A Preliminary Study of Water Quality Parameters in Elk and Skegemog Lakes

By Elk Skegemog Lakes
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Abstract

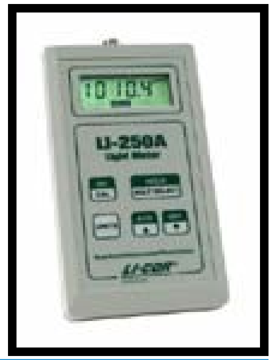
This report focuses on the preliminary efforts to study the basic state of the Elk and Skegemog lakes. These findings will offer a baseline for future data to be compared and a model for the feasibility of an intern based research project. In this introductory year we have studied the basic parameters for lake health how they change with depth. Elements included in the study are pH, temperature, phosphorous levels and lake clarity. Our hope is that this data can be available to the public to increase the understanding of the lakes' health and to be used by local governments as a way to protect their primary natural resource of the area.

Introduction

Elk Lake and Lake Skegemog have long been major attractions for businesses, tourists, and families coming to Elk Rapids and surrounding cities. In order to maintain these lakes' pristine quality, the Elk-Skegemog Lakes Association (ESLA) takes yearly water quality measurements to make ongoing assessments of the of the lakes' general health. In order to accomplish this, ESLA along with Elk Rapids High School interns used a variety of tools, including a Hydrolab Quanta and a Li-Cor light sensor which was purchased with a grant from the Elk Rapids Rotary in Spring of 2006 to measure water quality parameters.

The data collected for 2006 is presented in this report as a record of Elk and Skegemog Lakes' conditions for this year. Included are data and analysis for each lake's pH, temperature, phosphorous levels, and clarity.

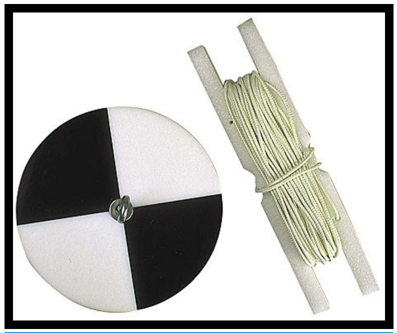
Methodology

Li-Cor Quantum Sensor and meter

To measure the clarity of the water in the lakes, a Li-Cor Quantum sensor was used. The Li-Cor sensor measures the amount of photosynthetically active radiation (PAR) present in an underwater environment at specific depths. This measurement is taken in $\mu mo/m^2/s$. The sensor resembles a light bulb and is usually mounted on a rigid frame that can be lowered into the water. The sensor is connected to a light meter, which can be used to display the amount of radiant light present. Lake clarity is mainly affected by the amount of suspended algae in the water and also by the amount of suspended sediment. Lakes with high levels of phosphorous and nitrogen tend to have lower water clarity because algae flourishes with the abundance of nutrients. Lakes with high water clarity tend to have lower amounts of nitrogen and phosphorous, and likewise, lower algae levels.

2006 was the first year that the Elk Skegemog Lake Association was able to use a Li-Cor sensor to measure clarity, so data is limited. In coming years though, more Li-Cor data will be gathered for comparison and discussion.



Secchi disk

A Secchi disk was also used to assess water clarity; historically this is the most popular method. To measure, a Secchi disk is lowered into the water. The clarity is measured by the distance below the water the Secchi disk is located when the disk is no longer visible. The drawback of a Secchi disk is that there can be a slight margin of error when depending on the human eye for a measurement. Results can also be altered by weather conditions or shadows cast by surrounding objects.

Hydrolab Quanta

The measurements of temperature, pH, and dissolved oxygen were taken by a Hydrolab instrument called the Quanta. The instrument is lowered into the water and collects the data along with its depth, time and date. The data is stored into a display unit where it can then be transferred to a computer for data extrapolation. The Hydrolab uses a small propeller that circulates water through the instrument for fresh readings at every depth. The unit uses a sensitive 30 K ohm variable resistance thermometer to measure. To measure pH the hydrolab is equipped with a glass bulb with an electrode-detecting device. The glass is filled with KCl and measures the rate of reaction between the KCl and hydrogen ions present in the water, giving pH. Dissolved oxygen is one of the most important parameters for aquatic life to exist. The diisolved oxygen content was measured by a selective membrane that only allows oxygen to penetrate it. The current is then measured from the electrochemical reduction of oxygen.

Van Dorn Bottle

To retrieve samples at different levels of the lake we used a Van Dorn bottle. The one used by ESLA is similar to the instrument pictured above but a handmade version. The bottle is dropped to the desired depth and then a weight is dropped down the line to trigger the closing of the plungers trapping the water inside the bottle. The samples can then be collected and sent to labs to be analyzed for whatever is desired, in this case phosphorous.

Discussion And Results

Elk Lake Secchi and Li-Cor Data

Photosynthetically Active Radiation (PAR) measurements help to analyze the amount of light available for intake by aquatic plants at different depths. As shown in figures 1 and 2, the amount of PAR decreases exponentially as depth increases. Li-Cor data is valuable because the measurements can aid in estimating lake turbidity and primary productivity.

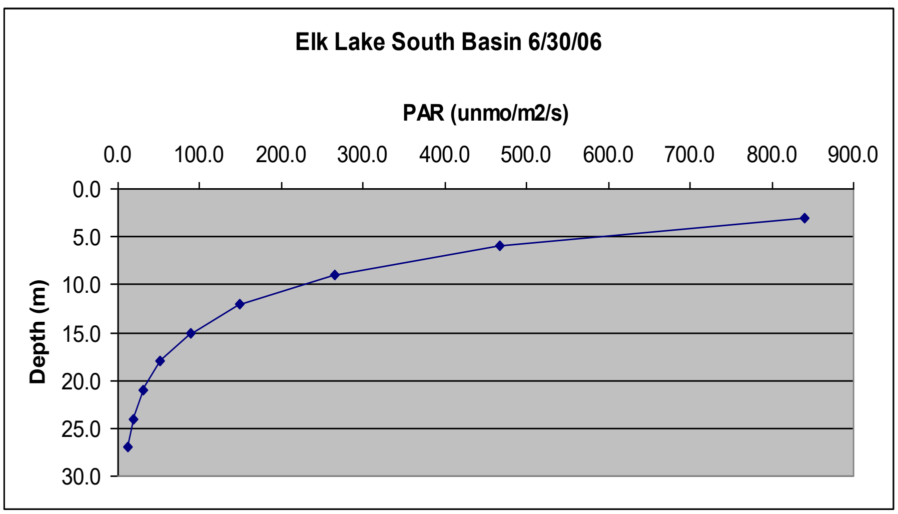


Figure 1

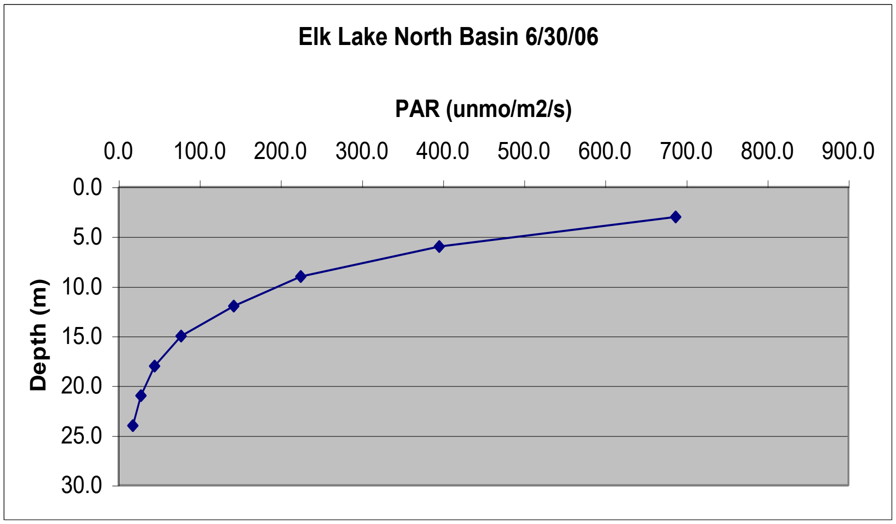


Figure 2

During the winter and early spring, clarity tends to be high at around eight to ten meters Secchi disk depth. As temperatures become warmer, clarity tends to decreases to two to four meters by late summer. The water clarity tends to decrease in summer months because the warmer temperatures and increased length of daylight are ideal for phytoplankton growth. Clarity throughout the year is also affected by calcite precipitation. The calcite, in warm waters, tends to precipitate around debris and also around phosphates in the water. The solid calcite can give the water a slightly cloudy appearance. During winter months when lakes become colder the calcite, which precipitated before, dissolves back into solution.

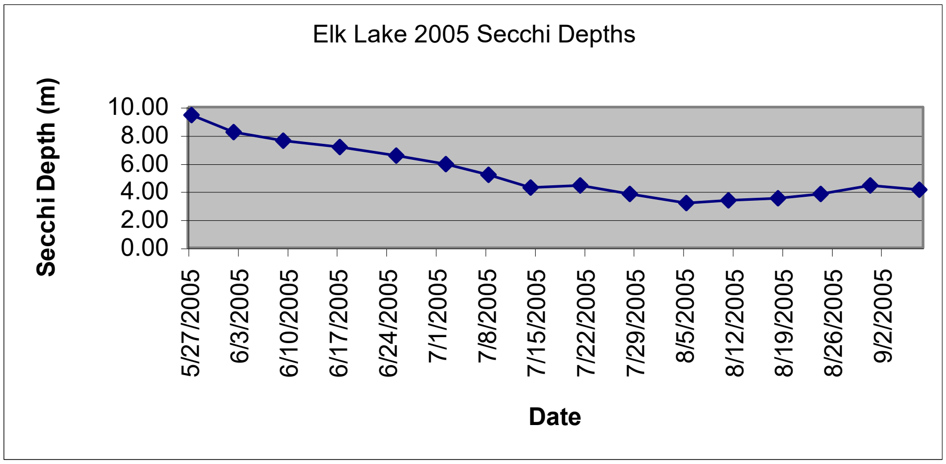


Figure 3

	Date	**Secchi Depth**
Elk Lake North Basin	6/30/06	6.3 m
Elk Lake South Basin	6/30/06	5.3 m

Figure 4

Lake Skegemog Secchi and Li-Cor Data

Lake Skegemog generally tends to have slightly lower clarity than Elk Lake, although both Secchi and Li-Cor data for Elk and Skegemog lakes follow the same trends as depth increases. The data from this year shows little deviation from Lake Skegmog Secchi readings from the past fourteen years.

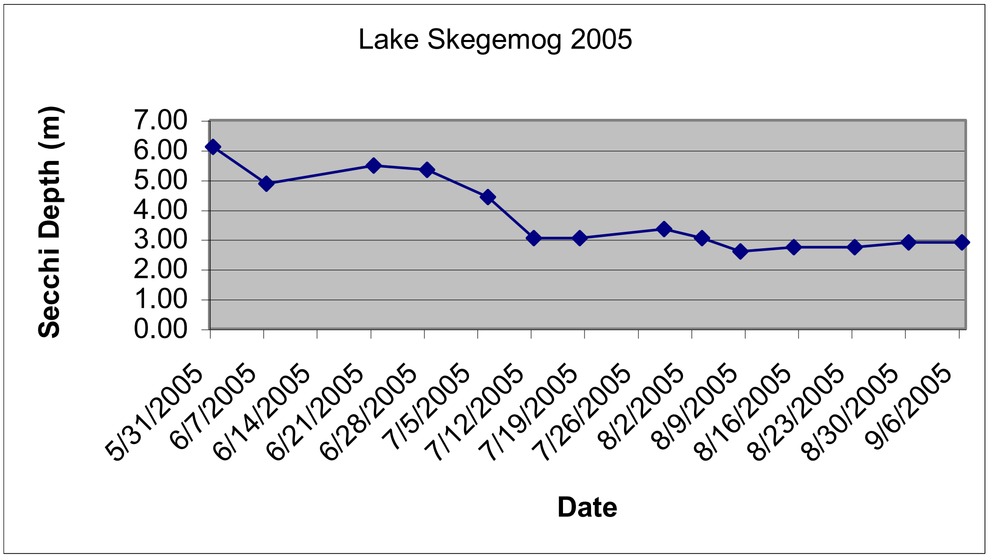


Figure 5

Date	**Secchi Depth**
6/22/06	4.6 m
6/30/06	5.9 m

Figure 6

Hydrolab data

Temperature

Figure 7 below shows the declination of temperature as depth increases for two of the sampling excursions on the north point of Elk Lake. The graph shows the natural thermocline of the lake in the summer months. It is hard to make any predictions of Elk's water quality based on this one graph, but as the situation around Elk changes in the future the changes in the thermocline can be compared to this baseline and predictions and responses can be made accordingly.

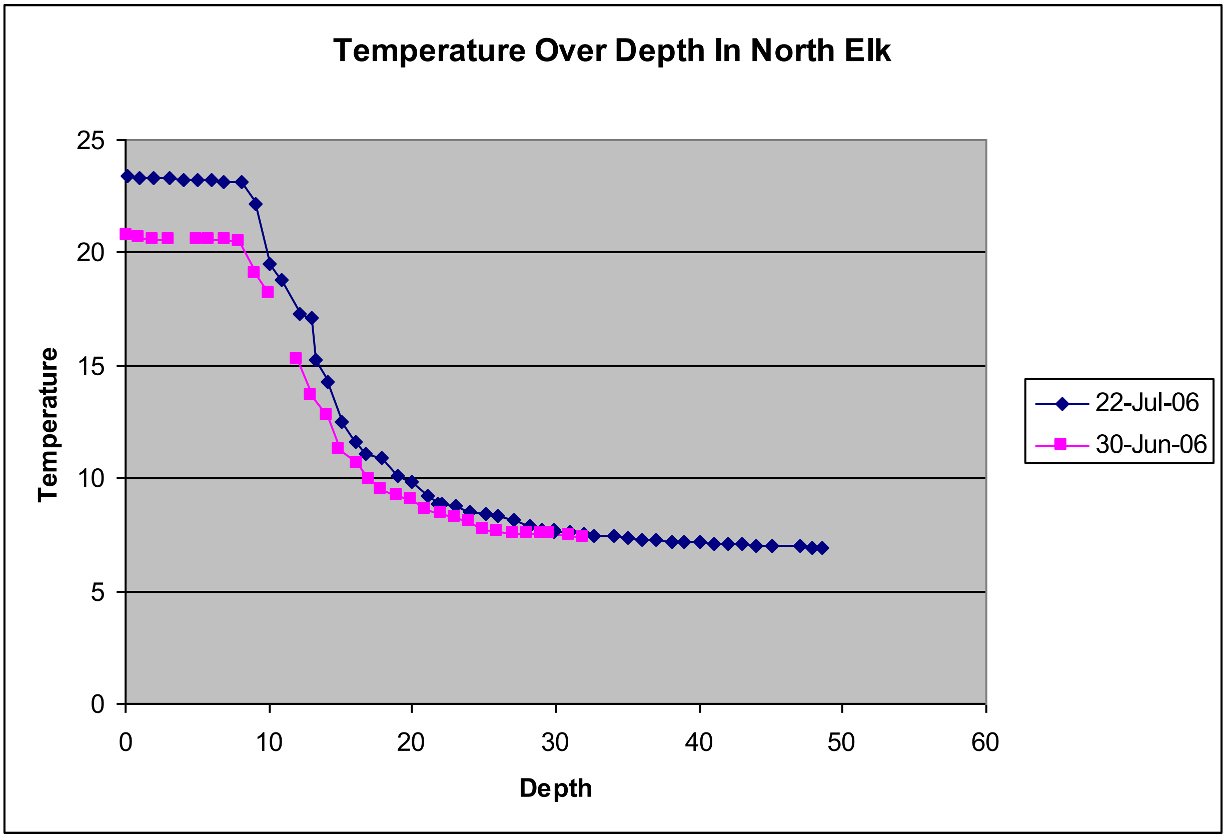


Figure 7

Figure 8 is shows the thermocline for South Elk on the same dates.

Figure 8

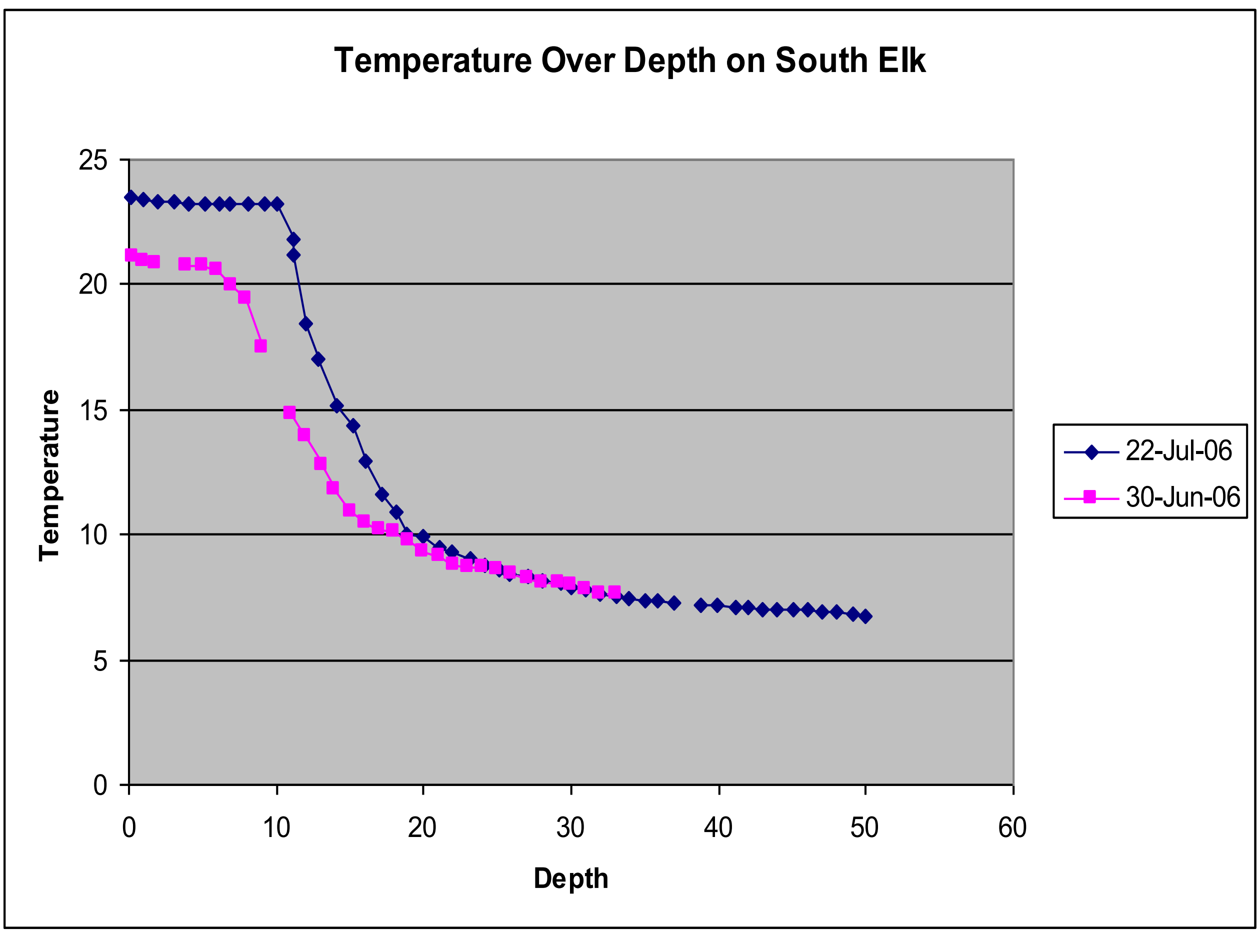


Figure 9 displays the thermocline in Skegemog Lake. There is virtually no change in over depth do to the lake being so shallow and receiving almost uniform heating.

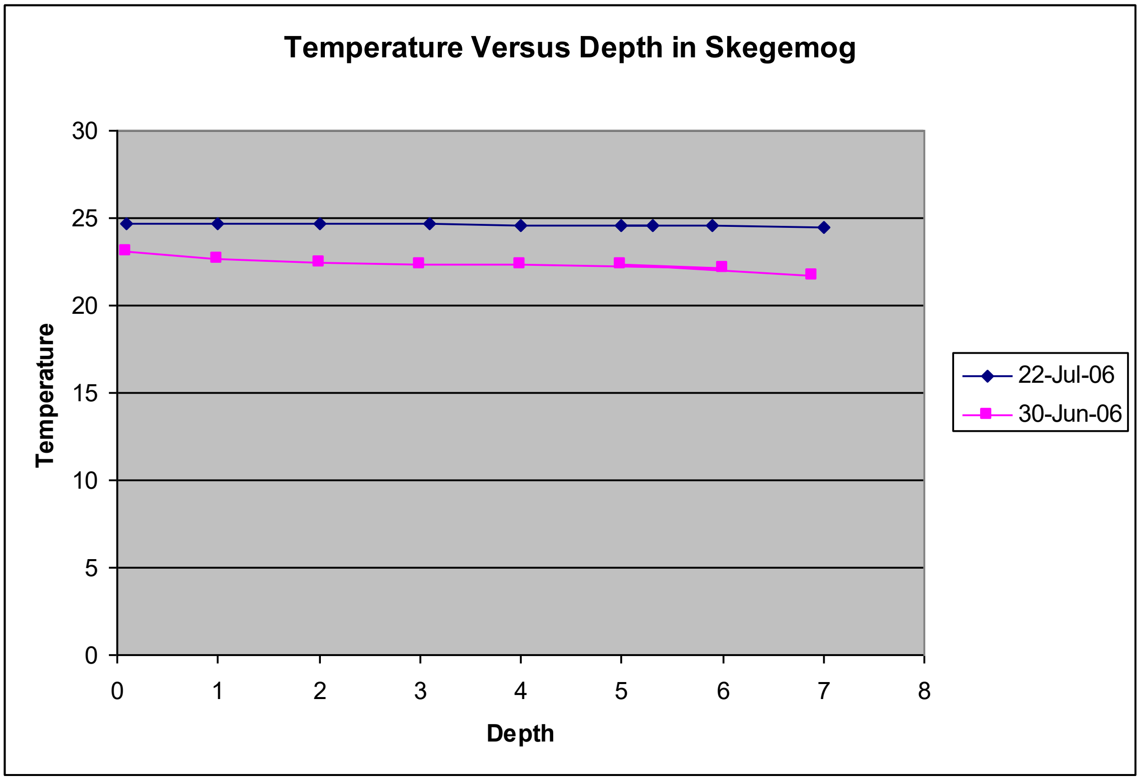


Figure 9

pH levels over increasing depth

This next graph shows the change in pH as the depth increases in North Elk. pH is an important parameter because most aquatic organisms need a relatively neutral environment to survive. A pH neutral level is 7, in these measurements the levels never deviate to far from that neutral level, so the graphs have changed scale in order to illustrate the more subtle changes. Again this will be a helpful baseline because if pH levels in the future get too high or too low it will be detrimental to all life that depends on the lake for existence.

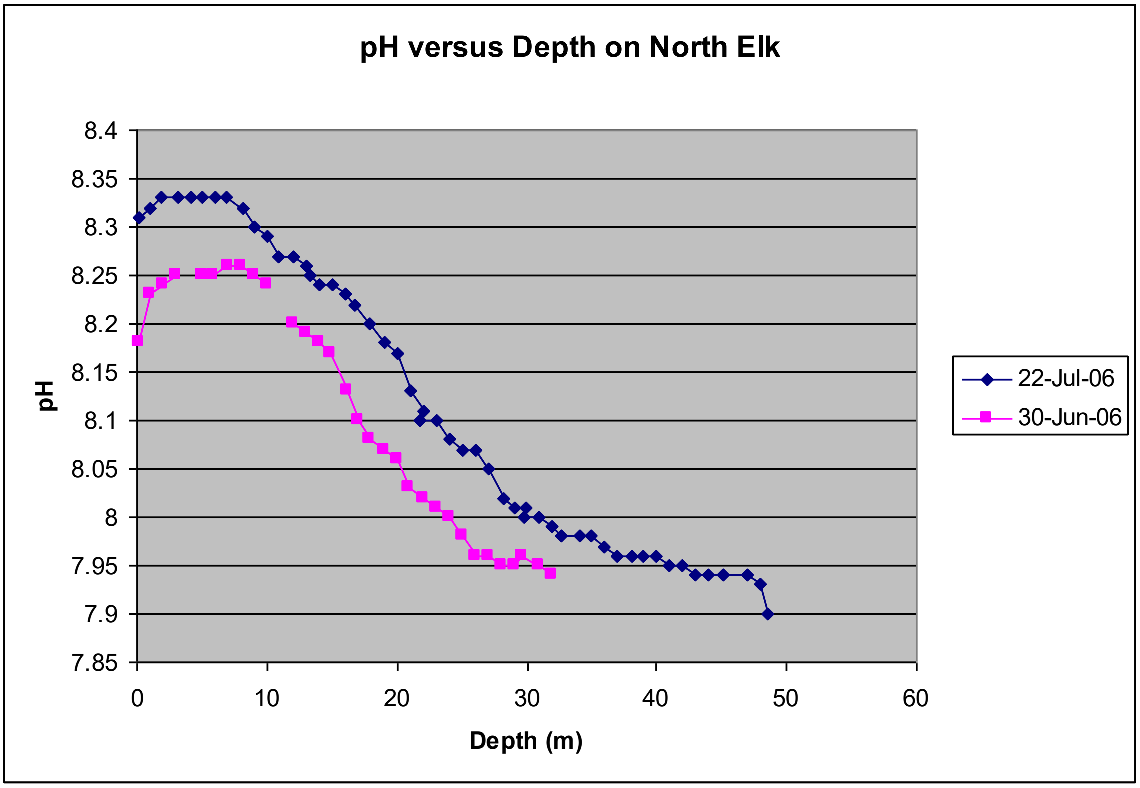

pH versus Depth on North Elk
8.4
8.35
8.3
8.25
8.2
8.15
8.1
8.05
8
7.95
7.9
7.85
pH
0
10
20
30
40
50
60
Depth (m)
22-Jul-06
30-Jun-06

Figure 10

Figure 11 shows the same data for the testing site at South Elk.

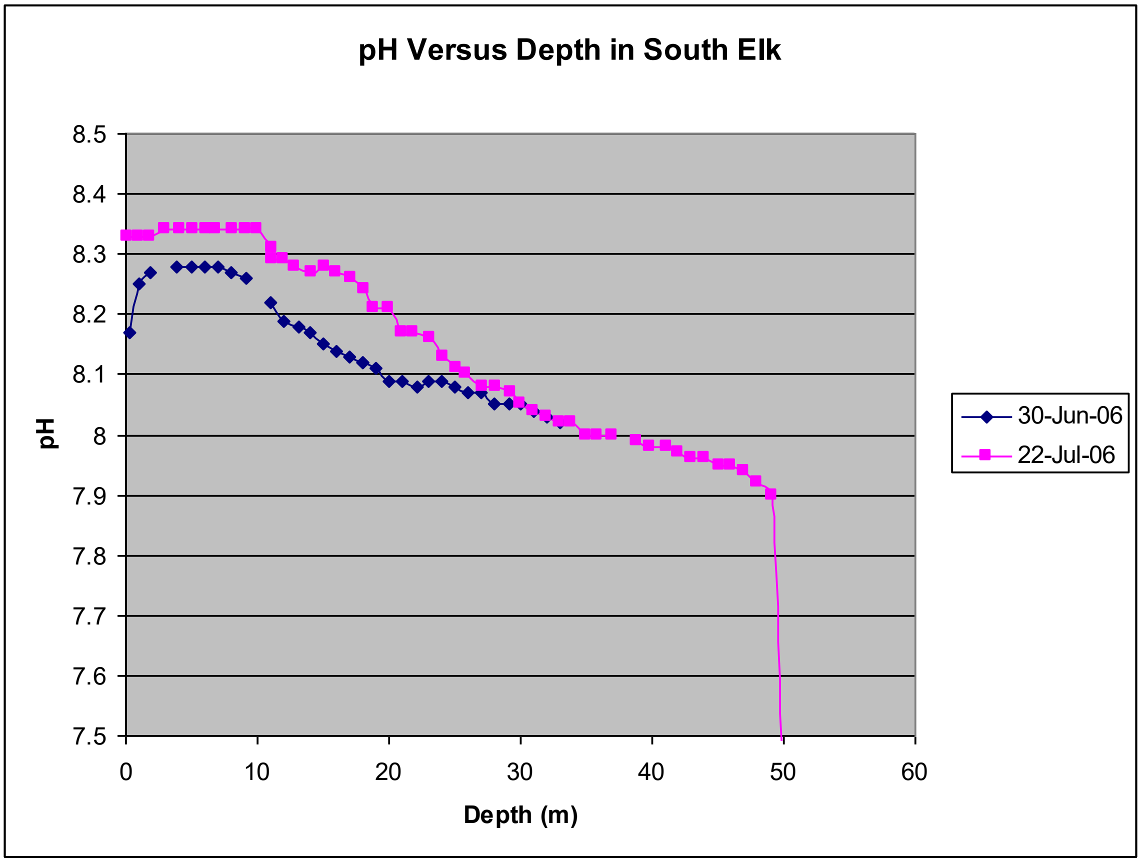


Figure 11

Dissolved Oxygen

Dissolved oxygen (DO) is a measure of how many oxygen ions are present in the water. It is a good indication of how much aquatic life is thriving because plants produce oxygen and animals consume it. The following charts show the fluctuation of DO as the depth increases. Figure 12 shows the DO in North Elk.

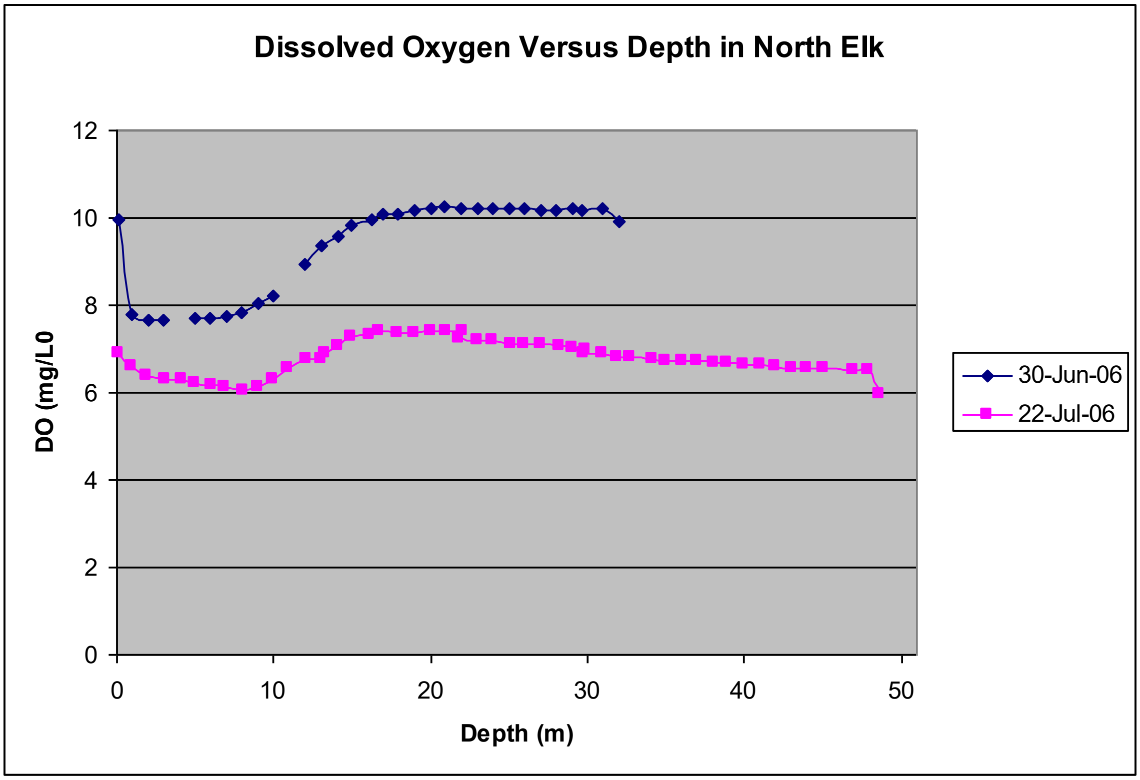


Figure 12

Figure 13 (below) shows South Elk's amounts of dissolved oxygen.

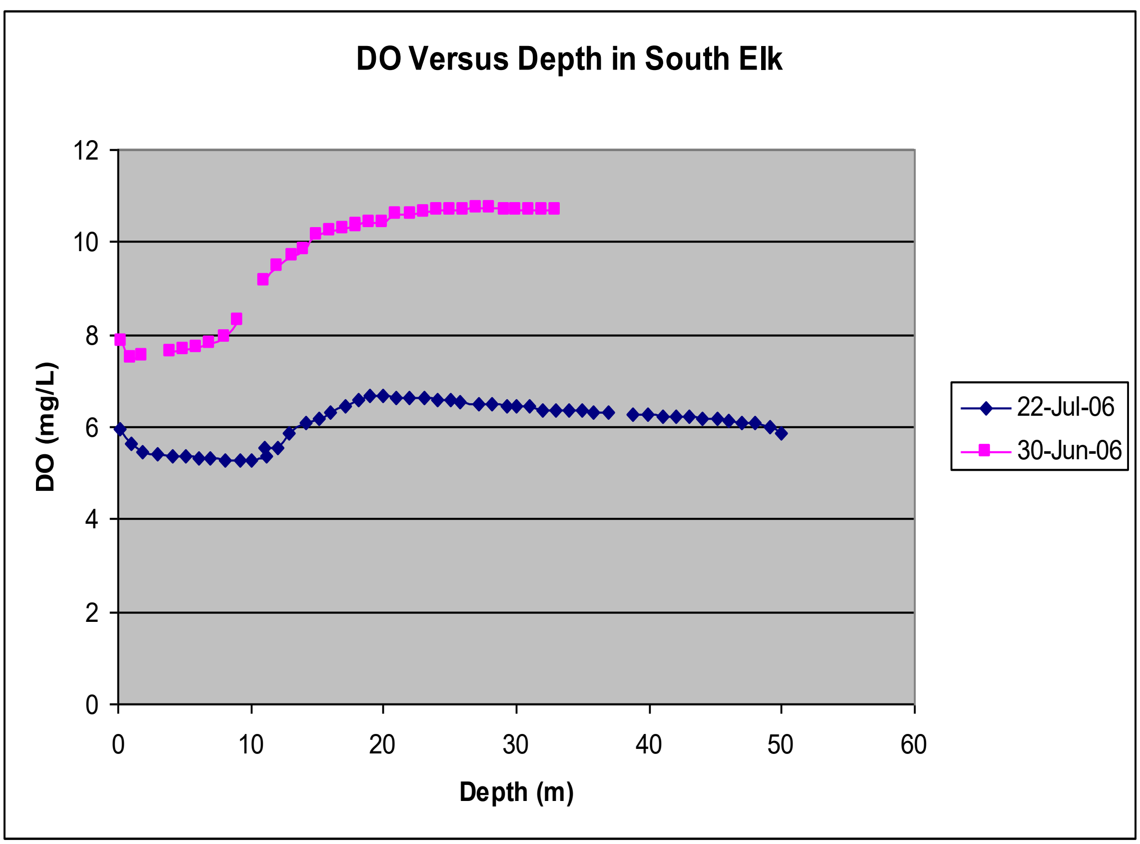


Figure 14 analyses the change in DO for Skegemog Lake.

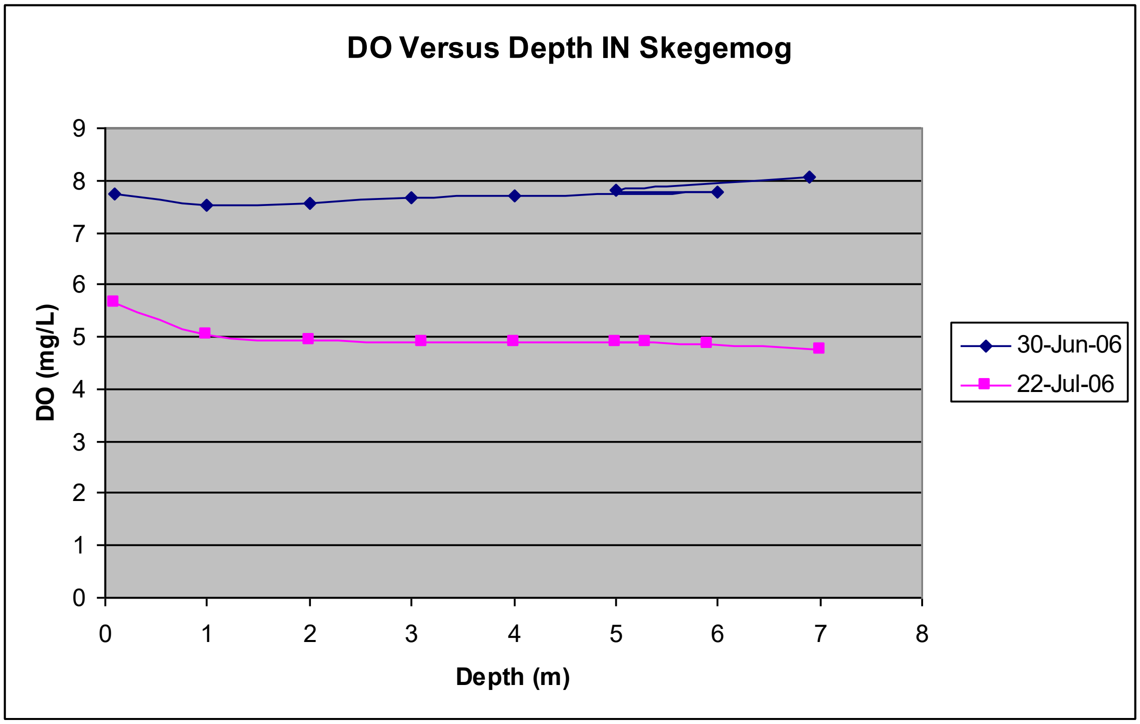


Figure 14

Phosphorous Levels

Phosphorus is a key nutrient for all aquatic ecosystems. It is used in plant growth, algal growth and is the main parameter for determining a lake's health. This phosphorous data can be extrapolated and inserted into computer models, which can predict the future state of the lake. Samples from the lake were taken using the Van Dorn bottle and samples from the stream were collected by hand. All samples were sent to the lab at Michigan State to be analyzed. The levels for a mid summer sampling is show in figure 15.

DATE:	8/30/2006	
Site	Depth	Phosphate Level: ppb
N. Elk	surface	1.4
N. Elk	mid	2.7
N. Elk	deep	3

S. Elk	surface	2.7
S. Elk	surface	2.7
S. Elk	surface	2.5
S. Elk	mid	1.4
S. Elk	deep	2.9
Skegemog	composite	4.4
Tributaries		
Vargason	Creek	7.2
Desmond	Creek	3.8
Rapid	River	4
Barker	Creek	5.3
Copeland	Creek	4.3
Battle	Creek	5.5
Williamsburg	Creek	5.2
OUTFLOW		
Elk River		3.3

Figure 15

GLOSSARY

Photosynthetically Active Radiation (PAR): the range of visble light radiation between 400 and 700 nanometers that can be absorbed by photosynthetic plants.

Turbidity: the clarity of water; typically affected by suspended phytoplankton.

Calcite: crystalline calcium carbonate.

Primary Productivity: The energy supplied by plants and other photosynthetic organisms at the base of the food chain.

REFERENCES

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http://waterontheweb.org/under/waterquality/turbidity.html

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