Otsego Lake limnological monitoring, 1997

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ABSTRACT

Limnological analyses of several abiotic factors were performed during 1997 on Otsego Lake, Cooperstown, N.Y. The purpose was to monitor the chemical and physical parameters affecting lake water quality for comparison with past findings. This work is part of an ongoing study begun thirty years ago. Throughout the year, profiles of water temperature, dissolved oxygen, pH and conductivity were measured using a Hydrolab Scout 2 at the deepest spot in the Lake (TR4-C). Water samples were collected in profile for the analyses of total phosphorus, nitrite+nitrate, calcium, chloride, and alkalinity. Photic-zone composite samples were collected for chlorophyll \( a \) determinations. Secchi disk transparency was measured. The data, after comparison with earlier information, indicate water quality varies in relation to the volume of cold water fish habitat in late summer. These changes are attributed to fluctuations in nutrient loading, weather conditions, and food web alterations due to the proliferation of the alewife.

INTRODUCTION


This study is the continuation of year-round protocol which began in 1991. The data collected in this report runs for the calendar year and is comparable with contributions by Homburger and Buttigieg (1992), Groff, et. al.(1993), Harman (1994; 1995) Austin et al. (1996), and Albright (1997).

MATERIALS AND METHODS

Data collection began January 3 and continued until December 23, 1997. During winter months (Jan.-Mar.) while the ice covered the surface of the lake, readings were taken monthly. During periods of open water bi-weekly or weekly readings were collected.

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Figure 1. Bathymetric map of Otsego Lake showing sampling site (TR4-C).
Data were collected near the deepest part of the Lake (TR4-C) (Figure 1), which is considered representative as past studies have shown the Lake to be spatially homogenous with respect to the factors under study (Iannuzzi, 1988). Physical measurements were recorded at 2 m intervals between 0 and 20 m and 40 m to the bottom; 5 meter intervals were used between 20 and 40 m. Measurements of pH, temperature, dissolved oxygen and conductivity were recorded on site with the use of a Hydrolab Scout 2 multiprobe digital microprocessor which had been calibrated according to manufacturer’s instruction immediately prior to use (Hydrolab Corp., 1993). Samples were collected for chemical analyses at 4 m intervals between 0 and 20 m and 40 m and the bottom; 10 m intervals were used between 20 and 40 m. A summary of methodologies employed for chemical analyses are given in Table 1. Composite samples were collected through the photic zone (surface to the depth at which light equals 1% ambient levels, determined with a Protomatic photometer) for chlorophyll a determinations. When variable light conditions precluded accurate photometric readings, sampling depth was to the Secchi depth times 2.7, which has been used as an estimator of the photic zone (Wetzel and Likens, 1991). Chlorophyll a measurements were made using a Turner Designs TD-700 fluorometer following the methods of Welschmeyer (1994).

RESULTS AND DISCUSSION

Temperature

Surface temperature reached a high of 23.95°C on July 17 and lows of 0°C when under ice. The near-bottom temperatures ranged from 2.20°C on February 19 to 5.63°C on November 24.

The Lake froze January 18 and remained ice-covered until April 6. Summer stratification was apparent by mid-May. The thermocline was completely eliminated by December 11.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from surface readings of 16.42 mg/l on February 19 to 8.53 mg/l on September 25. Near-bottom readings ranged from 12.38 mg/l on April 25 to 2.16 mg/l on November 24 (Figure 2).

Areal hypolimnetic oxygen depletion rates were only slightly better than those of 1995, which were the highest ever observed in Otsego (Table 2). This was a reversal of the situation in 1996, when oxygen-loss rates had exhibited some improvement from the previous year. Current values greatly exceed the lower limit of eutrophy (0.05 mg/cm²/day) suggested by Hutchinson (1957).

pH

pH measurements in Otsego Lake ranged from 7.3 near the bottom throughout much of the summer to 8.4 through the epilimnion on August 6.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample Vol.</th>
<th>Preservation</th>
<th>Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphorus-P</td>
<td>40 ml</td>
<td>H₂SO₄ to pH&lt;2</td>
<td>Persulfate digestion followed by single reagent ascorbic acid</td>
<td>EPA, 1983</td>
</tr>
<tr>
<td>Nitrite+Nitrate</td>
<td>25 ml</td>
<td>Filter and cool to &lt;4°C</td>
<td>Cadmium reduction</td>
<td>APHA, 1989</td>
</tr>
<tr>
<td>Calcium</td>
<td>50 ml</td>
<td>None</td>
<td>EDTA titrimetric method</td>
<td>EPA, 1983</td>
</tr>
<tr>
<td>Chloride</td>
<td>100 ml</td>
<td>None</td>
<td>Mercuric nitrate</td>
<td>APHA, 1989</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>100 ml</td>
<td>Cool to &lt;4°C, Measure ASAP</td>
<td>Titration to pH=4.6</td>
<td>APHA, 1989</td>
</tr>
</tbody>
</table>

Table 1. Summary of laboratory methodologies, 1997.
Figure 2. 1997 Otsego Lake dissolved oxygen profiles. Isopleths in mg/l.
<table>
<thead>
<tr>
<th>Interval</th>
<th>D.O. Deficit (mg/cm^2/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/16/69-09/27/69</td>
<td>0.080</td>
</tr>
<tr>
<td>05/30/72-10/14/72</td>
<td>0.076</td>
</tr>
<tr>
<td>05/12/88-10/06/88</td>
<td>0.042</td>
</tr>
<tr>
<td>05/18/92-09/29/92</td>
<td>0.091</td>
</tr>
<tr>
<td>05/10/93-09/27/93</td>
<td>0.096</td>
</tr>
<tr>
<td>05/17/94-09/20/94</td>
<td>0.096</td>
</tr>
<tr>
<td>05/19/95-10/10/95</td>
<td>0.102</td>
</tr>
<tr>
<td>05/14/96-09/17/96</td>
<td>0.090</td>
</tr>
<tr>
<td>05/08/97-09/25/97</td>
<td>0.101</td>
</tr>
</tbody>
</table>


Figure 3. Chloride concentrations at TR4-C, 1920-1997. Points later than 1990 represent yearly averages (modified from Peters, 1974).
Alkalinity

Alkalinity averaged 112 mg/l (as CaCO₃) throughout the year. The minimum value of 86 mg/l was observed at the surface on July 5; the maximum value (125 mg/l) occurred at 48 m on March 13. These data are consistent with earlier findings (Harman et al., 1997).

Calcium

Calcium dynamics paralleled those of alkalinity. The year-long average was 48.5 mg/l. A low of 34.5 mg/l was encountered at the surface on March 19; a high of 52.9 was observed at 48 m on the same date.

Conductivity

Conductivity (an indirect measure of ions in solution) values in Otsego ranged from 206 mmmhos/cm below the ice on March 19 to 304 mmmhos/cm at 48 m on the same date.

Chlorides

Chloride concentrations averaged 9.0 mg/l, exhibiting very little variation either temporally or spatially. The trend of increasing chloride levels, first recognized in the 1950s (Peters, 1987), presumably attributable to road salting, continues (Figure 3). Concentrations are approximately 1 mg/l higher than in 1996. Assuming sodium chloride is the source, this represents an addition of almost 600,000 kg (660 tons) of salt to the lake in the past year. These increases are despite the Village of Cooperstown’s continuing efforts to limit salt as an anti-icing compound.

Nutrients

Total phosphorus-P ranged from 5.6 ug/l at 30 m on July 31 to 17.3 ug/l at 48 m on March 19 and averaged 9.8 ug/l. Nitrite+nitrate-N ranged from 0.28 mg/l at the surface on September 25 to 0.68 mg/l at 48 m on August 14 and averaged 0.40 mg/l. The mean concentration of both nutrients was similar to other values reported in the 1990s. There was no evidence of phosphorus release from the sediments prior to fall turnover, as had been suggested following 1995 monitoring (Harman et al., 1997).

Chlorophyll a

Photic-zone mean chlorophyll a concentrations ranged from 3.4 ug/l (July 3) to 10.1 ug/l (June 19). The mean value over the collection period (February 19-December 11) was 5.7 ug/l. The mean measured value of 1996 was 7.7 ug/l; however, this is not directly comparable due to the fact that in 1996 chlorophyll data were collected only between July and December. 1997 data, as well as those concerning Secchi transparency, are presented in full in Figure 4.
Secchi disk transparency

Water transparency averaged 3.2 m and ranged from 1.4 m on July 19 to a high of 4.5 m on March 19 and April 25. Secchi transparencies, coupled with chlorophyll a photic zone means, are shown in Figure 4. Figure 5 summarizes annual mean Secchi transparencies at TR4-C in 1935, 1968-73, 1975-82, 1984-87, 1988, and 1992-97 (Harman et al., 1997).

REFERENCES


Figure 4. Mean photic zone chlorophyll $a$ concentrations (parts per billion) and Secchi depth transparency (meters), 1997.
Figure 5. Annual means of Secchi disk transparency, collected at TR4-C, 1935-97 (modified from Harman et al., 1997).


