Otsego Lake limnological monitoring, 2007

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ABSTRACT

Limnological analyses of several abiotic factors were performed during 2007 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®, a Hyrdolab Surveyor 4® or a Eureka Amphibian/Manta® at the deepest spot in the Lake (TR4-C). Water samples were collected in profile for the analyses of total phosphorus, nitrite+nitrate, ammonia, total nitrogen, 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).

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; 2004; 2005; 2006). Concurrent additional work included summer chlorophyll *a* profiles (Stevens 2007), descriptions of the zooplankton (Albright 2007) and neckton communities (Reinicke and Walters 2007; Golding, Reinicke and Foster 2007; Brooking and Cornwell 2007) and estimates of fluvial nutrient inputs (Snyder 2007).

MATERIALS AND METHODS

Readings were collected bi-weekly during open water conditions and monthly through the ice. However, because of unsafe ice conditions, data were only collected between 3 January and 17 November.

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®, a Hydrolab Surveyor 4® or a Eureka Amphibian/Manta® multiprobe digital microprocessor which had been calibrated according to manufacturer's instruction immediately prior to use (Hydrolab Corp. 1993; Eureka Environmental Engineering 2005). 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).

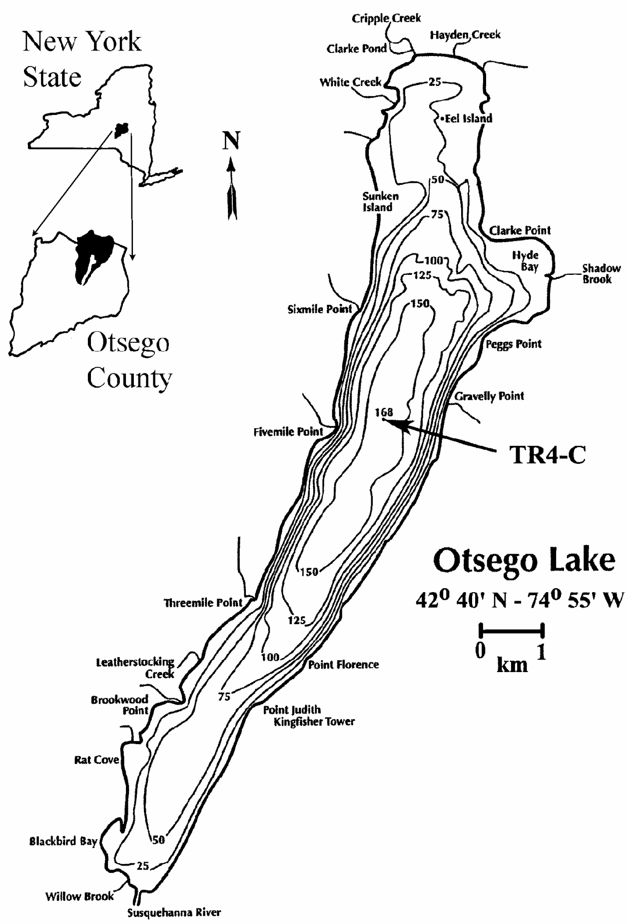

Figure 1. Bathymetric map of Otsego Lake showing sampling site (TR4-C).

Parameter	Sample volume	Preservation	Method	Reference
Total Phosphorus-P	10 ml	H_2SO_4 to pH<2	Persulfate digestion followed by single reagent ascorbic acid	Liao and Marten 2001
Total Nitrogen-N	5 ml	H_2SO_4 to pH<2	Cadmium reduction method following peroxodisulfate digestion	Pritzlaff 2003; Ebina et. al 1983
Nitrite+Nitrate-N	10 ml	H_2SO_4 to pH<2	Cadmium reduction	Pritzlaff 2003
Ammonia-N	10 ml	H_2SO_4 to pH<2	Phenolate	Liao 2001
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.

RESULTS AND DISCUSSION

Temperature

Surface temperature reached a high of 25.60 C^o on 3 August. The lake was completely covered by ice on 12February. The lake was completely ice-free on 23 April. Stratification was evident by 18 May.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from surface readings of 14.07 mg/l just under the ice on 16 March to 1.14 mg/l at the bottom on 8 November. Year long profiles are given in Figure 2. Areal hypolimnetic oxygen depletion rates, at 0.083 mg/cm^2/day, were the lowest since before 1992 (Table 2), but are still over the lower limit of europhy (0.05 mg/cm^2/day) suggested by Hutchinson (1957).

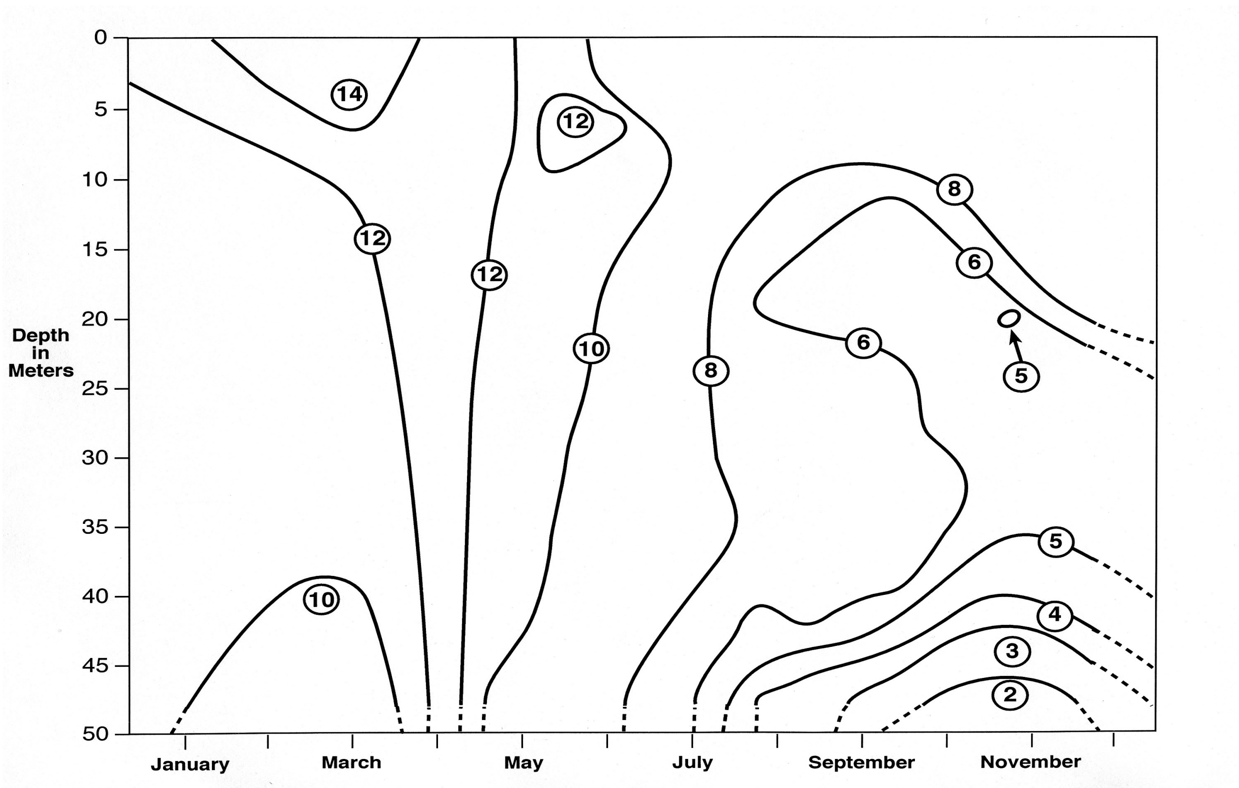

Figure 2. Otsego Lake oxygen profiles, 2007. Isopleths in mg/l.

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
05/20/05 – 09/24/05	0.102
05/27/05 – 10/05/05	0.085
05/05/06 – 09/26/06	0.084
05/18/07 – 09/27/07	0.083

Table 2. Areal hypolimnetic oxygen deficits (AHOD), Otsego Lake computed over summer stratification in 1969, 1972 (Sohacki, unpubl.), 1988 (Iannuzzi, 1991) and 1992-2007.

Conductivity

Conductivity (an indirect measure of ions in solution) values ranged from 244 *u*mhos/cm in surface waters through 8m on 16 October to 326 *u*mhos/cm at 48 m on 5 July.

Alkalinity

Alkalinity averaged 124 mg/l (as $CaCO_3$) throughout the year. The minimum value of 100 mg/l was observed on 16 August, 30 August, and 27 September between the surface and 8 m; the maximum value (140 mg/l) occurred on 16 October and 8 November at 44m and 48m. These values are higher than those reported for the summer of 2006 and are at the higher range of historically recorded values (Harman, et al. 1997).

Calcium

Calcium concentrations averaged 50.2 mg/l over the course of 2007. A low of 36.9 mg/l was observed at the surface on 30 August, while the highest value (57.7 mg/l) was obtained on 18 May and 13 September, at depths of 40m and 48m respectively.

Chlorides

Chloride concentrations averaged 14.2 mg/l, exhibiting very little variation either temporally or spatially (ranging from 13 to 16 mg/l). Since the mid 1980s chlorides concentrations have been increasing by 0.5 to 1.0 mg/l/year (with the exception of 2006), presumably attributable to road salting, however, the mean concentration in 2007 was actually 1.2 mg/l lower than that of 2006, and 2.2 mg/l lower than 2005. (Figure 3).

Nutrients

Total phosphorus-P averaged 9.7 *u*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 0.51 mg/l over the course of the year. Ammonia was consistently below detectable levels (< 0.02 mg/l). Total nitrogen averaged 0.69 mg/l. This implies that organic nitrogen averaged about 0.2 mg/l over the year.

Secchi disk transparency and chlorophyll *a*

Summertime (May-October) water transparency averaged 2.85 m and ranged from 1.5 m on 7 June to a high of 5.6 m on 16 October. Figure 4 summarizes Ann. mean summer (May-October) Secchi transparencies at TR4-C in 1935, 1968-73, 1975-82, 1984-87, 1988, and 1992-07. Composite chlorophyll *a* samples averaged 3.8 mg/l and ranged from 1.56 on 16 October to 9.76 on 22 June.

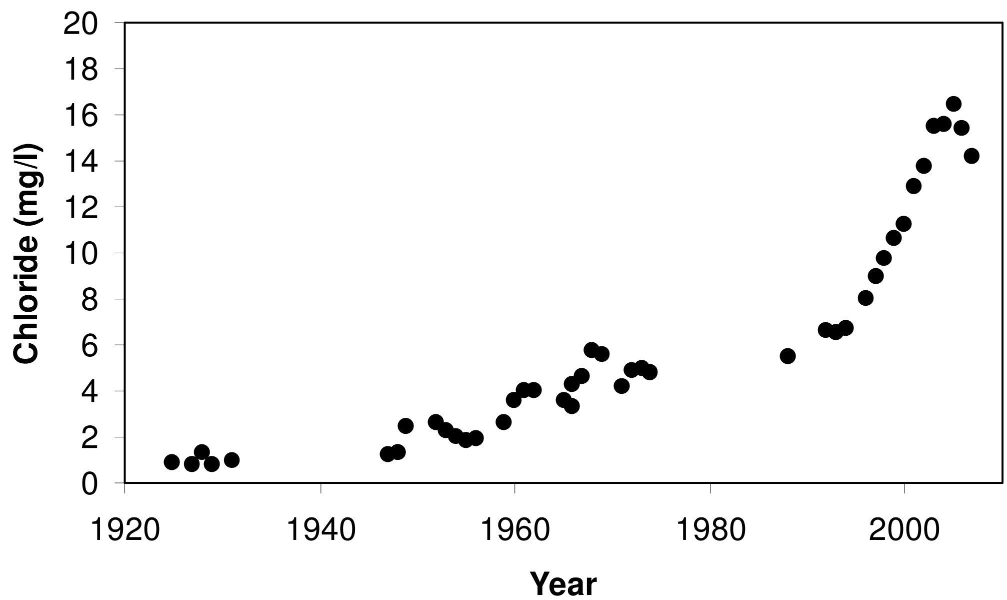

Figure 3. Mean chloride concentrations at TR4-C, 1925-2007. Points later than 1990 represent yearly averages (modified from Peters 1974).

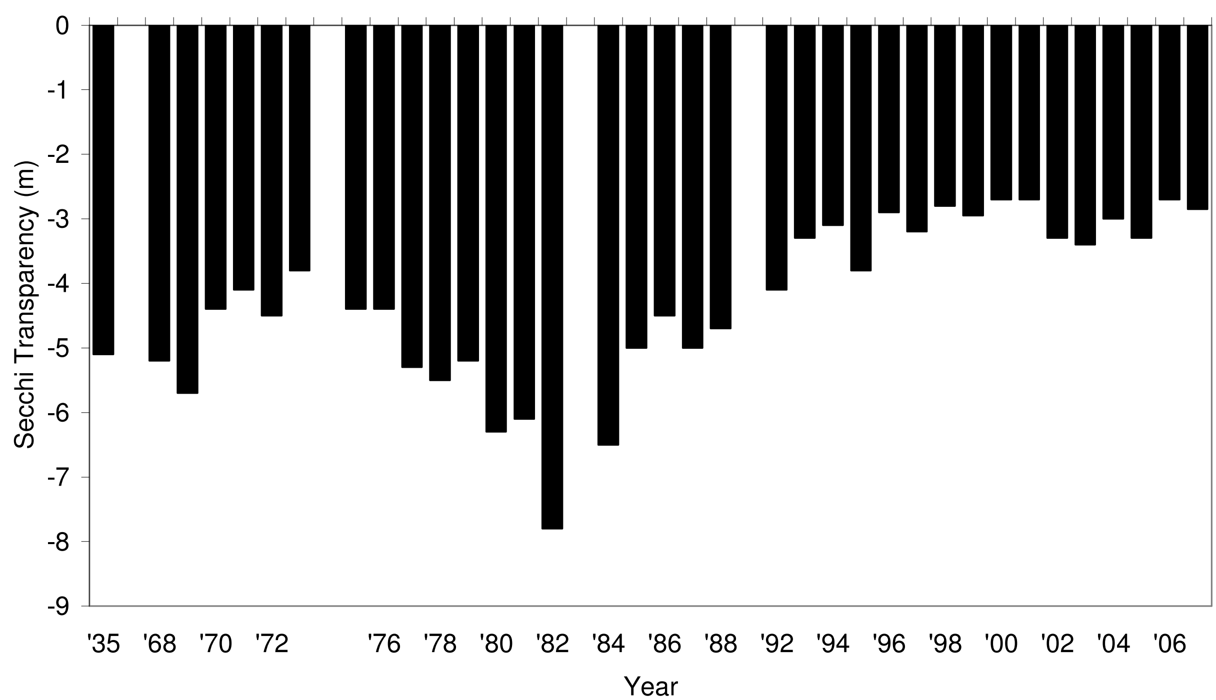

Figure 4. Mean summer (May-October) Secchi transparencies collected at TR4-C, 1935-2007.

CONCLUSIONS

Over the summer of 2007, mean chlorophyll *a* concentrations were comparable to those of recent years while mean numbers and sizes of cladaceran zooplankton continue to exceed those encountered between 1993 and 2003 (Albright 2007). Routine trap net collections indicate that littoral alewife (*Alosa psuedoharengus*) abundances are lower than measured since their establishment (Reinicke and Waters 2007), indicating that management strategies to control that species (Cornwell 2005) might be effective. Interestingly, mean summertime aerial hyplolimnetic oxygen depletion was among the lowest ever recorded, despite the fact that mean Secchi transparency was also among the lowest ever recorded. For the second consecutive year, the 15 year trend of markedly rising chloride concentrations was reversed, as concentrations declined by approximately 1 mg/l.

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