Otsego Lake limnological monitoring, 2004

Matthew F. Albright

ABSTRACT

Limnological analyses of several abiotic factors were performed during 2004 on Otsego Lake, Cooperstown, N.Y. The purpose was to monitor the chemical and physical parameters affecting 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® or a Surveyor 4® 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. Secchi disk transparency was measured. The data, after comparison with earlier information, indicate that 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

Otsego Lake is a glacially formed, dimictic lake supporting a cold water fishery. The Lake is generally classified as being chemically mesotrophic, although flora and fauna characteristically associated with oligotrophic lakes are present (Iannuzzi, 1991).


MATERIALS AND METHODS

Data collection began 12 February and continued until 3 December 04. Readings were collected bi-weekly during open water conditions and monthly through the ice. However, because of unsafe ice conditions, data were not collected between 22 February and 5 May.

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 1991). 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® or a Surveyor 4® 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 from the surface to 20 m for Chlorophyll $a$ measurements, which were determined using a Turner Designs TD-700® fluorometer following the methods of Welschmeyer (1994).

Figure 1. Bathymetric map of Otsego Lake showing sampling site (TR4-C).
RESULTS AND DISCUSSION

Temperature

Surface temperature reached a high of 22.97 °C on 29 July. The coldest temperature recorded was 0.25 °C at the surface on 12 February. The lake was completely covered by ice on 11 January; ice-out occurred 13 April. Stratification was evident by 20 May.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from surface readings of 13.17 mg/l below the ice on 12 February to 0.86 mg/l at the bottom just prior to fall overturn on 11 November. Year long profiles are given in Figure 2. Areal hypolimnetic oxygen depletion rates, at 0.102 mg/cm²/day, were generally higher than those encountered most years since data have been collected (Table 2) and are well over the lower limit of eutrophy (0.05 mg/cm²/day) suggested by Hutchinson (1957). This seemed largely the result of the metalimnetic minima in late summer being more pronounced than usual. The lowest mid-water reading was 3.77 at 14 m on 24 September.

Table 1. Summary of laboratory methodologies, 2004.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample volume</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-N</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</td>
<td>EPA 1983</td>
</tr>
<tr>
<td>Chloride</td>
<td>100 ml</td>
<td>None</td>
<td>Mercuric nitrate titration</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>
<tr>
<td>Chlorophyll 𝑎</td>
<td>100 ml</td>
<td>Ice sample, filter ASAP, process in reduced light</td>
<td>Fluorometric</td>
<td>Welshmeyer 1994</td>
</tr>
</tbody>
</table>
Figure 2. Otsego Lake oxygen profiles, 2004. Isopleths in mg/l.

<table>
<thead>
<tr>
<th>Interval</th>
<th>AHOD (mg/cm²/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>
<tr>
<td>05/20/99 – 09/27/99</td>
<td>0.095</td>
</tr>
<tr>
<td>05/11/00 – 09/14/00</td>
<td>0.109</td>
</tr>
<tr>
<td>05/17/01 – 09/13/01</td>
<td>0.092</td>
</tr>
<tr>
<td>05/15/02 - 09-26/02</td>
<td>0.087</td>
</tr>
<tr>
<td>05/16/03 – 09/18/03</td>
<td>0.087</td>
</tr>
<tr>
<td>05/20/05 – 09/24/05</td>
<td>0.102</td>
</tr>
</tbody>
</table>

pH

pH measurements in Otsego Lake ranged from 7.00 near the bottom on 3 December to 8.52 at the surface on 17 June.

Conductivity

Conductivity (an indirect measure of ions in solution) values ranged from 215 $\mu$hmhos/cm at the surface on 24 September to 321 $\mu$hmhos/cm at 48 m on 14 July.

Alkalinity

Alkalinity averaged 121 mg/l (as CaCO$_3$) throughout the year. The minimum value of 105 mg/l was observed at the surface on 17 August and 18 September; the maximum value (141 mg/l) occurred at 48 m on 12 February. These data are consistent with earlier findings (Harman et al., 1997).

Calcium

Calcium dynamics paralleled those of alkalinity. The year-long average was 50.3 mg/l. A low of 42.5 mg/l was encountered at the surface on 10 September August; a high of 57.7 was observed at 12 m on 14 July.

Chlorides

Chloride concentrations averaged 15.6 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 only slightly higher than those measured in 2003 following several years of increases of ~1 mg/l annually.

Nutrients

Total phosphorus-P averaged 8.0 $\mu$g/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). Nitrite+nitrate-N averaged 0.74 mg/l over the course of the year.
Figure 3. Mean chloride concentrations at TR4-C, 1925-2004. Points later than 1990 represent yearly averages (modified from Peters 1974).

Secchi disk transparency

Summertime (May-October) water transparency averaged 3.0 m and ranged from 1.8 m on 1 July to a high of 4.3 m on 24 September. Figure 4 summarizes Ann. mean summer (May-October) Secchi transparencies at TR4-C in 1935, 1968-73, 1975-82, 1984-87, 1988, and 1992-04.

CONCLUSIONS

Over the summer of 2004, mean chlorophyll $a$ concentrations, at <3 ug/l, were among the lowest ever recorded (Murray 2005) and mean numbers and sizes of cladaceran zooplankton continue to increase (Albright et al. 2005), as has been the case since 2001. Routine trap net collections indicate that littoral alewife (Alosa psuedoharengus) abundances were significantly lower than had been observed since 2000 (Leonard and Cheever 2005), indicating that management strategies to control that species (Cornwell in prep.) might be effective. These changes were also concurrent with the implementation of several strategies intended to decrease nutrient loading to Otsego Lake (i.e., Murray and Leonard 2005; Albright 2005). However, physical and chemical trophic indicators indicate a slight shift toward more eutrophic conditions in 2004 following several years of improvement. This implies that the results of mitigative efforts may only be apparent through long term monitoring because of annual meteorological variation.
Figure 4. May-October mean Secchi transparencies collected at TR4-C, 1935-04 (modified from Harman et al., 1997).

REFERENCES


