Mount Kemble Lake

2013 Year End Water Quality Summary

Mount Kemble Lake Association, Inc.

Morristown, NJ

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YEAR END SUMMARY
2013 WATER QUALITY PROGRAM
MOUNT KEMBLE LAKE

INTRODUCTION

The following report is the 2013 Year-End Summary of the Water Quality Monitoring and Lake Management Program for Mount Kemble Lake located in Morristown, Morris County, New Jersey. Included in this summary are details of lake surveys, water quality monitoring program, phytoplankton surveys, and observations logged during site visits in 2013. Recommendations for Mount Kemble Lake management efforts for the 2014 season are also included. The Appendix of this report includes graphs and tables of the 2013 field data, reference guides, along with supporting documents for this report.

Scientific Name	Common Name
Potamogeton foliosus	Leafy Pondweed
Potamogeton crispus	Curly-leaf Pondweed
Lemna minor	Small Duckweed
Najas guadalupensis	Southern Naiad
Potamogeton diversifolius	Variable Pondweed

Table 1. 2013 Observed Aquatic Macrophytes.

The 2013 Lake Management Program for Mount Kemble Lake focused on control of nuisance and invasive aquatic plant growth, most specifically curly-leaf pondweed (***Potamogeton crispus***), leafy pondweed (***Potamogeton foliosus***), and southern naiad (***Najas guadalupensis***). Through the season a total of five (5) different aquatic macrophytes were observed during surveys of the lake (Table 1), with invasive species highlighted in red. One (1) of these species (***Lemna minor***) is a floating aquatic plant.

LAKE MANAGEMENT

Aquatic biologists were at Mount Kemble Lake on six (6) dates April through August to conduct on-water assessments of aquatic vegetation and algae growth, and to perform *in situ* water quality analysis. On three (3) dates, comprehensive water quality analysis was conducted including, sampling for planktonic algae and zooplankton, lab sample collection and lake profile analysis for temperature and dissolved oxygen. Following each survey, biologists would review lake conditions to determine if management activity was required. In 2013, on two (2) dates Allied Biological field staff conducted herbicide and algaecide applications for control of nuisance aquatic vegetation growth. The table below provides a reference to indicate dates of applications, what aquatic pesticides were applied, and the target acreage and aquatic plant species for each date (Table 2).

Date	Service Performed	Acres Treated	Target Species
6/14/2013	Copper Sulfate	5	Filamentous algae
	Reward	5	*P. foliosus / P. crispus / L. minor*
7/18/2013	Copper Sulfate	5	Filamentous algae
	Reward	5	*N. guadalupensis*

Table 2: Mount Kemble Lake Treatment Log

The spring surveys at Mount Kemble Lake indicated that the lake was supporting trace density plant growth, with only a few individual stems of leafy pondweed observed in the shallow north end in May. During the survey in May it was evident that planktonic algae was colonizing in the water column, attributing a slight green color to the lake water column. Through April and May the lake environment was favorable requiring no aquatic herbicide or algaecide applications.

On June 14th an application of the contact herbicide **Reward** was applied to control five acres of moderate density leafy pondweed that was occupying approximately 60% of the western shoreline edge from the boat launch, south to the beach, and along 20% of the northeast shoreline adjacent to the northern most dock areas. Minor amounts of sparse density curly-leaf pondweed were within a two acre area adjacent to the north inlet. **Copper Sulfate** was also applied to target nuisance growth of filamentous algae colonizing along the higher density leafy pondweed growth.

The survey on July 18th suggested that the previous herbicide application successfully controlled the nuisance and invasive pondweed growth, as desirable densities of leafy pondweed were found along small portions of the lake perimeter. At this time surface water temperatures were nearly 90°F, promoting nuisance growth of southern naiad in the north end of the lake, extending along the western shoreline south to the beach, with additional growth noted along the northeast shoreline edge. A supplemental application of the herbicide **Reward** was applied for control of naiad growth, along with **Copper Sulfate** being utilized to suppress growth of filamentous algae in the vicinity of the shallow northern inlet.

The final lake survey of the season in August indicated that previous lake management efforts were successful at eradicating nuisance plant and algae growth, creating a healthy aquatic habitat that supports desirable densities of plant and algae growth, with the lake sustaining fair to good water clarity for the duration of the management season.

Water Quality Monitoring Program

In 2013, the water quality monitoring program included *in-situ* field measured limnological analysis including temperature/dissolved oxygen profiles, pH, transparency, alkalinity, and total hardness. In addition, surface water chemistry samples were collected at the north inlet and lake station, as well as from the lake bottom at the lake station site, and transported to Aqua Pro-Tech Laboratories (Fairfield, New Jersey) for analysis of the following parameters: ammonia, conductivity, nitrate, total phosphorus, and total suspended solids. Water samples were also collected for phytoplankton and zooplankton identification and enumeration. Provided in the Appendix is a short description of each water quality parameter, and laboratory data results. Below is the water quality data tabulated to provide a quick seasonal reference.

Water Quality Data Tables

Mount Kemble Lake Water Quality Results- Lake Station Surface					
Parameter	**Units**	**4/29/2013**	**6/28/2013**	**8/14/2013**	**Limits**
Temperature	°C	15.6	25.8	24.4	
Dissolved Oxygen	mg/L	9.40	8.49	6.82	<2
ph	SU	7.50	8.00	7.50	9
Alkalinity	feet	60.0	52.0	60.0	<4
Total Hardness	mg/L	120.0	100.0	100.0	100
Secchi	mg/L	5.0	5.0	5.0	120
Ammonia	mg/l	<0.2	<0.2	<0.2	0.3
Nitrate	mg/L	0.7	0.7	<0.2	0.3
Total Phosphorus	mg/L	0.04	0.04	0.04	0.03
Total Suspended Solids	mg/L	<3	4.0	10.0	25
Conductivity	Umhos/cm	320	330	248	1500

Table 3. 2013 Mount Kemble Lake Water Quality Results

Results highlighted in a red identify those that exceed the acceptable lake management limit.

Mount Kemble Lake Water Quality Results – Inlet Station					
Parameter	**Units**	**4/29/2013**	**6/28/2013**	**8/14/2013**	**Limits**
Temperature	°C	15.7	25.8	24.9	
Dissolved Oxygen	mg/L	9.16	7.51	8.04	<2
ph	SU	7.50	8.00	7.50	9
Alkalinity	mg/L	64.0	56.0	60.0	<4
Total Hardness	mg/L	120.0	100.0	100.0	100
Secchi	feet	5.0	5.0	5.0	120
Ammonia	mg/L	<0.2	<0.2	<0.2	0.3
Nitrate	mg/L	0.7	0.6	<0.2	0.3
Total Phosphorus	mg/L	0.05	0.04	0.05	0.03
Total Suspended Solids	mg/L	4.0	<3	<3	25
Conductivity	umhos/cm	310	300	252	1500

Table 4. 2013 Mount Kemble Lake Water Quality Results

Results highlighted in a red identify those that exceed the acceptable lake management limit.

Mt. Kemble Lake Water Quality Results–Lake Station-Bottom					
Parameter	**Units**	**4/29/2013**	**6/28/2013**	**8/14/2013**	**Limits**
Temperature	ºC	6.60	8.00	8.9	
Dissolved Oxygen	mg/L	1.74	0.14	0.08	<2
Ammonia	mg/L	<0.2			0.3
Nitrate	mg/L	0.7			0.3
Total Phosphorus	mg/L	0.04	0.09	0.13	0.03
Total Suspended Solids	mg/L	<3			25
Conductivity	umhos/cm	324.00			1500

Table 5. 2013 Mount Kemble Lake Water Quality Results

Results highlighted in a red identify those that exceed the acceptable lake management limit.

Water Quality Results Summary

During 2013, the surface water temperature was 15.7° C in April, and increased to 17.7°C, and 25.8°C in May and June, respectively. The water temperatures rose to 31°C on the July 18th lake survey date, driven by the elevated air temperatures that were prevalent throughout the mid-Atlantic region from late June through July. On the final survey date in August, water temperatures declined to 24.4°C.

The pH values collected from the inlet and lake station sites throughout the year ranged from 7.5 to 8.0, which falls within the typical range for freshwater lake systems, and is within historical readings of the past several years. The hardness levels ranged from 80 mg/L to 140 mg/L at either location throughout the season. The typical range characteristics to freshwater lakes are those falling between 4 and 200mg/L. The chemical composition of Mount Kemble Lake's surface water is considered moderately hard water. The alkalinity values remained consistent throughout the year from 60 to 88 mg/l, and within a comparable level compared to similar NJ freshwater lakes' chemical composition. Conductivity was consistent throughout the season with values ranging from 248 to 330 µmhos/cm., with the highest observed value received in the June sample.

Ammonia and nitrates are nutrients based on the chemical composition of nitrogen. These naturally occurring compounds when influenced by human activity can cause excessive plant and algae growth. All samples collected for ammonia returned levels that were not detectable by the lab.

Nitrates, however, were found elevated in the April and June samples, but were not detected in the August samples. In April, nitrate levels were 0.7 mg/L at all three sites, including the inlet, lake station and bottom sample. During the June sampling nitrate levels were 0.7 and 0.6 mg/L, at the lake station and inlet station, respectively. These values are double the threshold value for excessive aquatic plant productivity. These values are comparable to the data from 2012, which indicates higher values during the spring, and then declining through the season.

Phosphorus is usually present in freshwater lakes at low concentrations. Total phosphorus concentrations in a freshwater lake system should be less than 0.03 mg/L to prevent higher productivity. All samples collected in 2013 indicated that the lake system was Eutrophic (Table 4), with all sample values falling between 0.04 and 0.13 mg/L. The samples collected from the lake bottom contained the highest total phosphorous concentrations, increasing from 0.04 mg/L in April, to 0.09 and 0.13 mg/L in June and August respectively. The elevated total phosphorous concentrations supported later in the season are likely becoming released from the sediment. Anoxic conditions during this time facilitate the transfer of total phosphorous back to the water column. The surface total phosphorous samples indicated lower concentrations from 0.04 to 0.05 mg/L for all samples at both sampling sites.

Table 6: Trophic Status Based on Phosphorus Values

Oligotrophic <0.012mg/L Very Good	Mesotrophic 0.012 - 0.024mg/L Good	Eutrophic 0.025 - 0.096mg/L Fair	Hypereutrophic >0.096mg/L Impoundments

Transparency (water clarity) had displayed moderate variability in 2013, with observed secchi readings between four and eight and a half feet. The highest secchi measurement was recorded on August 5th, when planktonic algae sampling indicated densities of only 120 mg/L. The lowest observed clarity reading was on June 14th, affected by the highest density planktonic algae densities of the season. The June 28th phytoplankton sampling revealed moderate density and diversity of diatoms and green algae, with the assemblages consisting of 890 mg/l, and 810 mg/l, at the inlet and lake stations respectively. Overall, water clarity was considered fair to good throughout the season.

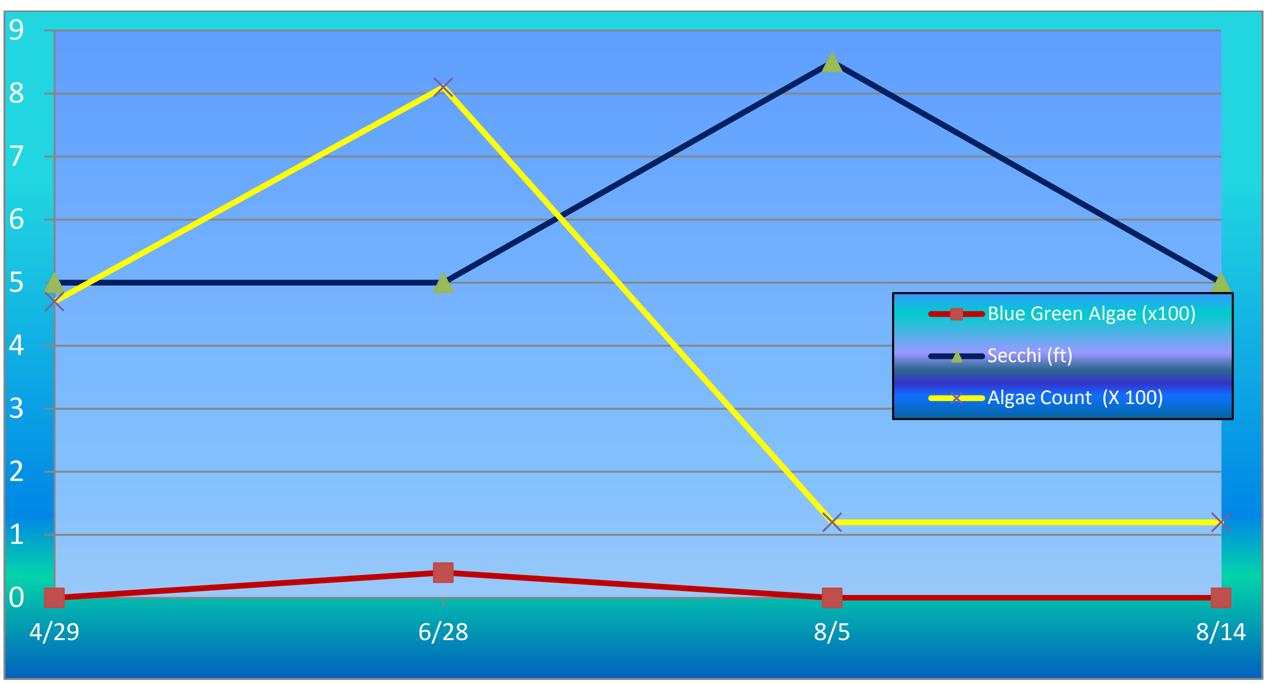


Table 7. Mount Kemble Lake Seasonal Profile

Lake Profile Description

In 2013, temperature and dissolved oxygen profiles were collected from the outlet station sampling site utilizing a temperature / dissolved oxygen meter. The April profile revealed a well mixed water column, with sufficient oxygen to within approximately three feet of the lake bottom. During June and August, planktonic algae densities limited water clarity, limiting sufficient dissolved oxygen levels to within approximately six to ten feet of the lake surface. In a healthy aquatic habitat, dissolved oxygen typically increases with increasing water depth as the water temperature declines, reflecting the relationship that as water temperature decreases, it has the ability to hold a greater dissolved oxygen content. The June and August profiles indicated a strongly stratified water column, with oxygen and temperature readings decreasing with increasing depth. Anaerobic conditions (low dissolved oxygen) allow nutrients to dissolve into the water column more readily and become more available for algae and plant uptake throughout the growing season. Complete profile graphs are provided in the Appendix of this report.

	4/2913		6/28/13		8/14/13	
Depth (m)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
Surface	15.6	9.4	25.8	8.49	24.4	6.82
1	15.6	9.4	24.8	9.26	24.4	6.81
2	15.4	9.19	23.2	10.17	23.9	6.88
3	13.9	9.5	19.3	0.83	23.7	4.37
4	11.5	8.65	15.9	0.18	20.7	0.23
5	9.9	9.07	13.8	0.16	15.5	0.13
6	7.7	6.29	10.9	0.16	12.6	0.10
7	6.8	3.13	9.3	0.16	11.2	0.09
8	6.6	1.74	8.4	0.15	9.2	0.09
9			8.0	0.14	8.9	0.08

Table 8. Mount Kemble Lake Dissolved Oxygen Profiles.

Plankton Surveys

Phytoplankton and Zooplankton surveys were conducted at Mount Kemble Lake in conjunction with the water quality monitoring program. In 2013, surface phytoplankton samples were collected at two established water quality monitoring site in April, June, and August. Samples were collected in dedicated, pre-rinsed one liter plastic bottle, and placed in a cooler with ice for transport. The samples were identified and enumerated under a compound microscope immediately upon return to Allied Biological's laboratory. The 2013 microscopic examination data sheets and graphs are provided in the Appendix. In 2013, a single vertical zooplankton tow was conducted at the lake station on each date. The collected sample was preserved in the field, and returned to ABI's lab for analysis.

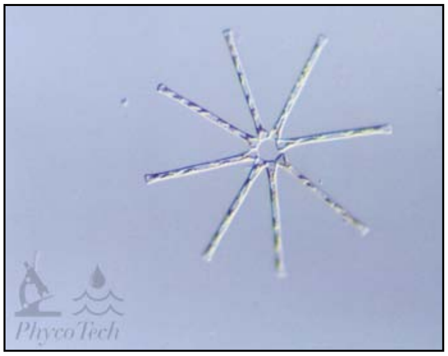
A Phytoplankton Primer

Lakes typically contain three broad categories of phytoplankton (also sometimes referred to as algae). These include filamentous phytoplankton, macroscopic multi-branched phytoplankton (which appear similar to submersed plants), and unicellular phytoplankton. Each category shall be discussed in turn, although the results of the 2013 sampling will focus on the unicellular phytoplankton population.

Filamentous phytoplankton are typically macroscopic (that is, visible with the naked eye), composed of long chains of cells that are attached to a substrate, typically the lake bottom, submersed or emergent vegetation, or rocks. This is called benthic filamentous algae (BFA), and rampant growth can become visible at the surface. As pieces of benthic filamentous algae break apart, it often floats on the surface as dense unsightly mats called floating filamentous algae (FFA). Typically, genera of green algae or blue-green algae develop into nuisance filamentous mats. Abundant nuisance growth of filamentous phytoplankton creates numerous negative impacts to a lake. These can include a decrease in aesthetics, a decrease in recreational uses, increased fishing frustration, and water quality degradation.

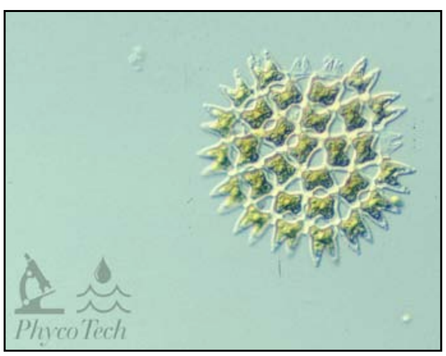
Macroscopic multi-branched phytoplankton appears to be submersed plants, especially when viewed in the water column. Physical examination reveals simple structures, no conductive tissue, and a lack of roots (instead having simplified rhizoids). Although typically only reaching heights of a few inches, under ideal conditions, this type of phytoplankton can reach lengths of several feet, and create a dense carpet on the bottom of a lake. Therefore, it typically does not reach nuisance levels in a lake, save for high use areas such as beaches and other popular swim areas. Since this phytoplankton occupies a similar ecological niche as submersed plants, it's often included in detailed and visual aquatic plant surveys. It provides numerous benefits to a lake system, including sediment stabilization, acting as a nutrient sink, providing invertebrate and fish shelter and habitat, and is one of the first to re-colonize a disturbed area. In the Northeast, muskgrass (*Chara* sp.) and stonewort (*Nitella* sp.) are two of the most common macroscopic multi-branched phytoplankton.

Unicellular phytoplankton are typically microscopic, and consist of individual cells or colonies of cells suspended in the water column. At high enough densities (often called a bloom), they can impart a green or brown (and sometimes, even red) tint to the water column. Unicellular phytoplankton belongs to several taxonomic groups with density and diversity of these groups often varying due to seasonality. When unicellular phytoplankton density becomes elevated it can reduce water clarity (giving the water a "pea soup" appearance), and impart undesirable odors. Usually blue-green algae are responsible for these odors, but other groups or extremely elevated densities can impart them as well. In addition to decreased aesthetics, unicellular phytoplankton blooms can cause degradation of water quality, increase the water temperature (turbid water warms faster than clear water), and can possibly produce a variety of toxins (in the case of blue-green algae), depending on the type of genera present and environmental conditions. Numerous groups of unicellular phytoplankton are common in the Northeast, including diatoms, golden algae, green algae, blue-green algae, euglenoids and dinoflagellates. Each group shall be discussed in turn.

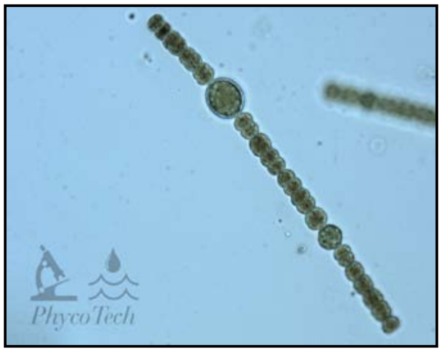


Diatoms are ubiquitous as a group, and often possess a rigid silica shell with ornate cell wall markings or etchings. The silica shells settle to the bottom substrate after they die, and under ideal conditions can become stratified. Limnologists can then study historical (and possibly even ancient) population characteristics of diatoms. Some are round and cylindrical (centric) in shape, while others are long and wing-shaped (pennales). They are usually brown in color, and reach maximum abundance in colder or acidic water. Therefore, they tend to dominate in winter and early spring. Common diatoms in the Northeast include *Fragilaria*, *Cyclotella*, *Navicula*, and *Asterionella* (pictured).

Golden Algae are typically yellow or light brown in color. Cell size is usually small oval shaped with a partially empty area, but several genera create colonies of smaller cells. Most have two flagella, and some type of scales or a rigid coating that grants it a fuzzy appearance. However, a few filamentous forms are possible as well. They typically prefer cooler water, so they dominate in the late fall, winter, or early spring. They also tend to bloom at deeper (cooler) depths. They are common in low nutrient water, and numerous forms produce taste and odor compounds. Common golden algae in the Northeast include *Dinobryon* (pictured), *Mallomonas*, and *Synura*.

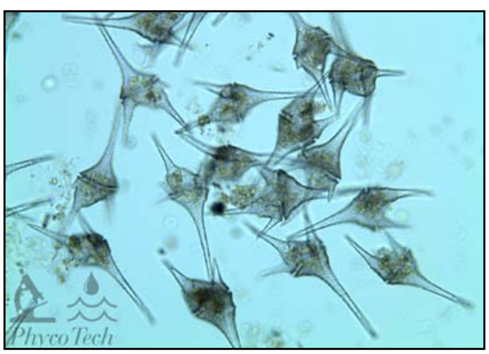


Green Algae are a very diverse group of unicellular phytoplankton. There is tremendous variability in this group which varies from family to family and sometimes even genus to genus. There are flagellated single cells, multi-cell colonies (some motile), filamentous forms and attached forms, typically with distinct cell shapes light green in color. Some prefer acidic waters, and others highly eutrophic (sewage) conditions. A green algae bloom usually occurs in water with high nitrogen levels. Green algae typically dominate in mid to late summer in the Northeast. Common genera include *Chlorella*, *Scenedesmus*, *Spirogyra* and *Pediastrum* (pictured).



Blue-green algae are actually photosynthetic bacteria. Therefore, they tend to be small, simple in structure and lacking interior cell details. Blue-green algae are typically encased in a mucilaginous outer layer. Some genera are adorned with heterocysts, swollen structures capable of fixing nitrogen, a competitive advantage. These types tend to bloom in nitrogen-poor or eutrophic systems. Yet, blue-green algae are tolerant of a wide variety of water chemistries, and boast many oligotrophic forms as well. Blue-green algae often have gas vesicles which provide increased buoyancy another competitive advantage over other groups of phytoplankton, due to their propensity to shade out others by blooming at the surface. Numerous blue-green algae are documented taste and odor (T&O) producers, and under certain environmental conditions and high enough densities, can produce toxins dangerous to fish, livestock, and possibly humans. Blue-green algae typically dominate a lake system in late summer to early fall. Common blue-green algae that occur in the Northeast include *Anabaena* (pictured), *Aphanizomenon*, *Microcystis* and *Coelosphaerium.*

Euglenoids are typically motile with 0 to 3 (typically 2) flagella, one of which is longer. Euglenoids has plasticity of shape, and usually are grass green in color (although sometime they are clear or even red). Most forms have a distinct red "eyespot. They are often associated with high organic content water, and eutrophic conditions. Common euglenoids that occur in the Northeast include *Euglena* (pictured), *Phacus*, and *Trachelomonas*.



Dinoflagellates are very common in marine environments, in which they often cause toxic blooms. However, toxin production in freshwater genera is very rare. Dinoflagellates are typically single ovoid to spherical cells, but large compared to phytoplankton from other groups. They usually possess two flagella (one wrapped around the middle of the cell) which grant them rotation while they move through the water column. Cellulose plates (armored dinoflagellates) are more common, but genera without cellulose plates (naked dinoflagellates) also occur. They generally prefer organic-rich or acidic waters, and can impart a coffee-like brown tint to the water at high enough densities. Common dinoflagellates in the Northeast include *Ceratium* (pictured) and *Peridinium*.

PHYTOPLANKTON RESULTS

In April, the phytoplankton density was considered moderate, with favorable diversity of diatoms, green and golden algae, and traces of euglenoids and dinoflagellates. The assemblages at the inlet and lake station were similar, with several diatoms, and the green algae *Chlorella* dominating each sample. *Euglena*, a euglenoid, was observed in both samples, while trace dinoflagellates (*Peridinium*) (lake station) and golden algae *Mallomonas* (inlet) were also present. There were no blue-green algae observed at this time.

Algal Group	**Inlet Station**		
% Abundance	**4/29/13**	**6/28/13**	**8/14/13**
Diatoms	**49%**	37%	3%
Golden Algae	8%	12%	
Protozoa		1%	
Green Algae	38%	**42%**	6%
Blue-green Algae		8%	**91%**
Dinoflagellates			
Euglenoids	5%		
Total Orgs / mL	**600**	**890**	**240**

Table 9. Inlet Station

Algal Group		**Lake Station**		
% Abundance	**4/29/13**	**6/28/13**	**8/5/13**	**8/14/13**
Diatoms	**56%**	**47%**	8%	
Golden Algae		6%		25%
Protozoa				
Green Algae	**38%**	42%	**67%**	**58%**
Blue-green Algae		5%		
Dinoflagellates	2%		25%	17%
Euglenoids	4%			
Total Orgs. / mL	**470**	**810**	**120**	**120**

Table 10. Lake Station

By June, the phytoplankton density and diversity increased at both sites, with assemblages comprised of eleven (11) genera at the inlet station, and ten (10) genera at the lake station. Green algae genera constituted 42% of the population at each site, with five (5) genera at the inlet, and six (6) genera at the lake station. A bloom of *Fragilaria*, a diatom, represented 33% of the inlet site (290 orgs. / mL), and 46% of the lake station (370 orgs. / ml). Trace amounts of *Anabaena*, a blue-green alga, and *Mallamonas*, a golden algae, were found in each of the samples.

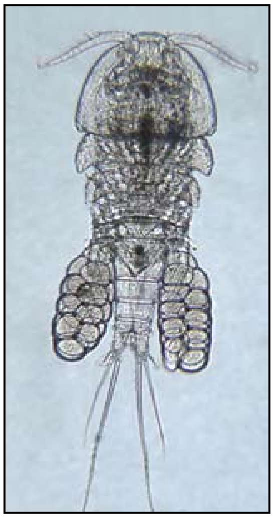
On August 5th, a sample was collected from the shoreline at the dock adjacent to the beach for enumeration. The sample contained low density and diversity, with six (6) genera combining for 120 orgs. / mL. Four (4) genera of green algae represented 67% of the assemblage, with a single diatom, *Fragilaria*, and a single dinoflagellate, *Peridinium* also present. Water clarity was the best observed reading of the season at eight and a half feet. Later in August during the comprehensive water quality sampling date, planktonic algae densities increased at the inlet site, but the lake station was similar to the sample collected earlier in the month at the inlet site. A minor bloom of the blue-green alga *Aphanizomenon* represented 91% of the assemblage, with trace amounts of a single genus of diatom and green algae. The sampling at the inlet station may have been more representative of the algae community in Clubhouse Pond, as opposed to Mount Kemble Lake.

A Zooplankton Primer

Zooplankton provides an important link in a typical lake's food web between phytoplankton and developing/juvenile stages of fish. In general, zooplankton feed on phytoplankton, while fish in turn feed on zooplankton. The rate of phytoplankton feeding efficiency is primarily based on body size, but zooplankton group, and to some effect specific genera, also plays an important role. There are three main groups of zooplankton found in freshwater systems: rotifers, cladocera, and copepods.

Rotifers are a diverse group of zooplankton, very common in lakes and marine environments alike. Rotifers are generally the smallest zooplankton of the three groups, and thus typically the least efficient phytoplankton grazers. Feeding preferences are determined primarily by mouth structures, and include generalist feeders (omnivores), which eat any small organic detritus encountered, and predators, which eat other smaller rotifers and small phytoplankton. Generalist feeders include *Filinia*, *Keratella*, *Lecane*, *Euchlanis*, and *Brachionus*. Predator genera include *Polyarthra* (larger species), *Asplanchna*, *Synchaeta*, and *Trichocerca*.

Cladocera are less diverse, but also very common in freshwater lakes. They are sometimes called "water fleas". They spend most of their lifecycle reproducing via parthenogenesis (asexual reproduction with an all female population) only switching to less efficient sexual reproduction when environmental conditions decline. Some genera (such as *Daphnia*) can be quite large (up to 5.0 mm long, visible without magnification), and thus can be classified as highly efficient phytoplankton grazers. Most cladocera are phytoplankton grazers, although their diet includes most organic matter ingested, including bacteria and protozoa. Body size (and thus mouth size) determines feeding efficiency, but ironically the larger-bodied genera are easier to see by predaceous fish, and thus typically have reduced numbers in populations of zooplanktivorous fish. *Daphnia* are the most efficient phytoplankton feeders, while *Ceriodaphnia*, *Bosmina* and *Eubosmina* are less efficient. There are a few predator genera as well, including *Polyphemus* and *Leptodora*.



Copepods are almost excusive to freshwater lake systems (not streams or rivers) and estuarine and marine systems. Of the six suborders native to the United States, three are parasitic, and three are free living. One of the free living, *Harpacticoida* are exclusively benthic and thus often not collected in traditional plankton tows (unless the bottom sediments are disturbed). The remaining two suborders, the Calanoida and the Cyclopoida are of primary concern during lake studies. All copepods have several naupilar stages, followed by several immature stages, before reaching an adult stage. Both suborder adults are considered large bodied zooplankton, but have distinct feeding preferences. Calanoids are almost exclusively phytoplankton feeders and have even demonstrated selective feeding strategies. Cyclopoids have mouth parts suitable for biting and seizing prey. Their diet is primarily other crustacean zooplankton (including cannibalism on younger life stages), as well as phytoplankton and organic detritus ingestion, but less efficiently.

Zooplankton samples were collected with an 80 um Nitex plankton net. At the Lake Station, a single vertical tow was performed to a depth of 18 feet. Using as little site water as possible, the sides of the net were rinsed of any trapped zooplankton, concentrating the organisms into the net bottom. This concentrate was then emptied into a clean 1000 mL HDPE sample bottle. Immediately after collection, the sample was preserved with an equal amount of 10% sucrose formalin, to achieve a 5% solution. Sucrose was added to the preservative to help maintain carapace integrity. The samples were then placed in a cooler stocked with blue ice. On arrival at ABI's laboratory, the samples were stored in a dark refrigerator until the samples were identified and enumerated.

In the laboratory, each sample was manually mixed for about one minute, before a one mL subsample was removed using a calibrated syringe. The subsample was placed on a Sedgewick-Rafter counting cell, and examined under a compound microscope at 100X magnification. By using calibrated guides on the microscope stage, the entire one mL sample was examined, and any zooplankton were identified and enumerated to the lowest practical taxa using regionally appropriate taxonomic keys. This procedure was repeated two more times to generate three replicate counts. The counts were then averaged, and back-calculated to achieve an organism per liter density. The zooplankton count data sheets in the Appendix describe the step by step procedures for all three replicates, and the final averaged densities. Also included in the Appendix are pie charts depicting the sample date zooplankton group distribution.

2013 Zooplankton Results

Zooplankton Group	**4/29/2013**	**6/28/2013**	**8/5/2013**
Rotifers	43.4%	**64.6%**	**49.7%**
Cladocera	**46.0%**	21.3%	20.0%
Copepoda	10.6%	14.0%	30.4%
Total Zooplankton (Orgs. / mL)	2246	1410	606

Table 11. Mount Kemble Lake 2013 Zooplankton Group Percent Abundance Distribution

In April, overall zooplankton density was 2,246 organisms per liter, which is considered high. Sample diversity was moderate with eleven (11) different species observed. Rotifers and Cladocerans comprised a nearly equivalent percentage of the assemblage, although diversity of Rotifers was much higher (7) than that of Cladocerans (3). *Daphnia*, a Cladoceran, accounted for 36% of the total assemblage, and 78% of the Cladoceran community. The assemblage is overall favorable given the high density of Cladocerans, more specifically, *Daphnia*, which are significant phytoplankton grazers, and provide the base of the food chain from a fisheries perspective.

The June sampling indicated the overall zooplankton density declining to 1,410 organisms per liter. This is considered moderate with the sample diversity increasing to fourteen (14) different species, which is considered high. Rotifer density increased to 64.6% of the population with nine different species. The omnivore *Polyarthra* was the most dominant accounting for 47% of the rotifers, and 30% of the overall assemblage. The Cladoceran *Daphnia* significantly decreased at this time, comprising only 4% of the Group, and less than 1% of the total assemblage. I assume the rest of the Cladocerans are smaller, less efficient phytoplankton feeders. The low density of the Cladoceran group is now putting little feeding pressure on the phytoplankton population.

In August, zooplankton density continued to decrease to 606 organisms per liter, which is considered moderate. Not surprisingly, sample diversity decreased slightly to eight (8) species, which is also considered moderate. Rotifers again dominated the assemblage, but decreased to 49.7% of the total zooplankton counted. Therefore, rotifers dominated the assemblage in June and August, and were dominant along with Cladocerans in April. Also similar to the previous two months, and the data from 2012, *Keratella* and *Polyarthra* were two of the most common zooplankton observed, although *Calanoid nauplii* density were the genus of highest density in August, composing 30% of the total community. At this time, no *Daphnia* were identified, signaling that planktonic algae had little feeding pressure.

Recommendations

The 2014 management program of Mount Kemble Lake will continue to focus on the control of nuisance densities of plant and algae growth. The target aquatic macrophyte species observed at Mount Kemble Lake in 2013 was the growth of southern naiad and curly-leaf and leafy pondweed. It is recommended that an application of the contact aquatic herbicide Reward be utilized in the early season for its ability to selectively control nuisance submerged vegetation by rapid absorption into the target plant. Since southern naiad is an annual aquatic plant, a supplemental application of a contact herbicide may be advised. In addition, it is beneficial to allow certain amounts of plants to persist in the lake to provide dissolved oxygen, habitat and compete for nutrients required for nuisance plant and algae development. The growth of leafy pondweed (*Potamogeton foliosus*) and southern naiad (*Najas guadalupensis)* should be encouraged in areas of the lake, such as the northern end, where they are not interrupting recreational activities or reducing the aesthetic appeal of the lake. The ideal location for allowing native plant species to persist would be in the northern inlet portion of the lake.

Copper sulfate will continue to provide the most effective and cost efficient management method for controlling nuisance density filamentous and planktonic algae growth. Numerous other copper and non-copper based algaecides are available and at the request of the Association, ABI would be happy to discuss these alternatives.

Efforts in the restoration of Mount Kemble Lake should focus on a nutrient inactivation treatment to bind phosphorus and other suspended particles in the water column to provide a nutrient barrier over lake sediments which will reduce sediment release of phosphorus. Water quality sampling has documented elevated phosphorus in the water column, which is a main nutrient source of plant and algae growth. An Alum treatment in previous years has displayed a dramatic improvement in water clarity, which typically lasts until the next significant water exchange period. Although this process was planned for the 2013 management season, favorable water quality conditions and water clarity proved an aluminum sulfate application to not be essential during the season. An additional measure to reduce the phosphorus levels within the system could be the use of an algaecide with a water quality enhancing component designed to assimilate phosphorus released from decomposing algae cells. A copper based product SeClear will control the growth of nuisance algae and assist in reducing the nutrient levels.

The current Mount Kemble Lake Water Quality Monitoring Program is well-designed, and provides suitable water quality data allowing for proactive management of the lakes' environment and reduces the opportunity for the development of problematic situations. It is important to continue water quality monitoring on a regular yearly basis over the long-term to build a baseline data record which will assist biologists in developing more quantitative analysis for greatest possible management procedures.

The entire staff at Allied Biological appreciates the opportunity to be of service to the Mount Kemble Lake Association and looks forward to assisting the Association on the stewardship of Kemble Lake for many years to come.

Sincerely,

Robert Schindler

Bob Schindler
Aquatic Biologist

APPENDIX

APPENDIX A: WATER QUALITY PARAMETER DESCRIPTION
APPENDIX B: AQUATIC MACROPHYTE GUIDE
APPENDIX C: PHYTOPLANKTON ENUMERATION CHARTS
APPENDIX D: WATER QUALITY SAMPLING MAP
APPENDIX F: DISSOLVED OXYGEN – TEMP. PROFILES
APPENDIX G: LAB DATA REPORTS

Appendix A: Water Quality Parameter Descriptions

Temperature

Temperature is measured in degrees Celsius, and is very important to aquatic biota. Several factors affect temperature in a lake system, including air temperature, season, wind, water flow through the system, and shade trees. Turbidity can also increase water temperature as suspended particles absorb sun rays more efficiently. Water depth also affects temperature. In general, deeper water remains cooler during the summer months.

Temperature preferences vary among aquatic biota. Since water temperature typically varies between 5 ºC and 30 ºC during the season, most aquatic biota can flourish under this wide range of temperatures. Of more concern is thermal shock, which occurs when temperature rapidly changes in a short amount of time. Some aquatic biota can become stressed when temperature changes as little as 1-2 ºC in a 24 hour period.

Dissolved Oxygen

Dissolved Oxygen is the measurement of the amount of oxygen freely available to aquatic biota in water. Several factors play a role in affecting the amount of dissolved oxygen in the water. These factors include temperature (warmer water holds less dissolved oxygen), low atmospheric pressure (such as higher altitude) decreases the solubility of oxygen, mineral content of the water can reduce the water's dissolved oxygen capacity, and water mixing (via wind, flow over rocks, or thermal upwelling) increases dissolved oxygen in the water. In addition, an over abundance of organic matter, such as dead algae or plants causes rapid aerobic bacteria growth. During this growth, bacteria consume oxygen during respiration, which can cause the water's dissolved oxygen to decrease.

Dissolved oxygen has a wide range, from 0 mg/L to 20 mg/L. To support diverse aquatic biota, 5-6 mg/L is minimally required, but 9-10 mg/L is an indicator of better overall water quality. Dissolved oxygen reading of below 4 mg/L is stressful to most aquatic organisms, especially fish.

Water Clarity

Transparency (or visibility) is measured with a Secchi disc, and can provide an experienced biologist with a quick determination of a lake's water quality. In short, higher visibility indicates a cleaner (and healthier) aquatic system. Cloudy conditions could indicate nutrient rich sediments entering the lake or excessive algal blooms due to nutrient availability, leading to a degradation of water quality.
Clear conditions allow greater light penetration and the establishment of a deeper photic zone. The photic zone is the depth of active photosynthesis carried out by plants and algae. A byproduct of photosynthesis is dissolved oxygen, required for use by higher aquatic organisms, such as zooplankton and fish.

Total Hardness

Hardness is a measure of dissolved salts in the water, usually calcium, but also magnesium and iron. Hardness is usually influenced by the rock and soil types of the watershed, and the amount of runoff over these surfaces. Hardness can be measured for only calcium content (Hardness (Ca)), or for all three salts, called Total Hardness. Water with Hardness (Ca) less than 10 mg/L can only support sparse aquatic biota. Freshwater typically has a Hardness (Ca) level from 4 to 100 mg/L. In general, the degree of total hardness can be classified according to the table to the right.

Alkalinity

Alkalinity is the measure of the water's capacity to neutralize acids. A higher alkalinity can buffer the water against rapid pH changes, which in turn prevents undue stress on aquatic biota due to fluctuating pH levels. The alkalinity of a lake is primarily a function of the watersheds soil and rock composition. Limestone, dolomite and calcite are all a source of alkalinity. High levels of precipitation in a short amount of time can decrease the waters alkalinity. A typical freshwater lake has an alkalinity of 20-200 mg/L. A lake with a low alkalinity typically also has a low pH, which can limit the diversity of aquatic biota.

pH

The measurement of acidity or alkalinity of the water is called pH (the "potential for hydrogen"). Several factors can impact the pH of a lake, including precipitation in a short amount of time, rock and soil composition of the watershed, algal blooms (increase the pH), and aquatic plant decomposition (decreases the pH). A pH level of 6.5 to 7.5 is considered excellent, but most lake systems fall in the range of 6.0 to 8.5. Aquatic biota can become stressed if the pH drops below 6.0, or increases above 8.5 for an extended amount of time.

Most aquatic biota are adapted to specific pH ranges. When the pH fluctuates rapidly, it can cause changes in aquatic biota diversity. Immature stages of aquatic insects and juvenile fish are more sensitive to low pH values than their adult counterparts. Therefore, a low pH can actually inhibit the hatch rate and early development of these organisms.

Conductivity

Conductivity is the measure of water's ability to conduct an electrical current, and is measured in umhos/cm, the higher the number of charged particles(ions) in the water, the easier for electricity to pass through it. Conductivity is useful in lake management by estimating the dissolved ionic matter in the water, the lower the conductivity, the higher the quality of water (oligotrophic). A higher conductivity usually indicates an abundance of plant nutrients (total phosphorous and nitrate), or eutrophic conditions. Industrial discharge, road salt runoff, and septic tank leaching can increase conductivity. Distilled water has a conductivity of 0.5 to 2.0 umhos/cm, while drinking water conductivity typically ranges from 50to 1,500 umhos/cm. Conductivity below 500 umhos/cm is considered ideal in a lake system.

Nitrate

Nitrates are chemical compounds derived from nitrogen and oxygen. Nitrogen is needed by all plants and animals to make proteins needed for growth and reproduction. Nitrates are generated during plant and animal decomposition, from man-made sources, and from livestock and waterfowl sources. Man-made sources of nitrates include septic system leaching, fertilizer runoff, and improperly treated wastewater. Freshwater lake systems can potentially receive large nitrate inputs from waterfowl, specifically large flocks of Canada geese. An increase in nitrate levels can in turn cause an increase in total phosphorous levels. A nitrate level greater than 0.3 mg/L can promote excessive growth of aquatic plants and algae.

Total Phosphorous

Total phosphorous is a chemical compound derived from phosphorous and oxygen. Total phosphorous is usually present in freshwater in low concentrations, and is often the limiting nutrient to aquatic plant growth. However, man-made sources of phosphorous include septic system leaching, fertilizer runoff, and improperly treated wastewater. These phosphorous inputs usually enter a freshwater lake system during rain events, and bank erosion.

A total phosphorous level greater than 0.03 mg/L can promote excessive aquatic plant growth and decomposition, either in the form of algal blooms, or nuisance quantities of aquatic plants. This process is called eutrophication, and when induced or sped up by man-made nutrient inputs, it is called cultural eutrophication. As a result of this excessive growth, recreational activities, such as swimming, boating, and fishing in the lake can be negatively impacted. In addition, aerobic bacteria will thrive under these conditions, causing a decrease in dissolved oxygen levels which can negatively impact aquatic biota such as fish.

Total Suspended Solids

Total suspended solids refer to all of the particulate matter suspended in the water column. When these solids settle to the bottom of a water body (a process called siltation), they become sediments. There are two components that make up total suspended solids: inorganic and organic. The inorganic portion is usually considerably higher than the organic portion and includes silts, clays, and soils. Organic solids include algae, zooplankton, bacteria and organic debris. All these solids create turbid (or “muddy”) conditions. The geology and vegetation of a watershed affect the amount of suspended solids that enter a lake system. Most suspended solids originate from accelerated soil erosion from agricultural operations, logging activities, and construction activities. Another source is the disturbance of bottom sediments from dredging activities, grazing of bottom feeding fish, and recreational activities such as boating.

Ammonia

Ammonia is a type of nitrogen compound used by plants and algae to support growth. Ammonia content in a body of water is influenced by decaying plants and animals, animal waste, industrial waste effluent, agricultural runoff, and atmospheric nitrogen gas transfer. A concentration exceeding 0.30 mg/L can promote excessive plant and algae growth. Elevated ammonia levels can increase nitrification, which in turn depletes the oxygen content of water. Extremely high ammonia levels can be toxic to aquatic biota (such as fish).

Appendix B: Aquatic Macrophyte Guide

Small Duckweed (*Lemna minor*. Common Names: Small duckweed, water lentil, lesser duckweed. **Native.**). Small duckweed is a free floating plant, with round to oval-shaped leaf bodies typically referred to as fronds. The fronds are small (typically less than 0.5 cm in diameter), and it can occur in large densities that can create a dense mat on the water's surface. Each frond contains three faint nerves, a single root (a characteristic used to distinguish it from other duckweeds), and no stem. Although it can produce flowers, it usually reproduces via budding at at a tremendous rate. Its population can double in three to five days. Since it is free floating, it drifts with the wind or water current, and is often found intermixed with other duckweeds. Since it's not attached to the sediment, it derives nutrients directly from the water, and is often associated with eutrophic conditions. It over winters by producing turions late in the season. Small duckweed is extremely nutritious and can provide up to 90% of the dietary needs for waterfowl. It's also consumed by muskrat, beaver and fish, and dense mats of duckweed can actually inhibit mosquito breeding.

Curly-leaf Pondweed (*Potamogeton crispus*. Common Name: curly-leaf pondweed. **Invasive.**): Curly-leaf pondweed has spaghetti-like stems that often reach the surface by mid-June. Its submersed leaves are oblong, and attached directly to the stem in an alternate pattern. The margins of the leaves are wavy and finely serrated, hence its name. No floating leaves are produced. Curly-leaf pondweed can tolerate turbid water conditions better than most other macrophytes. In late summer, Curly-leaf pondweed enters its summer dormancy stage. It naturally dies off (often creating a sudden loss of habitat and releasing nutrients into the water to fuel algae growth) and produces vegetative buds called turions. These turions germinate when the water gets cooler in the autumn and give way to a winter growth form that allows it to thrive under ice and snow cover, providing habitat for fish and invertebrates.

Leafy Pondweed (*Potamogeton foliosus*: Common Name: leafy pondweed. **Native**.): Leafy pondweed has freely branched stems that hold slender submersed leaves that become slightly more narrow as they approach the stem. The leaf contains 3-5 veins and often tapers to a point. No floating leaves are produced. It produces early season fruits in tight clusters on short stalks in the leaf axils. These early season fruits are often the first grazed upon by waterfowl during the season. Muskrat, beaver, deer and even moose also graze on the fruit. It inhabits a wide range of habitats, but usually prefers shallow water. It has a high tolerance for eutrophic conditions, allowing it to even colonize secondary water treatment ponds.

Southern Naiad (*Najas guadalupensis*. Common Names: Southern water nymph, bushy pondweed. **Native**.): Southern naiad is an annual aquatic plant that can form dense stands of rooted vegetation. Its ribbon-like leaves are dark-green to greenish-purple, and are wider and less pointed than slender naiad. Flowers occur at the base of the leaves, but are so small, they usually require magnification to detect. Southern naiad is widely distributed, but is less common than slender naiad in northern zones. Southern naiad reproduces by seeds and fragmentation.

Variable-leaf Pondweed (*Potamogeton diversifolius*. Common Names: Water-thread pondweed, variable-leaf pondweed, snailseed pondweed. **Native**.): Variable-leaf pondweed have freely-branched stems emerging from slender rhizomes. The submersed leaves are narrow and linear with one obvious midvein bordered by a row of hollow cells. The floating leaves are shaped like an ellipse, but are usually less than 4 cm long, Variable-leaf pondweed fruit spikes are produced in two distinct forms. It occurs in lakes, ponds, rivers and streams and prefers soft sediment and water less than 2 meters deep. Waterfowl graze on the fruit, and local fauna often graze on the stems and leaves.

MICROSCOPIC EXAMINATION OF WATER

Sample from: Mount Kemble Lake

Collection Date: 4/29/2013	**Examination Date: 4/30/2013**	**Amount Examined:** 200 ml.
Site A : North Station (Inlet)	**Site B: Lake Station**	**Site C:**

BACILLARIOPHYTA (Diatoms)	A	B	C
Asterionella	50	60	
Cocconeis			
Cyclotella	90	60	
Cymbella			
Diatoma			
Fragilaria	130	130	
Melosira			
Meridion			
Navicula		10	
Pinnularia			
Rhizosolenia			
Stephanodiscus			
Synedra	10		
Tabellaria	10		
Stauroneis			
Nitzschia			
Denticula			
Total Diatoms	**290**	**260**	**0**

CHRYSOPHYTA (Golden Algae)	A	B	C
Dinobryon			
Mallomonas	50		
Synura			
Tribonema			
Uroglenopsis			
Vaucheria			
Total Golden Algae	**50**	**0**	**0**

PROTOZOA	A	B	C
Actinophrys			
Vorticella			
Total Protozoa	**0**	**0**	**0**

CHLOROPHYTA (Green Algae)	A	B	C
Actinastrum			
Ankistrodesmus			
Chlamydomonas			
Chlorella	210	180	
Chlorococcum			
Closterium			
Coelastrum			
Cosmarium			
Desmodium			
Eudorina			
Gloeocystis			
Micrasterias			
Micratinium			
Microspora			
Mougeotia			
Oedogonium			
Oocystis			
Pandorina			
Pediastrum			
Phytoconis			
Rhizoclonium			
Scenedesmus	20		
Sphaerocystis			
Spirogyra			
Staurastrum			
Tetraedron			
Ulothrix			
Volvox			
Palmella			
Euastrum			
Zygnema			
Dictyosphaerium			
Quadrigula			
Bottryococcus			
Trackdomuccs			
Eaestrum			
Total Green Algae	**230**	**180**	**0**

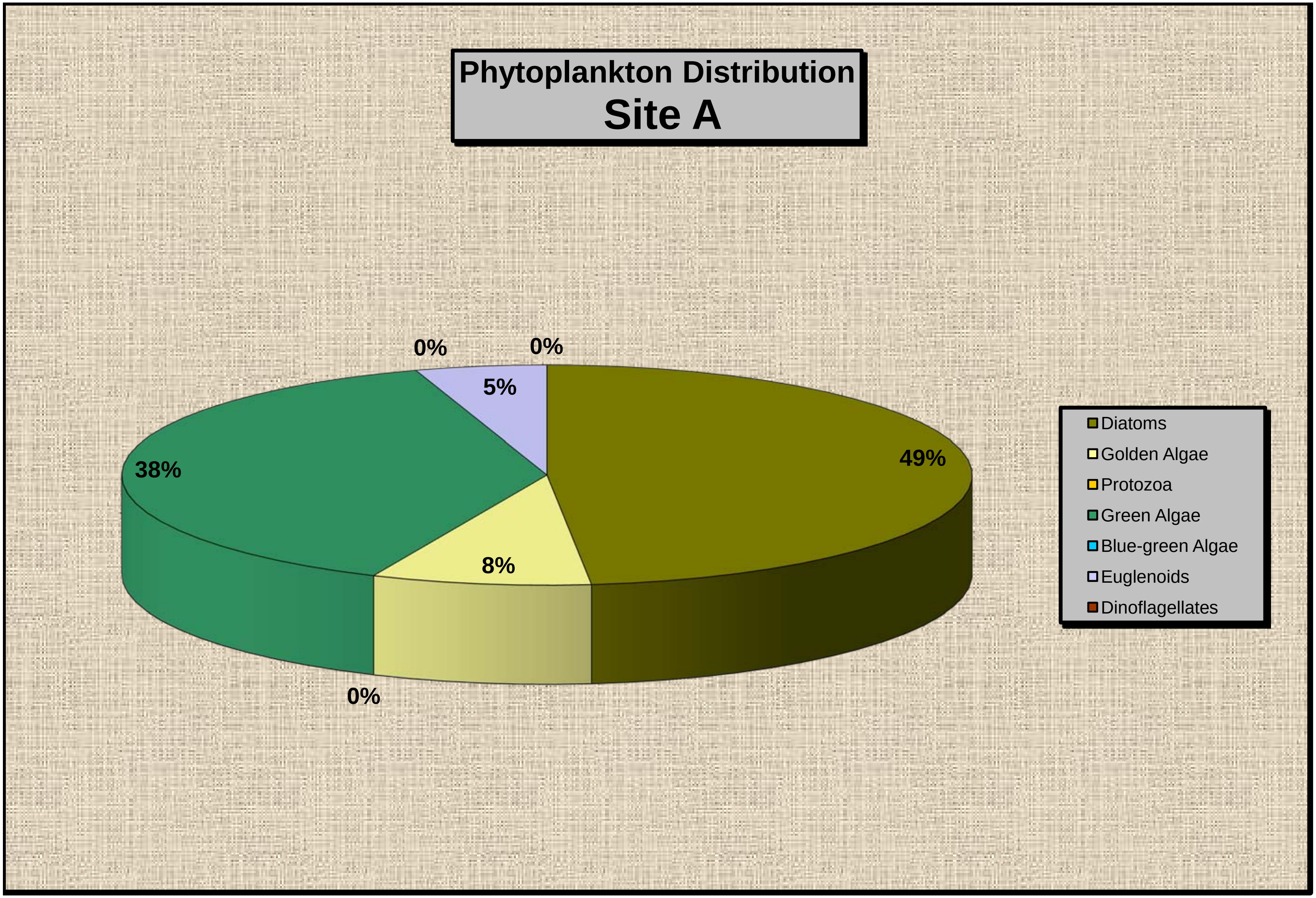
CYANOPHYTA (Blue-green Algae)	A	B	C
Anabaena			
Anacystis			
Aphanizomenon			
Coelosphaerium			
Cylindrospermum			
Gomphosphseria			
Lyngbya			
Microcystis			
Nostoc			
Oscillatoria			
Pseudoanabaena			
Synechocystis			
Total Blue-green Algae	**0**	**0**	**0**

EUGLENOPHYTA (Euglenoids)	A	B	C
Euglena	30	20	
Lepocinclis			
Phacus			
Trachelomonas			
Total Euglenoids	**30**	**20**	**0**

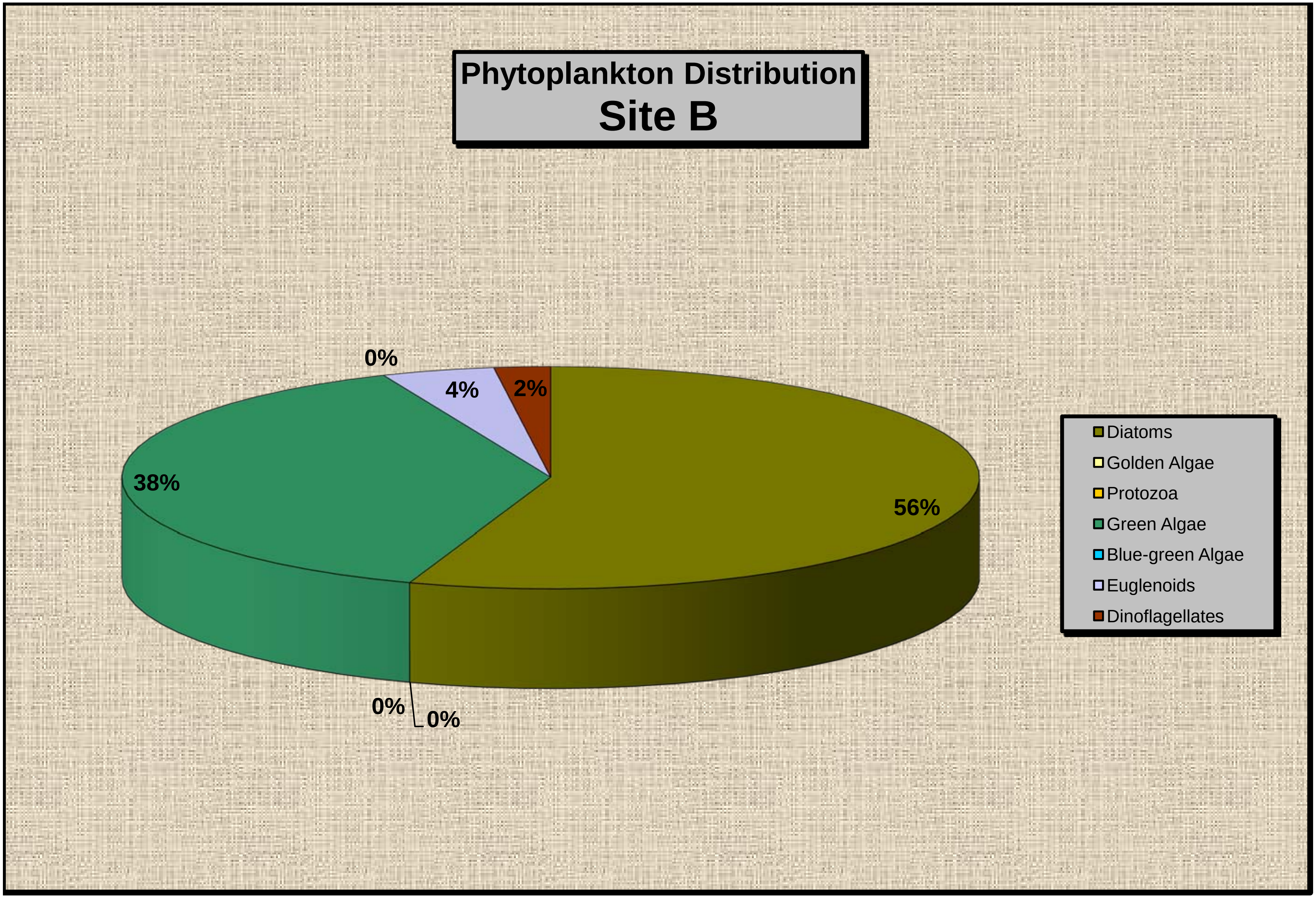
PYRRHOPHYTA (Dinoflagellates)	A	B	C
Ceratium			
Peridinium		10	
Gymnodinium			
Total Dinoflagellates	**0**	**10**	**0**

SITE	A	B	C
TOTAL GENERA:	9	7	
TRANSPARENCY:	5	5	
ORGANISMS PER MILLILITER:	**600**	**470**	**0**

NOTES: This was the first sampling event of 2013. Algal density was low to moderate at both sampling sites with moderate diversity. The assemblage was a seasonable mix of diatoms and green algae with some golden algae also observed. No nuisance blue-green algae were observed at either site. The water clarity is considered fair at both sites.



Phytoplankton Distribution
Site A
0%
0%
5%
49%
38%
8%
0%
Diatoms
Golden Algae
Protozoa
Green Algae
Blue-green Algae
Euglenoids
Dinoflagellates


Phytoplankton Distribution
Site B
0%
4%
2%
38%
56%
0%
0%
Diatoms
Golden Algae
Protozoa
Green Algae
Blue-green Algae
Euglenoids
Dinoflagellates

Allied Biological

MICROSCOPIC EXAMINATION OF WATER

Sample from: Mount Kemble Lake

Collection Date: 6/28/2013	**Examination Date: 6/28/2013**	**Amount Examined:** 200 ml.
Site A : North Station (Inlet)	**Site B: Lake Station**	**Site C:**

BACILLARIOPHYTA (Diatoms)	A	B	C
Asterionella			
Cocconeis			
Cyclotella			
Cymbella			
Diatoma			
Fragilaria	290	370	
Melosira			
Meridion			
Navicula	10		
Pinnularia			
Rhizosolenia			
Stephanodiscus			
Synedra	30	10	
Tabellaria			
Stauroneis			
Nitzschia			
Denticula			
Total Diatoms	**330**	**380**	**0**

CHRYSOPHYTA (Golden Algae)	A	B	C
Dinobryon			
Mallomonas	110	50	
Synura			
Tribonema			
Uroglenopsis			
Vaucheria			
Total Golden Algae	**110**	**50**	**0**

PROTOZOA	A	B	C
Actinophrys	10		
Vorticella			
Total Protozoa	**10**	**0**	**0**

CHLOROPHYTA (Green Algae)	A	B	C
Actinastrum			
Ankistrodesmus			
Chlamydomonas			
Chlorella			
Chlorococcum			
Closterium	20	10	
Coelastrum	210	160	
Cosmarium	20		
Desmodium			
Eudorina		10	
Gloeocystis	110	140	
Micrasterias			
Micratinium			
Microspora			
Mougeotia			
Oedogonium			
Oocystis			
Pandorina			
Pediastrum			
Phytoconis			
Rhizoclonium			
Scenedesmus			
Sphaerocystis		10	
Spirogyra			
Staurastrum	10		
Tetraedron			
Ulothrix		10	
Volvox			
Palmella			
Euastrum			
Zygnema			
Dictyosphaerium			
Quadrigula			
Bottryococcus			
Trackdomuccs			
Eaestrum			
Total Green Algae	**370**	**340**	**0**

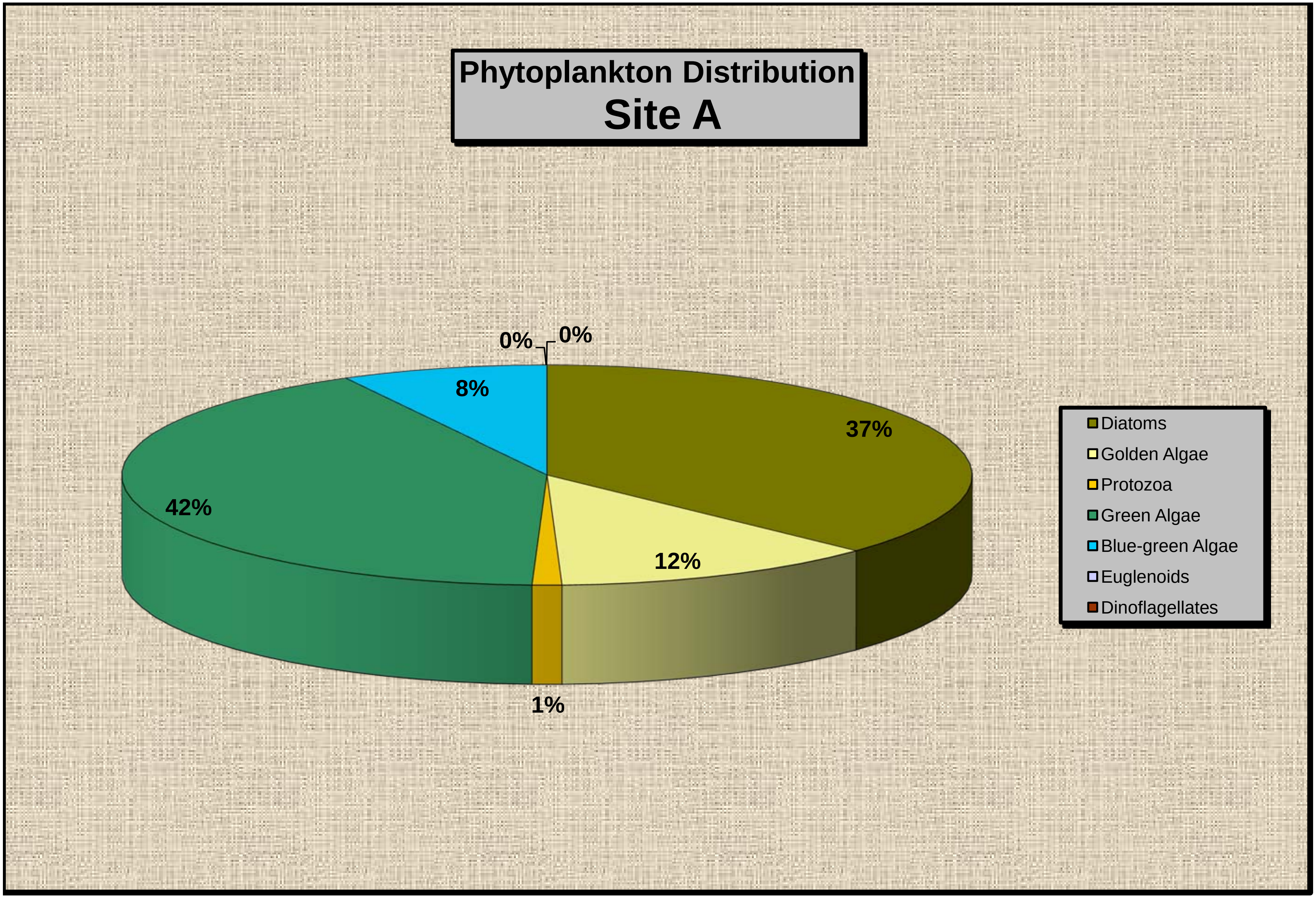
CYANOPHYTA (Blue-green Algae)	A	B	C
Anabaena	70	40	
Anacystis			
Aphanizomenon			
Coelosphaerium			
Cylindrospermum			
Gomphosphseria			
Lyngbya			
Microcystis			
Nostoc			
Oscillatoria			
Pseudoanabaena			
Synechocystis			
Total Blue-green Algae	**70**	**40**	**0**

EUGLENOPHYTA (Euglenoids)	A	B	C
Euglena			
Lepocinclis			
Phacus			
Trachelomonas			
Total Euglenoids	**0**	**0**	**0**

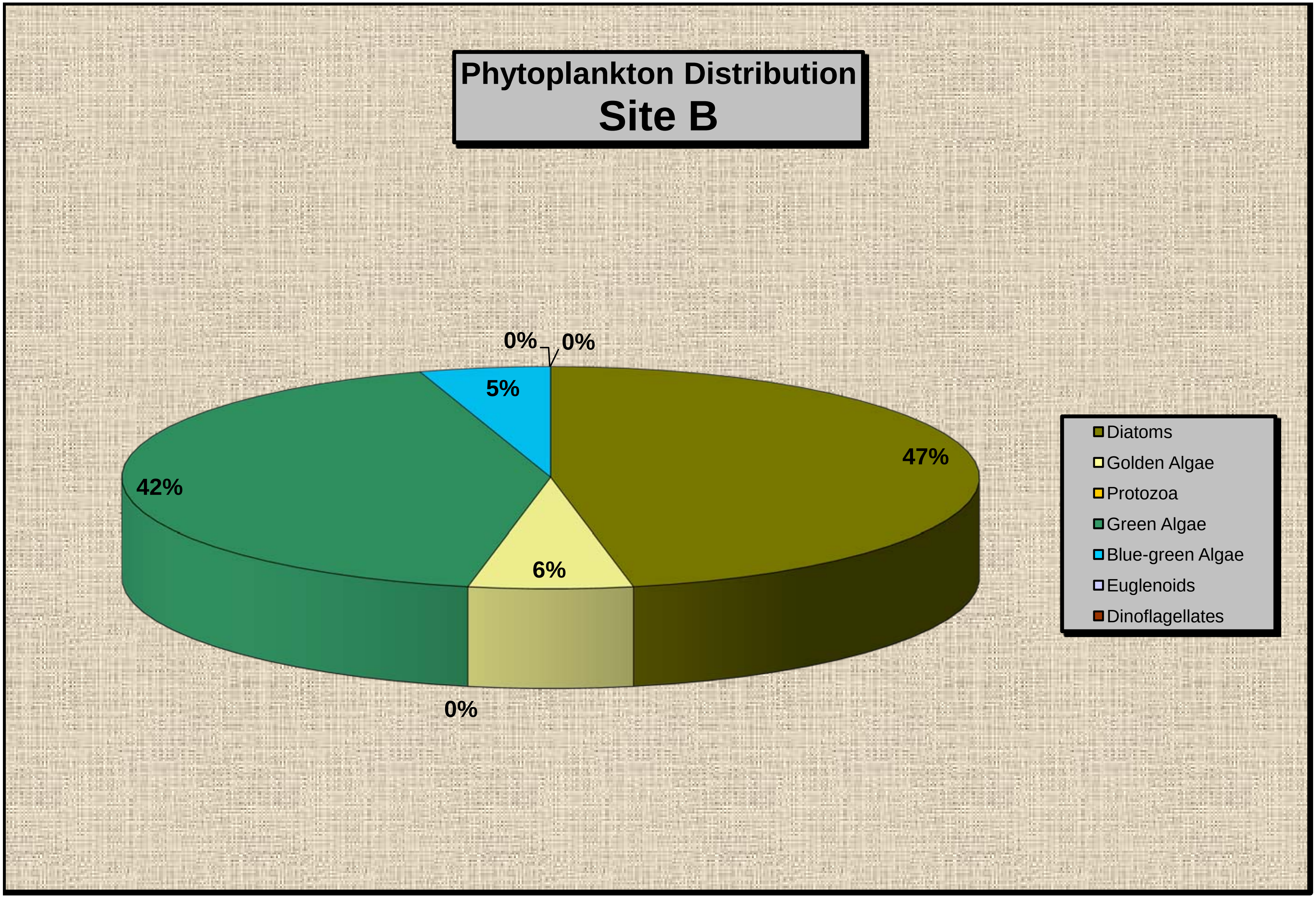
PYRRHOPHYTA (Dinoflagellates)	A	B	C
Ceratium			
Peridinium			
Gymnodinium			
Total Dinoflagellates	**0**	**0**	**0**

SITE	A	B	C
TOTAL GENERA:	11	10	
TRANSPARENCY:	5	5	
ORGANISMS PER MILLILITER:	**890**	**810**	

NOTES: Algal density is now considered moderate with high diversity at both sites. In comparison to the last sampling event, algal density has increased at both sites. The lake station sites was a mixture of diatoms and green algae while the inlet site was dominated by diatoms only. Trace densities of blue green algae were also observed at both sites, but are non-problematic at this time. Trace amounts of protozoa were observed at site A only. Water clarity continues to be fair at both sites.



Phytoplankton Distribution
Site A
0%
0%
8%
37%
42%
12%
1%
Diatoms
Golden Algae
Protozoa
Green Algae
Blue-green Algae
Euglenoids
Dinoflagellates


Phytoplankton Distribution
Site B
0%
0%
5%
47%
42%
6%
0%
Diatoms
Golden Algae
Protozoa
Green Algae
Blue-green Algae
Euglenoids
Dinoflagellates

Allied Biological

MICROSCOPIC EXAMINATION OF WATER

Sample from: Mount Kemble Lake

Collection Date: 8/5/2013	**Examination Date: 8/5/2013**	**Amount Examined:** 200 ml.
Site A : Dock at Beach	**Site B:**	**Site C:**

BACILLARIOPHYTA (Diatoms)	A	B	C
Asterionella			
Cocconeis			
Cyclotella			
Cymbella			
Diatoma			
Fragilaria	10		
Melosira			
Meridion			
Navicula			
Pinnularia			
Rhizosolenia			
Stephanodiscus			
Synedra			
Tabellaria			
Stauroneis			
Nitzschia			
Denticula			
Total Diatoms	**10**	**0**	**0**

CHRYSOPHYTA (Golden Algae)	A	B	C
Dinobryon			
Mallomonas			
Synura			
Tribonema			
Uroglenopsis			
Vaucheria			
Total Golden Algae	**0**	**0**	**0**

PROTOZOA	A	B	C
Actinophrys			
Vorticella			
Total Protozoa	**0**	**0**	**0**

CHLOROPHYTA (Green Algae)	A	B	C
Actinastrum			
Ankistrodesmus			
Chlamydomonas			
Chlorella			
Chlorococcum			
Closterium			
Coelastrum	50		
Cosmarium			
Desmodium			
Eudorina			
Gloeocystis	10		
Micrasterias			
Micratinium			
Microspora			
Mougeotia			
Oedogonium			
Oocystis			
Pandorina			
Pediastrum	10		
Phytoconis			
Rhizoclonium			
Scenedesmus	10		
Sphaerocystis			
Spirogyra			
Staurastrum			
Tetraedron			
Ulothrix			
Volvox			
Palmella			
Euastrum			
Zygnema			
Dictyosphaerium			
Quadrigula			
Bottryococcus			
Trackdomuccs			
Eaestrum			
Total Green Algae	**80**	**0**	**0**

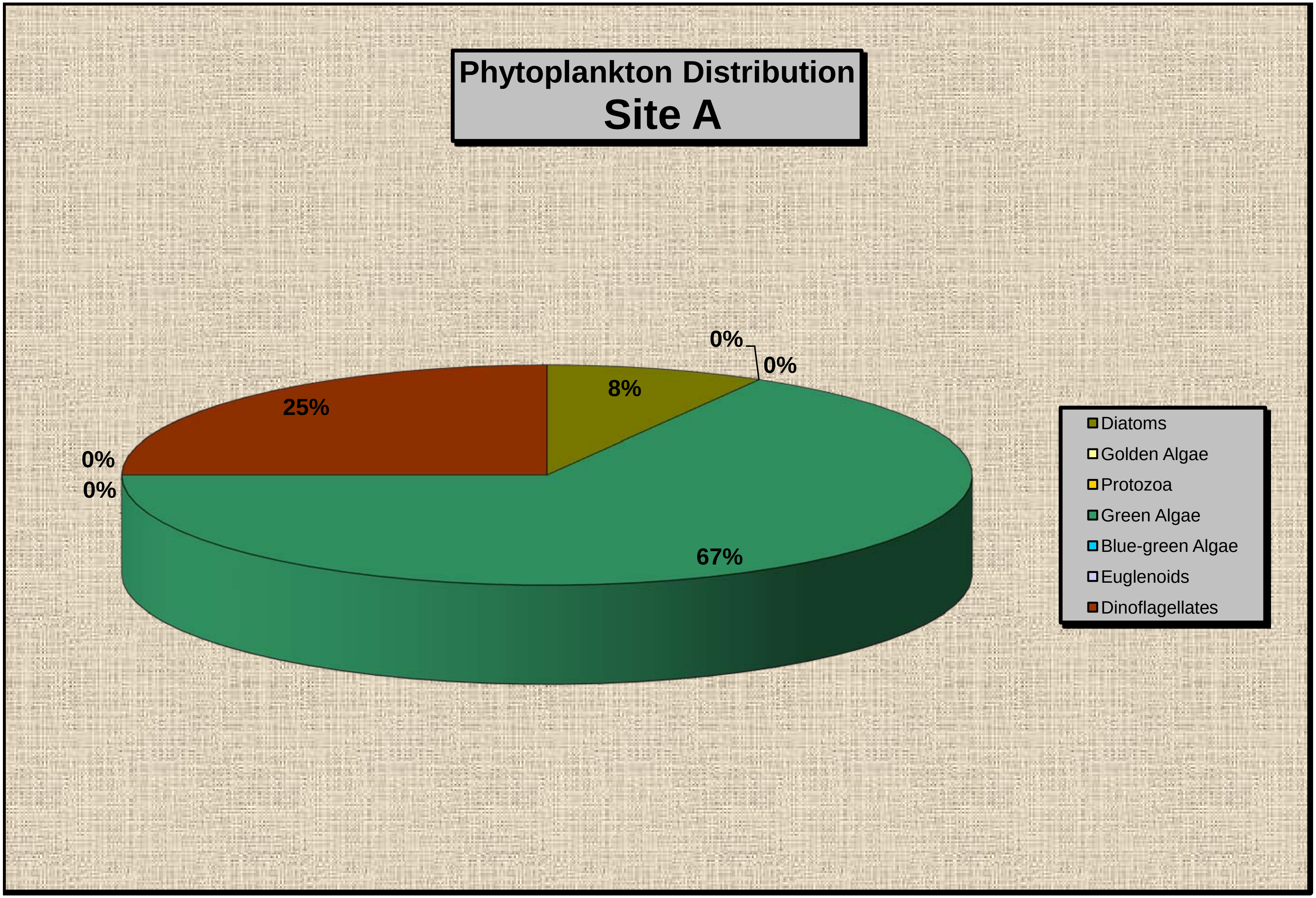
CYANOPHYTA (Blue-green Algae)	A	B	C
Anabaena			
Anacystis			
Aphanizomenon			
Coelosphaerium			
Cylindrospermum			
Gomphosphseria			
Lyngbya			
Microcystis			
Nostoc			
Oscillatoria			
Pseudoanabaena			
Synechocystis			
Total Blue-green Algae	**0**	**0**	**0**

EUGLENOPHYTA (Euglenoids)	A	B	C
Euglena			
Lepocinclis			
Phacus			
Trachelomonas			
Total Euglenoids	**0**	**0**	**0**

PYRRHOPHYTA (Dinoflagellates)	A	B	C
Ceratium			
Peridinium	30		
Gymnodinium			
Total Dinoflagellates	**30**	**0**	**0**

SITE	A	B	C
TOTAL GENERA:	6		
TRANSPARENCY:	8.5		
ORGANISMS PER MILLILITER:	**120**	**0**	

NOTES: Sample was taken of the dock at the beach. Algal diversity is considered moderate. Algal density is considered light and favorable. The assemblage is dominated by the green algae Coelastrum. Trace densities of dinoflagellates and diatoms were observed this week. Water clarity is considered excellent, especially considering its early August.


Phytoplankton Distribution
Site A
0%
0%
8%
25%
0%
0%
67%
Diatoms
Golden Algae
Protozoa
Green Algae
Blue-green Algae
Euglenoids
Dinoflagellates

MICROSCOPIC EXAMINATION OF WATER

Sample from: Mount Kemble Lake

Collection Date: 8/14/2013	**Examination Date: 8/14/2013**	**Amount Examined:** 200 ml.
Site A : North Station (Inlet)	**Site B: Lake Station**	**Site C:**

BACILLARIOPHYTA (Diatoms)	A	B	C
Asterionella			
Cocconeis			
Cyclotella			
Cymbella			
Diatoma			
Fragilaria			
Melosira			
Meridion			
Navicula			
Pinnularia	10		
Rhizosolenia			
Stephanodiscus			
Synedra			
Tabellaria			
Stauroneis			
Nitzschia			
Denticula			
Total Diatoms	**10**	**0**	**0**

CHRYSOPHYTA (Golden Algae)	A	B	C
Dinobryon			
Mallomonas			
Synura		30	
Tribonema			
Uroglenopsis			
Vaucheria			
Total Golden Algae	**0**	**30**	**0**

PROTOZOA	A	B	C
Actinophrys			
Vorticella			
Total Protozoa	**0**	**0**	**0**

CHLOROPHYTA (Green Algae)	A	B	C
Actinastrum			
Ankistrodesmus			
Chlamydomonas			
Chlorella			
Chlorococcum			
Closterium			
Coelastrum		40	
Cosmarium	20		
Desmodium			
Eudorina			
Gloeocystis		30	
Micrasterias			
Micratinium			
Microspora			
Mougeotia			
Oedogonium			
Oocystis			
Pandorina			
Pediastrum			
Phytoconis			
Rhizoclonium			
Scenedesmus			
Sphaerocystis			
Spirogyra			
Staurastrum			
Tetraedron			
Ulothrix			
Volvox			
Palmella			
Euastrum			
Zygnema			
Dictyosphaerium			
Quadrigula			
Bottryococcus			
Trackdomuccs			
Eaestrum			
Total Green Algae	**20**	**70**	**0**

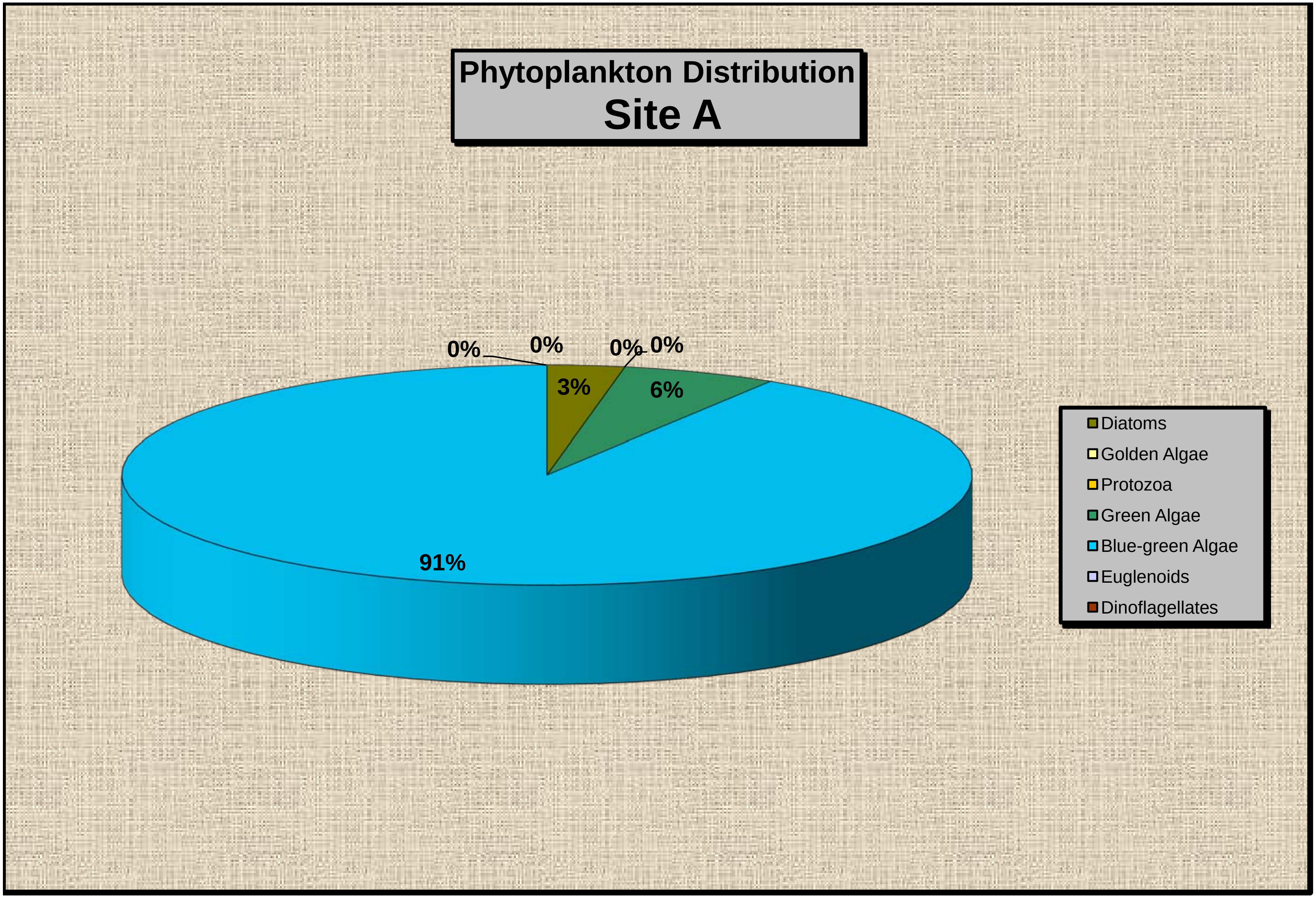
CYANOPHYTA (Blue-green Algae)	A	B	C
Anabaena			
Anacystis			
Aphanizomenon	310		
Coelosphaerium			
Cylindrospermum			
Gomphosphseria			
Lyngbya			
Microcystis			
Nostoc			
Oscillatoria			
Pseudoanabaena			
Synechocystis			
Total Blue-green Algae	**310**	**0**	**0**

EUGLENOPHYTA (Euglenoids)	A	B	C
Euglena			
Lepocinclis			
Phacus			
Trachelomonas			
Total Euglenoids	**0**	**0**	**0**

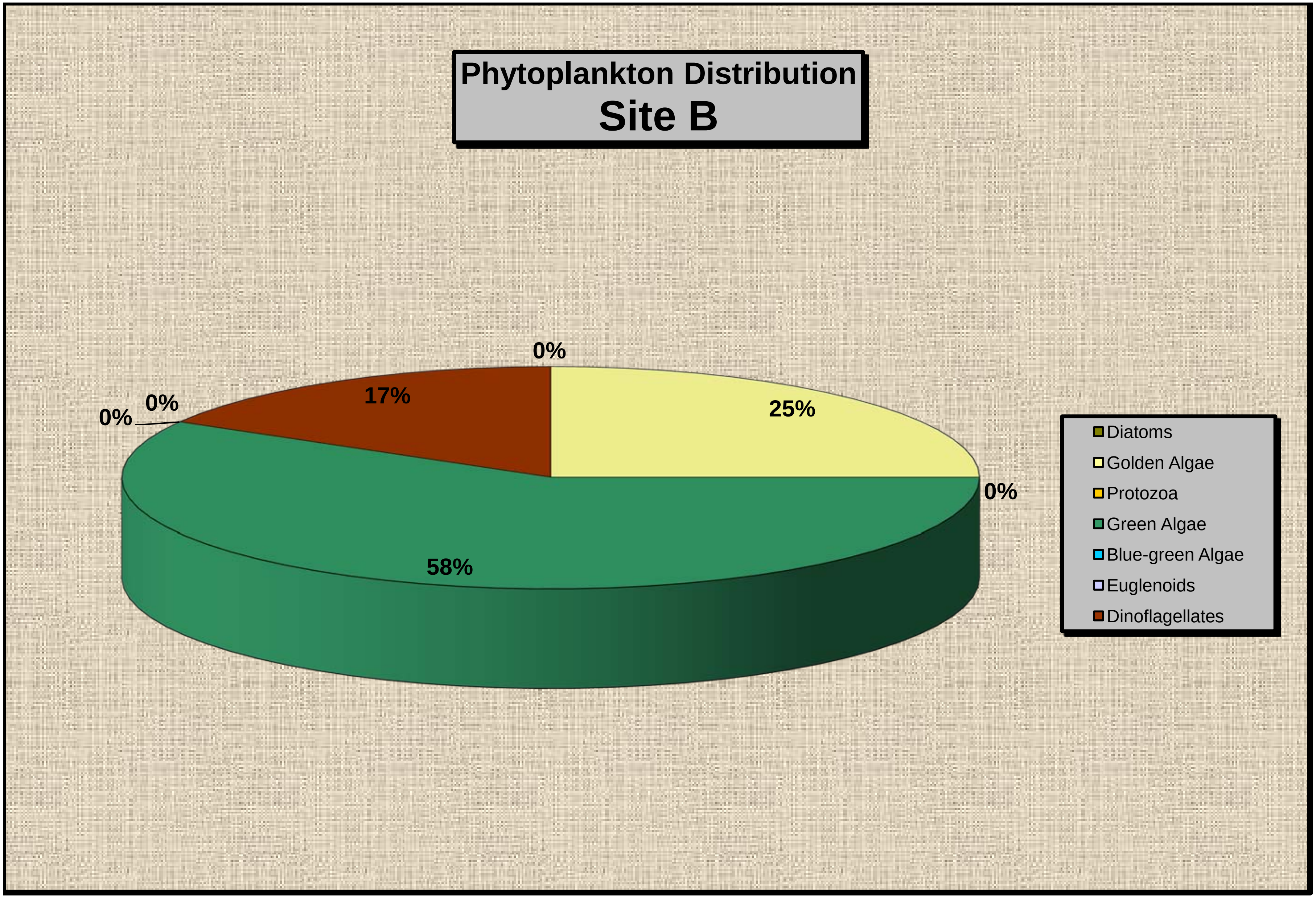
PYRRHOPHYTA (Dinoflagellates)	A	B	C
Ceratium		20	
Peridinium			
Gymnodinium			
Total Dinoflagellates	**0**	**20**	**0**

SITE	A	B	C
TOTAL GENERA:	3	4	
TRANSPARENCY:	5	5	
ORGANISMS PER MILLILITER:	**340**	**120**	

NOTES: Since the last sampling event, algal density increased but is still considered low at both sites. Algal diversity is also considered low at both sites. Site A is dominated by the blue green algae Aphanizomenon. Site B is dominated by green algae. Other green algae were observed as well this week. Blue green algae is non-problematic at this time, but should be monitored in the upcoming weeks. Trace densities of dinoflagellates (site B), golden algae (site B), and diatoms (site A) were also observed. Water clarity decreased at site A. Clarity is considered fair to good at both sites.

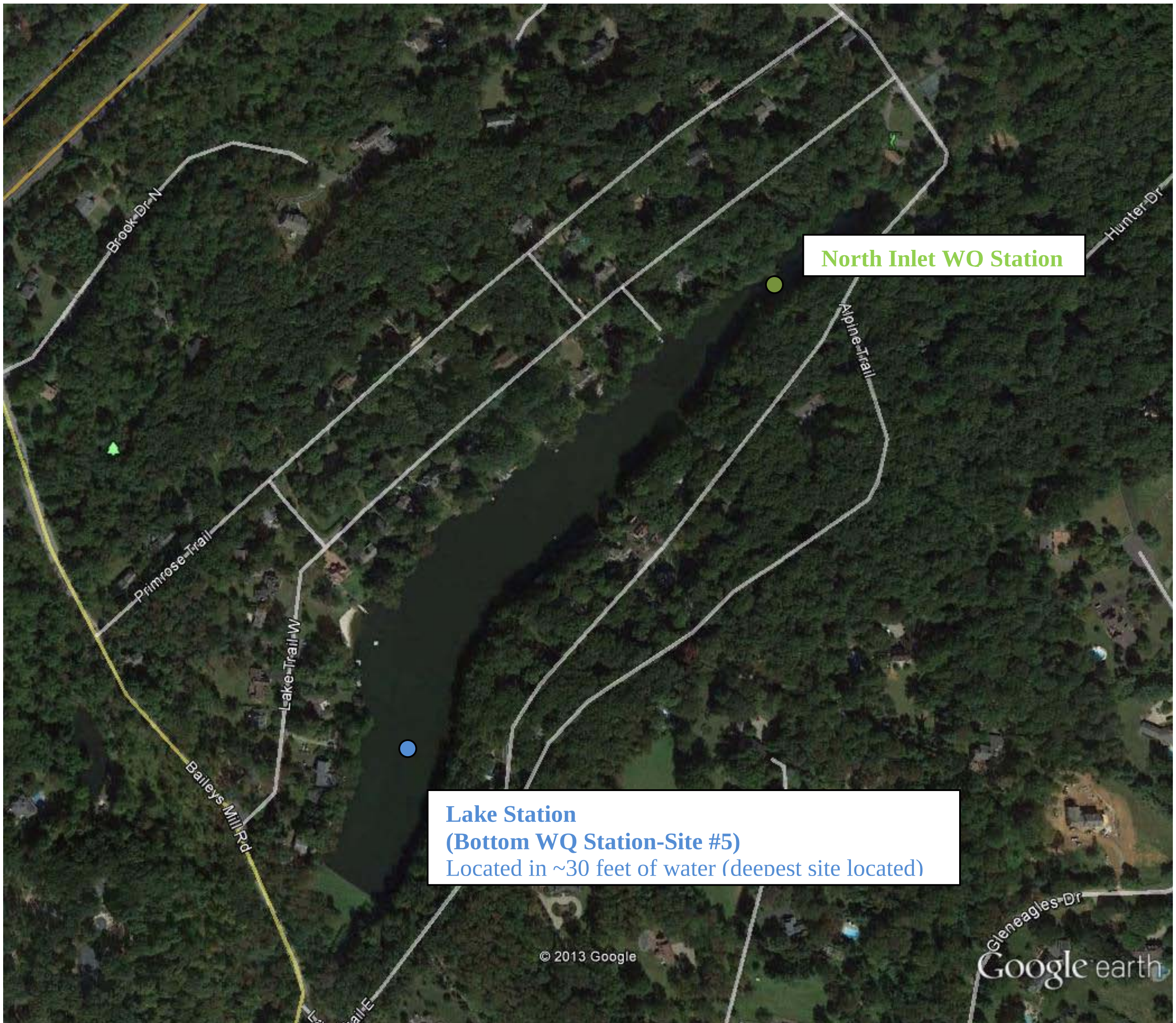


Phytoplankton Distribution
Site A
0%
0%
0%
0%
3%
6%
91%
Diatoms
Golden Algae
Protozoa
Green Algae
Blue-green Algae
Euglenoids
Dinoflagellates



Phytoplankton Distribution
Site B
0%
17%
0%
0%
25%
0%
58%
Diatoms
Golden Algae
Protozoa
Green Algae
Blue-green Algae
Euglenoids
Dinoflagellates

Mount Kemble Lake 2013 Water Quality Monitoring Sites



Mount Kemble Lake

Morris County, New Jersey

2013 Water Quality Sampling Sites Map

● = North Inlet WQ Site

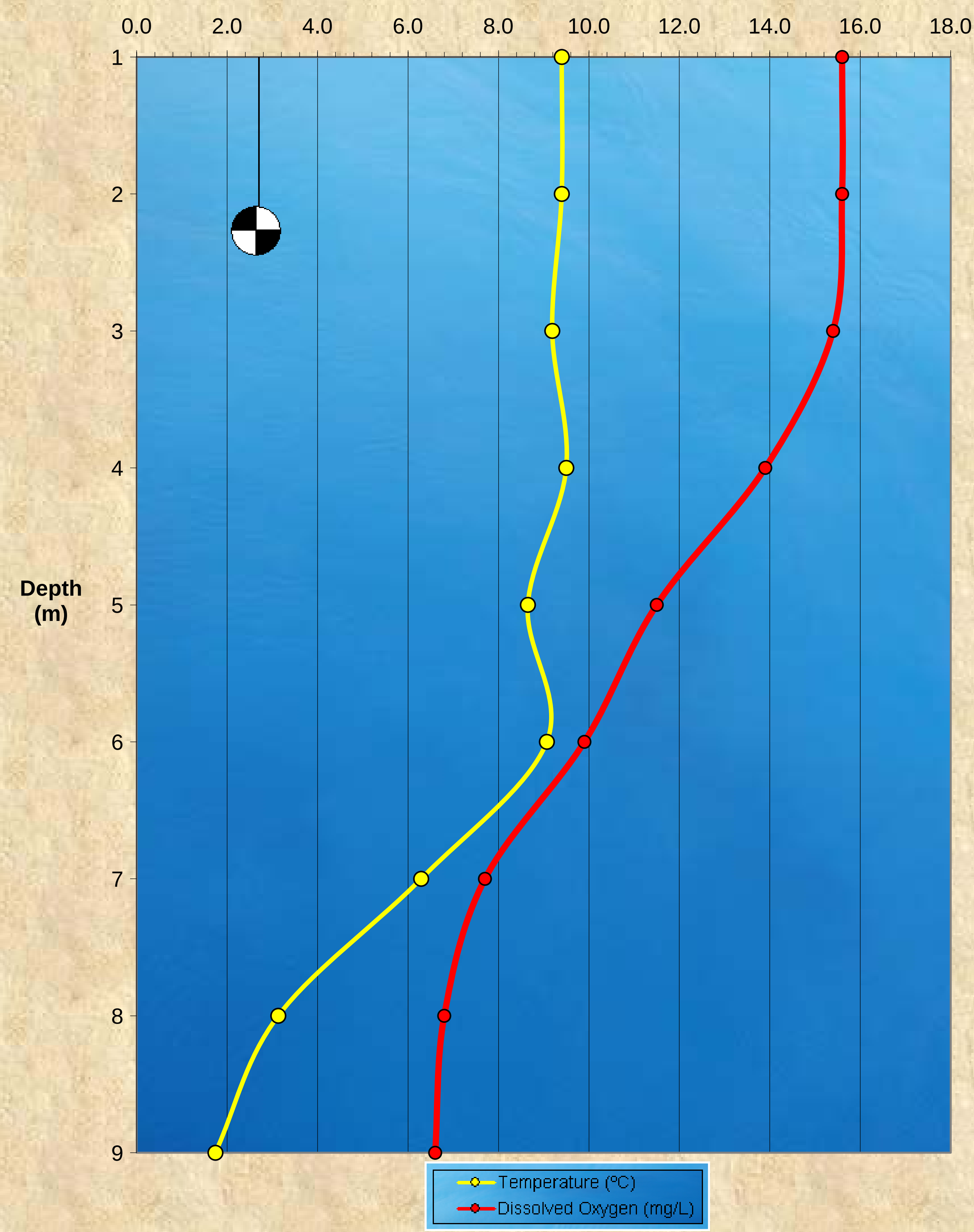
● = Lake Station WQ Site

Allied Biological

580 Rockport Road
Hackettstown, NJ 07840
(908) 850-0303
FAX 850-4994

Allied Biological

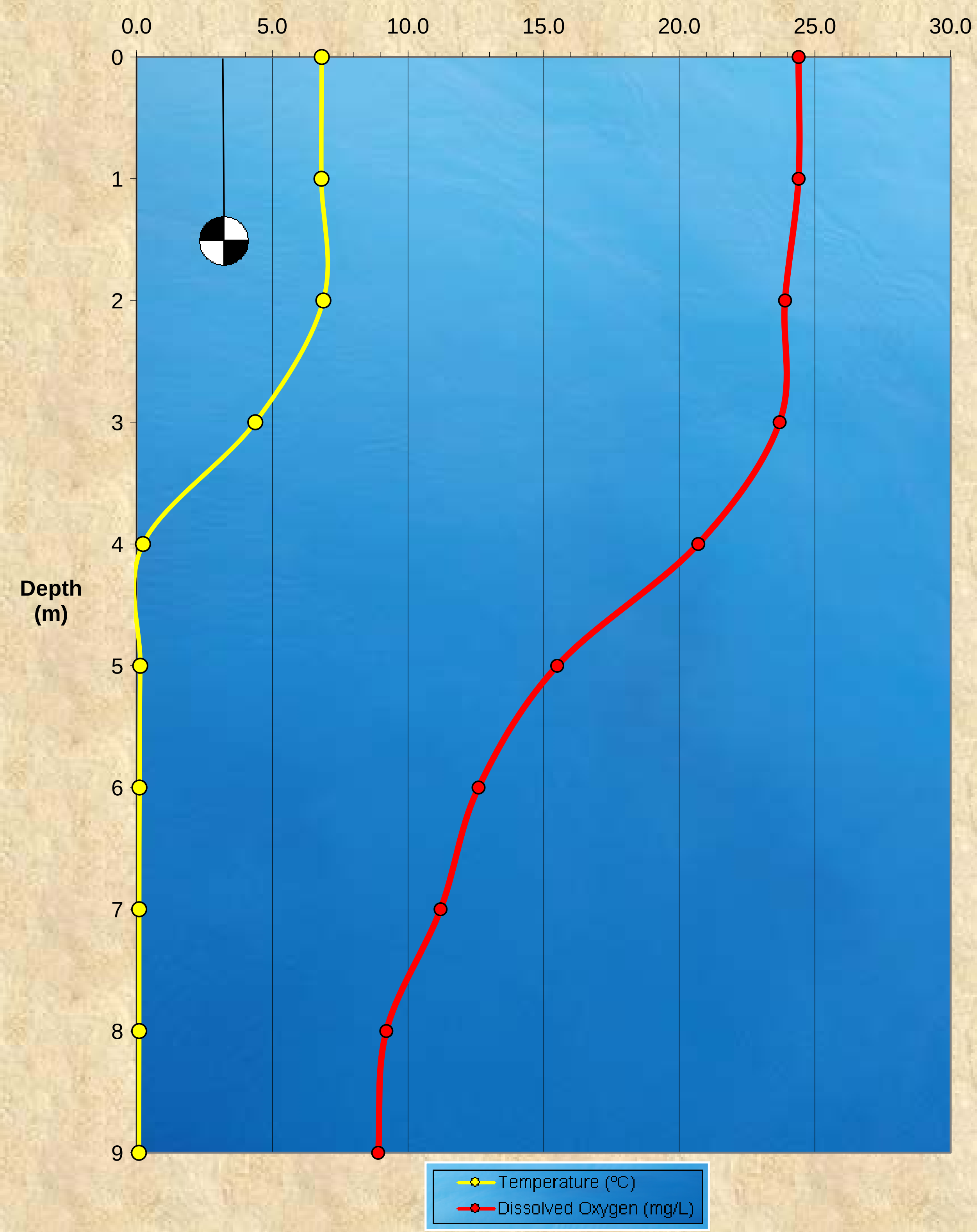
Mount Kemble Lake Profile
Lake Station
April 29, 2013



Mount Kemble Lake Profile
Lake Station
June 28, 2012

Allied Biological

Mount Kemble Lake Profile
Lake Station
August 14, 2013

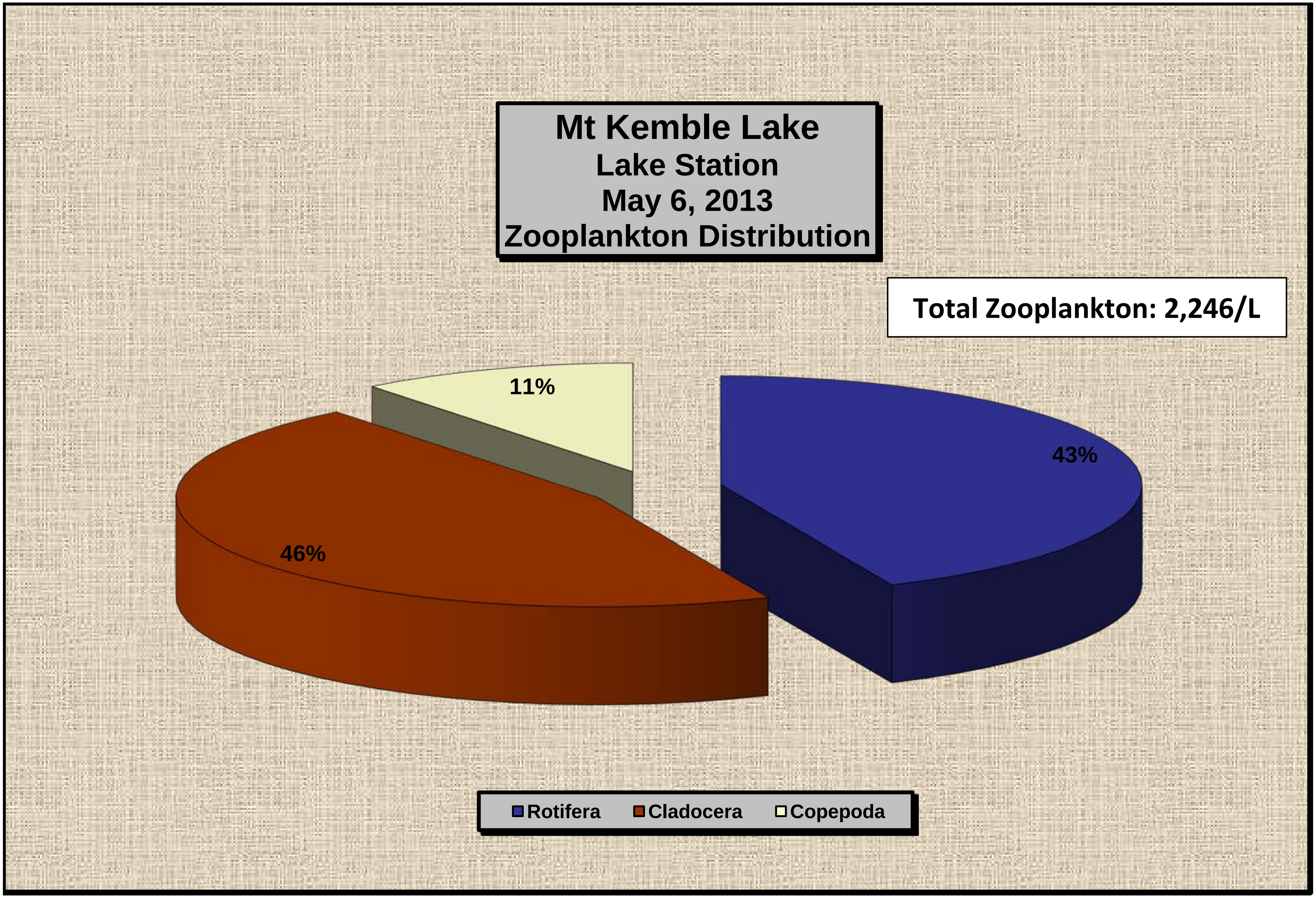


Zooplankton Count Results

Site: Mt. Kemble Lake **Date: 5/6/13**

Group	Order	Family	Genus	Replicate A	Replicate B	Replicate C	Total/3 (# per mL)	x1000 mL (= 1 L)	Water sampled (L)	# organisms per L
Rotifera										
	Ploima	Brachionidae	*Brachionus*			2	0.67	667	76.6	9
			Keratella	19	23	25	22.33	22333	76.6	292
		Asplanchnidae	*Asplanchna*	13	6	8	9.00	9000	76.6	117
		Synchaetidae	*Synchaeta*	3	2	1	2.00	2000	76.6	26
			Polyarthra	16	17	13	15.33	15333	76.6	200
	Flosculariacea	Conochiloides	*Conochilus*	25	26	24	25.00	25000	76.6	326
		Gastropidae	*Ascomorpha*		1		0.33	333	76.6	4
									Total:	**974**
Cladocera	**Cladocera**	Daphnidae	*Daphnia*	86	56	42	61.33	61333	76.6	801
			Ceriodaphina	1	1		0.67	670	76.6	9
		Bosminidae	*Bosmina*	14	23	14	17.00	17000	76.6	223
									Total:	**1033**
Copepoda										
	Calanoida		*Calanoid* nauplii	27	12	13	17.33	17333	76.6	226
	Cyclopoida	Cyclopoidae		1	2		1.00	1000	76.6	13
									Total:	**239**

Total Organisms per L	Rotifera	%	Cladocera	%	Copepoda	%
2246	974	43.4%	1033	46.0%	239	10.6%

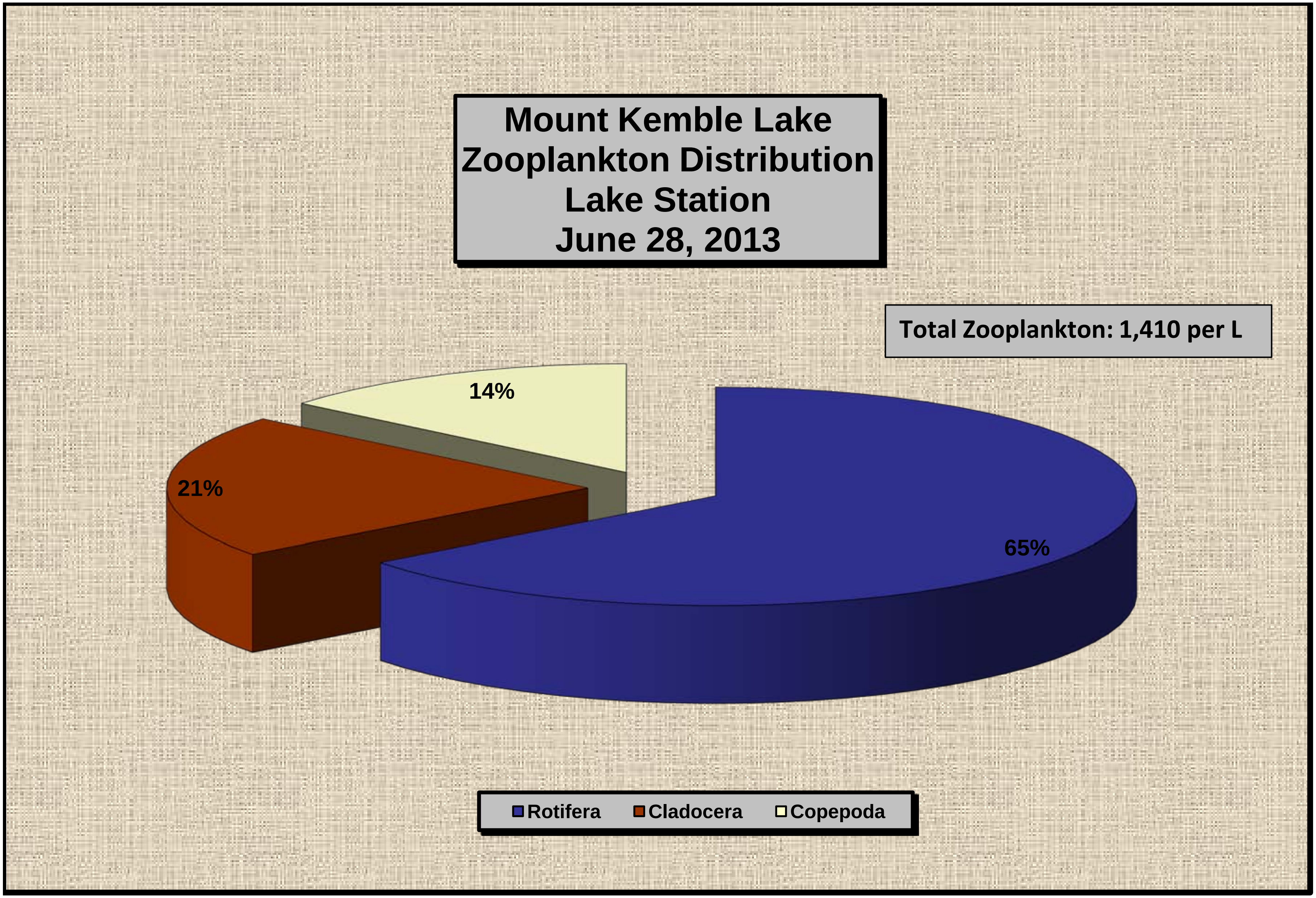

Mt Kemble Lake
Lake Station
May 6, 2013
Zooplankton Distribution
Total Zooplankton: 2,246/L
11%
43%
46%
Rotifera
Cladocera
Copepoda

Zooplankton Count Results

Site: Mt. Kemble Lake **Date: 6/28/13**

Group	Order	Family	Genus	Replicate A	Replicate B	Replicate C	Total/3 (# per mL)	x1000 mL (= 1 L)	Water sampled (L)	# organisms per L
Rotifera										
	Ploima	Asplanchnidae	*Asplanchna*	13	7	7	9.00	9000	62.1	145
		Brachionidae	*Brachionous*			3	1.00	1000	62.1	16
			Keratella	4	9	7	6.67	6667	62.1	107
			Kellicottia	1			0.33	333	62.1	5
		Synchaetidae	*Polyarthra*	28	29	23	26.67	26667	62.1	429
			Synchaeta	2	2	4	2.67	2667	62.1	43
		Trichocercidae	*Trichocerca*	4	5	3	4.00	4000	62.1	64
	Flosculariacea	Conochilidae	*Conochilus*	6	5	7	6.00	6000	62.1	97
		Lencanidae	*Ascomorpha*			1	0.33	333	62.1	5
									Total:	**911**
Cladocera	**Cladocera**									
		Daphnidae	*Ceriodaphina*	1	1		0.67	667	62.1	11
			Daphina	11	8	7	8.67	8667	62.1	140
		Bosminidae	*Bosmina*	10	10	8	9.33	9333	62.1	150
									Total:	**301**
Copepoda										
	Cyclopoida	Cyclopoidae	*Cyclopoid* nauplii	15	14	7	12.00	12000	62.1	193
			Cyclopoida			1	0.33	333	62.1	5
									Total:	**198**

Total Organisms per L	Rotifera	%	Cladocera	%	Copepoda	%
1410	911	64.6%	301	21.3%	198	14.0%

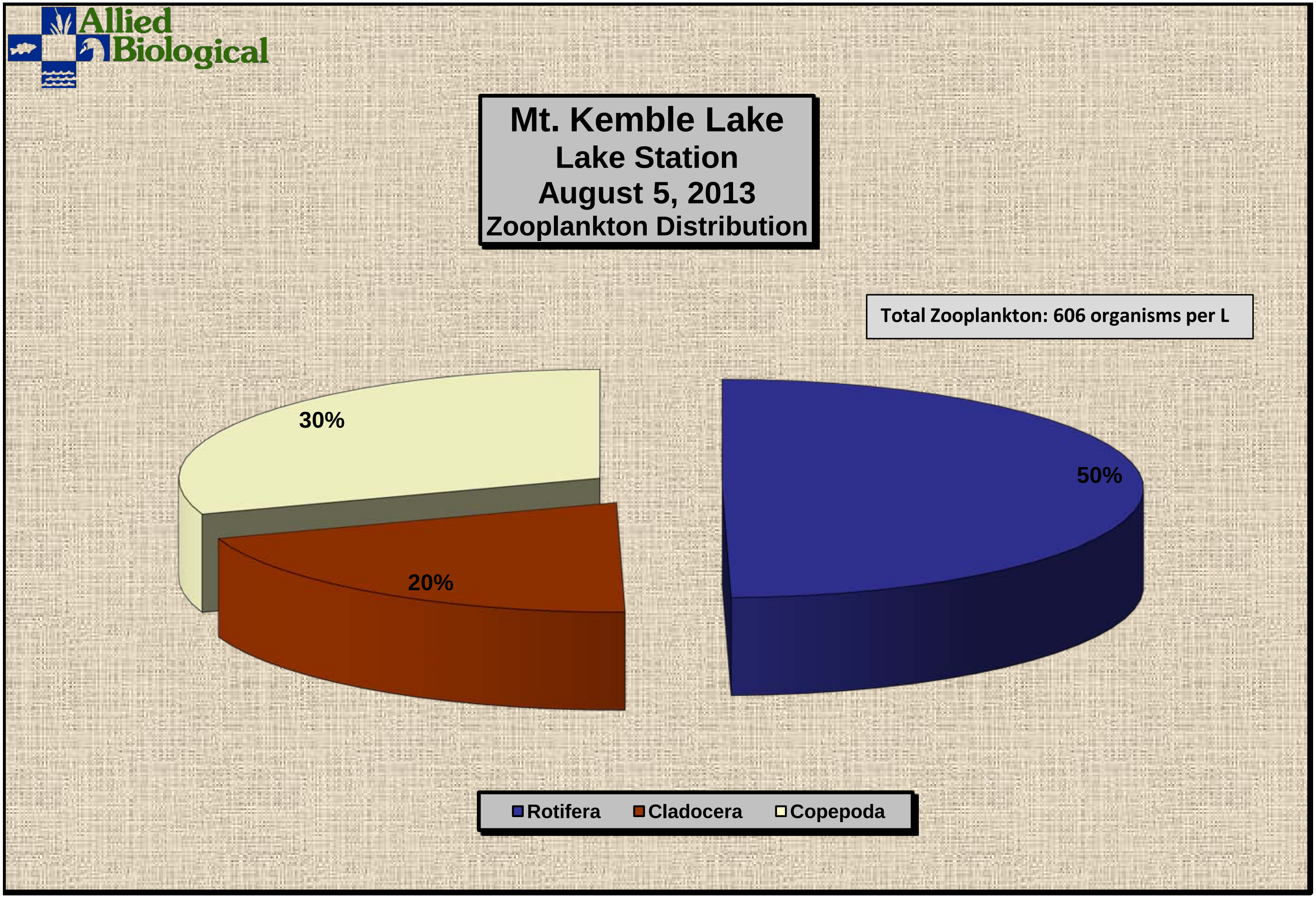

Mount Kemble Lake
Zooplankton Distribution
Lake Station
June 28, 2013
Total Zooplankton: 1,410 per L
14%
21%
65%
Rotifera
Cladocera
Copepoda

Zooplankton Count Results

Site: Mt. Kemble Lake Station **Date: 8/5/13**

Group	Order	Family	Genus	Replicate A	Replicate B	Replicate C	Total/3 (# per mL)	x1000 mL (= 1 L)	Water sampled (L)	# organisms per L
Rotifera										
	Ploima	Brachionidae	*Brachionous*	1	3	1	1.67	1,670	68.8	24
			Keratella	10	10	9	9.67	9670	68.8	141
		Synchaetidae	*Polyarthra*	3	13	6	7.33	7330	68.8	107
		Trichocercidae	*Trichocerca*	2	2	1	1.67	1670	68.8	24
	Flosculariacea	Conochilidae	*Conochilus*	1			0.33	330	68.8	5
									Total:	**301**
Cladocera	**Cladocera**									
		Daphnidae	*Ceriodaphina*	2			0.67	667	68.8	10
		Bosminidae	*Bosmina*	12	10	1	7.67	7670	68.8	111
									Total:	**121**
Copepoda										
	Calanoida		*Calanoid* nauplii	12	11	15	12.67	12670	68.8	184
									Total:	**184**

Total Organisms per L	Rotifera	%	Cladocera	%	Copepoda	%
606	301	49.7%	121	20.0%	184	30.4%



Allied Biological
Mt. Kemble Lake
Lake Station
August 5, 2013
Zooplankton Distribution
Total Zooplankton: 606 organisms per L
30%
20%
50%
Rotifera
Cladocera
Copepoda

APL
AQUA PRO-TECH LABORATORIES

CERTIFICATIONS
NJ DEP 07010 / NY DOH 11634 / CT PH-0233
US ARMY CORPS (USACE)

ANALYTICAL RESULTS SUMMARY

Client	**Allied Biological Inc** 580 Rockport Rd. Hackettstown, NJ 07840	**APL Order ID Number**	**13040953**
		Date Sampled	04/29/2013 13:45
		Date Received	04/29/2013 15:15
Contact	C. Doyle	**Matrix**	Lake
Project		**Site**	Mt Kemble Lake
Report Date	05/10/2013 18:12	**Customer Service Rep.**	

Sample Number/ Parameter	Method	Analysis Time	Analyst	Result	Units	RL
13040953-001 NORTH STATION						
Ammonia	SM 4500NH3C	05/07/2013 10:30	YKIZNER	<0.2	mg/L	0.2
Conductivity	SM 2510B	05/02/2013 12:00	JVAGHELA	310	umhos/cm	1
Nitrate as N	EPA 300	04/29/2013 23:23	ASTOICA	0.7	mg/L	0.2
Phosphorus, Total	SM4500P-E	05/10/2013 10:00	YKIZNER	0.05	mg/L	0.01
Total Suspended Solids	EPA 160.2/ SM 2540 D	05/06/2013 10:00	MARK	4	mg/L	3
13040953-002 LAKE STATION SURFACE						
Ammonia	SM 4500NH3C	05/07/2013 10:30	YKIZNER	<0.2	mg/L	0.2
Conductivity	SM 2510B	05/02/2013 12:00	JVAGHELA	320	umhos/cm	1
Nitrate as N	EPA 300	04/29/2013 23:23	ASTOICA	0.7	mg/L	0.2
Phosphorus, Total	SM4500P-E	05/10/2013 10:00	YKIZNER	0.04	mg/L	0.01
Total Suspended Solids	EPA 160.2/ SM 2540 D	05/06/2013 10:00	MARK	<3	mg/L	3
13040953-003 LAKE STATION BOTTOM						
Ammonia	SM 4500NH3C	05/07/2013 10:30	YKIZNER	<0.2	mg/L	0.2
Conductivity	SM 2510B	05/02/2013 12:00	JVAGHELA	324	umhos/cm	1
Nitrate as N	EPA 300	04/29/2013 23:23	ASTOICA	0.7	mg/L	0.2
Phosphorus, Total	SM4500P-E	05/10/2013 10:00	YKIZNER	0.04	mg/L	0.01
Total Suspended Solids	EPA 160.2/ SM 2540 D	05/06/2013 10:00	MARK	<3	mg/L	3
13040953-004 INLET						
Phosphorus, Total	SM4500P-E	05/10/2013 10:00	YKIZNER	0.06	mg/L	0.01
13040953-005 OUTLET						
Phosphorus, Total	SM4500P-E	05/10/2013 10:00	YKIZNER	0.04	mg/L	0.01

SA: See attached report
RL: Reporting Limit

Brian Wood

Brian Wood
Laboratory Director

QA

1275 BLOOMFIELD AVENUE, BLDG. 6, FAIRFIELD, NJ 07004 TEL 973 227 0422 FAX 973 227 2813

Order Information

Allied Biological Inc

APL Order ID :	**13060929**
Site Name :	**Mt Kemble Lake**
Date to Lab :	**6/28/2013 12:34:00 PM**

Samples List

Field ID	Lab ID	Matrix
North Station	**13060929-001**	Lake
Lake Station Surface	**13060929-002**	Lake
Lake Station Bottom	**13060929-003**	Lake

Printing Options

Page Breaks Off

Turning **Page Breaks** on prints each sample on a new page. Turning **Page Breaks** off prints the report on the minimum number of pages.

North Station   13060929-001   6/28/2013 , 10:25:00 AM   Lake

Click here to request additional or contingent analyses for this Sample ID.

Test	Method	Date Posted	MDL	Result	Units	Limit
Phosphorus, Total	SM4500P-E	7/2/2013	0.01	0.04	mg/L	-
Nitrate as N	EPA 300	7/1/2013	0.2	0.6	mg/L	-
Ammonia	SM 4500NH3C	7/5/2013	0.2	<0.2	mg/L	-
Conductivity	SM 2510B	7/16/2013	1	300	umhos/cm	-
Total Suspended Solids	EPA 160.2/ SM 2540 D	7/5/2013	3	<3	mg/L	-

Lake Station Surface   13060929-002   6/28/2013 , 10:40:00 AM   Lake

Click here to request additional or contingent analyses for this Sample ID.

Test	Method	Date Posted	MDL	Result	Units	Limit
Phosphorus, Total	SM4500P-E	7/2/2013	0.01	0.04	mg/L	-
Nitrate as N	EPA 300	7/1/2013	0.2	0.7	mg/L	-
Ammonia	SM 4500NH3C	7/5/2013	0.2	<0.2	mg/L	-
Conductivity	SM 2510B	7/16/2013	1	330	umhos/cm	-
Total Suspended Solids	EPA 160.2/ SM 2540 D	7/5/2013	3	4	mg/L	-

Lake Station Bottom   13060929-003   6/28/2013 , 10:45:00 AM   Lake

Click here to request additional or contingent analyses for this Sample ID.

Test	Method	Date Posted	MDL	Result	Units	Limit
Phosphorus, Total	SM4500P-E	7/2/2013	0.01	0.09	mg/L	-

Report Key:

| *Description*

APL

AQUA PRO-TECH LABORATORIES

Certified Environmental Testing

Analytical Results Summary

Mt. Kemble Lake

Client:	**Allied Biological**	**Contact:**	**Chris Doyle**
APL Order ID:	**3080483**	**Received:**	**8/14/13 12:50**

Sample ID/Analysis	Method	Prepared	Analyzed	Result	Qual	MDL	RL	Units
3080483-01 (Lake)	North Station			Collected:	8/14/13 11:00			
General Chemistry								
Phosphorus	4500PE	8/22/13 9:00	8/22/13 9:00	**0.0400**			**0.0100**	**mg/L**
Nitrate	EPA 300	8/14/13 13:00	8/14/13 13:00	ND			0.200	mg/L
Specific conductance	SM 2510B	8/19/13 11:49	8/19/13 11:49	**248**			**1.00**	**umhos/cm**
Total Suspended Solids	SM 2540D	8/21/13 11:16	8/21/13 11:16	**10.0**			**3.00**	**mg/L**
Ammonia as N	SM 4500 NH3 D	8/21/13 10:00	8/21/13 10:00	ND			0.200	mg/L
3080483-02 (Lake)	Lake Station- Surface			Collected:	8/14/13 11:15			
General Chemistry								
Phosphorus	4500PE	8/22/13 9:00	8/22/13 9:00	**0.0500**			**0.0100**	**mg/L**
Nitrate	EPA 300	8/14/13 13:00	8/14/13 13:00	ND			0.200	mg/L
Specific conductance	SM 2510B	8/19/13 11:49	8/19/13 11:49	**252**			**1.00**	**umhos/cm**
Total Suspended Solids	SM 2540D	8/21/13 11:16	8/21/13 11:16	ND			3.00	mg/L
Ammonia as N	SM 4500 NH3 D	8/21/13 10:00	8/21/13 10:00	ND			0.200	mg/L
3080483-03 (Lake)	Lake Station- Bottom			Collected:	8/14/13 11:20			
General Chemistry								
Phosphorus	4500PE	8/22/13 9:00	8/22/13 9:00	**0.130**			**0.0100**	**mg/L**

ND - Indicates compound analyzed for but not detected
J - Indicates estimated value
B - Indicates compound found in associated blank
E - Concentration exceeds highest calibration standard

D - Indicates result is based on a dilution
P - Greater than 25% diff. between 2 GC columns.
MDL - Minimum detection limit
RL - Reporting limit