Otsego Lake limnological monitoring, 2002

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ABSTRACT

Limnological analyses of several abiotic factors were performed during 2002 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\textsuperscript{®} or a Surveyor 4\textsuperscript{®} 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


This study is the continuation of year-round protocol that began in 1991. The data collected in this report run for the calendar year and are comparable with contributions by Homburger and Buttigieg (1992), Groff, \textit{et al.}(1993), Harman (1994; 1995) Austin \textit{et al.} (1996), and Albright (1997; 1998; 1999; 2000; 2001; 2002). Concurrent with this work included summer chlorophyll \textit{a} profiles (Wyman, 2003), descriptions of the zooplankton and neckton communities (Martin, 2003, Cornwell, 2003; Tibbits, 2003), and estimates of fluvial nutrient inputs (Meehan, 2003; Albright, in prep.).

MATERIALS AND METHODS

Data collection began 8 March and continued until 20 December 02. Readings were collected bi-weekly during open water conditions and monthly through the ice. However, because of anticipated icing conditions, data were not collected until 8 March.
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 2® 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)
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RESULTS AND DISCUSSION

Temperature

Surface temperature reached a high of 25.48 °C on 7 July. The coldest temperature recorded was 1.56 °C at 10 and 12 m on 8 March. The lake did not freeze during the 2001-2002, a situation not before recorded since records have been kept (1842). Because the lake was able to circulate throughout the winter, bottom temperatures and whole-lake heat content were lower than ever before recorded by the BFS. This is despite the unseasonably warm air temperatures recorded throughout the region.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from surface readings of 14.33 mg/l at the surface on 8 March to 8.21 mg/l on 1 August. Near-bottom readings ranged from 12.00 mg/l on 12 April to 1.86 mg/l on 17 October. Year long profiles are given in Figure 2. Metalimnetic minima are generally encountered in Otsego, where concentrations typically approximate 4 mg/l by mid fall. An extreme situation was observed in 2000, where a stratum about 6 m deep having less than 4 mg/l was encountered on 9 October. On that date, dissolved oxygen was 2.99 mg/l at 16 m.

Areal hypolimnetic oxygen depletion rates were lower than those recorded on Otsego

<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>H_2SO_4 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>

Table 1. Summary of laboratory methodologies, 2001.
since 1988 (Table 2), though current values are well over the lower limit of eutrophy (0.05 mg/cm$^2$/day) suggested by Hutchinson (1957).

Figure 2. Otsego Lake oxygen profiles, 2002. Isopleths in mg/l (ADD).

<table>
<thead>
<tr>
<th>Interval</th>
<th>AHOD (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>
<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>
</tbody>
</table>


**pH**

pH measurements in Otsego Lake ranged from 7.10 near the bottom on 8 November to 8.54 at the surface on 4 June.

**Conductivity**

Conductivity (an indirect measure of ions in solution) values in Otsego averaged 284 $\mu$mhos/cm and ranged from 247 $\mu$mhos/cm at the surface and 2 m on 26 September to 307 $\mu$mhos/cm at 48 m on 8 November.

**Alkalinity**

Alkalinity averaged 112 mg/l (as CaCO$_3$; S.D = 6.7) throughout the year. The minimum value of 90 mg/l was observed at 4 m on 28 August; the maximum value (122 mg/l) occurred at 48 m on 8 November. These data are consistent with earlier findings (Harman *et al.*, 1997).

**Calcium**
Calcium dynamics paralleled those of alkalinity. The year-long average was 48.2 mg/l (S.D.= 3.9). A low of 37.7 mg/l was encountered at the surface and at 4 m on 27 September; a high of 61.7 was observed at 30 m on 3 July.

**Chlorides**

Chloride concentrations averaged 13.7 mg/l (S.D.= 0.5), 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 0.9 mg/l higher than in 2001. Assuming sodium chloride is the source, this represents an addition of about 574,000 kg (632 tons) of salt to the lake in the past year (though it should be noted that recently adopted deicers also contain magnesium and calcium chlorides).

![Figure 3. Mean chloride concentrations at TR4-C, 1925-2002. Points later than 1990 represent yearly averages (modified from Peters, 1974).](image)

**Nutrients**

Total phosphorus-P averaged 8.3 
\( \mu \text{g/l} \) (S.D.= 3.1) and ranged from 2.1 \( \mu \text{g/l} \) at 30 m on 3 July to 20.6 \( \mu \text{g/l} \) at 8 m on 15 May. 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 0.57 mg/l and ranged from 0.27 mg/l at 4 m on 13
September to 0.91 mg/l at 40 m on 20 June.

**Secchi disk transparency**

Water transparency averaged 3.4 m (S.D. = 0.8) and ranged from 1.6 m on 3 July to a high of 4.9 m on 17 October. Figure 4 summarizes annual mean summer (May-October) Secchi transparencies at TR4-C in 1935, 1968-73, 1975-82, 1984-87, 1988, and 1992-02.

![Figure 4. May-October mean Secchi transparencies collected at TR4-C, 1935-02 (modified from Harman et al., 1997).](image)

**CONCLUSIONS**

Every trophic indicator which was assessed indicated improved water quality over 2002. Summertime clarity was higher and chlorophyll $a$ lower (Waymen, 2003) than in recent years, while the rate of hypolimnetic oxygen was lower than it had been since 1988. It is not likely that such a sudden change is reflective of changes in the watershed. However, a decline in the planktivorous alewife (*Alosa pseudoharengus*), documented by acoustic surveys between fall 2001 and spring 2002, might be responsible (Warner and Cornwell, unpubl.). Concurrent with that, an increase in crustacean zooplankton size and biomass was reported (Martin, 2003). That, through trophic cascades, would likely affect other trophic parameters. While a definitive cause for the alewife decline is not known, possibly causes could be: 1) the cyclic nature of that fish (Smith, 1985); 2) the colder-than-usual temperatures during the summer, to which alewifes are sensitive (Kortman, 1997); or 3) the successful re-establishment of walleye (*Stizostedion vitreum*) between 2000 and 2002. The latter action was taken to utilize the forage base provided
by the alewife. Current research is evaluating any lake wide impacts that might come about should the walleye significantly reduce the alewife (Cornwell, in prep.)

REFERENCES


Albright, M.F. In prep. Evaluating changes in phosphorus and sediment loading by Shadow Brook following the establishment of agricultural best management practices in its drainage basin. SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.


Welschmeyer, N.A. 1994. Fluorometric analysis of chlorophyll a in the presence of chlorophyll