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 report 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 neckton 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).

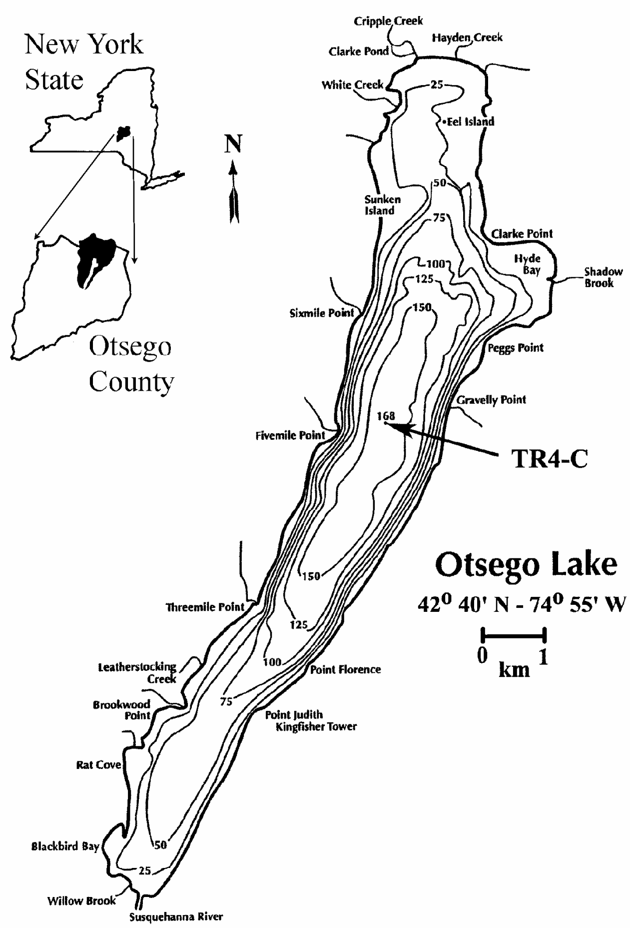

Figure 1. Bathymetric map of Otsego Lake showing sampling site (TR4-C).

Parameter	Sample volume	Preservation	Method	Reference
Total Phosphorus-P	40 ml	H_2SO_4 to pH<2	Persulfate digestion followed by single reagent ascorbic acid	EPA 1983
Nitrite+Nitrate-N	25 ml	Filter and cool to <4^o 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^{o}C, measure ASAP	Titration to pH=4.6	APHA 1989
Chlorophyll *a*	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^o on 22 August. The coldest temperature recorded was 0.2 C^o 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

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 minimas 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 (i.e., concentrations were higher) than those recorded on Otsego 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).

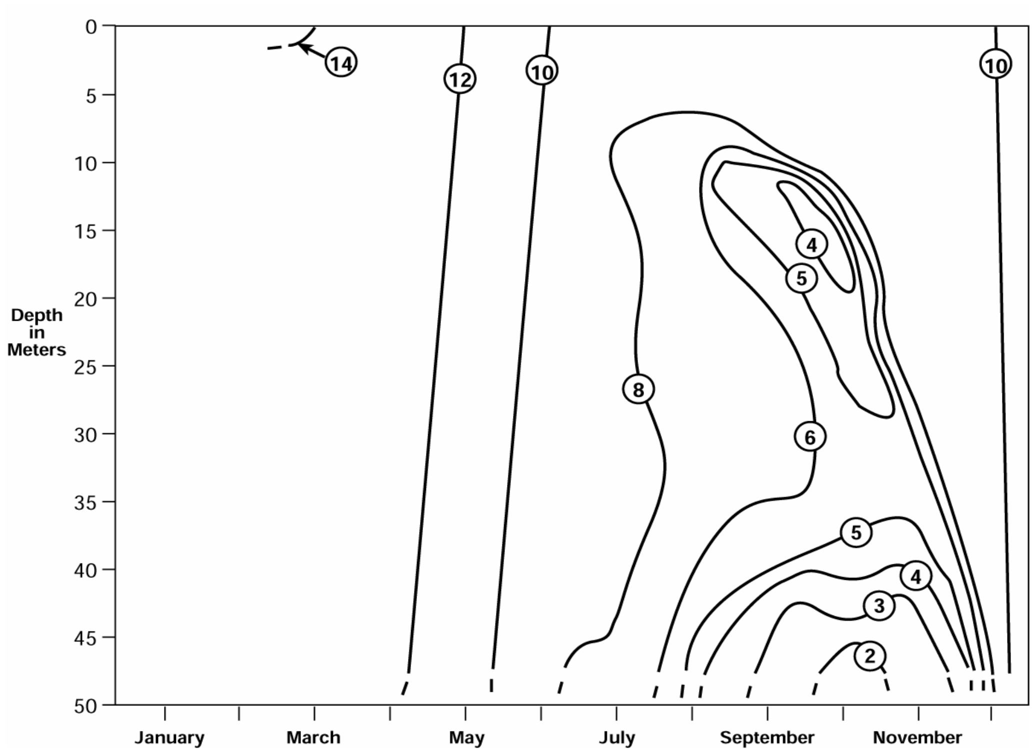

Figure 2. Otsego Lake oxygen profiles, 2002. Isopleths in mg/.

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

Table 2. Areal hypolimnetic oxygen deficits (AHOD), Otsego Lake computed over summer stratification in 1969, 1972 (Sohacki, unpubl.), 1988 (Iannuzzi, 1991) and 1992-2002.

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 *u*mhos/cm and ranged from 247 *u*mhos/cm at the surface and 2 m on 26 September to 307 *u*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 13.7mg/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).

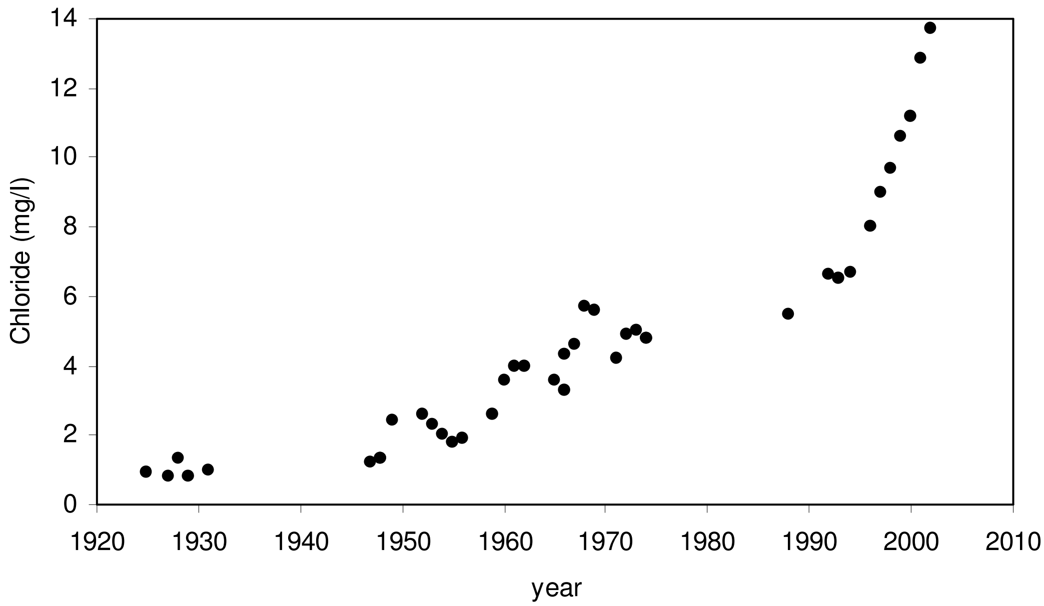

Figure 3. Mean chloride concentrations at TR4-C, 1925-2002. Points later than 1990 represent yearly averages (modified from Peters, 1974).

Nutrients

Total phosphorus-P averaged 8.3 *u*g/l (S.D.= 3.1) and ranged from 2.1 *u*g/l at 30 m on 3 July to 20.6 *u*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. The summertime mean was the highest recorded since 1995. 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

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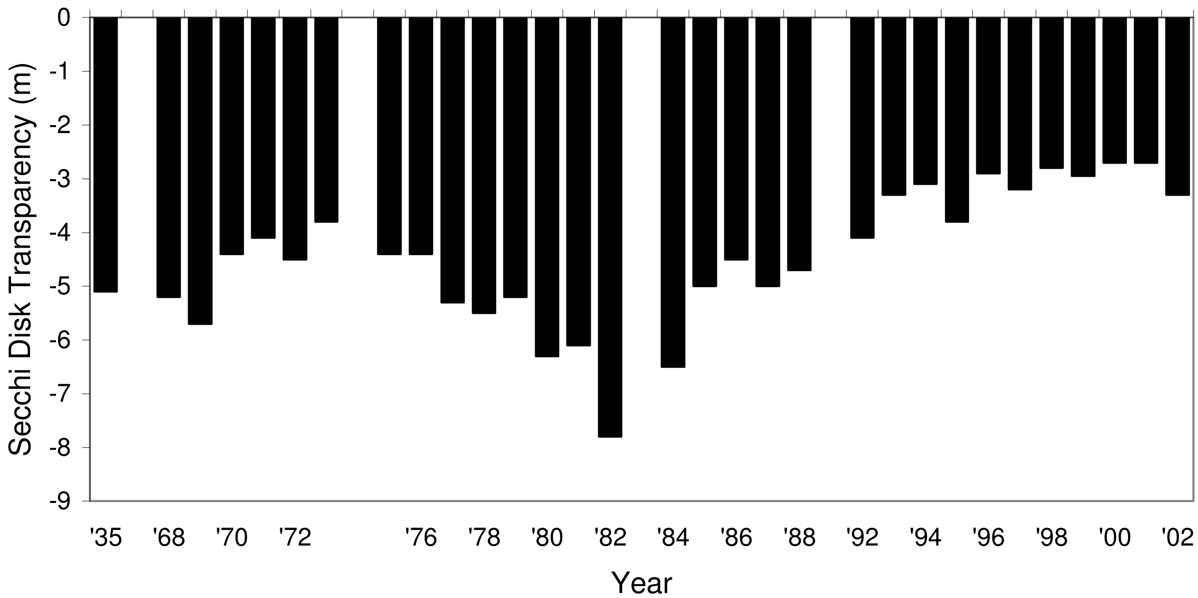

Figure 4. May-October mean Secchi transparencies collected at TR4-C, 1935-02 (modified from Harman et al., 1997).

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 depletion 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 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 (*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, 2003.)

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