Executive Summary

Skaneateles Lake
Lake Monitoring Report
2007

Submitted to
Town Board
Town of Skaneateles
By
Lake Monitoring Committee

Background

In 1996 the Town of Skaneateles Comprehensive Plan established the goal that water quality in Skaneateles Lake should remain at least as good as it was in 1995. To implement that recommendation, in February 2006, the Town of Skaneateles appointed a Lake Monitoring Committee and charged them with developing a plan to establish a base line and monitor the water quality of the most important natural resource in the community, Skaneateles Lake. The committee formulated a plan, which was approved by the Town Board in August of 2006. After bids were received the Town signed a contract with Upstate Freshwater Institute to conduct a lake-wide monitoring program from April through October 2007. The result of that work is summarized in this document. A complete report is available for viewing in the town office, 24 Jordan St. Skaneateles, NY 13152.

Introduction

Monitoring is a necessary component of effective management and protection of our valuable aquatic resources. The only way to document prevailing water quality, and to identify changes, is through the consistent, regular measurement of appropriate parameters over time. It is impossible to document important changes in aquatic ecosystems without such measurements. Monitoring over several years, serves to establish baseline conditions. It also provides an opportunity to fine tune the program design and document levels of interannual variability. The establishment of baseline conditions represents a valid basis for comparison of future changes in water quality for resource managers. Effective monitoring may provide key information to support the development testing and application of mathematical models of water quality. Moreover, execution of monitoring programs often serves to engage local stakeholders in the quality and management of their aquatic resources.

The goals of this monitoring program were to collect information that will contribute to water quality management for Skaneateles Lake, in particular to maintain the current trophic state of the lake. Specific goals include:

a. Establishment of current baseline conditions
b. Update historic record of water quality
c. Use modern optical instrumentation to develop insights; to protect the lake's unique water clarity; determine regulating characteristics; and evaluate the potential for remote sensing of water clarity in the future
d. Contribute to the design of a long-term monitoring program

Findings

Skaneateles Lake is oriented in a north/northwest-south/southeast direction. It is the third deepest of the Finger Lakes at 299 ft and possesses a relatively small watershed in relation to the surface area of the lake. The time it takes to replace the water in the lake is around 18 years which is the second longest of all of the Finger Lakes.

The lake thermal stratification regime determines the timing of turnover, the onset of stratification and the depths and dimensions of the layers in the stratified lake and is critically important in understanding the functioning of the lake.

Mixing of the entire lake begins at the end of the summer stratification period, which is typically in late October or early November and continues up into mid-May when a weak stratification pattern develops. By mid to late June 2007 stratification strengthened, and became progressively better developed throughout the summer and into the fall. Monitoring, which terminated in October, could not pick up the onset of fall turnover, which most likely occurred in November 2007.

The stratification regime in Skaneateles Lake is generally similar to other lakes in the region with the following exceptions. Skaneateles Lake has a

a. delayed establishment of stratification
b. delayed warming of upper waters
c. colder temperatures in hypolimnion (deep colder layer)
d. delayed onset of fall turnover
e. thicker metalimnion (intermediate layer)

All, of which, is due to the greater depth of Skaneateles Lake and the greater extent of light penetration.

Skaneateles Lake is a very clear, unproductive (oligotrophic) body of water by most metrics. Productivity refers to the rate of plant growth, particularly algae, in an aquatic ecosystem. The three trophic states are oligotrophy, mesotrophy, and eutrophy, corresponding to low, intermediate and high productivity. Levels of productivity are commonly estimated by surrogate metrics such as (1) total phosphorus; (2) chlorophyll a; (3) Secchi disc transparency; and (4) rate of depletion of oxygen from the lower strata of the lake during stratification.

Levels of total phosphorus, chlorophyll a, and Secchi disc transparency are summarized in Table 1 and compared to criteria for trophic state. In each case Skaneateles Lake is clearly characterized as an oligotrophic, low productivity lake. A comparison of data collected in earlier years shows that the current condition of Skaneateles Lake is well within the range of values covering its history over the last 35 years.

Most lakes lose oxygen from the deeper strata of the lake, the hypolimnion, as a result of decomposition processes during the stratified period. The rate of oxygen depletion is a function of a lake's productivity – high productivity leads to rapid depletion, low productivity leads to low rates of depletion. Measurement of oxygen concentrations in the deepest strata of the lake (from 100 ft to the bottom of the lake) showed highest concentrations in that layer, characteristic of oligotrophic lakes. A preliminary estimate of the rate of depletion of dissolved oxygen in the deepest strata from May through August for 2007 was 260 mg/m2/day decline in dissolved oxygen averaged over the time period. Such a rate is at the boundary between oligotrophy and mesotrophy. This needs to be watched with care in the future since it may be an indication that the lake is becoming more productive.

Table 1. Summary of the 2007 monitoring in relation to relevant historical data and criteria for oligotrophy.

Year	Chl a (ug/L)	Secchi disc (m)	Total Phosphorus (ug/L)
1910		10.3	
Early 1970s	1.95	6.6	6.1
1972	1.5	5.4	
1973	0.85	5.1	
1982		8.4	
1987		7.0	
1988	0.23	7.8	
1996	1.0	6.0	3.0
1997	0.3	8.4	5.3
1998	0.76	8.1	
1999	0.55	7.7	3.9
2004		8.0	
2005	0.76	7.8	3.5
2006	0.99	7.5	
2007	1.05	8.0	4.8
Skan Lake Average	0.90	7.47	4.43
Criteria	< 4	> 4	< 10

Comparison of data across sampling stations from south to north showed very little spatial variation in results. Values collected at the southern stations were very similar to values collected at the northern stations. This suggests that it may be possible to reduce sampling stations in the future. It is possible, however, that the small differences may be due to the low rainfall in 2007. Sampling in 2008 should help answer that question.

The special emphasis on clarity and related optical characteristics is in recognition of the especially high quality of these features in Skaneateles Lake relative to those for other lakes in the region. Skaneateles Lake has long been noted for the beauty of its water, which has made it particularly attractive to residents and visitors alike. These attributes deserve special attention to understand and thereby protect these conditions. In 2007 variations in water clarity were compared to several possible causes including phytoplankton densities, clay mineral concentrations, and calcium carbonate particles. Using scanning electron microscopy it was possible to identify the fraction of the particle population that regulated water clarity as clay mineral particles.

Most of the clay mineral particles are delivered to the lake from the watershed. These findings have management value for targeting potential causes of degraded clarity conditions and need to be carefully monitored in the future. Additionally, the optics component of the 2007 monitoring program served to evaluate the potential for using remote sensing technologies (e.g., from satellite or airplane fly-over) to measure key attributes.

A phenomenon found in clear lakes where chlorophyll levels peak well below the surface creating a deep chlorophyll maximum was found in Skaneateles Lake. This can be due to either phytoplankton thriving in deeper water creating an elevated level of chlorophyll at depth or an accumulation of algal cells due to a slowing of the sinking rate as the cells reach the stratified layers of the lake. In Skaneateles in 2007 this occurred at 30 m or about 100 ft where the chlorophyll level was 4 times that at the surface. This is a temporary, but lake-wide phenomenon, indicative of an oligotrophic lake with clear water.

Measurements of nitrate nitrogen levels in the upper 10 m of the lake declined from May through September reflecting a net loss attributable to plant uptake during the summer. Such measures can aid in the monitoring of primary production in the illuminated water column and serve as an additional measure of trophic state of the lake.

Conclusions

1. Skaneateles Lake mixes from the fall (Oct/Nov) until stratification begins to develop in late May or early June. This stratification pattern is generally characteristic of other large deep lakes in the region.
2. Four indicators were used to determine the trophic state of the lake: total phosphorus, chlorophyll a, water clarity, and the rate of oxygen removal from the lower layer of the lake during stratification. Three of the four indicators clearly place Skaneateles Lake in the least productive (oligotrophic) category.
3. The oxygen concentrations in the hypolimnion of Skaneateles Lake were highest in the lower stratum (hypolimnion) characteristic of oligotrophic lakes. However, a preliminary estimate of the rate of depletion of dissolved oxygen in the deepest strata from May through August suggests that the rate of loss may be a sign of increased productivity. The loss (260

mg/m2/day) is close to the boundary between oligotrophy and mesotrophy. This bears watching.

4. A brief examination of the trophic state of Skaneateles Lake over time by comparing earlier data suggests that the lake has not changed dramatically since the early 1970's.
5. This study identified a deep lake-wide chlorophyll maximum layer (DCM) at about 100 ft on June 29. A DCM is not uncommon in lakes where light penetrates deeply into the water column. The DCM could be due to increased chlorophyll in cells of algae at that depth due to an optimal combination of light and nutrients or a reduction in the rate of sinking of algal cells causing an increase in their concentration at depth.
6. Using optical parameters measuring light penetration into the water and the extent of light scattering off of particles, coupled with scanning electron microscopy it was possible to characterize the particles and to establish the nature of the particles governing water clarity in the lake over the sampling period. Silt was the predominant particle type affecting water clarity. Careful attention to this in future monitoring will be helpful in maintaining the high water clarity that has characterized Skaneateles Lake in the past.

Recommendations

1. UFI recommends continuing current sampling program until a solid baseline can be established. The Lake Monitoring Committee, in consultation with UFI, should consider whether the number of sites could be reduced after experience with a rainy year. If there is little difference between sites then we may be able to eliminate several stations.
2. Monthly sampling frequency seems appropriate for oligotrophic lakes like Skaneateles. In order to capture variations in water quality in relation to runoff events, however, it may be desirable to establish a higher frequency program for 2009, particularly if fewer sites are monitored. The Lake Monitoring Committee, in consultation with UFI, should make this evaluation at the end of the 2008 sampling year.
3. UFI should continue to measure the decline in oxygen in the hypolimnion to establish the existence of any trends.
4. UFI should continue to evaluate the possibility of assessing certain elements of the lake's water quality through remote sensing in the future.
5. In future sampling of chlorophyll care needs to be taken to account for the deep chlorophyll maximum layer.

6. Scanning electron microscopic identification of particles causing turbidity should be conducted regularly to determine sources of turbidity.
7. The Lake Monitoring Committee, in consultation with UFI, should consider using the rate of aerial nitrogen depletion from the zone of production as another metric of changes in trophic state.