Otsego Lake limnological monitoring, 1998

Matthew F. Albright

ABSTRACT

Limnological analyses of several abiotic factors were performed during 1998 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 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; 1998).

MATERIALS AND METHODS

Data collection began 3 April and continued until 16 December 1997. Readings were collected weekly or bi-weekly. Tenuous ice conditions prevented sampling during winter

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months.

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 \( \alpha \) 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 \( \alpha \) 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 23.48\(^{\circ}\)C on 23 July and lows of 0\(^{\circ}\)C when under ice. The near-bottom temperatures reached 4.91 on 4 December. Winter profiles were not recorded due to thin ice.

According to the US Weather Service, the lake froze 15 February, though some reported several acres of open water throughout the winter. Summer stratification was apparent by mid-May. The thermocline was completely eliminated by December 16.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from surface readings of 12.40 mg/l on 17 April to 8.36 mg/l on 8 October. Near-bottom readings ranged from 11.83 mg/l on 3 April to 0.81 mg/l on 19 November (Figure 2).

Areal hypolimnetic oxygen depletion rates were similar to those of the 1990's, which are significantly higher than were measured historically (Table 2). Current values greatly exceed the lower limit of eutrophy (0.05 mg/cm\(^2\)/day) suggested by Hutchinson (1957).
Figure 1. Bathymetric map of Otsego Lake showing sampling site (TR4-C).
<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. 1998 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>
<tr>
<td>05/15/98-09/17/98</td>
<td>0.095</td>
</tr>
</tbody>
</table>

Figure 3. Mean chloride concentrations at TR4-C, 1920-98. Points later than 1990 represent yearly averages (modified from Peters, 1974).
pH

pH measurements in Otsego Lake ranged from 7.08 near the bottom on 6 August to 8.43 at the surface on 11 June.

Alkalinity

Alkalinity averaged 109 mg/l (as CaCO₃) throughout the year. The minimum value of 90 mg/l was observed at the surface on 31 August and 17 September; the maximum value (123 mg/l) occurred at 48 m on 19 November. These data are consistent with earlier findings (Harman et al., 1997).

Calcium

Calcium dynamics paralleled those of alkalinity. The year-long average was 45.3 mg/l. A low of 37.7 mg/l was encountered at 4 m on 17 September; a high of 50.5 was observed at 44 and 48 m on 19 November.

Conductivity

Conductivity (an indirect measure of ions in solution) values in Otsego ranged from 233 mmhos/cm at the surface on 17 September to 285 mmhos/cm at 48 m on 8 October.

Chlorides

Chloride concentrations averaged 9.7 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 0.7 mg/l higher than in 1997. Assuming sodium chloride is the source, this represents an addition of about 400,000 kg (440 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. In the future it cannot be assumed that NaCl is the sole source of chlorides, as local municipalities have begun to use a deicer that contains significant levels of MgCl.

Nutrients

Total phosphorus-P ranged from 5.3 µg/l at 40 m on 20 August to 23.9 µg/l at 8 m on 6 August and averaged 9.9 µg/l. Nitrite+nitrate-N ranged from 0.28 mg/l at the surface on 5 November to 0.92 mg/l at 30 m on 20 August and averaged 0.65 mg/l. 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 3.3 \( \mu g/l \) (3 April) to 9.8 \( \mu g/l \) (4 December). The mean value over the collection period (3 April to 4 December) was 5.6 \( \mu g/l \). While seasonal trends were quite different than in 1997, the range and mean was similar. 1998 data, as well as those concerning Secchi transparency, are presented in full in Figure 4.

Secchi disk transparency

Water transparency averaged 2.8 m (the lowest mean transparency on record) and ranged from 0.9 m on 2 July to a high of 4.2 m on 5 November. 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 1992-98 (Harman et al., 1997).

REFERENCES


Figure 4. Mean photic zone chlorophyll a concentrations (parts per billion) and Secchi depth transparency (meters), 1998.
Figure 5. Annual means of Secchi depth transparency, collected at TR4-C, 1935-98 (modified from Harman et al., 1997).


