

Otsego Lake limnological monitoring, 2001

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ABSTRACT

Limnological analyses of several abiotic factors were performed during 2001 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). Concurrent with this work included summer chlorophyll *a* profiles (Wyman, 2002), descriptions of the zooplankton and nekton (Cornwell, in prep.; Meehan, 2002) communities, and estimates of fluvial nutrient inputs (Parker, 2002; Albright, 2002.).

MATERIALS AND METHODS

Data collection began 19 January and continued until 30 November 01. Readings were collected weekly or bi-weekly during open water conditions and monthly through the ice. However, because of tenuous ice conditions no data were collected in April. Additionally,

because of anticipated icing conditions, data were not collected in December. However, as of 15 March 02 the lake has not frozen and is not expected to do so. If that proves so, it will mark the first year that it has not closed since records have been taken (1842).

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).

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, 2001.

RESULTS AND DISCUSSION

Temperature

Surface temperature reached a high of 25.14 C° on 9 August. The near-bottom temperatures reached 2.62 C° on 19 January. The ice went out 15 April. Summer stratification was apparent by mid-May. The lake did not re-freeze this year.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from surface readings of 12.81 mg/l just under the ice on 2 March to 8.37 mg/l on 30 August. Near-bottom readings ranged from 9.26 mg/l on 17 May to 1.01 mg/l on 9 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 than those recorded on Otsego since 1996 (Table 2), though current values are almost double the lower limit of eutrophy ($0.05 \text{ mg/cm}^2/\text{day}$) suggested by Hutchinson (1957). This year's improvement is likely a result of reduced nutrient inputs because of low precipitation resulted in minimal runoff throughout the spring and summer.

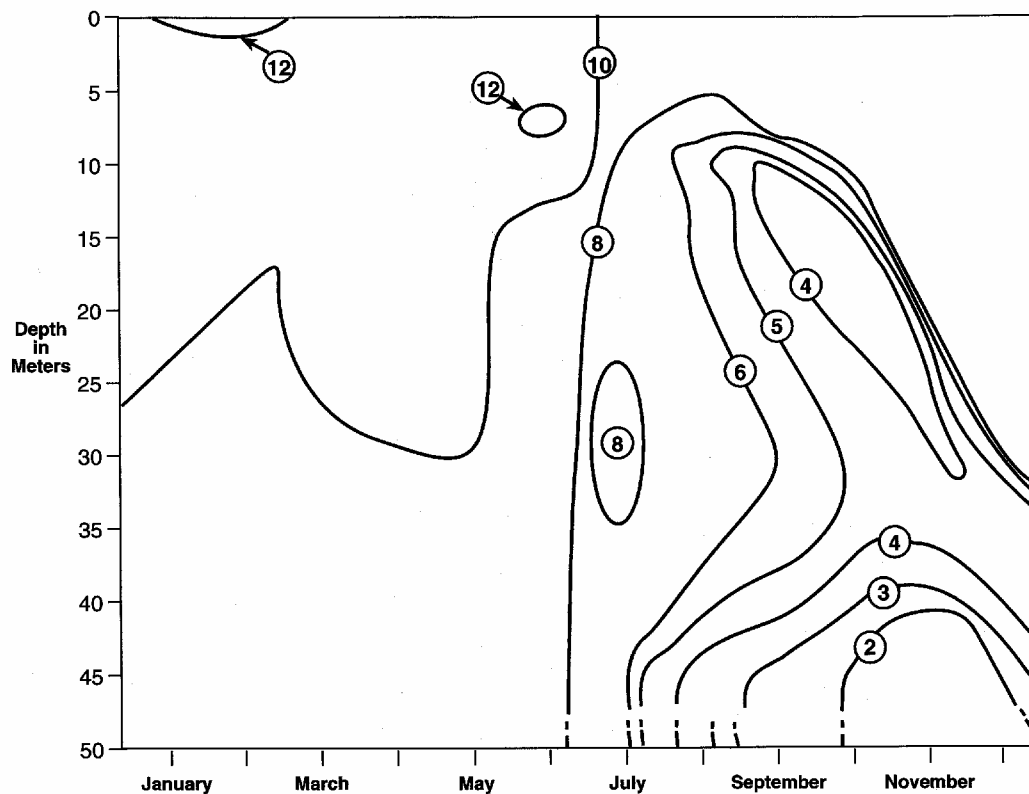


Figure 2. Otsego Lake oxygen profiles, 2001. Isoleths in mg/l.

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

Table 2. Areal hypolimnetic oxygen deficits (AHOD), Otsego Lake computed over summer stratification in 1969, 1972 (Sohacki, unpubl.), 1988 (Iannuzzi, 1991) and 1992-2000.

pH

pH measurements in Otsego Lake ranged from 7.14 near the bottom on 9 October to 8.91 at 16 and 18 m on 28 June.

Alkalinity

Alkalinity averaged 114 mg/l (as CaCO₃) throughout the year. The minimum value of 90 mg/l was observed at the surface on 30 August; the maximum value (134 mg/l) occurred at 48 m on 3 March. These data are consistent with earlier findings (Harman *et al.*, 1997).

Calcium

Calcium dynamics paralleled those of alkalinity. The year-long average was 47.9 mg/l. A low of 36.1 mg/l was encountered at the surface on 13 September; a high of 55.3 was observed at 48 m on 15 March.

Conductivity

Conductivity (an indirect measure of ions in solution) values in Otsego ranged from 179 mmhos/cm at 4 m on 3 March to 326 mmhos/cm at 48 m on the same date.

Chlorides

Chloride concentrations averaged 12.8 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 1.6 mg/l higher than in 2000, which represents the largest one-year increase ever recorded. Assuming sodium chloride is the source, this represents an addition of about 1,020,000 kg (1,120 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).

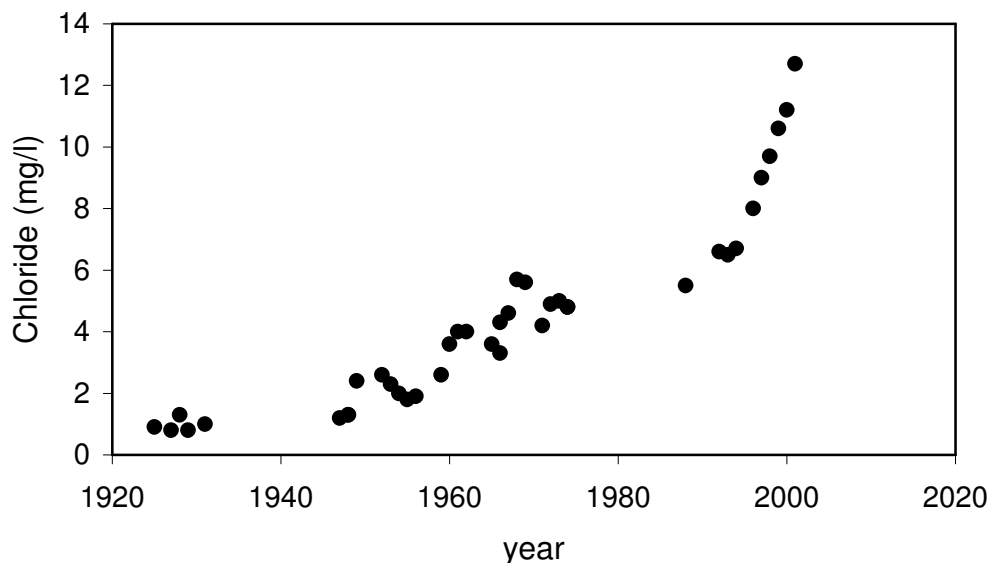


Figure 3. Mean chloride concentrations at TR4-C, 1925-2001. Points later than 1990 represent yearly averages (modified from Peters, 1974).

Nutrients

Total phosphorus-P ranged from 3.4 $\mu\text{g/l}$ at 20 m and on 9 August to 25.2 $\mu\text{g/l}$ at the surface on 3 March and averaged 10.3 $\mu\text{g/l}$. 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 ranged from 0.14 mg/l at 4 m on 9 October to 0.79 mg/l at 40 m on 13 September and averaged 0.59 mg/l.

Secchi disk transparency

Water transparency averaged 2.7 and ranged from 1.1 m on 9 August to a high of 3.7 m on 9 October. Figure 4 summarizes annual mean summer (May-October) Secchi transparencies at TR4-C in 1935, 1968-73, 1975-82, 1984-87, 1988, and 1992-01.

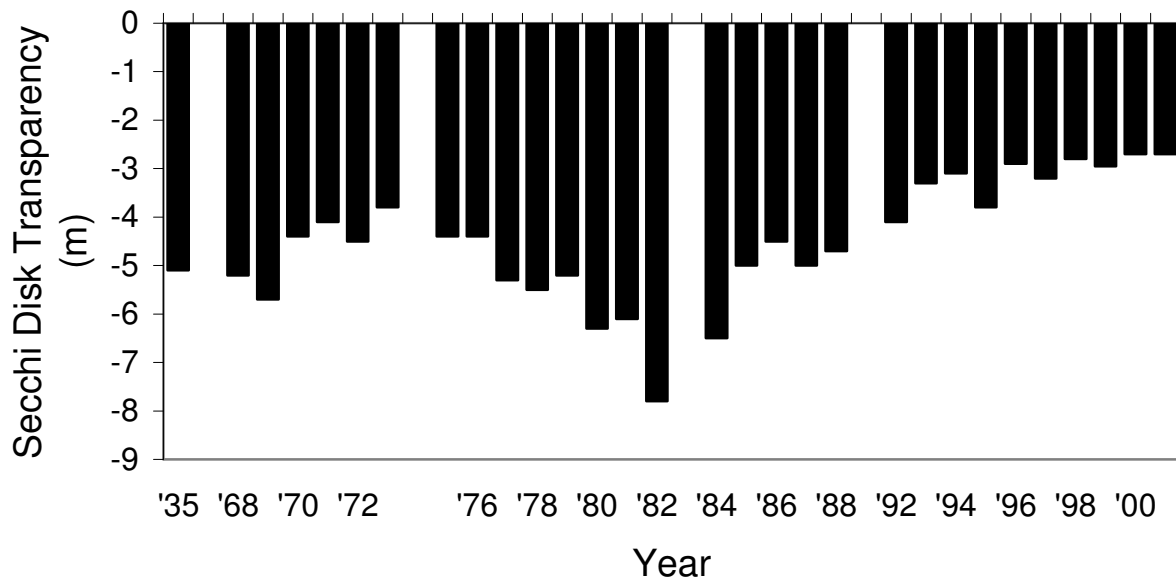


Figure 4. May-September mean Secchi transparencies collected at TR4-C, 1935-99 (modified from Harman et al., 1997).

CONCLUSIONS

While Otsego's transparencies throughout 2001 were among the lowest ever recorded, other trophic indicators reflect improvements in water quality compared to the past several years. Both total phosphorus and nitrite+nitrate concentrations have declined slightly and the summertime rate of hypolimnetic oxygen depletion was lower than recorded since 1996. Those changes are likely due primarily to meteorological variability. Most of Otsego's nutrient supply originates from overland runoff and is a direct function of precipitation. The monthly precipitation averages for April – August between 1842 – 1998 were 8.36, 9.34, 10.70, 8.89 and 8.79 cm, respectively (Hollis, unpubl.), totaling 46.08 cm. The amount observed in Springfield for those months in 2001 were 3.43, 7.32, 9.55, 8.10 and 2.39 cm (Nelson, 2002), totaling only 30.80 cm. It is expected that many years of data are needed to realize in-lake changes resulting from watershed management activities.

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