

Otsego Lake limnological monitoring, 2003

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ABSTRACT

Limnological analyses of several abiotic factors were performed during 2003 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). Since the establishment in 1968 of the Biological Field Station, limnological investigations have been ongoing (Clikeman 1979; Godfrey 1980; Harman 1974; Harman and Sohacki 1976; Harman 1978; Harman 1979; Harman 1980; Harman and Sohacki 1980; Homburger and Buttigieg 1991; Iannuzzi 1988; Monostory 1972; Sohacki 1970; 1971; 1972; 1973; 1974; 1975; Stam and Wassmer 1969).

This study is the continuation of year-round protocol that began in 1991. The data collected in this Rept. run for the calendar year and are comparable with contributions by Homburger and Buttigieg (1992), Groff, et. al.(1993), Harman (1994; 1995) Austin et al. (1996), and Albright (1997; 1998; 1999; 2000; 2001; 2002; 2003). Concurrent with this work included summer chlorophyll *a* profiles (Schmitt 2004), descriptions of the zooplankton (Burns 2004a) and nekton communities (Burns 2004b; Cornwell in prep.; Tibbits 2004) and estimates of fluvial nutrient inputs (Meehan 2004; Albright 2004).

MATERIALS AND METHODS

Data collection began 22 February and continued until 23 December 03. Readings were collected bi-weekly during open water conditions and monthly through the ice. However, because of anticipated icing conditions, data were not collected between 22 February and 16

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 (Iannuzz 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).

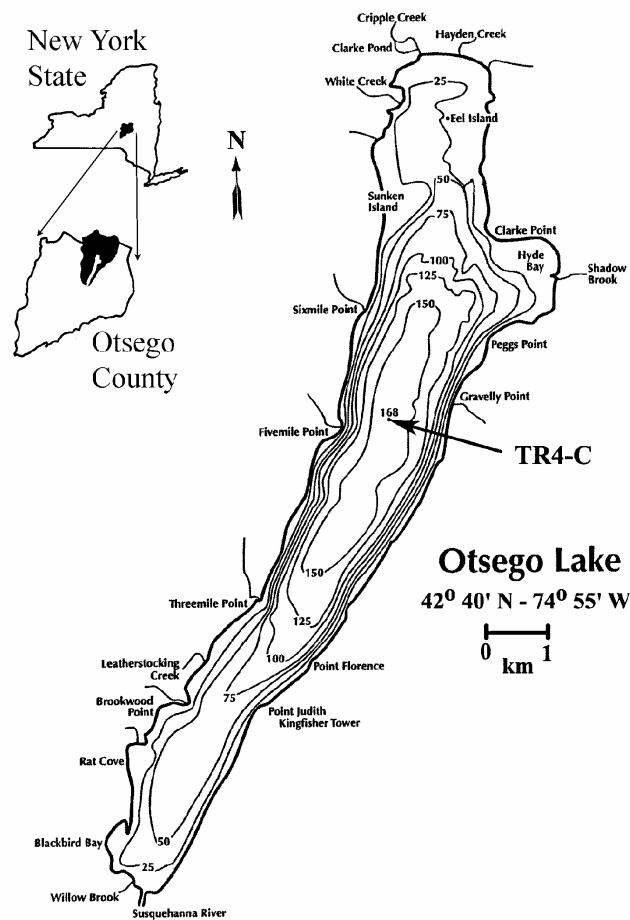


Figure 1. Bathymetric map of Otsego Lake showing sampling site (TR4-C).

Parameter	Sample volume	Preservation	Method	Reference
Total Phosphorus-P	40 ml	H ₂ SO ₄ to pH<2	Persulfate digestion followed by single reagent ascorbic acid	EPA 1983
Nitrite+Nitrate-N	25 ml	Filter and cool to <4° C	Cadmium reduction	APHA 1989
Calcium	50 ml	None	EDTA titrimetric	EPA 1983
Chloride	100 ml	None	Mercuric nitrate titration	APHA 1989
Alkalinity	100 ml	Cool to <4°C, measure ASAP	Titration to pH=4.6	APHA 1989
Chlorophyll <i>a</i>	100 ml	Ice sample, filter ASAP, process in reduced light	Fluorometric	Welshmeyer 1994

Table 1. Summary of laboratory methodologies, 2002.

RESULTS AND DISCUSSION

Temperature

Surface temperature reached a high of 24.21 C° on 22 August. The coldest temperature recorded was 0.2 C° at the surface on 22 February. The lake was completely covered by ice on 14 January; ice-out occurred 17 April. Stratification was evident by 16 May.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from surface readings of 14.51 mg/l below the ice on 22 February to 2.38 mg/l at the bottom on 11 November. Year long profiles are given in Figure 2. Metalimnetic minimas, typically encountered in Otsego, were much less pronounced in 2003 than in recent years. The lowest mid-water reading was 5.50 mg/l at 16 m on 8 October. 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, at 0.087 mg/cm²/day, were the same as those of 2002, lower (i.e., concentrations were higher) than those recorded on Otsego since 1988 (Table 2). However, current values are well over the lower limit of eutrophy (0.05 mg/cm²/day) suggested by Hutchinson (1957).

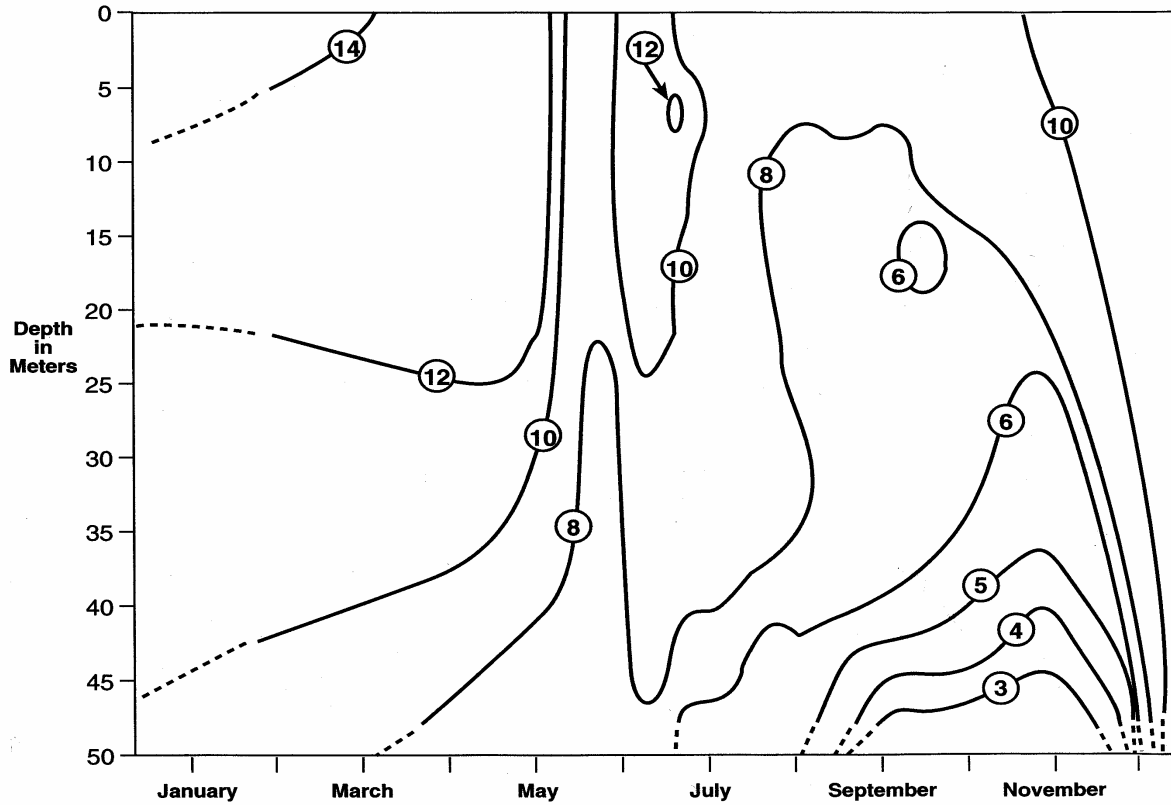


Figure 2. Otsego Lake oxygen profiles, 2003. Isoleths in mg/l.

Interval	AHOD (mg/cm ² /day)
05/16/69 – 09/27/69	0.080
05-30-72 – 10/14/72	0.076
05/12/88 – 10/06/88	0.042
05/18/92 – 09/29/92	0.091
05/10/93 – 09/27/93	0.096
05/17/94 – 09/20/94	0.096
05/19/95 – 10/10/95	0.102
05/14/96 – 09/17/96	0.090
05/08/97 – 09/25/97	0.101
05/15/98 – 09/17/98	0.095
05/20/99 – 09/27/99	0.095
05/11/00 – 09/14/00	0.109
05/17/01 – 09/13/01	0.092
05/15/02 - 09-26/02	0.087
05/16/03 – 09/18/03	0.087

Table 2. Areal hypolimnetic oxygen deficits (AHOD), Otsego Lake computed over summer stratification in 1969, 1972 (Sohacki, unpubl.), 1988 (Iannuzzi, 1991) and 1992-2003.

pH

pH measurements in Otsego Lake ranged from 7.11 near the bottom on 8 August to 8.62 at the surface on 29 May.

Conductivity

Conductivity (an indirect measure of ions in solution) values ranged from 238 $\mu\text{mhos/cm}$ at the surface on 12 June to 326 $\mu\text{mhos/cm}$ at 48 m on 26 June.

Alkalinity

Alkalinity averaged 116 mg/l (as CaCO_3) throughout the year. The minimum value of 98 mg/l was observed at the surface and 4 m on 22 August and 18 September; the maximum value (128 mg/l) occurred at 48 m on 22 February. These data are consistent with earlier findings (Harman et al., 1997).

Calcium

Calcium dynamics paralleled those of alkalinity. The year-long average was 50.0 mg/l. A low of 41.7 mg/l was encountered at the surface on 22 August; a high of 55.3 was observed at 12 m on 12 June.

Chlorides

Chloride concentrations averaged 15.25 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 1.55 mg/l higher than in 2002. Assuming sodium chloride is the source, this represents an addition of about 988,000 kg (1,088 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). Chloride levels are also elevated in ground water near the lake, indicating that inputs may be, in part, due to historical salt applications.

Nutrients

Total phosphorus-P averaged 10.0 $\mu\text{g/l}$ and ranged from 4.4 $\mu\text{g/l}$ at 4 m on 8 September to 28.0 $\mu\text{g/l}$ at the surface on 22 February. 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 0.69 mg/l and ranged from 0.36 mg/l at 8 m on 8 October to 0.90 at 20 m on 22 February and 44 m on 18 September.

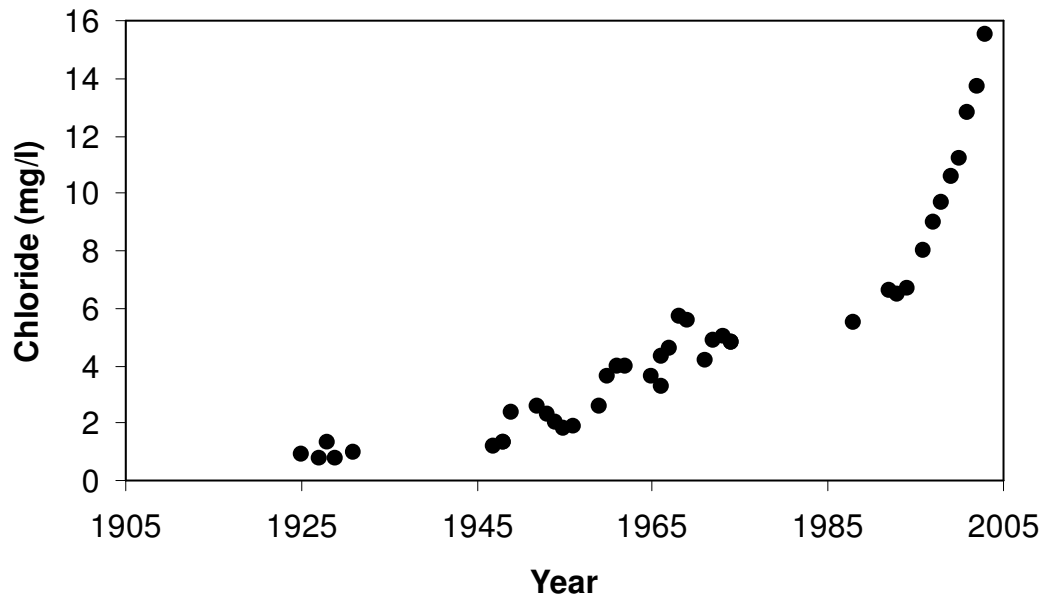


Figure 3. Mean chloride concentrations at TR4-C, 1925-2002. Points later than 1990 represent yearly averages (modified from Peters 1974).

Secchi disk transparency

Summertime (May-October) water transparency averaged 3.4 m and ranged from 1.3 m on 25 July to a high of 5.5 m on 8 September. The summertime mean was the highest recorded since 1995. Figure 4 summarizes Ann. mean summer (May-October) Secchi transparencies at TR4-C in 1935, 1968-73, 1975-82, 1984-87, 1988, and 1992-03.

CONCLUSIONS

Every trophic indicator which was assessed indicated improved water quality over 2002. Summertime clarity was higher and chlorophyll *a* lower (Schmitt 2004) than in recent years, while the rate of hypolimnetic oxygen depletion was as low as 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 (Burns 2004). That, through trophic cascades, would likely affect other trophic parameters. While a definitive cause for the alewife decline is not known, possible causes could be: 1) the cyclic nature of population fluctuations typical of that fish (Smith 1985); 2) the colder-than-usual temperatures during the summer, to which alewives are sensitive (Kortman 1997); or 3) the successful re-establishment

of walleye (*Sander vitreus*) between 2000 and 2003. 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 2003.)

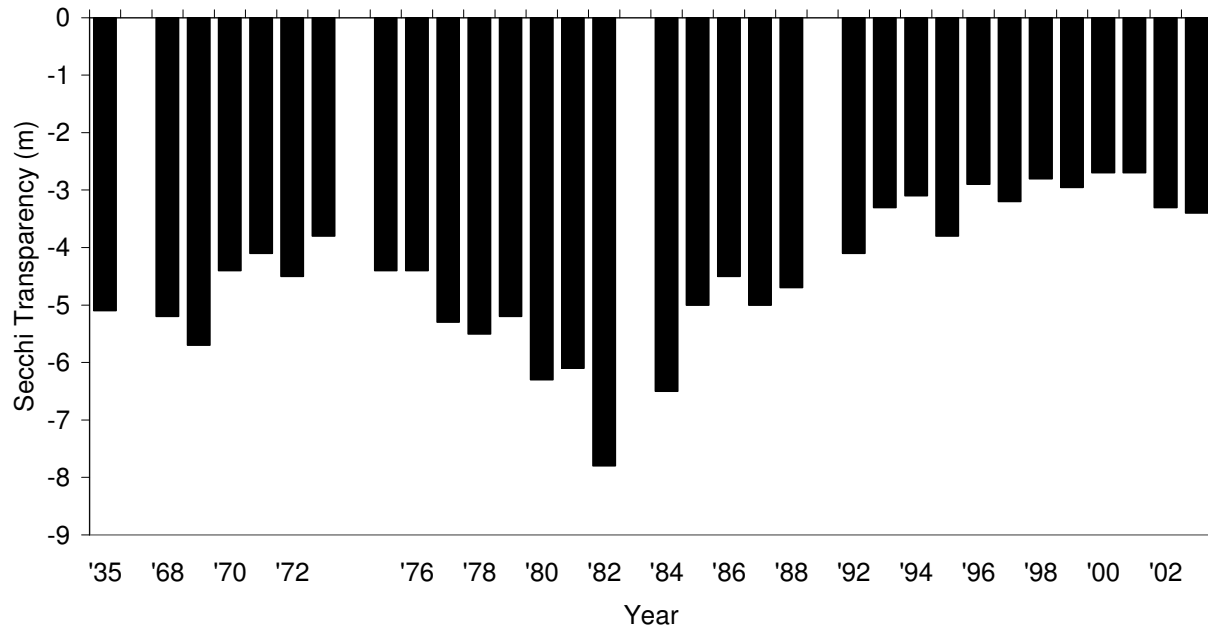


Figure 4. May-October mean Secchi transparencies collected at TR4-C, 1935-03 (modified from Harman et al., 1997).

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