Otsego Lake limnological monitoring, 2005

Matthew F. Albright

ABSTRACT

Limnological analyses of several abiotic factors were performed during 2005 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). Concurrent additional work included summer chlorophyll *a* profiles (Zurmuhlen 2006), descriptions of the zooplankton (Albright and Somerville 2006) and neckton communities (Sommerville 2006; Reynolds and Somerville 2006; Brooking and Cornwell 2006) and estimates of fluvial nutrient inputs (Reynolds 2006).

MATERIALS AND METHODS

Data collection began 9 February and continued until 1 December 05. Readings were collected bi-weekly during open water conditions and monthly through the ice. However, because of unsafe ice conditions, data were not collected between 18 March and 9 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®, 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).

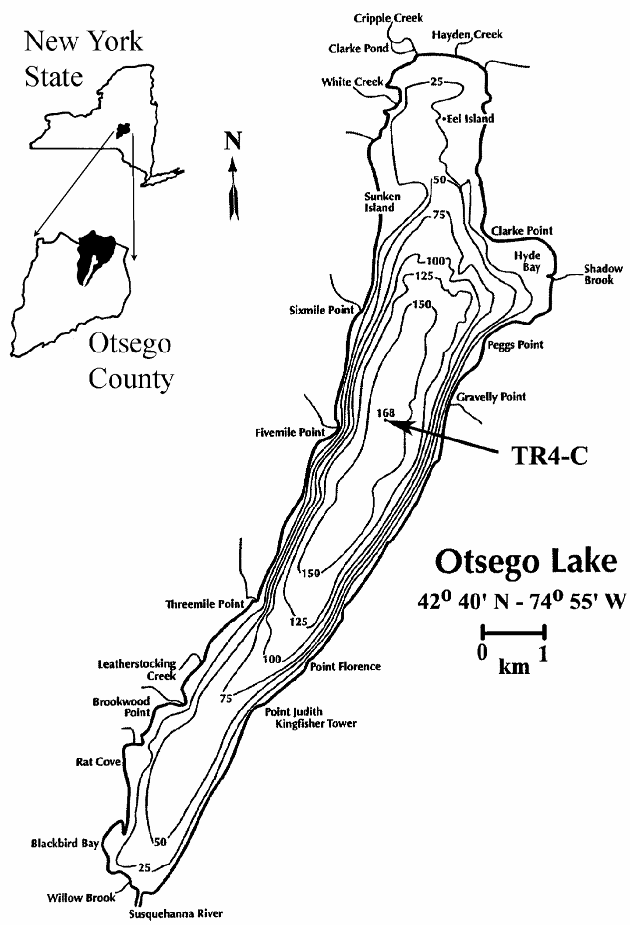

Figure 1. Bathymetric map of Otsego Lake showing sampling site (TR4-C).

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°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, 2004.

RESULTS AND DISCUSSION

Temperature

Surface temperature reached a high of 25.56 C° on 21 July. The coldest temperature recorded was 0.57 C° at the surface on 9 February. The lake was completely covered by ice on 21 January; ice-out occurred 11 April. Stratification was evident by 9 May.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from surface readings of 14.57 mg/l below the ice on 1 March to 0.54 mg/l at the bottom on 11 November. Year long profiles are given in Figure 2. Areal hypolimnetic oxygen depletion rates, at 0.085 $mg/cm^2/day$, were the lowest since before 1992 (Table 2), but are still over the lower limit of eutrophy (0.05 $mg/cm^2/day$) suggested by Hutchinson (1957). The improvement in 2005 seems to be a less-than-normal metalimnetic minima as the summer progressed (considerable more water occupies shallower strata than those deeper). The lowest mid-water reading was 4.71 mg/l at 16 m on 5 October.

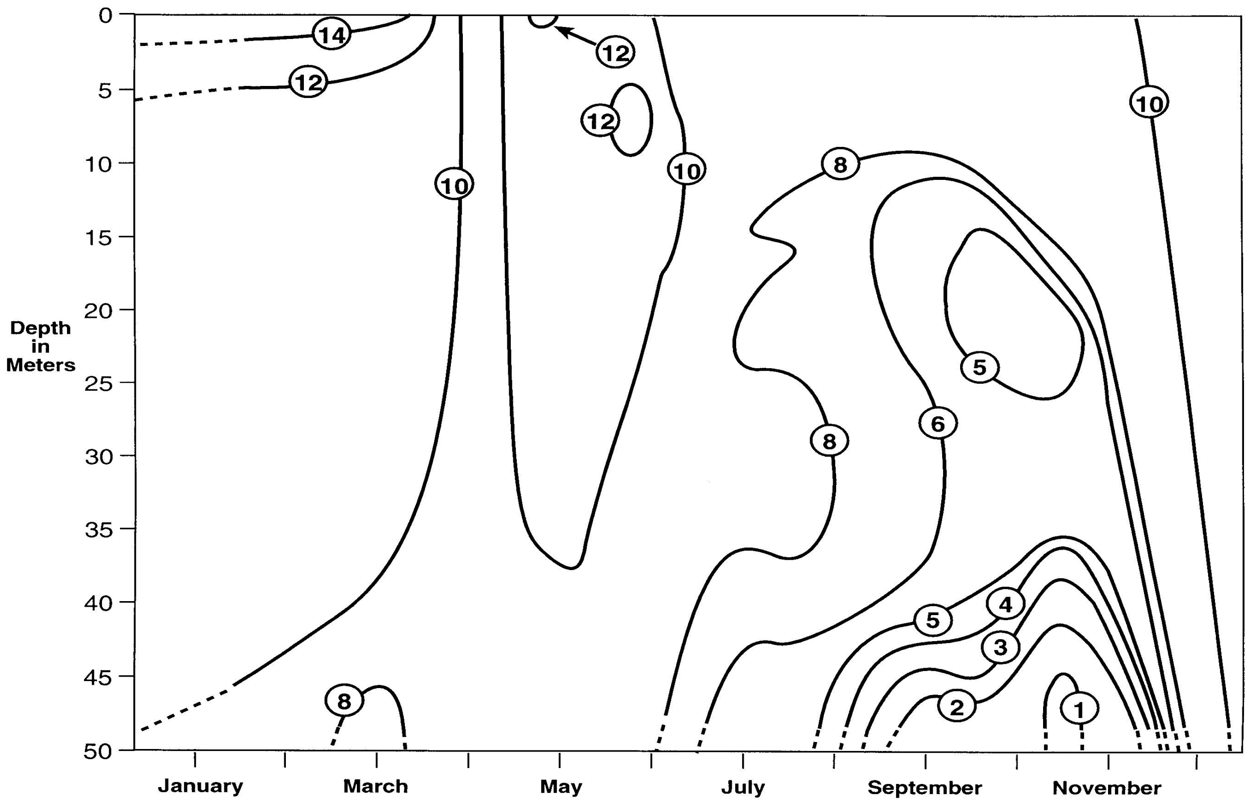

Figure 2. Otsego Lake oxygen profiles, 2005. Isopleths in mg/l.

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

Table 2. Areal hypolimnetic oxygen deficits (AHOD), Otsego Lake computed over summer stratification in 1969, 1972 (Sohacki, unpubl.), 1988 (Iannuzzi, 1991) and 1992-2005.

pH

pH measurements in Otsego Lake ranged from 7.19 near the bottom on 16 July to 8.51 at 4 m on 4 August.

Conductivity

Conductivity (an indirect measure of ions in solution) values ranged from 194 *u*mhos/cm at the surface on 9 June to 348 *u*mhos/cm at 48 m on 1 November.

Alkalinity

Alkalinity averaged 121 mg/l (as $CaCO_3$) throughout the year. The minimum value of 100 mg/l was observed at the surface on 5 October; the maximum value (135 mg/l) occurred at the surface on 9 February. These data are consistent with earlier findings (Harman et al., 1997).

Calcium

Calcium dynamics paralleled those of alkalinity. The year-long average was 50.2 mg/l. A low of 38.4 mg/l was encountered at the surface on 4 August; a high of 64.9 was observed at 44 m on 23 June.

Chlorides

Chloride concentrations averaged 16.4 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).

Nutrients

Total phosphorus-P averaged 9.6 *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 0.53 mg/l over the course of the year. Ammonia, measured this year for the first time, was consistently below detectable levels (< 0.02 mg/l). Total nitrogen, also measured for the first time in 2005, averaged 0.75 mg/l. This implies that organic nitrogen averaged about 0.2 mg/l over the year.

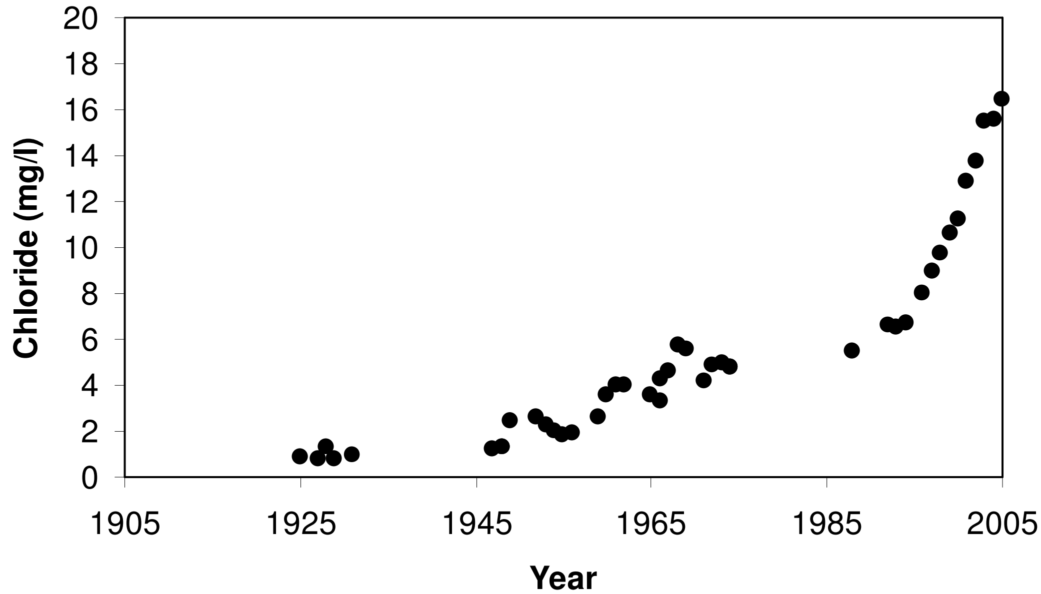

Figure 3. Mean chloride concentrations at TR4-C, 1925-2004. Points later than 1990 represent yearly averages (modified from Peters 1974).

Secchi disk transparency

Summertime (May-October) water transparency averaged 3.3 m and ranged from 1.8 m on 27 May to a high of 5.7 m on 16 September. Figure 4 summarizes Ann. mean summer (May-October) Secchi transparencies at TR4-C in 1935, 1968-73, 1975-82, 1984-87, 1988, and 1992-05.

CONCLUSIONS

Over the summer of 2005, mean chlorophyll *a* concentrations, at ~3 ug/l, were among the lowest ever recorded (Zurmuhlen 2006) and mean numbers and sizes of cladaceran zooplankton continue to exceed those encountered between 1993 and 2003 (Albright and Somerville 2006). Routine trap net collections indicate that littoral alewife (*Alosa psuedoharengus*) abundances are lower than measured since their establishment (Reynolds and Somerville 2006), indicating that management strategies to control that species (Cornwell 2005.) might be effective. (However, hydroacoustic surveys conducted in fall 05 indicate a resurgence of young-of-year alewives (Brooking and Cornwell 2006)). Physical and chemical indicators, while not showing marked improvement over the last few years, have not continued their trend of decline evident throughout the 1990s.

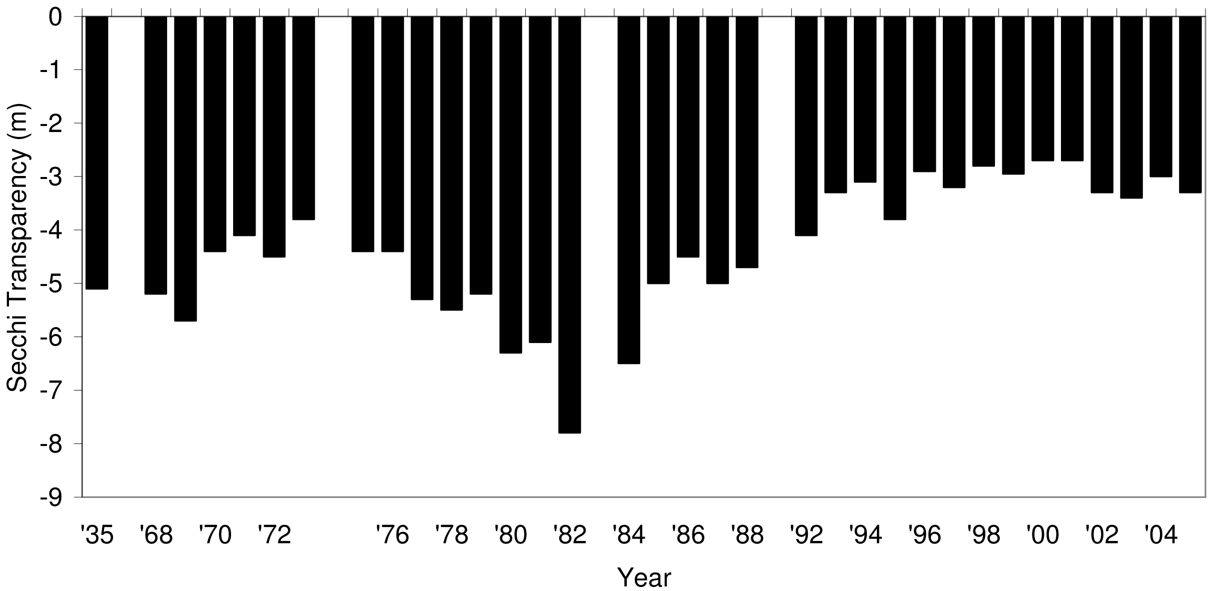

Figure 4. May-October mean Secchi transparencies collected at TR4-C, 1935-04 (modified from Harman et al., 1997).

REFERENCES

Albright, M.F. 2005. Evaluating changes in phosphorus and sediment loading by Shadow Brook following the establishment of agricultural best management practices in its drainage basin. *In* 37th Ann. Rept. (2004). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F., R. Hamway and L. Hingula. 2005. Assessment of Otsego Lake's zooplankton community, summer 2004. *In* 37th Ann. Rept. (2004). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 2004. Otsego Lake limnological monitoring, 2003. *In* 36th Ann. Rept. (2003). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 2003. Otsego Lake limnological monitoring, 2002. *In* 35th Ann. Rept. (2002). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 2002. Otsego Lake limnological monitoring, 2001. *In* 34th Ann. Rept. (2001). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 2001. Otsego Lake limnological monitoring, 2000. *In* 33rd Ann. Rept. (2000). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 2000. Otsego Lake limnological monitoring, 1999. *In* 32nd Ann. Rept. (1999). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 1999. Otsego Lake limnological monitoring, 1998. *In* 31st Ann. Rept. (1998). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 1998. Otsego Lake limnological monitoring, 1997. *In* 30th Ann. Rept. (1997). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 1997. Otsego Lake limnological monitoring, 1996. *In* 29th Ann. Rept. (1996). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 1996. Hydrological and nutrient budgets for Otsego Lake, N.Y. and relationships between land form/use and export rates of its sub-basins. 29th Occasional Paper. SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. 2002. Evaluating changes in phosphorus and sediment loading by Shadow Brook following the establishment of agricultural best management practices in its drainage basin. *In* 34th Ann. Rept. (2001). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Albright, M.F. and T. Somerville. *In* 38th Ann. Rept. (2005). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.2006. A survey of Otsego Lake's zooplankton community, summer 2005.

APHA, AWWA, WPCF. 1989. Standard methods for the examination of water and wastewater, 17th ed. American Public Health Association. Washington, DC.

Austin, T., M.F. Albright and W.N. Harman. Otsego Lake monitoring, 1995. In 28th Ann. Rept. (1995). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Brooking, T.E. and M.D. Cornwell. Hydroacoustic surveys of Otsego Lake, 2006. *In* 38th Ann. Rept. (2005). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Cornwell, M.D. 2005.Re-introduction of walleye to Otsego Lake; Re-establishing a fishery and subsequent influences of a top predator. Occas. Pap. No. 40. SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Ebina, J., T. Tsutsui, and T. Shirai. 1983. Simultaneous determination of total nitrogen and total phosphorus in water using peroxodisulfate oxidation. Water Res. 17(12): 1721-1726.

EPA. 1983. Methods for the analysis of water and wastes. Environmental Monitoring and Support Lab. Office of Research and development. Cincinnati, OH.

Eureka Environmental Engineering. 2004. Manta water quality probe, startup guide. Austin, TX.

Groff, A., J. J. Homburger and W. N. Harman. 1993. Otsego Lake limnological monitoring,

1992. *In* 24th Ann. Rept. (1991). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Harman, W.N. 1994. Otsego Lake limnological monitoring, 1994. *In* 26th Ann. Rept. (1993). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Harman, W.N., L.P. Sohacki, and P.J. Godfrey. 1980. The limnology of Otsego Lake. *In* Bloomfield, J. A. (ed.). Lakes of New York State. Vol. III. Ecology of East-Central N.Y. Lakes. Academic Press, Inc., New York.

Harman, W.N., L.P. Sohacki, M.F. Albright, and D.L. Rosen. 1997. The state of Otsego Lake, 1936-1996. Occasional Paper #30, SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Hollis, H. Unpublished data. Cooperative observer, National Weather Service. Cooperstown, NY. 13326.

Homburger, J. J. and G. Buttigieg. 1991. Otsego Lake limnological monitoring. *In* 24th Ann. Rept. (1991). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Hutchinson, G.E. 1957. A treatise on limnology. Vol. 1. Geography, physics and chemistry. Wiley, New York.

Hydrolab Corporation, 1993. Scout 2 operating manual. Hydrolab Corp. Austin, TX.

Iannuzzi, T.J. 1991. A model plan for the Otsego Lake watershed. Phase II: The chemical limnology and water quality of Otsego Lake, Occasional Paper #23. SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Kortman, R.W. 1997. Pers. comm. Ecosystem Consulting Service. Coventry, CT.

Liao, N. 2001. Determination of ammonia by flow injection analysis. QuikChem®Method 10-107-06-1-J. Lachat Instruments, Loveland, Colorado.

Liao, N. and S. Marten. 2001. Determination of total phosphorus by flow injection analysis colorimetry (acid persulfate digestion method). QuikChem®Method 10-115-01-1-F. Lachat Instruments. Loveland, Colorado.

Nelson, J. and N. Nelson. 2002. Personal communication. Volunteer weather observers. Springfield, N.Y. 13468.

Peters, T. 1987. Update on chemical characteristics of Otsego Lake water. *In* 19th Ann. Rept. (1986). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Pritzlaff, D. 2003. Determination of nitrate/nitrite in surface and wastewaters by flow injection analysis. QuikChem®Method 10-107-04-1-C. Lachat Instruments. Loveland, Colorado.

Reynolds, E.W. Water quality monitoring of five major tributaries in the Otsego Lake watershed, summer 2005. *In* 38th Ann. Rept. (2005). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Reynolds, E.W. and T.J. Somerville. 2006. Summer 2005 trap net monitoring of the fish community in the littoral zone at Brookwood Point and Rat Cove. *In* 38th Ann. Rept. (2005). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Somerville, T. 2006. Diet analysis of predator fish in Otsego Lake prior and subsequent to walleye (*Sander vitreus*) stocking, 2005. . *In* 38th Ann. Rept. (2005). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.

Welschmeyer, N.A. 1994. Fluorometric analysis of chlorophyll *a* in the presence of chlorophyll *b* and pheopigments. Limnol. Oceanogr. 39:1985-1992.

Zurmuhlen, S. 2006. Chlorophyll *a* analysis of Otsego Lake, summer 2005. *In* 38th Ann. Rept. (2005). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta.