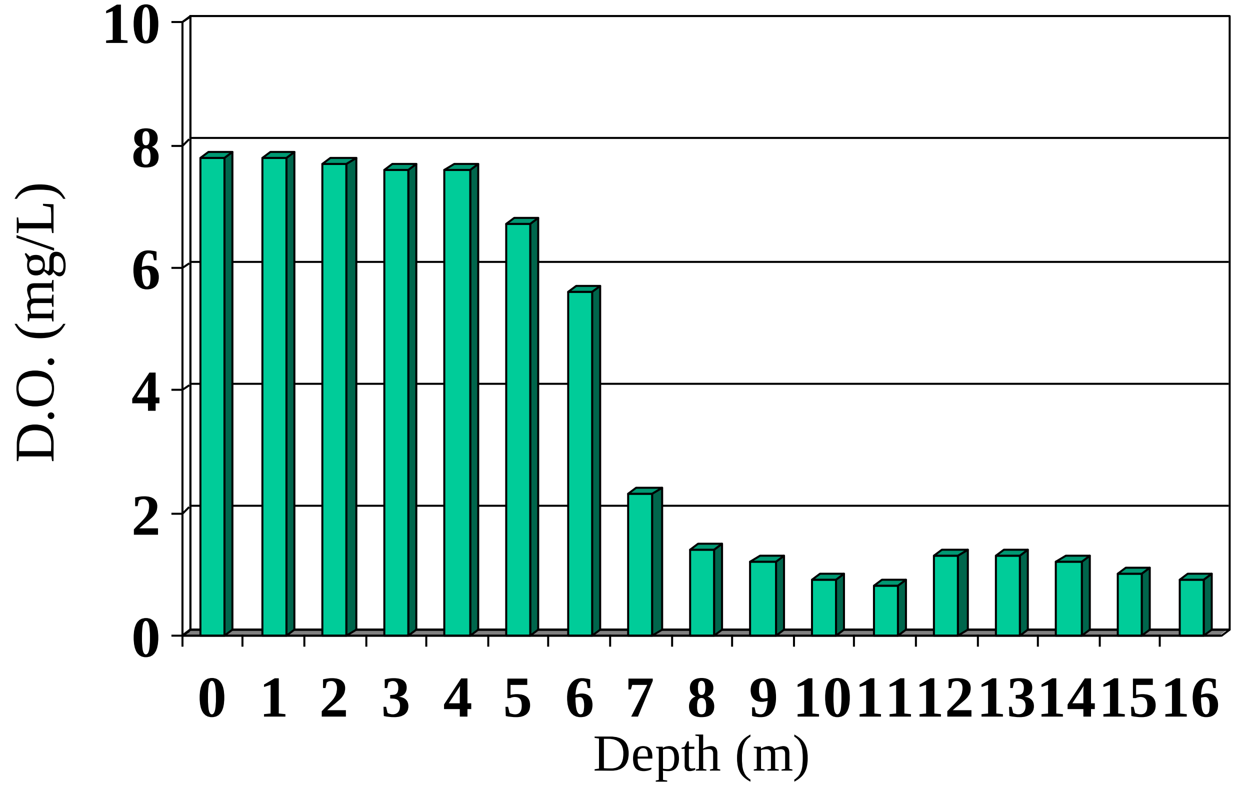

Figure 2-Treasure Lake D.O. Percent Saturation July

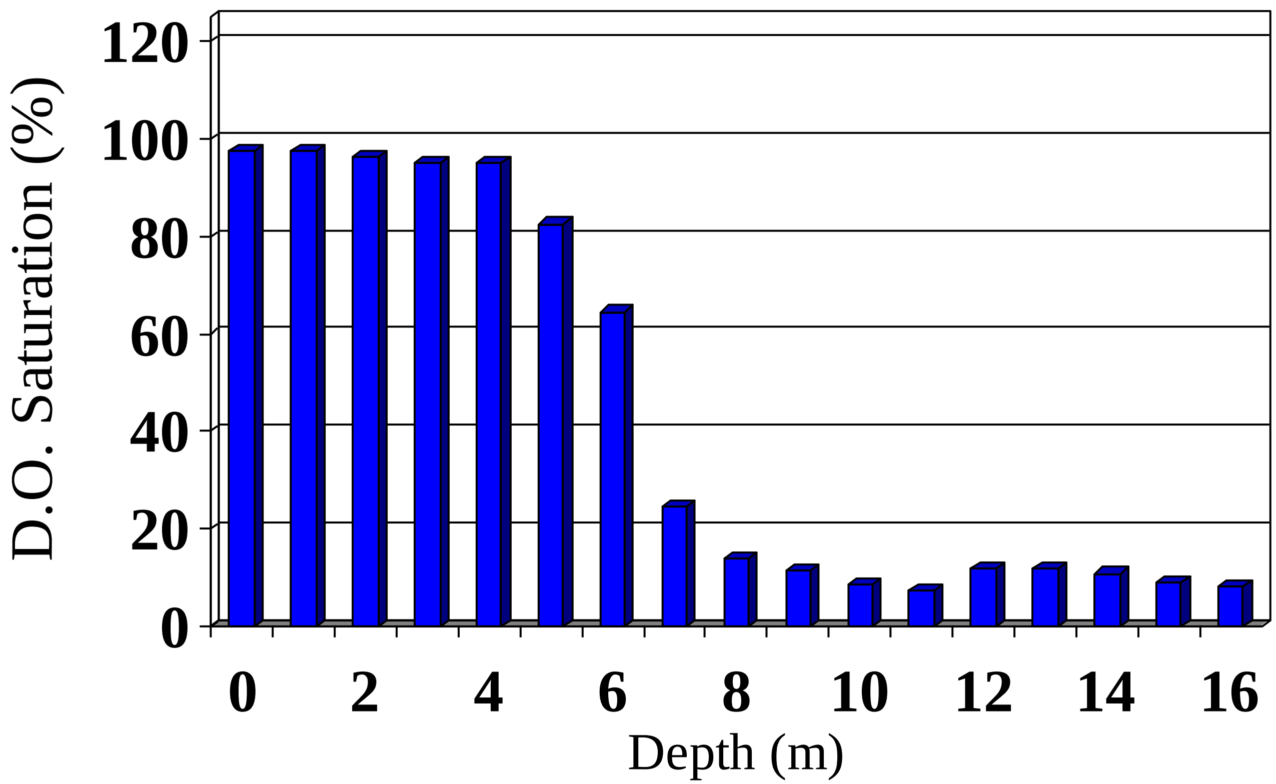

Figure 3-Treasure Lake Dissolved Oxygen August

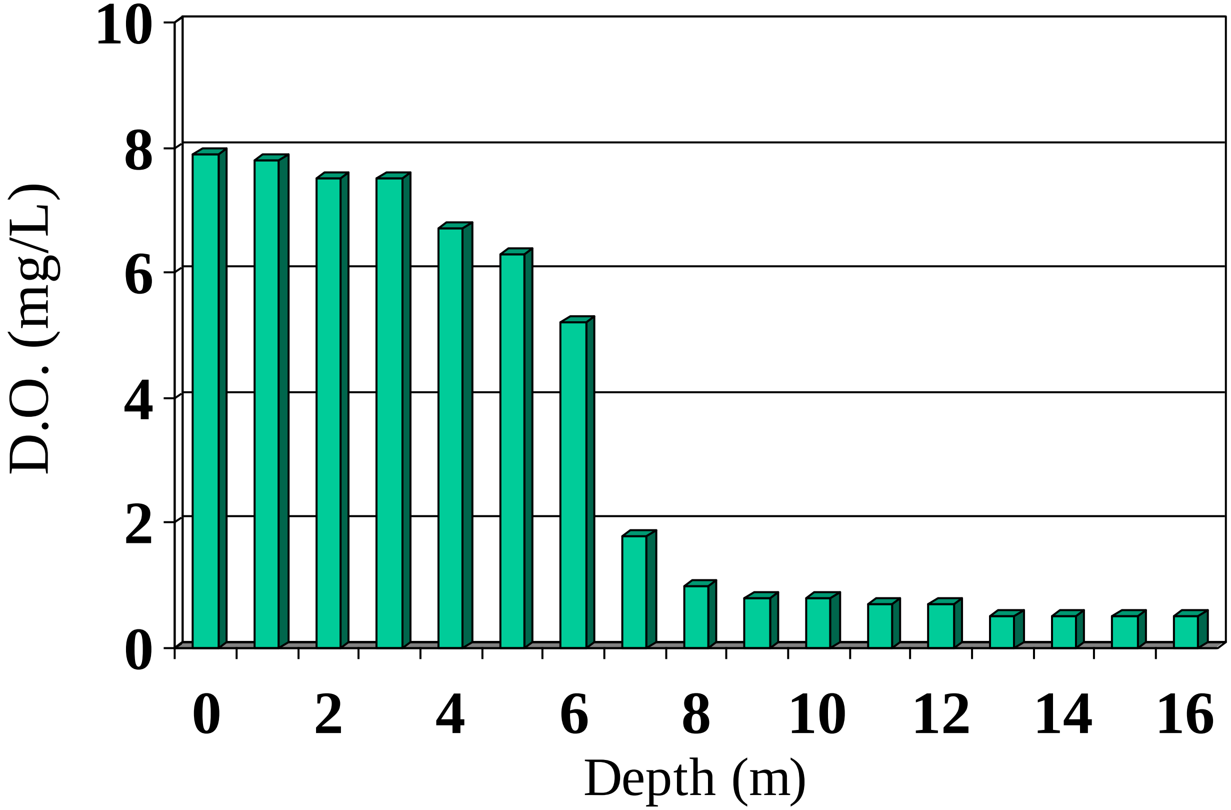

Figure 4-Treasure Lake D.O. Percent Saturation August

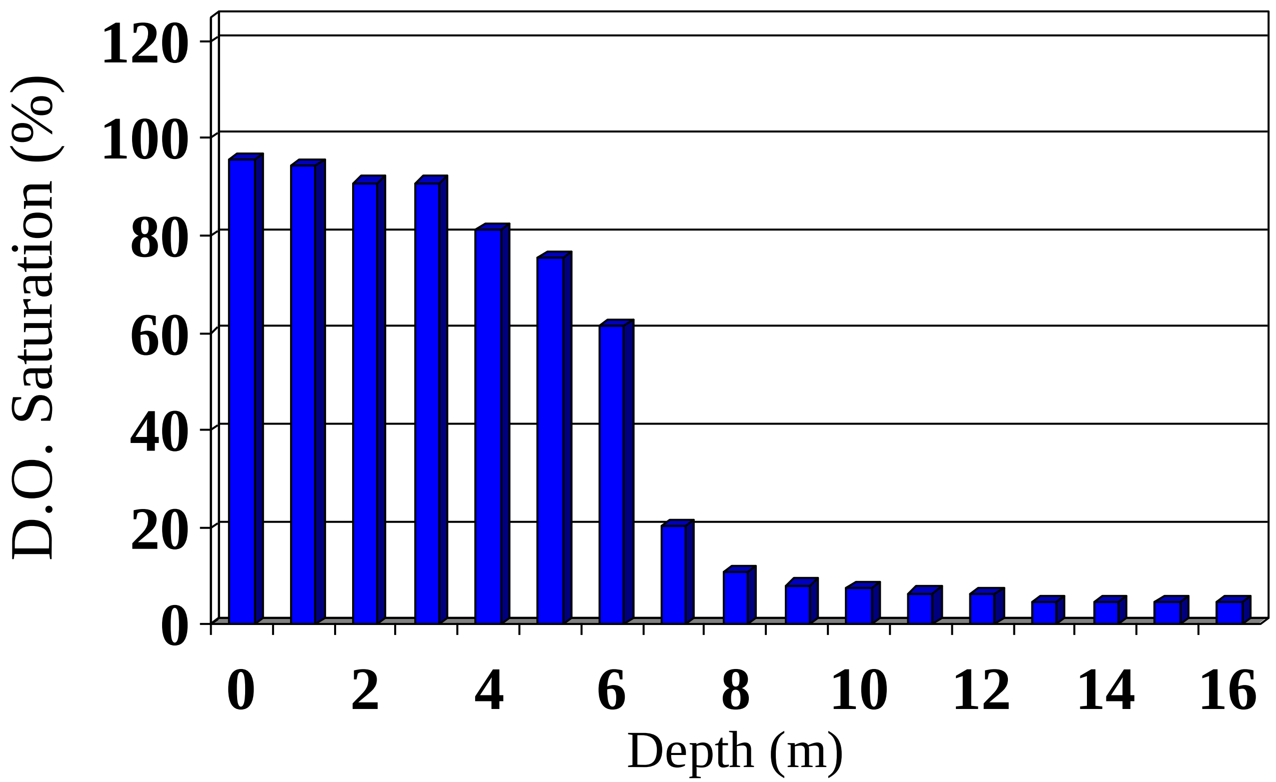

Figure 5-Treasure Lake Temperature Data July

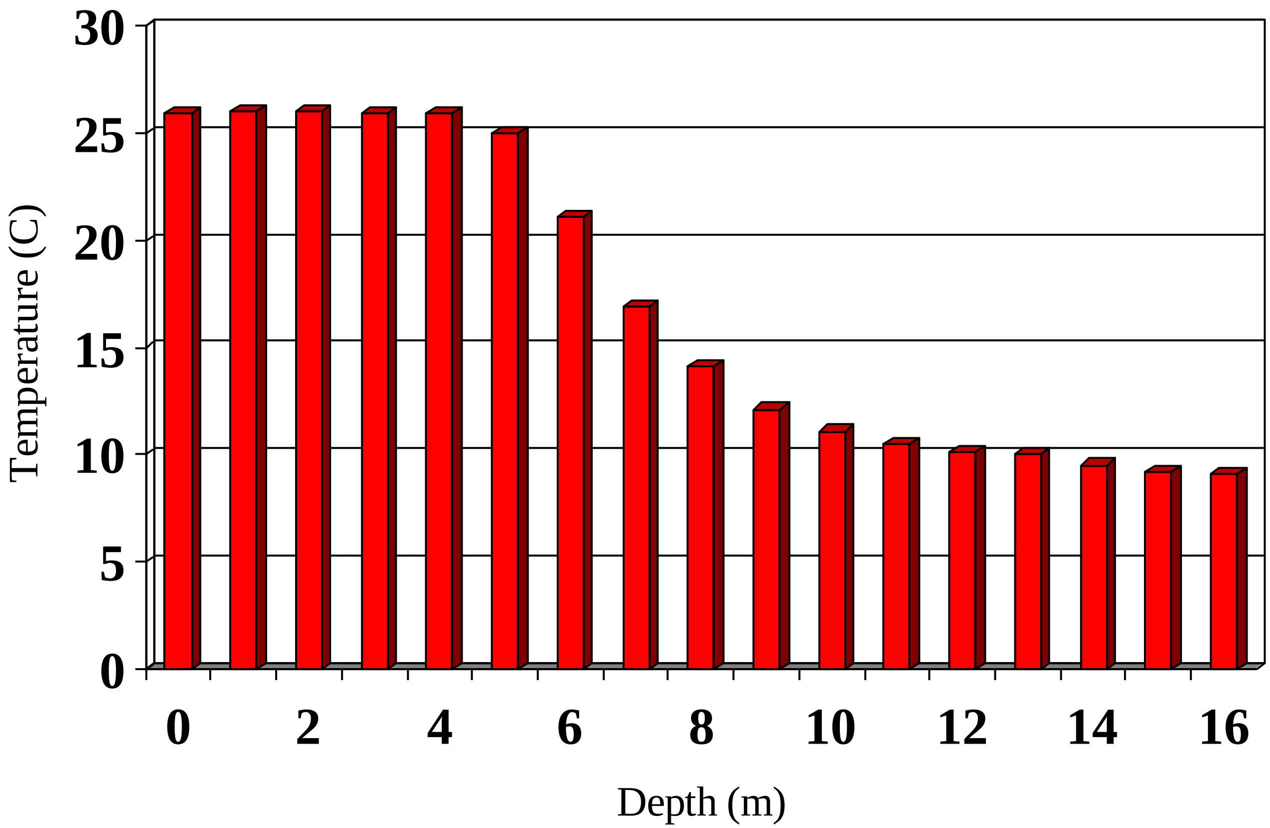

Figure 6-Treasure Lake Temperature Data August

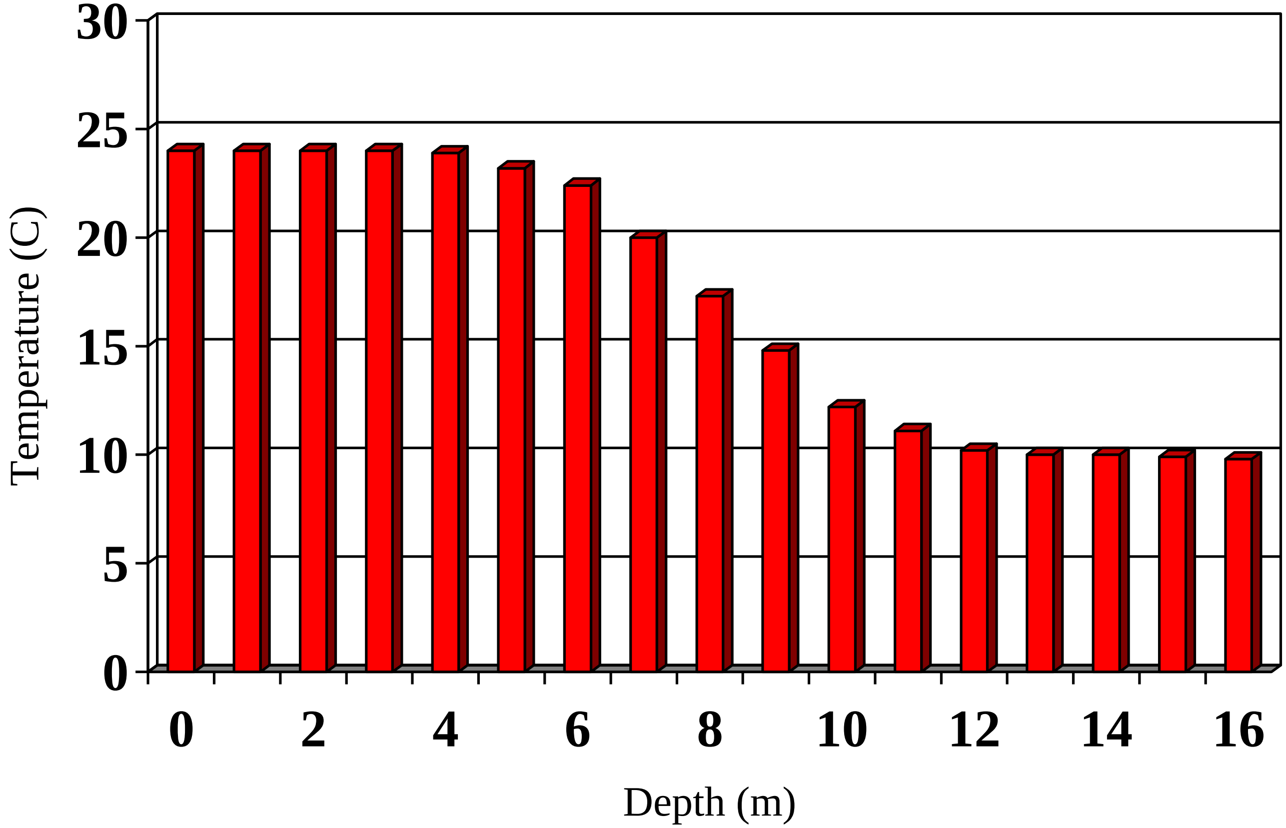

Figure 7-Treasure Lake pH Data July

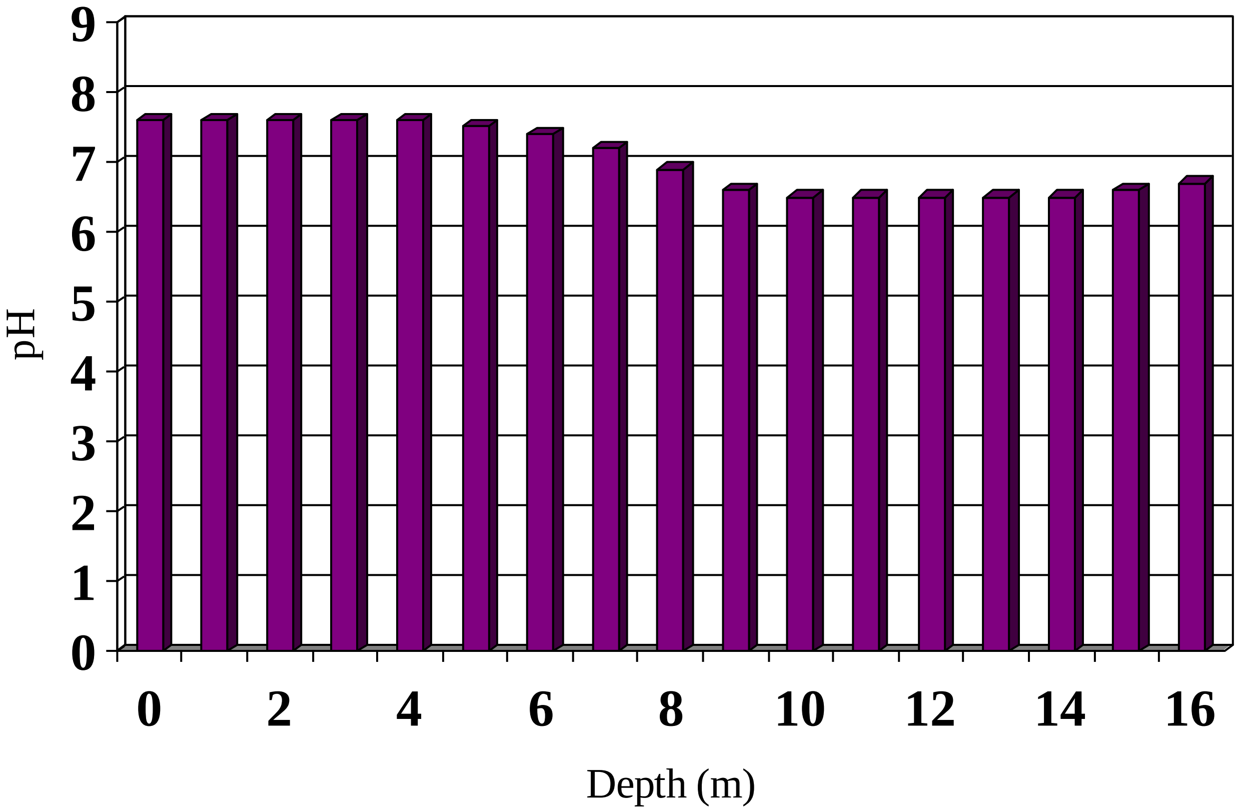

Figure 8-Treasure Lake pH Data August

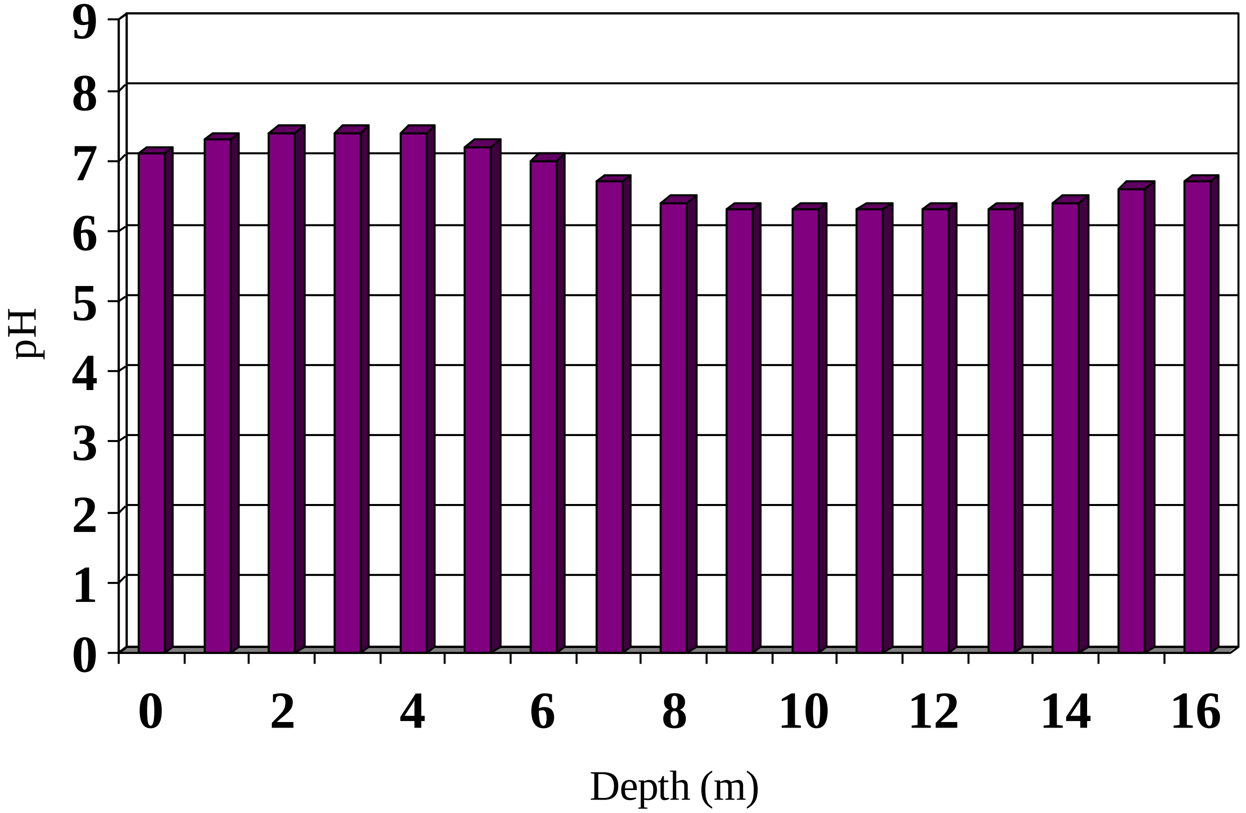

Figure 9-Treasure Lake Conductivity Data July

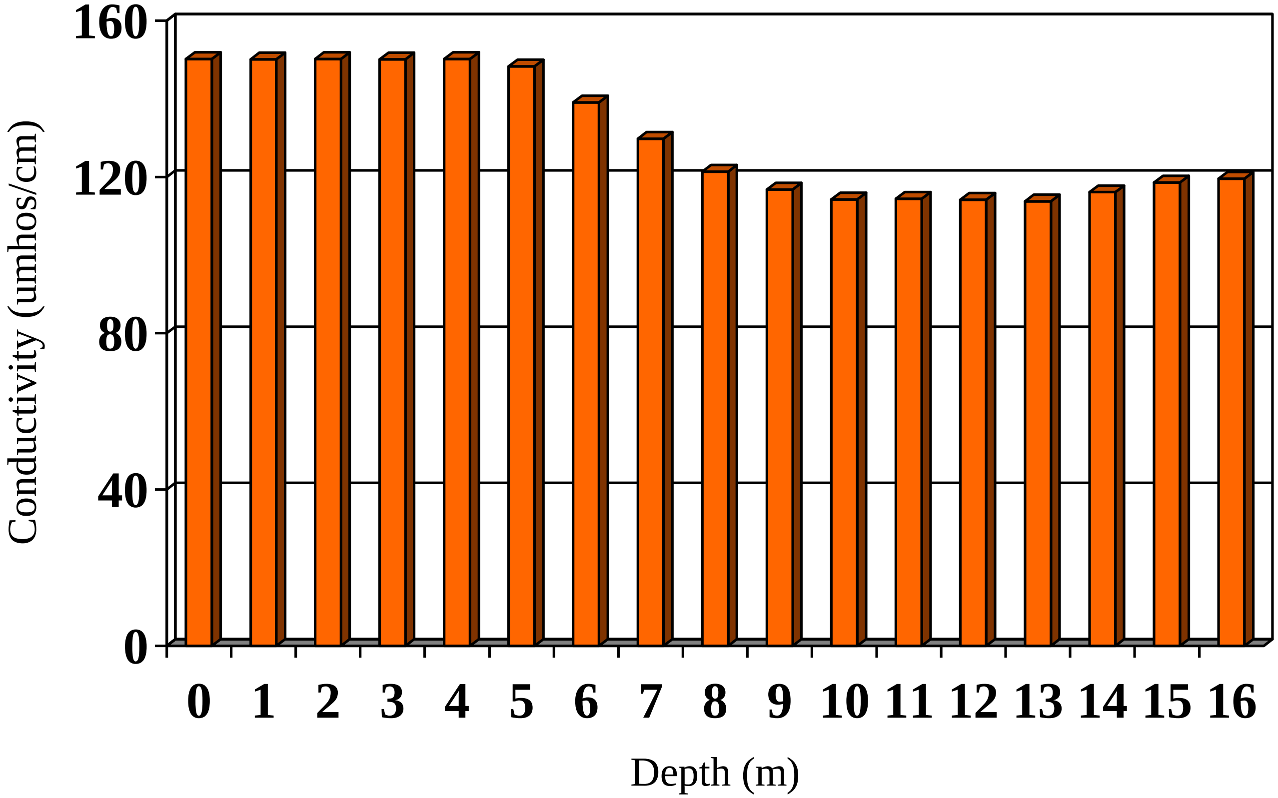

Figure 10-Treasure Lake Conductivity Data August

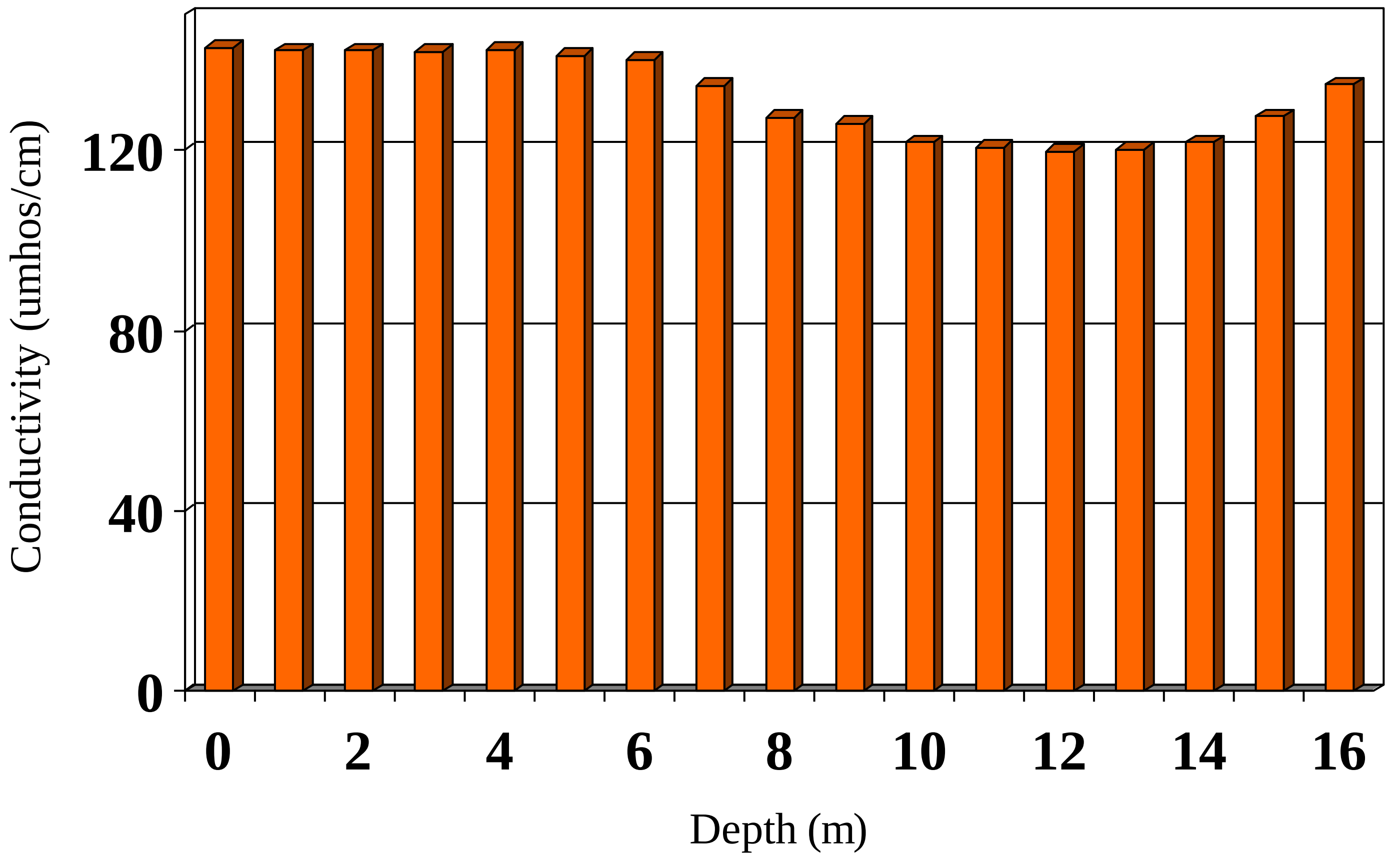

Table 2– Treasure Lake Monitoring Summary – TSI Indicators and Lab Data

Date	Total Phosphorous (mg/L)	Secchi Depth (m)	Chlorophyll-a (µg/L)	Phytoplankton		Zooplankton	
				Cells/mL	µg/L	#/L	UG/L
7/26/22	0.008	3.0	2.41	700.7	1602.5	49.0	204.0
8/22/22	0.009	6.0	2.56	2845.4	4969.2	9.42	42.7

Table 3 - Trophic State Indices for Treasure Lake

Calculated Trophic State Indices	Annual TSI Values					
	2017	2018	2019	2020	2021	2022
Total Phosphorus	24.2	27.4	27.4	33.4	38.1	35.0
Secchi Depth	30.6	40.0	40.0	37.7	38.8	38.3
Chlorophyll *a*	34.9	32.8	43.4	39.3	35.5	39.5

Bimini Lake Monitoring Data

Date: 7-26-22 Location: Dam Weather: Sunny, East 0-5 mph

Observer: KL Secchi Depth: 6.0 m Time: 10:05 AM

Depth (m)	Dissolved Oxygen (mg/L)	Dissolved Oxygen %Saturation	Temperature (ºC)	pH	Conductivity (µmhos/cm @25ºC)
0.0	8.6	107.63	26.0	8.2	159.6
1.0	8.4	105.265	26.1	8.3	160.6
2.0	8.2	102.76	26.1	8.4	161.2
3.0	8.1	101.5	26.1	8.4	161.6
4.0	8.0	100.25	26.1	8.3	161.3
5.0	8.0	100.00	25.9	8.2	159.1
6.0	10.7	123.41	21.1	8.0	148.2
7.0	10.9	116.08	16.9	8.0	135.5
8.0	11.3	113.45	14.1	7.9	126.4
9.0	10.2	98.65	12.4	7.8	119.0
10.0	9.6	90.14	11.1	7.6	115.2
11.0	8.1	74.31	10.1	7.5	112.4
12.0	6.1	54.66	9.1	7.2	110.7
13.0	4.4	39.22	8.9	7.1	108.6
14.0	3.6	31.69	8.4	7.0	108.6
15.0	2.6	22.79	8.2	7.0	109.0
16.0	1.8	15.69	8.0	6.9	110.5
17.0	1.2	10.46	8.0	7.1	117.9
18.0	0.8	6.96	7.9	7.1	120.2

Chlorophyll *a*: 0.61 µg/L

Total Phosphorus: <0.00717 mg/L

Bimini Lake Monitoring Data

Date: 8-22-22 Location: Dam Weather: Overcast

Observer: JP Secchi Depth: 9.6 m Time: 1215 PM

Depth (m)	Dissolved Oxygen (mg/L)	Dissolved Oxygen %Saturation	Temperature (ºC)	pH	Conductivity (µmhos/cm @25ºC)
0.0	8.3	102.22	24.9	7.44	170.1
1.0	8.1	99.02	24.5	7.35	169.2
2.0	8.0	97.09	24.1	7.49	168.7
3.0	7.3	88.48	24.0	7.5	168.5
4.0	7.3	88.48	24.0	7.51	168.3
5.0	7.2	87.27	24.0	7.51	168.1
6.0	7.2	87.27	24.0	7.5	168.0
7.0	8.5	97.93	21.0	7.32	155.9
8.0	8.9	94.78	16.9	7.32	138.8
9.0	9.0	90.18	14.0	7.23	130.9
10.0	8.6	84.15	12.9	7.13	126.1
11.0	8.0	74.77	10.9	6.94	121.6
12.0	5.1	46.58	9.0	6.78	118.9
13.0	2.3	20.55	9.0	6.64	119.4
14.0	1.4	12.42	8.7	6.54	119.8
15.0	0.7	6.18	8.5	6.48	120.2

Chlorophyll *a*: 0.56 µg/L

Total Phosphorus: <0.00717 mg/L

Figure 11-Bimini Lake Dissolved Oxygen July

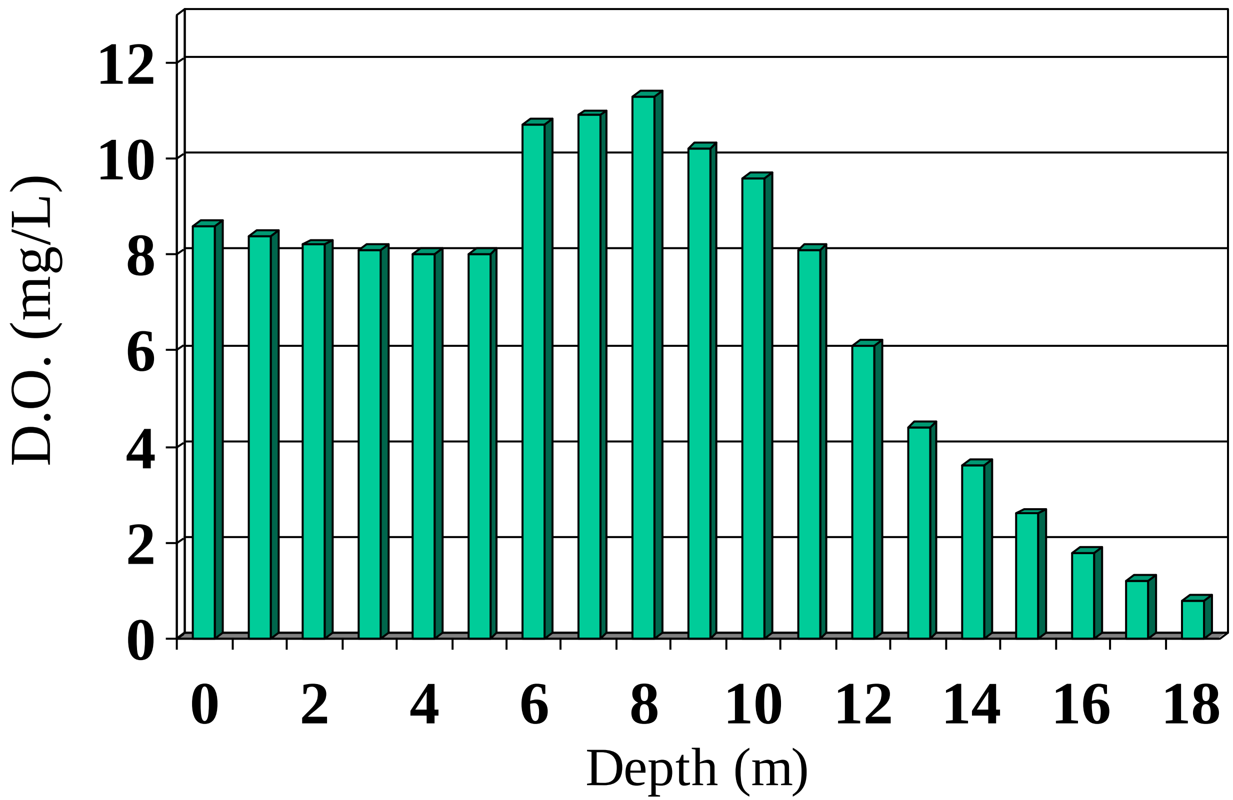

Figure-12 Bimini Lake D.O. Percent Saturation July

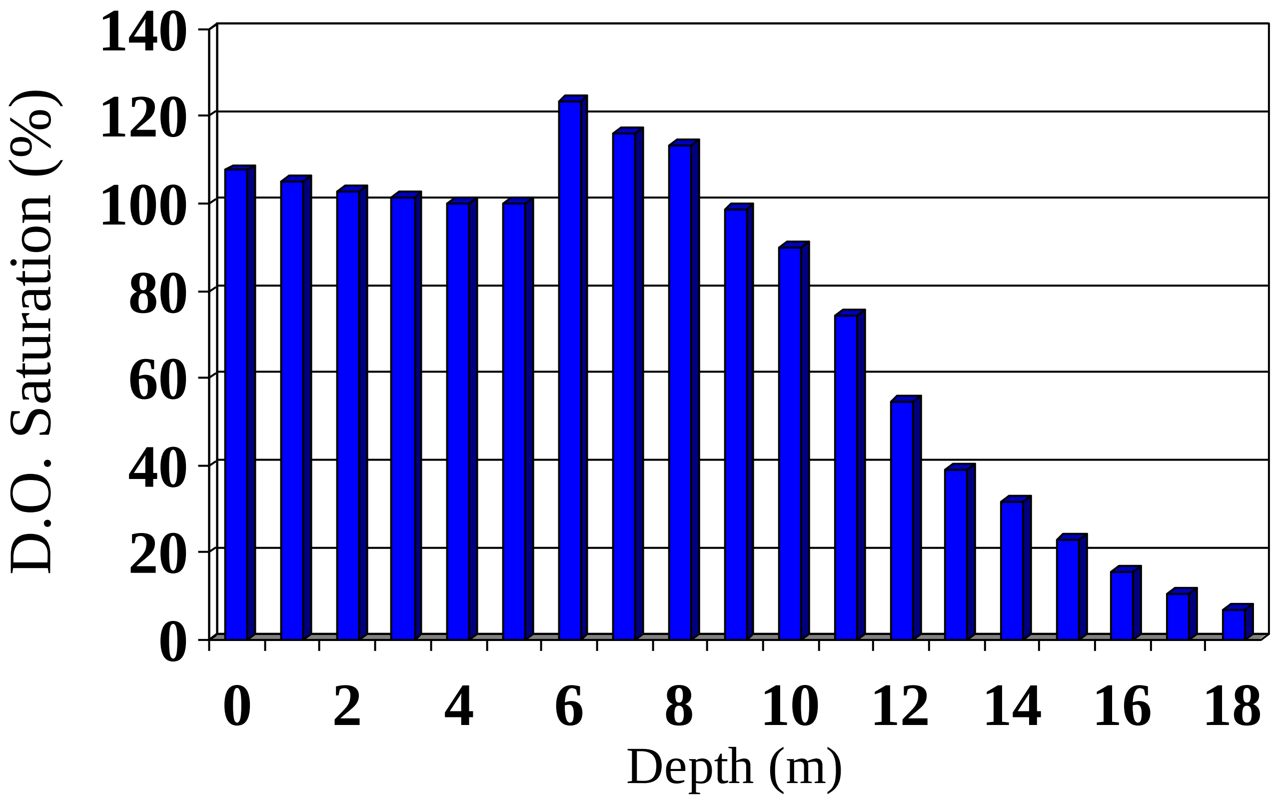

Figure 13-Bimini Lake Dissolved Oxygen August

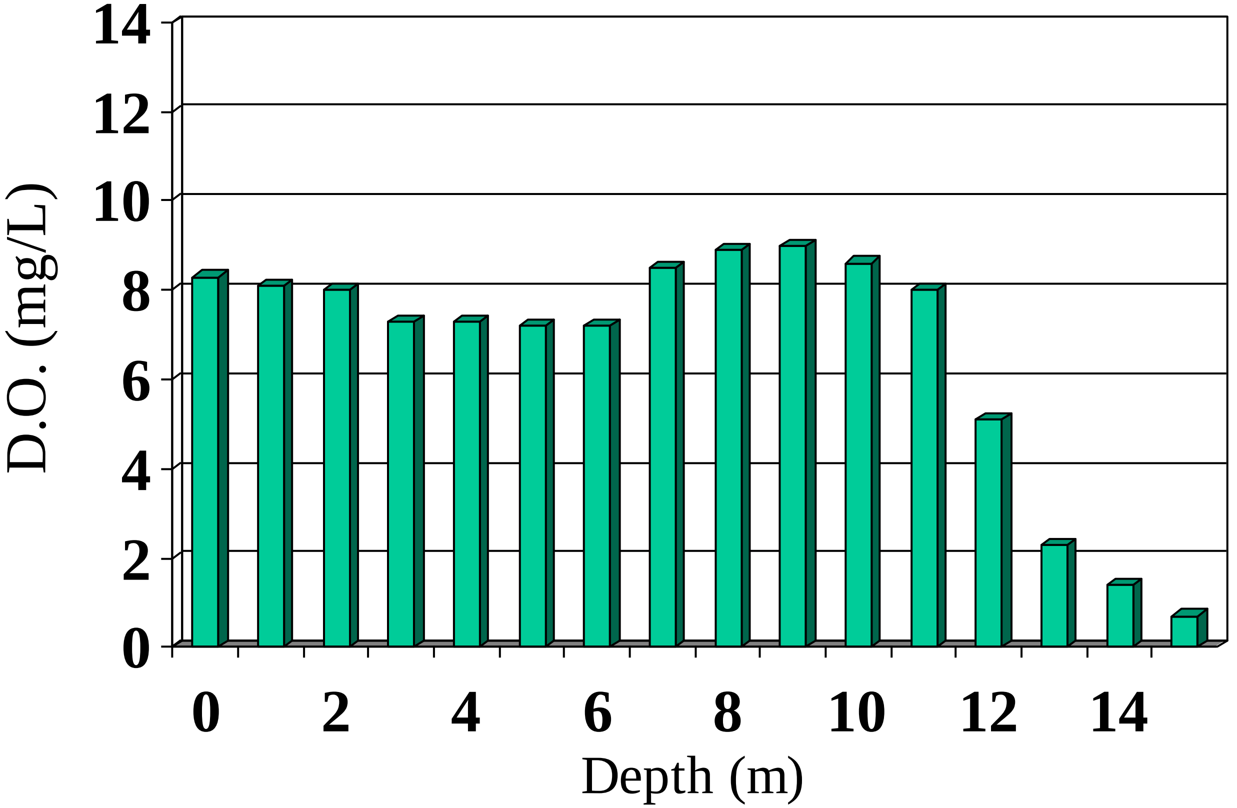

Figure 14-Bimini Lake D.O. Percent Saturation August

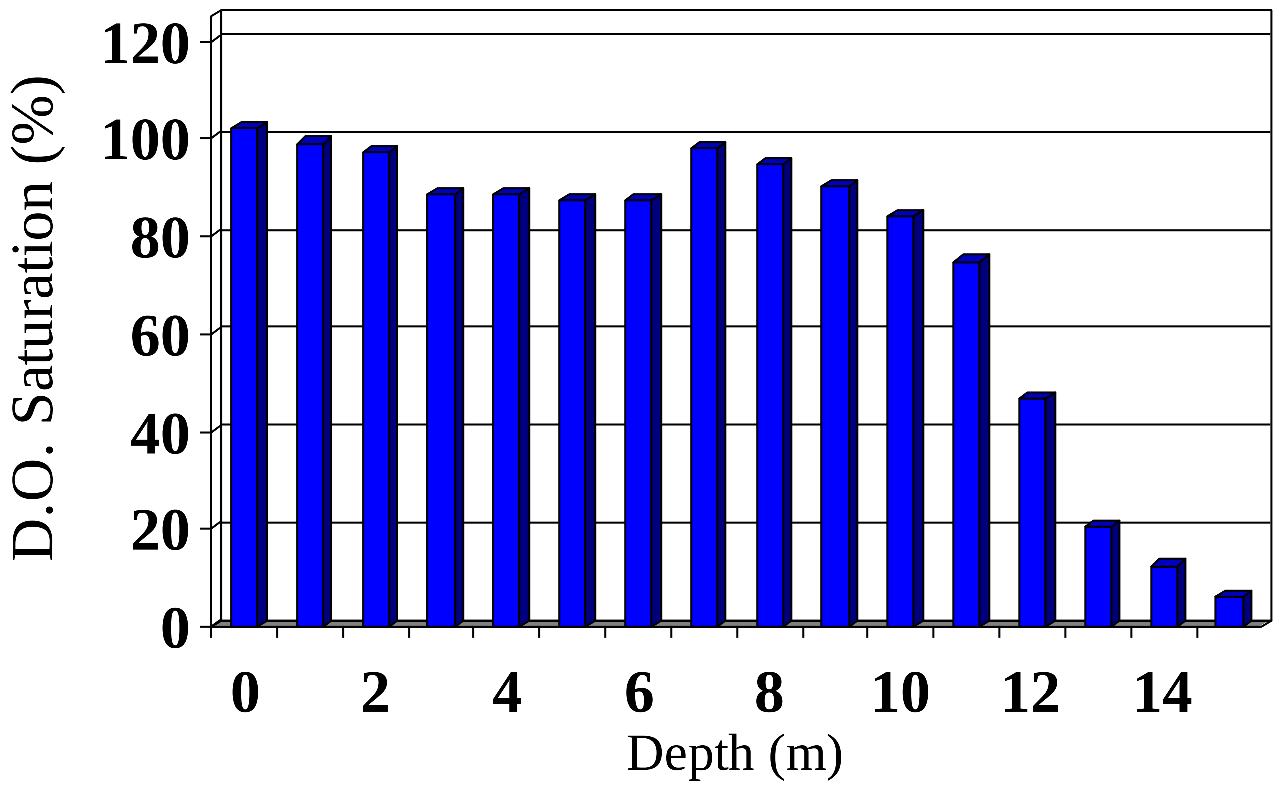

Figure 15-Bimini Lake Temperature Data July

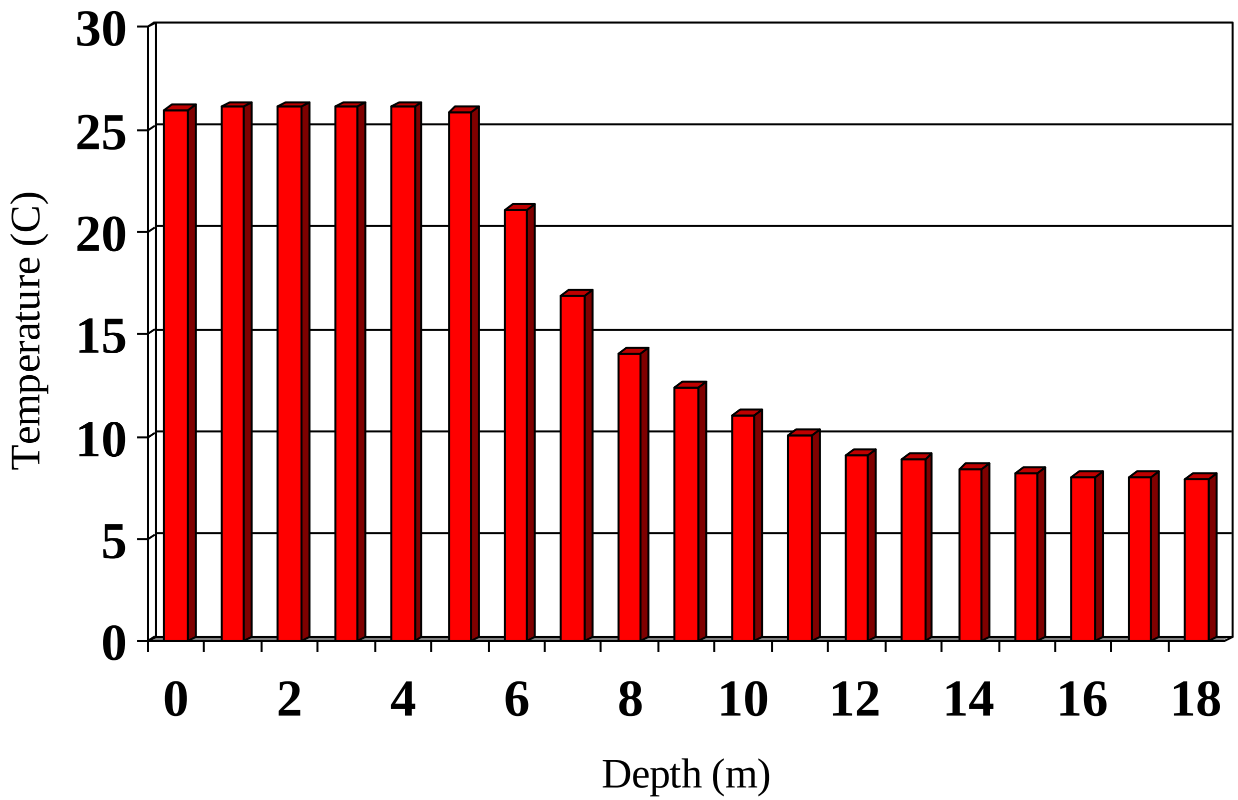

Figure 16-Bimini Lake Temperature Data August

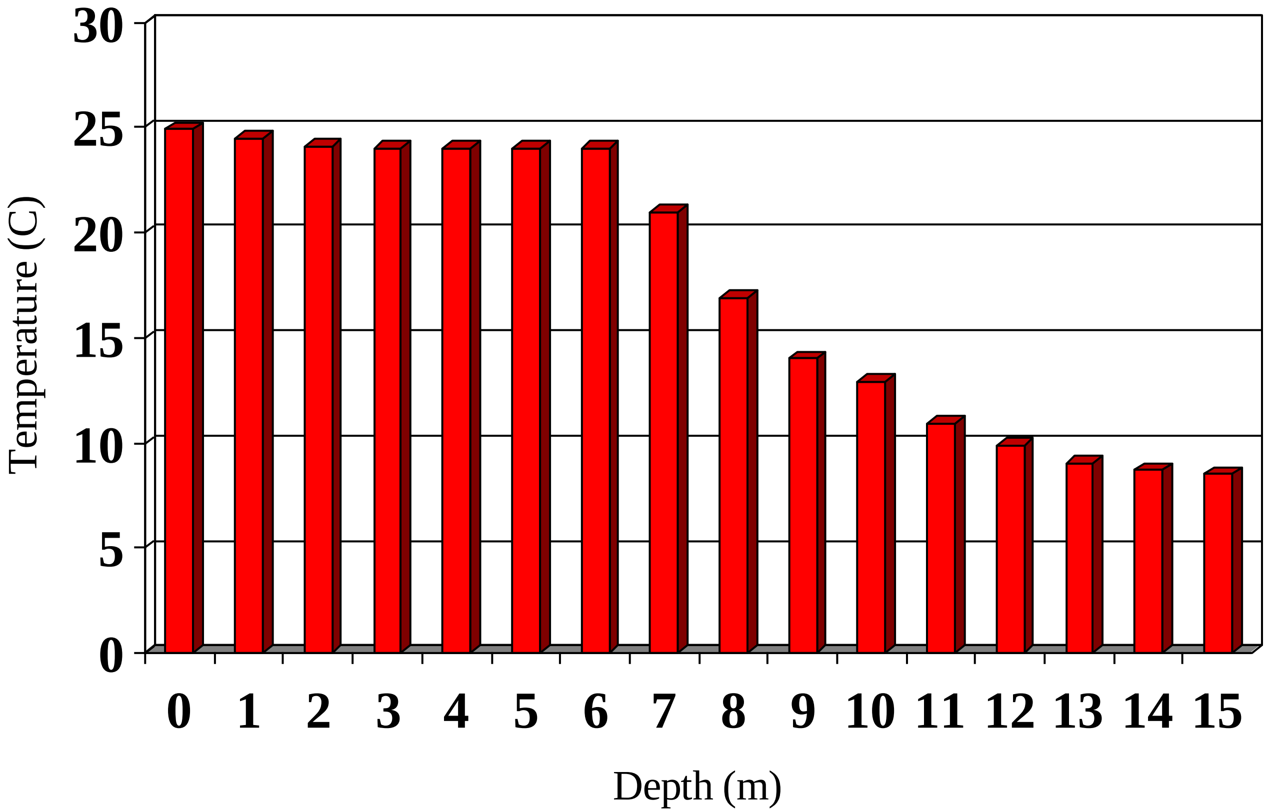

Figure 17-Bimini Lake pH Data July

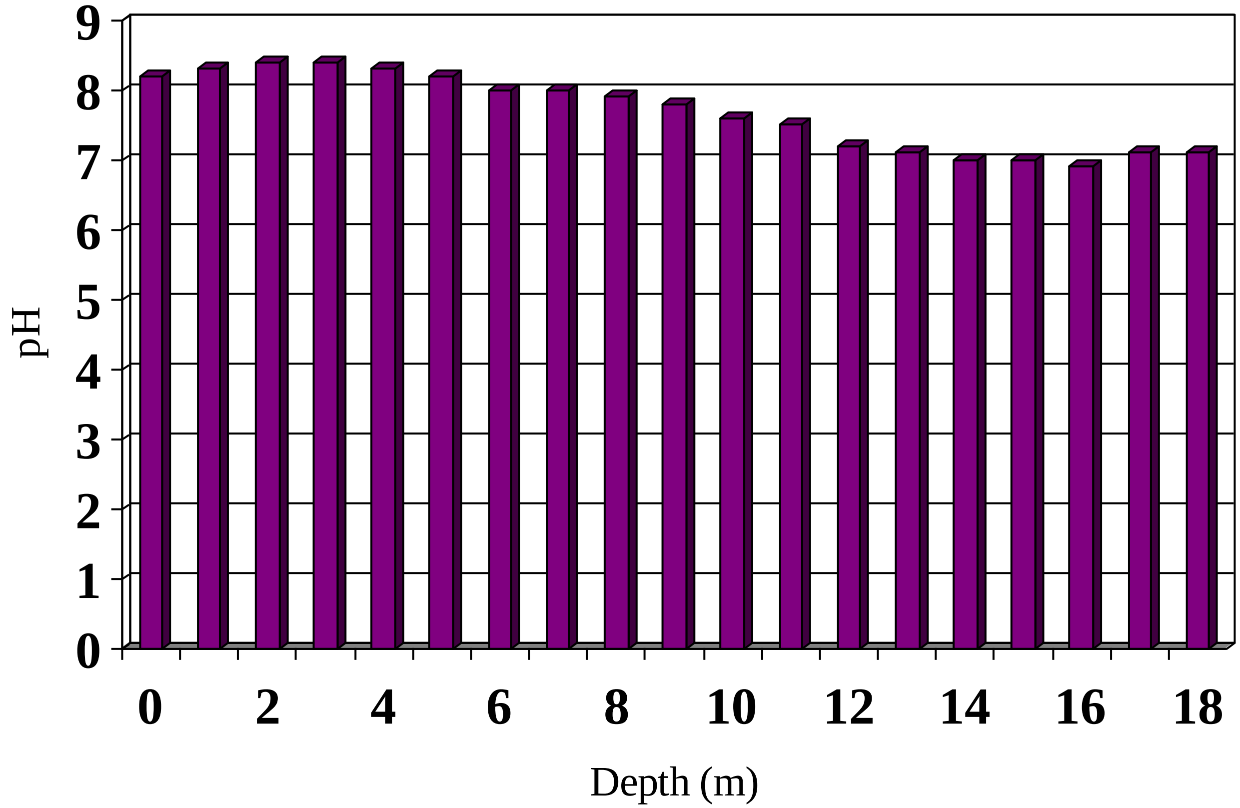

Figure 18-Bimini Lake pH Data August

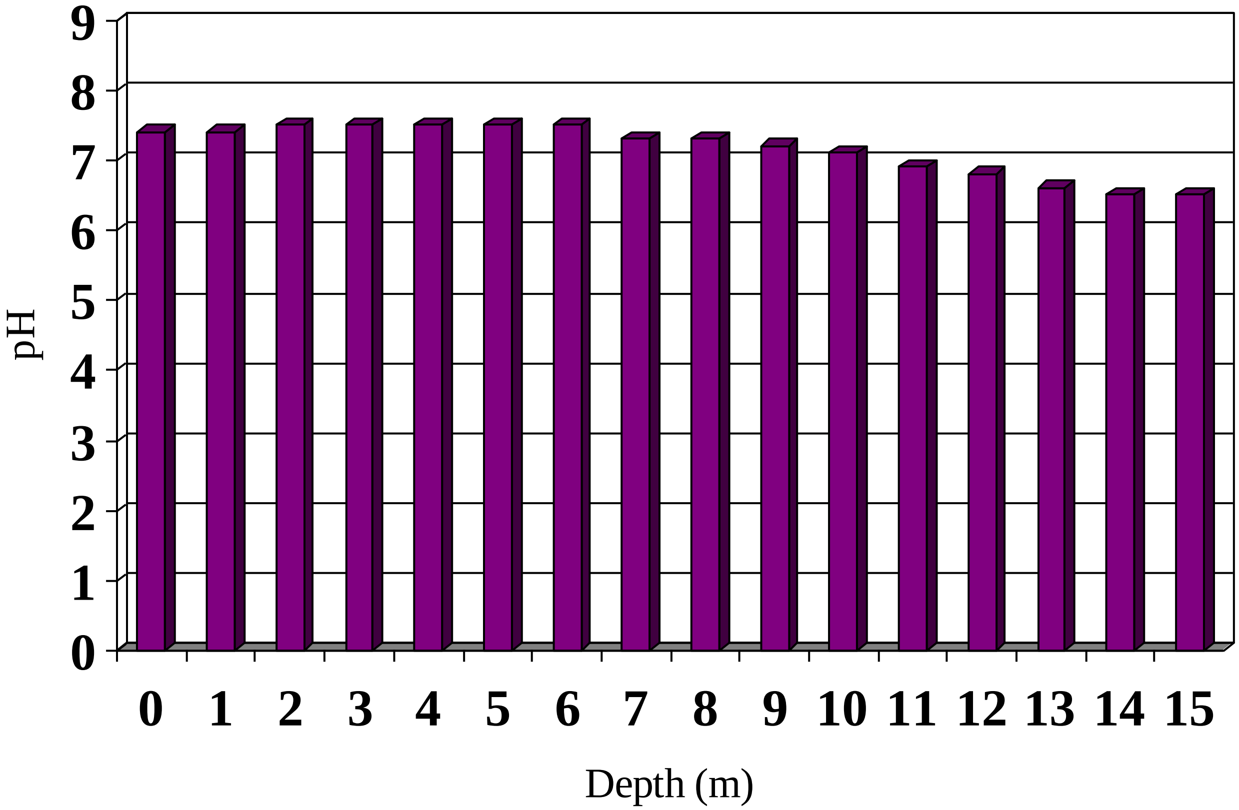

Figure 19-Bimini Lake Conductivity Data July

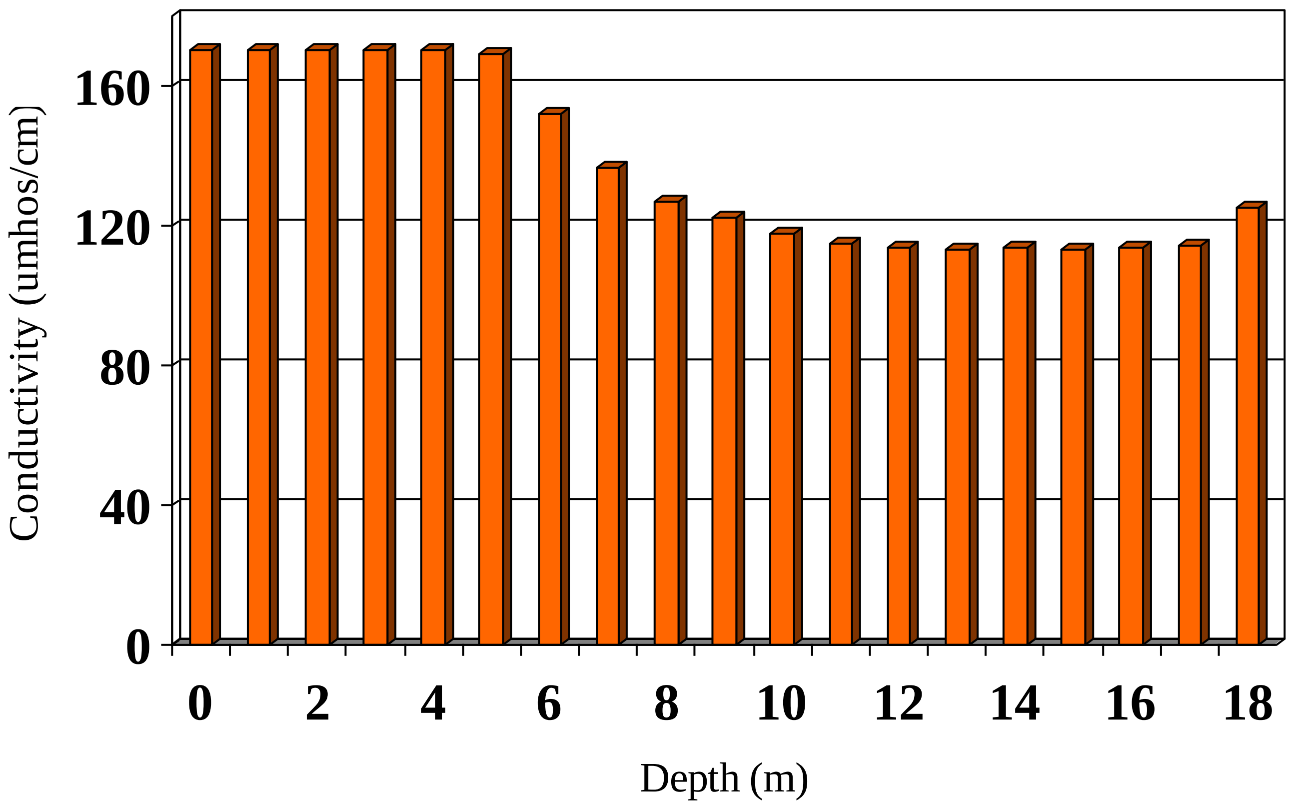

Figure 20-Bimini Lake Conductivity Data August

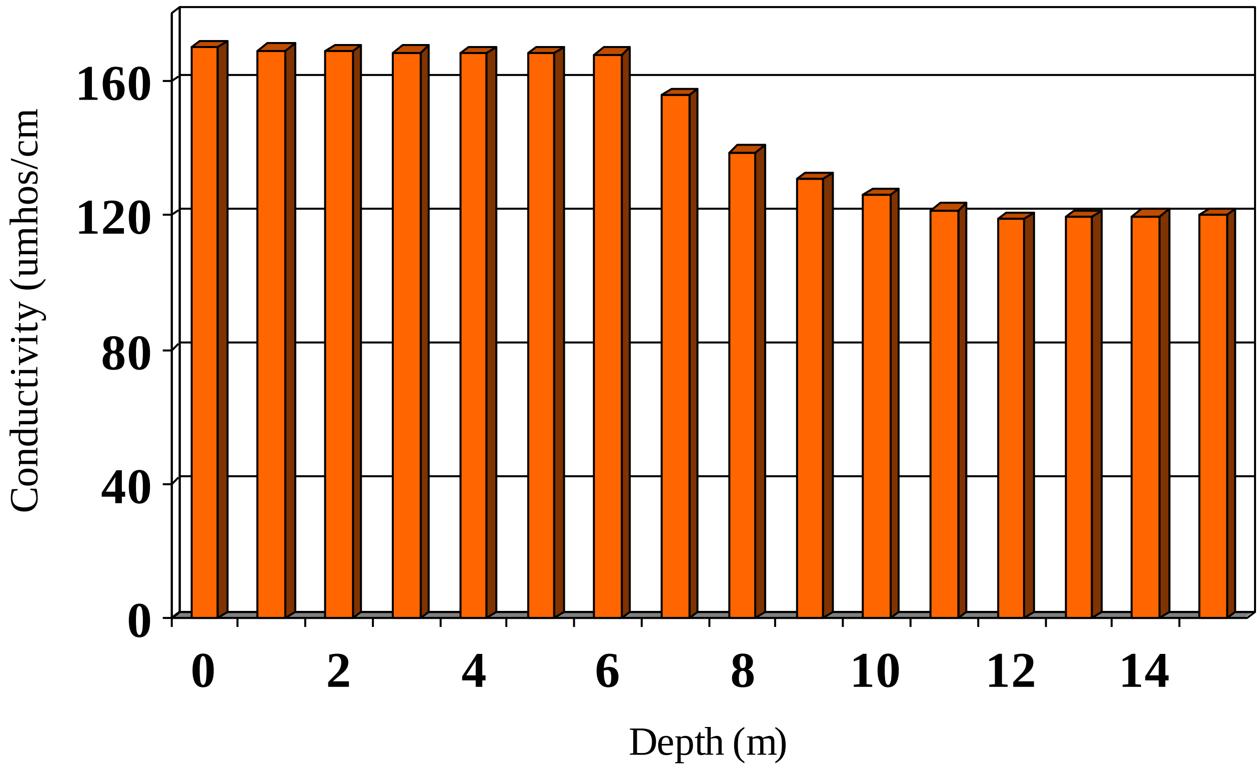

Table 4 –Bimini Lake Monitoring Summary – TSI Indicators and Lab Data

Date	Total Phosphorous (mg/L)	Secchi Depth (m)	Chlorophyll-a (µg/L)	Phytoplankton		Zooplankton	
				Cells/mL	µg/L	#/L	UG/L
7/26/22	<0.00717	6.0	0.61	654.9	1497.4	33.2	53.6
8/23/21	<0.00717	9.6	0.56	82.95	132.7	9.0	33.2

Table 5 - Trophic State Indices for Bimini Lake

Calculated Trophic State Indices for	Annual TSI Values					
	2017	2018	2019	2020	2021	2022
Total Phosphorus	24.2	27.4	27.4	32.6	30.0	30.0
Secchi Depth	27.1	32.9	30.2	31.5	31.1	30.4
Chlorophyll *a*	30.4	26.7	27.5	27.5	30.1	25.4

Treasure Lake Water Quality Synopsis

The results of the water quality monitoring during the summer of 2022 show that Treasure Lake and Bimini Lake have excellent water quality for recreational lakes. Lake water quality is evaluated based on the productivity of the water body. Lakes like Treasure Lake and Bimini Lake that have multiple purposes such as fishing, swimming and boating need to have water quality that will allow for the production of a desirable fishery while allowing for desirable swimming and boating as well. Although lakes with very low productivity have very clear water that is desirable for swimming and boating, they usually have poor fish populations due to low productivity. Conversely, lakes with very high productivity have diverse fisheries but often have undesirable water quality for swimming and boating. Treasure Lake and Bimini Lake have water quality that allow for a productive fishery without the problems found in lakes with higher productivity such as noxious algae blooms.

Productivity is classified based on a model called Trophic State Index (TSI). TSI's are calculated using the water quality data collected and give a "rating" for certain water quality parameters that indicate the health or condition of the lake. The three trophic state water quality parameters used are: total phosphorus, Secchi depth and chlorophyll *a*. Phosphorus is a key nutrient used by plants and algae to grow. Phosphorus is needed to produce the food at the lower end of the food chain for the fish population, but too much is a bad thing. High levels of phosphorus are associated with noxious algae blooms. Secchi depth is a measure of water clarity. A numerically higher secchi depth reading indicates better water clarity. The last parameter is chlorophyll *a*. Chlorophyll *a* is found in algae and therefore; the more chlorophyll present usually means more algae is present.

A calculation is performed after the data is collected to determine a number that is the TSI and will be between 1 and 100. A trophic state index of less than 35 indicates that the lake would have low nutrients and low productivity. These lakes would have clear water for swimming, but their fish population is usually slow growing and less than desirable from a fishing perspective. A TSI of 35 to 50 indicates a lake that would have moderate nutrients and productivity. These lakes are considered most desirable for recreation as they have good water quality for swimming, boating and fish productivity. This season the average TSI numbers for Treasure Lake were as follows: total phosphorus-35.0, Secchi-38.3 and chlorophyll *a*-39.4. The TSI values for Lake Bimini were: total phosphorous 30.0, secchi 30.4, and chlorophyll 25.4. These TSI values show that the water quality for Treasure Lake and Bimini Lake are quite favorable. There are enough nutrients present to support healthy aquatic life without causing undesirable conditions in the lake. The other parameters measured during the season; such as oxygen levels, pH, conductivity and total dissolved/suspended solids all indicate that Treasure Lake and Bimini Lake are healthy and thriving waterbodies.

The environmental monitoring program for Treasure Lake and Bimini Lake is a great asset. The extensive, historic database that is being developed allows for a detailed evaluation of changing water quality conditions that occur throughout a given season. The collection of monthly data on a seasonal basis provides a database of irreplaceable information. Therefore, it is recommended that the monitoring program be continued in 2023. The monitoring program should include both chemical and biological water quality characteristics. Past monitoring programs provide Treasure Lake with an excellent database for the lakes. This database can be used to determine if annual information is following a long-term trend or is the result of annual climatological variations. This information can then be used to evaluate management options.

Management Recommendations

It is important to continue monitoring these parameters each year to better manage the lake. Fertilizers used on lawns are one source of nutrients that could easily run off into the lakes. It is important to keep residents informed about using fertilizers properly. Measures should be taken to control and buffer run off before it enters the lake.

Eurasian Water Milfoil is present in Treasure Lake and Bimini Lake. It is important to control the growth of this plant because it is highly invasive. When left uncontrolled, the milfoil will severely inhibit the recreational usage of the lake. The native species of aquatic plants should be allowed to grow in the lake. They can be selectively controlled in areas of high usage. It is also important to put measures into place that will control any new invasive plants from entering the lake. Boats, trailers, fishing equipment, etc. should all be thoroughly cleaned and checked before entering the lake. It is much easier and inexpensive to prevent an invasion from occurring than to eliminate the problem once it has become established.

Summary of Recommendations for 2023

- Monitor Water Quality
- Control Nutrients Entering the Lakes
- Control the growth of Eurasian Milfoil
- Control the growth of native plants in high-use areas
- Keep new invasive plants from entering the lakes

Phytoplankton Density (cells/mL)

PHYTOPLANKTON DENSITY (CELLS/ML)				
	Bimini	**Bimini**	**Treasure**	**Treasure**
TAXON	**07/26/22**	**08/22/22**	**07/26/22**	**08/22/22**
BACILLARIOPHYTA				
Centric Diatoms				
Cyclotella	47	16	0	0
Araphid Pennate Diatoms				
Asterionella	0	0	0	33
Fragilaria/related taxa	94	16	0	279
Synedra	0	0	64	0
Coccoid/Colonial Chlorophytes				
Ankistrodesmus	0	0	46	0
Oocystis	0	0	0	66
Quadrigula	0	0	0	16
Scenedesmus	0	0	0	66
Sphaerocystis	0	0	0	525
Filamentous Chlorophytes				
Other Filamentous Greens	0	0	0	98
Desmids				
Staurastrum	0	4	0	0
CHRYSOPHYTA				
Flagellated Classic Chrysophytes				
Dinobryon	413	24	419	1435
Synura	0	16	109	262
Uroglena	94	0	0	0
CRYPTOPHYTA				
Cryptomonas	0	8	36	0
Trachelomonas	0	0	0	66
PYRRHOPHYTA				
Ceratium	6	0	9	0
Peridinium	0	0	18	0
DENSITY (CELLS/ML) SUMMARY				
BACILLARIOPHYTA	**141.6**	**31.6**	**63.7**	**311.6**
Centric Diatoms	47.2	15.8	0	0
Araphid Pennate Diatoms	94.4	15.8	63.7	311.6

Monoraphid Pennate Diatoms	0	0	0	0
Biraphid Pennate Diatoms	0	0	0	0
CHLOROPHYTA	**0**	**3.95**	**45.5**	**770.8**
Flagellated Chlorophytes	0	0	0	0
Coccoid/Colonial Chlorophytes	0	0	45.5	672.4
Filamentous Chlorophytes	0	0	0	98.4
Desmids	0	3.95	0	0
CHRYSOPHYTA	**507.4**	**39.5**	**527.8**	**1697.4**
Flagellated Classic Chrysophytes	507.4	39.5	527.8	1697.4
Non-Motile Classic Chrysophytes	0	0	0	0
Haptophytes	0	0	0	0
Tribophytes/Eustigmatophytes	0	0	0	0
Raphidophytes	0	0	0	0
CRYPTOPHYTA	**0**	**7.9**	**36.4**	**0**
CYANOPHYTA	**0**	**0**	**0**	**0**
Unicellular and Colonial Forms	0	0	0	0
Filamentous Nitrogen Fixers	0	0	0	0
Filamentous Non-Nitrogen Fixers	0	0	0	0
EUGLENOPHYTA	**0**	**0**	**0**	**65.6**
PYRRHOPHYTA	**5.9**	**0**	**27.3**	**0**
TOTAL	**654.9**	**82.95**	**700.7**	**2845.4**

Phytoplankton Biomass (µg/L)

	PHYTOPLANKTON BIOMASS (UG/L)			
TAXON	**Bimini 07/26/22**	**Bimini 08/22/22**	**Treasure 07/26/22**	**Treasure 08/22/22**
BACILLARIOPHYTA				
Centric Diatoms				
Cyclotella	118.0	39.5	0.0	0.0
Araphid Pennate Diatoms				
Asterionella	0.0	0.0	0.0	6.6
Fragilaria/related taxa	28.3	4.7	0.0	83.6
Synedra	0.0	0.0	51.0	0.0
Coccoid/Colonial Chlorophytes				
Ankistrodesmus	0.0	0.0	4.6	0.0
Oocystis	0.0	0.0	0.0	26.2
Quadrigula	0.0	0.0	0.0	3.3
Scenedesmus	0.0	0.0	0.0	6.6
Sphaerocystis	0.0	0.0	0.0	105.0
Filamentous Chlorophytes				
Other Filamentous Greens	0.0	0.0	0.0	157.4
Desmids				
Staurastrum	0.0	3.2	0.0	0.0
CHRYSOPHYTA				
Flagellated Classic Chrysophytes				
Dinobryon	1239.0	71.1	1255.8	4305.0
Synura	0.0	12.6	87.4	209.9
Uroglena	9.4	0.0	0.0	0.0
CRYPTOPHYTA				
Cryptomonas	0.0	1.6	7.3	0.0
Trachelomonas	0.0	0.0	0.0	65.6
PYRRHOPHYTA				
Ceratium	102.7	0.0	158.3	0.0
Peridinium	0.0	0.0	38.2	0.0
DENSITY (UG/ML) SUMMARY				
BACILLARIOPHYTA	**146.3**	**44.2**	**51.0**	**90.2**
Centric Diatoms	118.0	39.5	0.0	0.0
Araphid Pennate Diatoms	28.3	4.7	51.0	90.2

Monoraphid Pennate Diatoms	0.0	0.0	0.0	0.0
Biraphid Pennate Diatoms	0.0	0.0	0.0	0.0
CHLOROPHYTA	**0.0**	**3.2**	**4.6**	**298.5**
Flagellated Chlorophytes	0.0	0.0	0.0	0.0
Coccoid/Colonial Chlorophytes	0.0	0.0	4.6	141.0
Filamentous Chlorophytes	0.0	0.0	0.0	157.4
Desmids	0.0	3.2	0.0	0.0
CHRYSOPHYTA	**1248.4**	**83.7**	**1343.2**	**4514.9**
Flagellated Classic Chrysophytes	1248.4	83.7	1343.2	4514.9
Non-Motile Classic Chrysophytes	0.0	0.0	0.0	0.0
Haptophytes	0.0	0.0	0.0	0.0
Tribophytes/Eustigmatophytes	0.0	0.0	0.0	0.0
Raphidophytes	0.0	0.0	0.0	0.0
CRYPTOPHYTA	**0.0**	**1.6**	**7.3**	**0.0**
CYANOPHYTA	**0.0**	**0.0**	**0.0**	**0.0**
Unicellular and Colonial Forms	0.0	0.0	0.0	0.0
Filamentous Nitrogen Fixers	0.0	0.0	0.0	0.0
Filamentous Non-Nitrogen Fixers	0.0	0.0	0.0	0.0
EUGLENOPHYTA	**0.0**	**0.0**	**0.0**	**65.6**
PYRRHOPHYTA	**102.7**	**0.0**	**196.6**	**0.0**
TOTAL	**1497.4**	**132.7**	**1602.5**	**4969.2**

Zooplankton Density (#/L)

ZOOPLANKTON DENSITY (#/L)

TAXON	Bimini 7/26/22	Bimini 8/22/22	Treasure 7/26/22	Treasure 8/22/22
ROTIFERA				
Asplanchna	3.1	0.0	0.0	0.0
Brachionus	9.4	0.0	19.0	0.5
Conochilus	5.5	0.0	0.0	0.0
Kellicottia	3.1	0.4	2.4	0.0
Keratella	5.5	0.8	1.6	1.3
Polyarthra	0.8	0.4	0.8	0.0
COPEPODA				
Copepoda-Cyclopoida				
Cyclops	0.4	1.2	0.0	1.0
Mesocyclops	0.8	1.6	6.3	1.0
Copepoda-Calanoida				
Diaptomus	0.0	0.4	0.0	0.3
Other Copepoda-Nauplii	3.1	2.7	6.3	3.1
CLADOCERA				
Bosmina	0.4	0.4	0.0	0.0
Ceriodaphnia	0.0	0.0	0.0	0.0
Daphnia dubia	0.4	0.8	11.9	1.3
Daphnia pulex	0.8	0.4	0.8	0.8
Diaphanosoma	0.0	0.0	0.0	0.0
OTHER ZOOPLANKTON				
Chaoboridae	0.001	0.011	0.029	0.000
SUMMARY STATISTICS				
DENSITY				
PROTOZOA	0.0	0.0	0.0	0.0
ROTIFERA	27.3	1.6	23.7	1.8
COPEPODA	4.3	5.9	12.6	5.5
CLADOCERA	1.6	1.6	12.6	2.1
OTHER ZOOPLANKTON	0.0	0.0	0.0	0.0
TOTAL ZOOPLANKTON	33.2	9.0	49.0	9.4

Zooplankton Biomass (µg/L)

ZOOPLANKTON BIOMASS (UG/L)

TAXON	Bimini 7/26/22	Bimini 8/22/22	Treasure 7/26/22	Treasure 8/22/22
ROTIFERA				
Asplanchna	3.1	0.0	0.0	0.0
Brachionus	0.8	0.0	1.7	0.0
Conochilus	0.2	0.0	0.0	0.0
Kellicottia	0.1	0.0	0.1	0.0
Keratella	0.5	0.1	0.1	0.1
Polyarthra	0.1	0.0	0.1	0.0
COPEPODA				
Copepoda-Cyclopoida				
Cyclops	1.0	2.9	0.0	2.5
Mesocyclops	3.7	2.0	30.2	5.0
Copepoda-Calanoida				
Diaptomus	0.0	0.2	0.0	0.1
Other Copepoda-Nauplii	8.3	7.2	16.7	8.3
CLADOCERA				
Bosmina	0.4	0.4	0.0	0.0
Ceriodaphnia	0.0	0.0	0.0	0.0
Daphnia dubia	4.3	6.8	123.3	13.5
Daphnia pulex	30.6	8.5	17.1	12.8
Diaphanosoma	0.0	0.0	0.0	0.0
OTHER ZOOPLANKTON				
Chaoboridae	0.6	5.3	14.6	0.0
SUMMARY STATISTICS				
BIOMASS				
PROTOZOA	0.0	0.0	0.0	0.0
ROTIFERA	4.9	0.1	2.0	0.2
COPEPODA	12.9	12.2	46.9	15.9
CLADOCERA	35.2	15.6	140.5	26.3
OTHER ZOOPLANKTON	0.6	5.3	14.6	0.0
TOTAL ZOOPLANKTON	53.6	33.2	204.0	42.4