

Stratification Patterns In Central NH Lakes



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Introduction

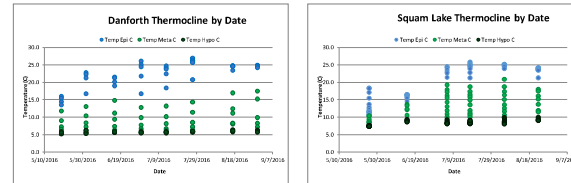
New Hampshire is home to 1,300 lakes and ponds. These lakes and ponds provide the state with fresh water, biodiversity, recreational opportunities, beautiful scenery, and encourage tourism. Lake ecosystems are affected by changes in the atmosphere, their water shed, or ground water, and naturally change over time. Human activities can accelerate these changes and can greatly diminish the value of a lake or pond. By monitoring lake and pond water quality we can identify any changes that may be of concern and from there identify the source of change and work to mitigate it. During the summer of 2016 we conducted a monitoring study of Squam Lake and Lower Danforth Pond. The monitoring provided an understanding of their condition as well as seasonal trends of the monitored variables. The variables we monitored included water temperature, dissolved oxygen, specific conductance, turbidity, chlorophyll A, total phosphorous, sulfate, iron and manganese.

Methods

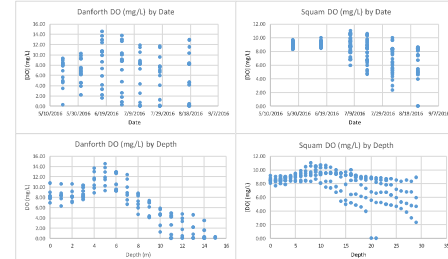
In the field, we took measurements for temperature, dissolved oxygen, saturation, and conductivity. These measurements were taken at one meter intervals, starting at the bottom of the water column. Proxy measurements were also taken for turbidity using a Secchi Disk. This field data was used to model the different layers of the water column. Samples were taken from the water column in the middle of each layer using a Kemmerer sampler. These samples were separated into bottles for lab analyses (Chloride, Iron and Manganese, Sulfate, and Total Phosphorus). An integrated sample was also taken from the top 7 meters of the water column for Chlorophyll-A analysis and C/N filtration. The Kemmerer samples were brought to the NH State Labs in Concord for their analyses. In the lab at Plymouth State University, the integrated samples were measured using lab equipment for pH, Conductivity, and Turbidity. 1200 mL of the integrated samples were filtered through Whatman filter papers, then shipped to Salem State University for Carbon/Nitrogen ratio analysis.



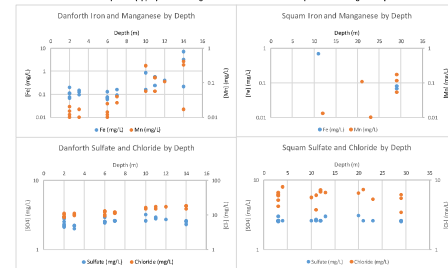
Data



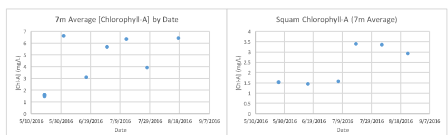
[Fig. 1: Thermocline Models showing the change in temperature/depth profile of Danforth (left) and Squam (right) during each monitoring session]



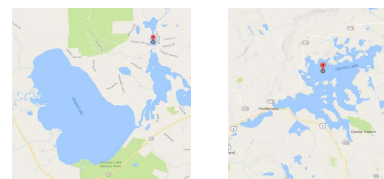
[Fig. 2 Dissolved Oxygen concentrations modeled by depth and data for each water body. The depth profile (bottom) shows the range of DO concentrations detected for that specific depth whereas the data profiles (top) show the range of DO concentrations for each specific monitoring session]



[Fig. 3 Iron, manganese, sulfate, and chloride concentrations modeled by depth, showing the range of concentrations for each depth across all monitoring sessions. Models for concentration by date were excluded due to an overall lack of comparable data]



[Fig. 4 Chlorophyll-a concentrations modeled by date. Depth models are not included, since the chlorophyll-a samples were taken across a seven meter section of the water column. There are three data points for the first monitoring session at Danforth (left) because three isolated samples were taken at different depths.]



[Fig. 5 Maps showing the relative locations of both bodies of water]

Discussion

In our analysis of the data we collected, we modeled several graphs of the water column. The two most prominent graphs (Fig. 1) display the stratification of each lake as the Summer progressed. Since Squam Lake was much deeper than Danforth, we saw a much more pronounced pattern, where the range of temperatures across the layers expanded as time passed. In both models, we can see that the Epilimnion and Hypolimnion (Top and Bottom layers) have relatively consistent temperatures, with the Metalimnion (Middle) expressing a much quicker rate of change in temperature as depth increases.

We also modeled data for the concentrations of dissolved oxygen (DO), sulfate, chloride, iron, and manganese. The main trend we see with DO (Fig. 2) is a noticeable increase in concentration as we enter the Metalimnion, with a relatively steady decrease as depth decreases. The Epilimnion displays a very consistent profile in both lakes. If we look at the DO profile by date, we see that it expresses a similar trend to the thermocline models. This fits into our expectations, since DO is a function of water temperature so we would expect to see some similarity between the two data sets. Looking at the sulfate and chloride concentrations (Fig. 3), we see that they remained relatively stable throughout our monitoring with a slight uptick as depth increases.

The iron and manganese concentrations display a similar trend, where the concentration increases with depth. In Squam, there were not very many detections of these metals, but Danforth returned results that were often in excess of State Recommended Levels. These concentrations also increased later in the Summer. Looking at the chlorophyll-a concentrations (Fig. 4), we see that Squam lake displays a noticeable trend, with a sharp increase in mid-July. Danforth's chlorophyll-a concentrations were all over the place, with no apparent trends aside from an overall increase as time progressed.

Acknowledgements

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