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Long-term Trends and the Trophic Status of Conesus Lake 2012: A report to the Livingston County Planning Department Geneseo, NY

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Executive Summary

1. Conesus Lake monitoring conducted by personnel from The College at Brockport during the summer of 2012 determined the current trophic status of the lake and if any improvements or further degradation of water quality had occurred. To accomplish this goal, lake chemistry was monitored from 22 May to 14 August 2012 and the following were completed: a trophic state assessment of the lake and an evaluation of long-term trends in lake chemistry.

2. Sodium is a component of deicing salt, which is used heavily during the winter on roads in the Conesus Lake watershed. Since 1985 there is a clear trend of increasing salt in the waters of Conesus Lake. The current average summer concentration of sodium is 27.85 mg Na/L: an increase of ~ 3 mg Na/L since 2009 (mean=24.63 mg Na/L) in the epilimnion of Conesus Lake. This is an increase of ~ 10 mg Na/L of sodium in the past 25 years. Whether or not this is a health issue is currently being debated by the US EPA.

3. Total phosphorus (TP) provides an estimate of all fractions of phosphorus potentially available to aquatic plants. From 22 May through 2 July 2012, TP and soluble reactive phosphorus (SRP) concentration were low and similar from the 0-m to 22-m depth. By 17 July, TP and SRP began to increase in the hypolimnion due to anaerobic conditions and remained high through the end of the sampling period. In 2012 the average epilimnetic TP concentration was 18.80 µg P/L. Historically, average concentrations of TP in the epilimnion of Conesus Lake have surpassed the NYSDEC Ambient Water Quality Guideline of 20 µg P/L of surface waters. During the summer of 2012, the average epilimnetic TP concentration was for the first time in 30 years below the 20 µg P/L NYS guideline. This decrease in epilimnetic TP concentrations may be the result of management efforts in various agriculturally dominated Conesus Lake watersheds.

4. Algal abundance in lakes can be estimated by measuring chlorophyll *a (*Chl *a)* concentrations. Epilimnetic Chl *a* concentrations in the summer of 2012 ranged from 3.0 to ~11 µg/L with an average of 6.6 µg/L. Considering Chl *a* concentrations, the lake was classified for many years as eutrophic (Chl *a* greater than 7.3). However, since ~ 2000 Chl *a* concentrations have been decreasing and since 2004 have fallen into the mesotrophic range (2.6 to 7.3 µg/L).

5. Carlson's Trophic Status Index (TSI) was developed to assess the trophic state of a lake by considering summer epilimnetic TP, Chl *a* concentrations, and summer secchi disk depth. This index is one of several that can be used to evaluate the trophic status of a lake; that is, what is the overall productivity of the lake. The TSI for TP (45.1), chlorophyll (49.2), and secchi disk (46.0) averaged 46.8, suggesting a mesotrophic status for Conesus Lake.

6. Several different indicators suggest that Conesus Lake water quality and trophic status may be improving. Total phosphorus is below the 20 µg P/L guideline of the NYSDEC, Chl *a* levels have decreased to a less productive state, and the trophic status index has changed from eutrophic to mesotrophic. All suggest a mesotrophic state and temporal improvement. These suggested improvements in the open waters of Conesus Lake may be the result of management efforts in various agriculturally dominated Conesus Lake watersheds discussed in Makarewicz *et al*. (2009, 2012).

Recommendations

1. The monitoring of Conesus Lake should continue. Current results suggest a slow improvement in it's surface water. The status of the lake's water quality has been an issue for many years. If it is indeed improving as suggested, this success story needs to be communicated to the general public.

2. The importance of managing nutrients and soil loss from the watershed is now even more important to prevent a relapse or return to less desirable conditions. Continuing efforts to reduce nutrient losses from sources in agriculture, from septic systems above the ring sewer, and from lawn fertilizers should be emphasized.

Introduction

Conesus Lake is the western-most lake of the Finger Lakes Region of New York State. The lake is 12.6 km long in a north-south direction and has an average width of 1.06 km. Conesus is a relatively shallow lake compared to other New York Finger Lakes with an average depth of 11.5 m and a maximum depth of 20.2 m (SOCL 2002). The Conesus Lake watershed encompasses six towns (Conesus, Geneseo, Groveland, Livonia, Sparta, and Springwater) in Livingston County. The watershed is characterized by slight slopes at the northern outlet and southern inlet areas and steeper slopes along the flanks and southern portion of the lake. There are numerous tributaries and rivulets entering the lake (Forest *et al.* 1978) that account for large amounts of erosion and sediment that enter the lake system. For example, in August 2005 Stantec Consulting Services (2005) indicated that most of the 12 stream reaches visited were in an unstable state due to the heavy sediment supplies of the past and to the related geomorphic adjustment.

In 2000 the New York State Department of Environmental Conservation (DEC) listed Conesus Lake on its Priority Waterbodies List (DEC 2000). The DEC identified the lake as impaired for boating and bathing purposes, stressed relative to fishing and aesthetics, and threatened as a water supply. The Livingston County Planning Department reported the following problems as being critical to the degraded health of Conesus Lake: 1) weed growth and invasive species, 2) increased algae from phosphorus loading, 3) pathogens from animal waste, 4) pesticides from residential and agricultural sources, 5) increasing salts from deicing chemicals on impervious surfaces, and 6) erosion from various land-use practices and developments (SOCL 2002). Since then, monitoring and management plans for land use have been recommended and/or updated (Makarewicz *et al*. 2008, Makarewicz and Lewis 2009, CLWC 2011). A major achievement of long-term monitoring on Conesus Lake is the creation of a database that can be used as a tool to assess the trophic health of the lake over time. Measuring selected chemicals, such as phosphorus, measuring the transparency of water, and determining the amount of algae (chlorophyll as a surrogate) in the water provide an indication of trophic status and water quality. When these indicators are compared with historical data collected over the last 30 years by the Livingston County Planning Department, trends in the environmental health of the lake may be determined The goal of this project was to update information on water chemistry of Conesus Lake to determine if any progress has been made in improving water quality and trophic state of the lake.

Methods

Water sampling and physical measurements were taken at approximately the deepest point in the southern basin of Conesus Lake (GPS coordinates: 42.75473, -77.71535) beginning on 22 May and ending on 14 August 2012. Water samples for nutrient analysis were taken at 3-m intervals from 0 to 18 m, while a Hydrolab DataSonde 5® (Model DS5) recorded temperature, Chl *a*, and dissolved oxygen at 1-m intervals from the below the surface of the water (0 m) to just above the sediment surface (between 21-22 m depending on the date).

Water samples were taken with a Van Dorn water bottle, preserved, and analyzed using standard methodologies (APHA 2012). All samples for dissolved nutrient analysis [SRP, nitrate (NO_2+NO_3)] were filtered immediately on site with 0.45-μm MCI

Magna Nylon 66 membrane filters and held at 4°C until analysis the next day. Samples for each depth were analyzed for TP [APHA Method 4500-P F and persulfate digestion (APHA 4500-p.b. 5)], NO_2+NO_3 (APHA Method 4500-NO_3-F), total nitrogen (TN) (APHA Method 4500-N C), and SRP (APHA Method 4500-P F). Analyses for these parameters were performed on a Technicon AutoAnalyser II. Direct Air-Acetylene Flame Method (APHA 3111 B) was used for the analysis of dissolved sodium in the epilimnion (3-m depth). Method Detection limits were as follows: SRP (0.48 µg P/L), TP (0.38 µg P/L), TN (0.020 mg N/L), sodium (0.78 mg Na/L), and NO_2+NO_3 (0.005 mg N/L). The secchi-disk depth was determined a black and white 20-cm disk.

The Hydrolab was calibrated for dissolved oxygen and chlorophyll prior to each sampling date. Independent measurements of Chl-*a* (2-m tube composite) were made using a Turner Model 111 Fluorometer. Aliquots of 500-mL of water sample were filtered through glass fiber filters and extracted with 90% alkaline acetone. Extracted samples were centrifuged and measured fluorometrically (Wetzel and Likens 2000). Dissolved oxygen samples were collected at several depths using a Van Dorn Sampler and analyzed by the azide modification of the Winkler Method (APHA Method 4500-O C). Results for dissolved oxygen and Chl-*a* from the Hydrolab were compared to Winkler and fluorometric results. If required, the Hydrolab was recalibrated prior to a field trip.

Quality Control

All water samples were analyzed within 24 hours of collection at the Water Chemistry Laboratory at The College at Brockport, State University of New York (NELAC – EPA Lab Code # NY01449). In general, this program includes biannual proficiency audits, annual inspections, and documentation of all samples, reagents, and equipment under good laboratory practices. All quality control (QC) measures are assessed and evaluated on an on-going basis. As required by NELAC and New York's ELAP certification process, method blanks, duplicate samples, laboratory control samples, and matrix spikes are performed at a frequency of one per batch of 20 or fewer samples. Field blanks are routinely collected and analyzed. Analytical data generated with QC samples that fall within prescribed acceptance limits indicate the test method was in control. For example, QC limits for laboratory control samples and matrix spikes are based on the historical mean recovery plus or minus three standard deviations. QC limits for duplicate samples are based on the historical mean relative percent difference plus or minus three standard deviations. Data generated with QC samples that fall outside QC limits indicate the test method was out of control. These data are considered suspect and the corresponding samples are reanalyzed. As part of the NELAC certification, the lab participates semi-annually in proficiency testing program (blind audits, Table 1) for each category of ELAP approval. If the lab fails the proficiency audit for an analyte, the lab director is required to identify the source and correct the problem to the certification agency.

Results and Discussion

Temperature and Dissolved Oxygen

Because of the abnormally warm spring in 2012, the lake was stratified by the first sampling date on 22 May 2012 (Fig. 1) and remained stratified to the last sampling date on 14 August 2012 (Fig. 2). The epilimnion never exceeded ~ 8 m in depth. Epilimnetic dissolved oxygen concentrations always remained above 7 mg/L (Figs. 1 and 2). On 22 May 2012, the deep colder water area, the hypolimnion, had ~ 4 mg/L of oxygen present. A month later (5 June 2012), hypolimnetic oxygen was ~ 1 mg/L from ~ 15 to 22 m of depth. By 19 June, the hypolimnion was anaerobic; that is, anoxic conditions were evident. By 7 July, anaerobic conditions were observed from ~ 7 m to 22 m of depth.

Phosphorus (Figures 1-5, Table 2)

Soluble reactive phosphorus (SRP) consists of the inorganic orthophosphate (PO_4) form of phosphorus that is soluble in water. These orthophosphates are directly taken up by algae and are generally considered the limiting factor for plant growth in New York lakes. Measuring SRP acts as an index of the amount of phosphorus immediately available for algal growth. Over the 2012 summer, epilimnetic (0 and 3 m) SRP ranged from 0.10 to 3.0 µg P/L. Hypolimnetic SRP concentrations reached as high as 349.6 µg

P/L by 14 August as a result of the anoxic conditions that cause sediments to release phosphorus (Figs. 1 and 2). Since 2002, SRP has decreased in the epilimnion (Fig. 5).

Total phosphorus (TP) provides an estimate of all fractions of phosphorus potentially available to aquatic plants. From 22 May through 2 July 2012, TP and SRP concentrations were low and similar from the 0-m to 22 m depth. By 17 July, TP and SRP began to increase in the hypolimnion due to anaerobic conditions and remained high through the end of the sampling period (Fig. 3). In 2012 the average epilimnetic (0 and 3m) TP concentration was 18.8 µg P/L ranging from a low of 11.1 µg P/L on May 22 to a high of 22.4 µg P/L on July 2 (Table 2). Historically, average concentrations of TP in the epilimnion of Conesus Lake have surpassed the NYSDEC Ambient Water Quality Guideline of 20 µg P/L of surface waters (Fig. 4). During the summer of 2012, the average epilimnetic TP concentration was for the first time in 30 years below the 20 µg P/L NYS guideline (Fig. 4). This decrease in epilimnetic TP concentrations may be the result of management efforts in various agriculturally dominated Conesus Lake watersheds (Makarewicz *et al*. 2009, Makarewicz *et al*. 2012).

Hypolimnetic (below 9 m) TP concentrations remained similar to the epilimnetic concentrations through 2 July (Fig. 3). However, hypolimnetic (below 9 m) TP concentrations began to increase on 17 July (Fig. 3) due to sediments releasing phosphorus as a by-product of anaerobic redox reactions which develop with thermal stratification (Figs. 1 and 2). Total phosphorus concentrations reached as high as ~ 400 µg P/L in the hypolimnion by 14 August, 2012. This is ~ 200 µg P/L lower than the 600 µg P/L concentration of TP in the hypolimnion in 2009 (Makarewicz *et al*. 2009). Because the amount of P released from sediment to the hypolimnion is dependent on the length of stratification period, this result may or may not be directly related to improved management in Conesus Lake watersheds. As mentioned, TP concentrations in the epilimnion and hypolimnion appear to be on a decreasing trend over the past few sampling years (Fig. 4).

Chlorophyll *a*

Algal abundance in lakes can be estimated by measuring chlorophyll *a* concentrations. In lakes where phosphorus is the limiting nutrient, algal abundance generally reflects any increase or decrease in phosphorus concentrations. With depth, Chl *a* concentration generally peaks in the lower portion of the epilimnion (0 to 6 m) and into the metalimnion (~ 6 to ~ 9m, Figs. 1 and 2). Epilimnetic Chl *a* concentrations in the summer of 2012 ranged from 3.0 to ~ 11 µg/L with an average of 6.6 µg/L (Figs. 1 and 2). Since 1985, average summer epilimnetic concentrations are quite variable (average range = 3.0 to 14.7 µg/L). Considering Chl *a* concentrations, the lake was classified for many years as eutrophic (Chl a greater than 7.3, Table 3). However, since ~ 2000 Chl *a* concentrations have been decreasing and since 2004 have fallen into the mesotrophic range (2.6 to 7.3 µg/L, Table 3).

Nitrate and Total Nitrogen

Nitrate is a compound which occurs naturally and may be augmented by point and nonpoint sources of nitrate which include septic systems, fertilizers and manure, and industrial waste and landfills. At elevated levels, nitrate can be harmful to animals and people. In Conesus Lake, nitrate concentrations were generally very low (<0.15 mg N/L) at all depths over the summer of 2012 (Fig. 3). Low levels of NO_2+NO_3 tend to favor the growth of nuisance blue-green algae (Cyanobacteria), which dominate Conesus Lake during the summer and are capable of fixing atmospheric nitrogen. Average epilimnetic nitrate had generally been increasing in the lake until 2004, when the levels began to decrease (Fig. 5). This trend continued in 2012 where the average epilimnetic concentration was 0.03 mg N/L and nitrate was not detectable at all depths by August (Fig. 5).

Total nitrogen represents the sum of organic and inorganic nitrogen compounds. In 2012 total nitrogen ranged from 0.33 to 0.58 mg N/L in the epilimnion and averaged 0.43 mg N/L. Hypolimnetic total nitrogen increased from 0.59 mg N/L in May to 1.21 mg N/L in August (Fig. 4).

Sodium

Sodium enters a watershed mainly through its use as a deicing salt for roads. In winters, these deicing salts are used heavily around Conesus Lake, and as a result sodium has had an increasing trend in the lake since 1985 (Fig. 5). Throughout the summer, sodium concentrations were similar from the surface to the bottom of the lake (Fig. 6). In 2012 average epilimnetic sodium was 27.85 mg Na/L and ranged from 23.76 to 30.53 mg Na/L. This level of average epilimnetic sodium was the highest it has been since the start of its measurements in 1985 and is much higher than the debated EPA's 20 mg Na/L Drinking Water Equivalency Level (DWEL or guidance level) for sodium (Makarewicz *et al*. 2009).

The Environmental Health of Conesus Lake

Carlson's Trophic Status Index (TSI) was developed to assess the trophic state of North American lakes by considering summer epilimnetic TP, Chl-*a* concentrations, and summer secchi-disk depth. This index is one of several that can be used to evaluate the trophic status of a lake; that is, what is the overall productivity of the lake. The TSI for TP (45.1), chlorophyll (49.2), and secchi disk (46.0) averaged 46.8, suggesting a mesotrophic status for Conesus Lake (Table 3). Also, average Chl *a* (6.5 µg/L), TP (18.8 µg/L), and secchi disk (3.0 m) readings for the summer 2012 period also suggest a mesotrophic status for Conesus Lake (Table 3). Lastly, the temporal trends in TP, Chl *a,* and the overall Trophic Status Index (Table 4) have been decreasing over the past decade. As discussed earlier, Chl *a* concentrations have for years suggested a eutrophic state for Conesus Lake (Chl *a* greater than 7.3, Table 3). However, since ~ 2000 chlorophyll *a* concentrations have been decreasing and since 2004 have fallen into the mesotrophic range (2.6 to 7.3 µg/L, Fig. 5). Similarly, during the summer of 2012, the average epilimnetic TP concentration was for the first time in 30 years below the 20 µg P/L NYS guideline (Fig. 4). Several different indicators are suggesting that the water quality and trophic status of the open offshore waters of Conesus Lake may be improving. The decrease in epilimnetic TP concentrations may be the result of management efforts in various agriculturally dominated Conesus Lake watersheds (Makarewicz *et al*. 2009, 2012).

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Table1. Results of proficiency audit for the Brockport water quality laboratory.

WADSWORTH CENTER
NEW YORK STATE DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY APPROVAL PROGRAM

New York ELAP Proficiency Test Report

Lab Id: 11439

EPA Lab Code: NY01449

SUNY BROCKPORT
125 LENNON HALL SUNY
BROCKPORT BROCKPORT,
NY 14420 (585) 395-5747
Director: DR. JOSEPH C. MAKAREWICZ

Shipment Date : 17-Jan-2012
Closing Date : 01-Mar-2012
Score Date : 21-Mar-2012

ELAP is an A2LA accredited Proficiency Testing Provider. Certificate Number 1785.01

Shipment: 350 Non Potable Water Chemistry

Analyte Name	Units	Sample ID	Test Method	Prep Method	Result/ Analysis Date	Mean/ Assigned Value	Standard Deviation/ Fixed %	Acceptance Limits	Score
Sample: Non Potable Water Inorganic Nutrients									
Nitrate (as N)	mg/L	5007	SM 18-21 4500-NO3 F (00)		36.71	35.6	2.55	28.0 - 43.3	Satisfactory
Analyte Code: 1810					2/15/2012	35.9		*90 passed out of 94 reported results.*	
Orthophosphate (as P)	mg/L	5007	SM 18-21 4500-P F		4.11	4.16	0.249	3.41 - 4.90	Satisfactory
Analyte Code: 1870					2/15/2012	4.14		*78 passed out of 80 reported results.*	
Sample: Non Potable Water Minerals II									
Sodium, Total	mg/L	5037	SM 18-21 3111B (99)		58.9	57.0	2.85	48.5 - 65.6	Satisfactory
Analyte Code: 1155					2/29/2012	57.1		*59 passed out of 63 reported results.*	
Sample: Non Potable Water Nitrite									
Nitrite as N	mg/L	5041	SM 18-21 4500-NO2 B (00)		2.614	2.51	0.13	2.12 - 2.90	Satisfactory
Analyte Code: 1840					2/15/2012	2.51		*82 passed out of 84 reported results.*	
Sample: Non Potable Water Organic Nutrients									
Kjeldahl Nitrogen, Total	mg/L	5004	EPA 351.2 Rev. 2.0		13.95	12.8	1.38	8.69 - 17.0	Satisfactory
Analyte Code: 1795					2/28/2012	13.1		*68 passed out of 69 reported results.*	
Phosphorus, Total	mg/L	5004	SM 18-21 4500-P F		7.62	7.36	0.437	6.05 - 8.67	Satisfactory
Analyte Code: 1910					2/24/2012	7.33		*78 passed out of 86 reported results.*	

Table 2. Conesus Lake water chemistry at the deepest point in the South Basin. TP =Total Phosphorus, TN=Total Nitrogen, SRP=Soluble Reactive Phosphorus, Na=Sodium. 12 May to 14 August 2012. ND=non-detectable.

Date	Depth (m)	TP (µg P/L)	Nitrate (mg N/L)	SRP (µg P/L)	TN (mg N/L)	Na (mg/L)
5/22/2012	0	11.1	ND	3.0	0.45	29.49
5/22/2012	3	14.9	ND	0.9	0.41	28.96
5/22/2012	6	17.6	ND	0.2	0.48	28.80
5/22/2012	9	18.6	0.04	0.2	0.55	28.55
5/22/2012	12	15.9	0.07	0.2	0.54	28.10
5/22/2012	15	15.7	0.04	0.2	0.50	27.72
5/22/2012	18	18.6	0.07	0.2	0.59	27.92
6/5/2012	0	17.6	0.02	1.2	0.33	27.99
6/5/2012	3	20.0	ND	1.4	0.35	27.64
6/5/2012	6	19.8	ND	0.2	0.35	27.78
6/5/2012	9	16.5	0.02	0.2	0.25	27.66
6/5/2012	12	13.0	0.09	0.2	0.35	27.63
6/5/2012	15	16.3	0.08	0.9	0.50	27.05
6/5/2012	18	23.0	0.06	5.2	0.64	27.48
6/19/2012	0	19.0	0.04	1.5	0.36	24.03
6/19/2012	3	21.9	0.13	1.7	0.37	23.76
6/19/2012	6	18.7	0.06	0.7	0.40	24.76
6/19/2012	9	15.3	0.06	0.7	0.46	23.85
6/19/2012	12	11.9	0.09	0.2	0.43	23.34
6/19/2012	15	10.1	0.10	0.2	0.55	23.94
6/19/2012	18	12.9	0.05	1.7	0.74	23.14
7/2/2012	0	19.4	0.04	0.1	0.36	30.29
7/2/2012	3	22.4	0.03	0.1	0.37	30.53
7/2/2012	6	22.0	0.04	0.7	0.38	30.01
7/2/2012	9	11.6	0.04	1.0	0.33	30.29
7/2/2012	12	13.5	0.08	3.5	0.35	30.40
7/2/2012	15	17.1	0.04	5.1	0.61	30.13
7/2/2012	18	15.4	0.04	2.9	0.72	30.24

Table 2. (continued)

Date	Depth (m)	TP (µg P/L)	Nitrate (mg N/L)	SRP (µg P/L)	TN (mg N/L)	Na (mg/L)
7/17/2012	0	21.1	0.07	0.2	0.53	27.80
7/17/2012	3	22.0	0.07	0.2	0.58	28.66
7/17/2012	6	22.2	0.09	4.1	0.57	28.93
7/17/2012	9	12.7	0.07	0.7	0.45	28.39
7/17/2012	12	10.8	0.12	2.5	0.51	28.06
7/17/2012	15	107.6	0.07	98.5	0.82	28.50
7/17/2012	18	160.3	0.07	102.6	1.18	28.61
8/1/2012	0	18.0	ND	0.1	0.38	27.69
8/1/2012	3	20.5	ND	0.1	0.51	27.43
8/1/2012	6	19.8	ND	0.2	0.38	27.17
8/1/2012	9	17.5	ND	2.0	0.22	26.48
8/1/2012	12	61.7	ND	39.7	0.40	26.88
8/1/2012	15	61.4	ND	38.8	0.37	26.44
8/1/2012	18	235.4	ND	125.5	0.69	28.40
8/14/2012	0	14.0	ND	0.5	0.55	27.77
8/14/2012	3	21.1	ND	0.5	0.54	26.93
8/14/2012	6	12.8	ND	0.2	0.48	27.08
8/14/2012	9	19.0	ND	0.3	0.43	27.24
8/14/2012	12	96.6	ND	70.1	0.50	26.45
8/14/2012	15	169.2	ND	143.4	1.13	26.77
8/14/2012	18	393.8	ND	349.6	1.21	26.29

Table 3. General relationship of lake productivity in relation to phosphorus, nitrogen, transparency and chlorophyll *a* compared to summer epilimnion values of Conesus Lake in 2012. Adapted from Carlson and Simpson (1996). Conesus Lake secchi disk and epilimnetic (0 to 3 m) total phosphorus and chlorophyll *a* concentrations are from 22 May 2012 to 14 August 2012.

	Trophic Status Index	**Epilimnetic Total Phosphorus (µg P/L)**	**Chl *a* (µg/L)**	**Secchi Disk (m)**
Oligotrophic	<30	<6	<0.95	>8
Mesotrophic	40 to 50	12-24	2.6 - 7.3	2-4
Eutrophic	50 to 60	24-48	7.3-20	1-2
Hypereutrophic	>70	96-192	20-56	0.25-0.5
Conesus Lake (2012)	46.8	18.79	6.57	3.0

Table 4. Carlson TSI values for TP, Chl *a,* and secchi disk depth from 1985-2012, and average TP, Chl-*a*, and secchi disk depth values for all years combined.

Carlson's Trophic Status Index				
	TP	**Chl *a***	**Secchi**	**Mean TSI**
1985	53.5	45.4	43.4	47.4
1988	49.7	52.0	43.6	48.4
1991	47.9	52.2	45.6	48.6
1993	53.0	55.4	48.0	52.1
1996	48.2	54.0	44.0	48.7
1999	48.1	52.3	ND	50.2
2000	46.0	53.7	ND	49.9
2000	48.0	56.3	ND	52.2
2003	53.0		ND	53.0
2004	52.0	49.6	47.6	49.7
2009	48.0	47.9	45.0	47.0
2012	**45.1**	**49.2**	**46.0**	46.8
Average	49.4	51.6	45.4	48.8

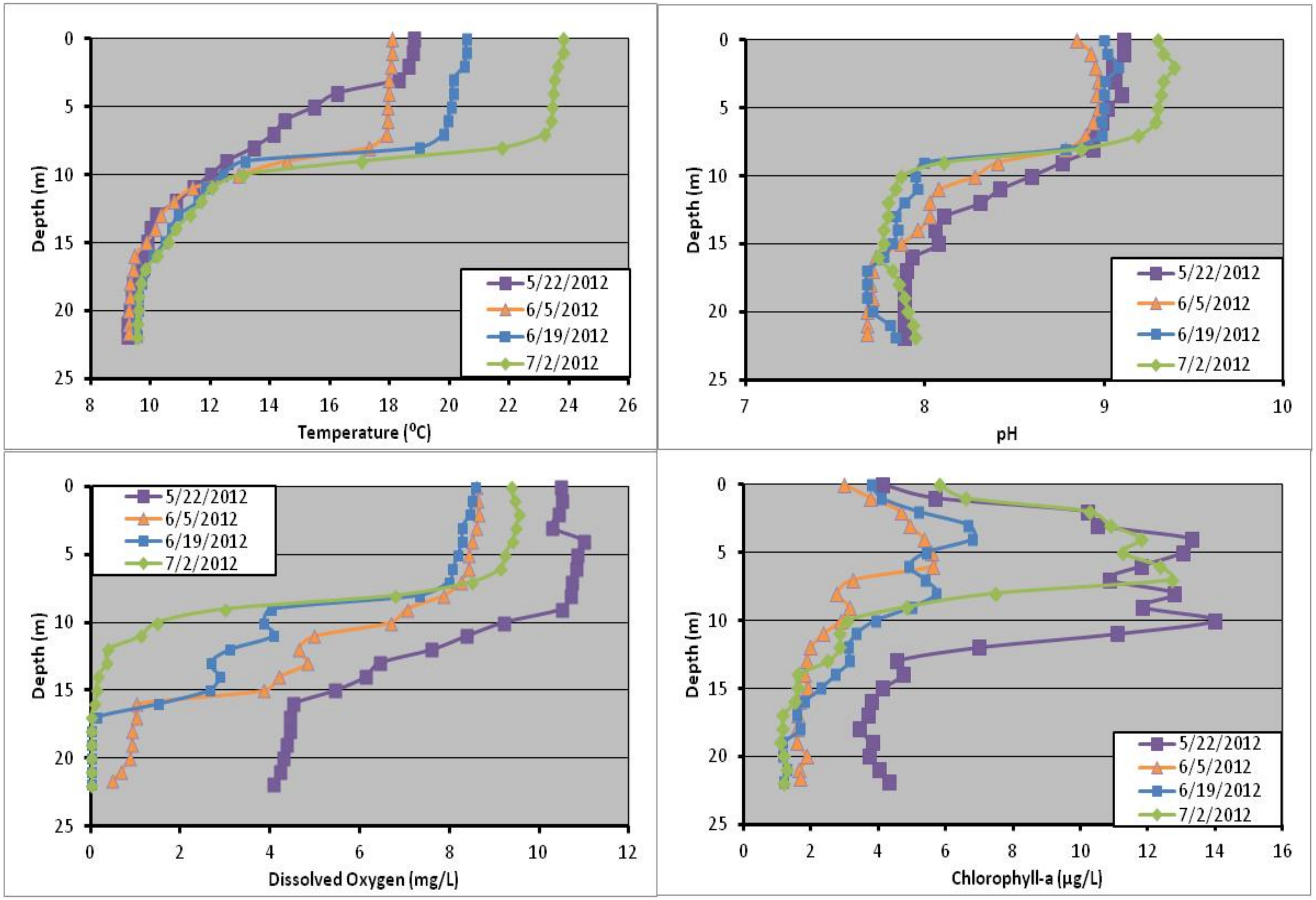

Figure 1. Depth profiles of temperature, pH, dissolved oxygen, and chlorophyll *a* at the deepest location in Conesus Lake from 22 May -2 July 2012.

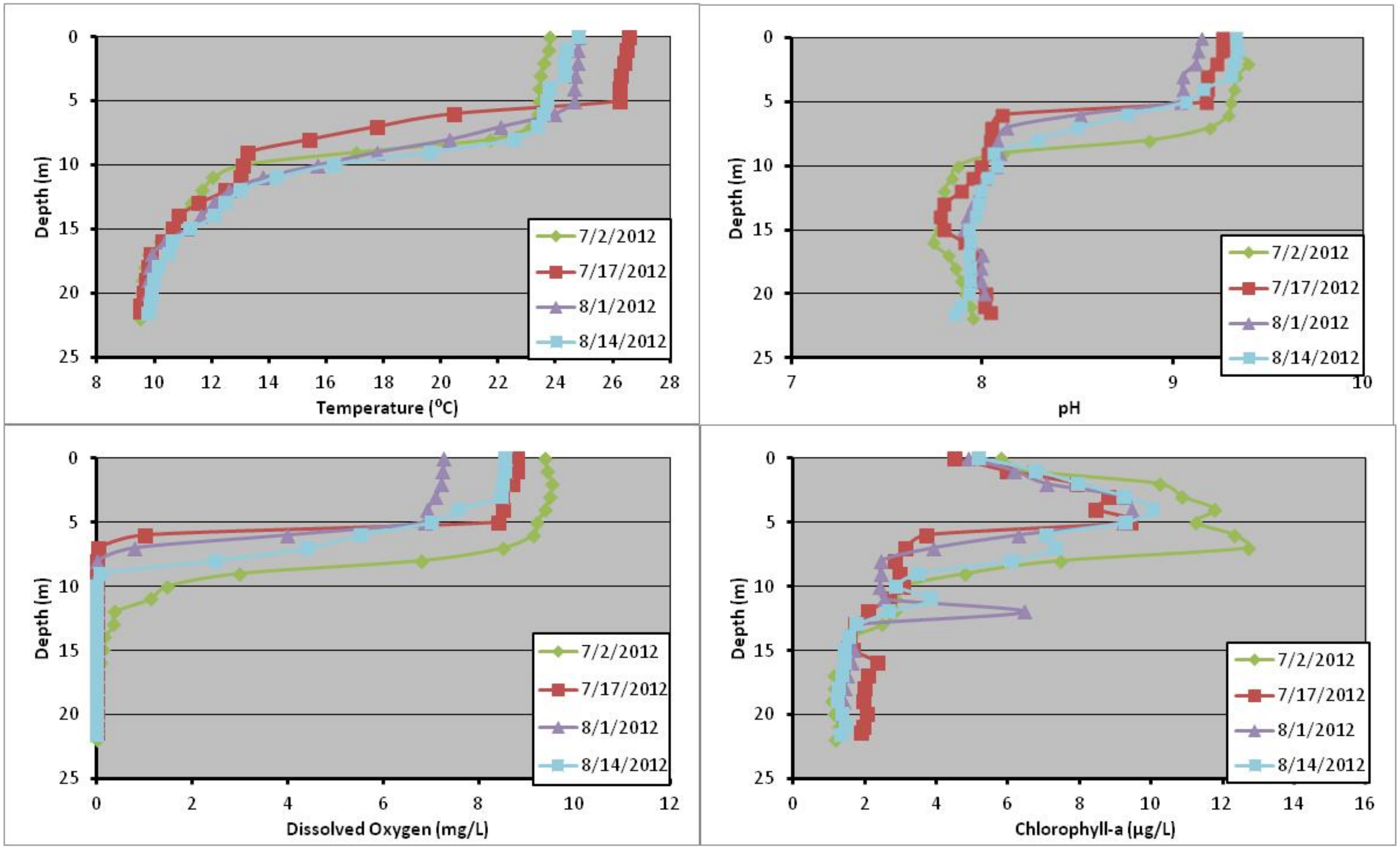

Figure 2. Depth profiles of temperature, pH, dissolved oxygen, and chlorophyll *a* at the deepest location in Conesus Lake from 2 July-14 August 2012.

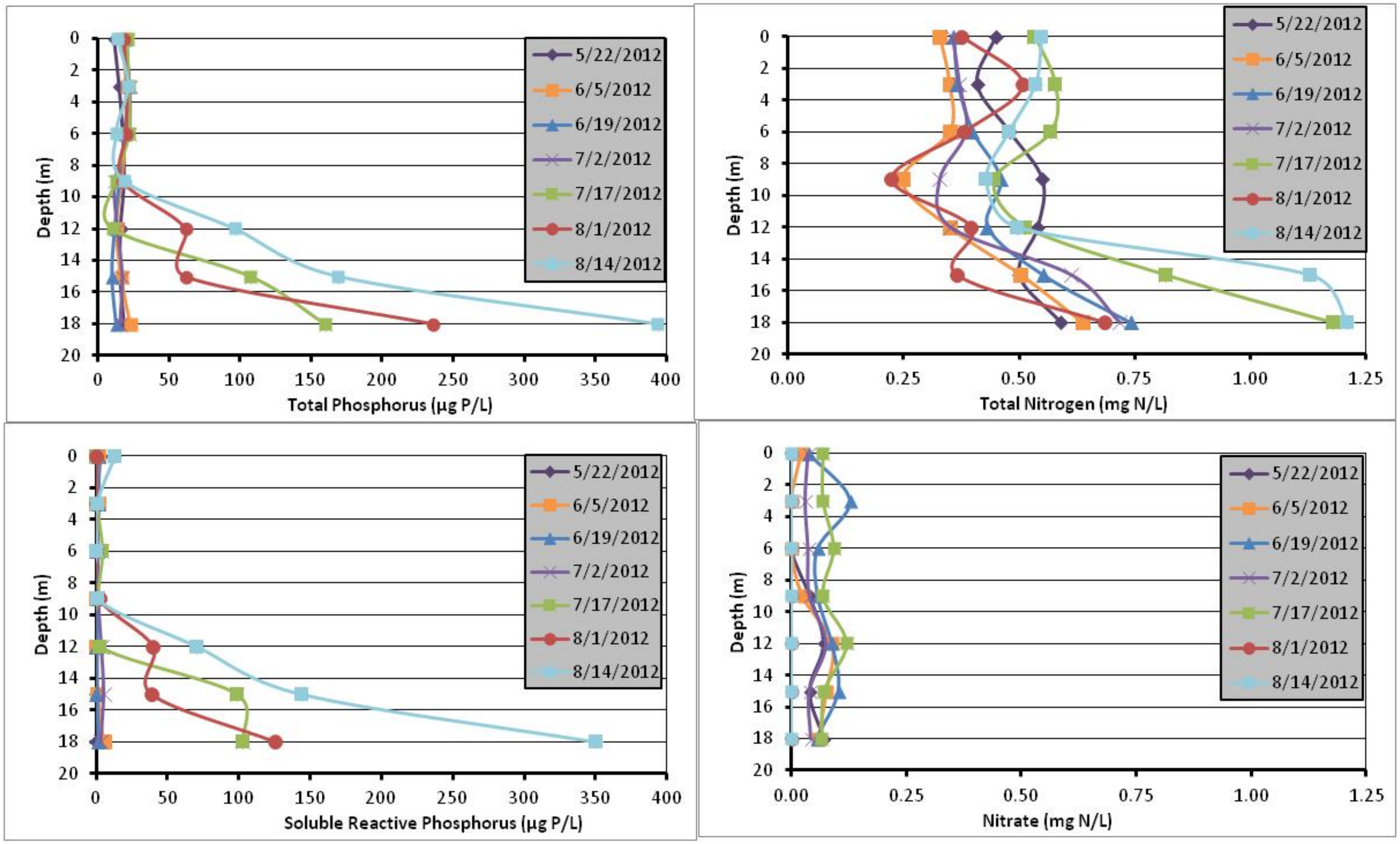

Figure 3. Depth profiles of total phosphorus, soluble reactive phosphorus, nitrate, and total nitrogen at the deepest location in Conesus Lake from May-August 2012.

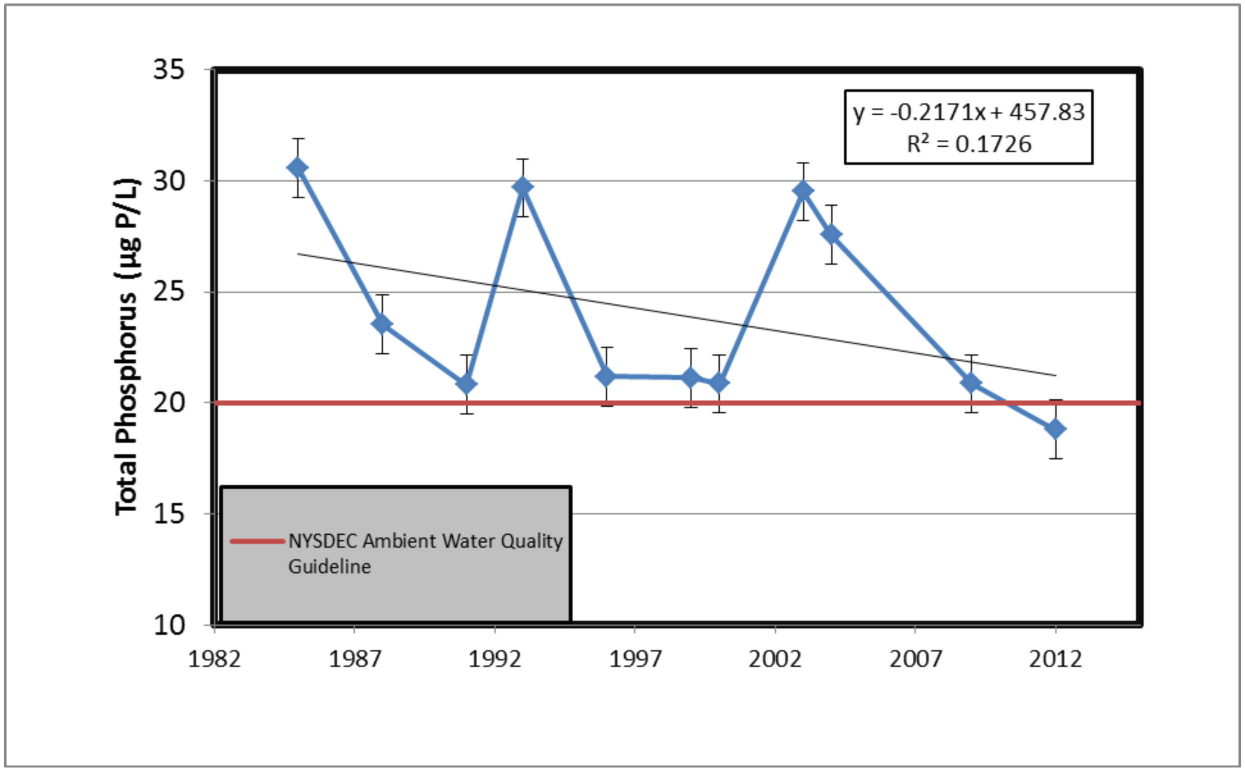

Figure 4. Average epilimnetic total phosphorus concentrations (µg P/L) from 1985-2012.

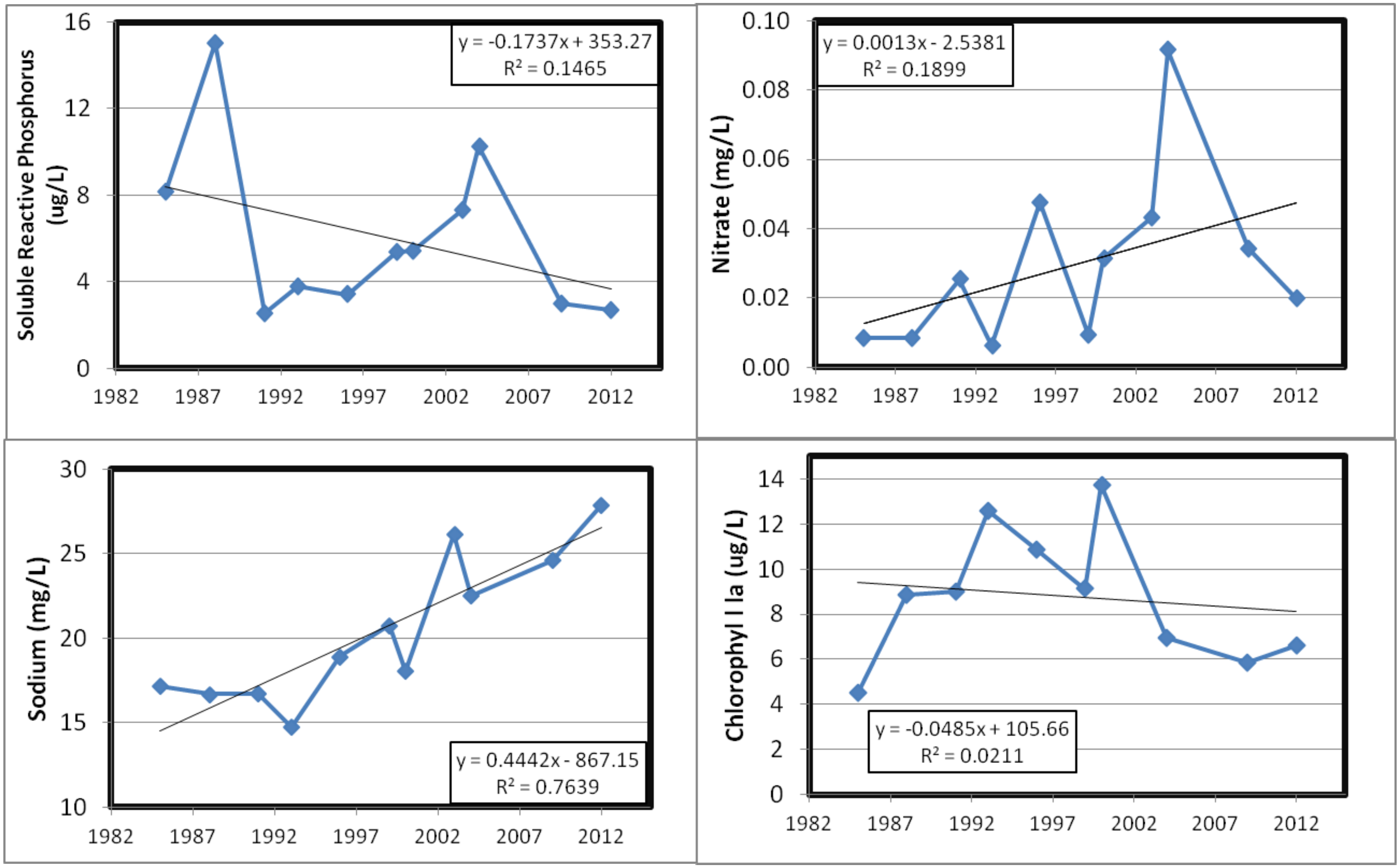

Figure 5. Average epilimnetic concentrations of soluble reactive phosphorus, nitrate, sodium, and chlorophyll *a* from 1985-2012.

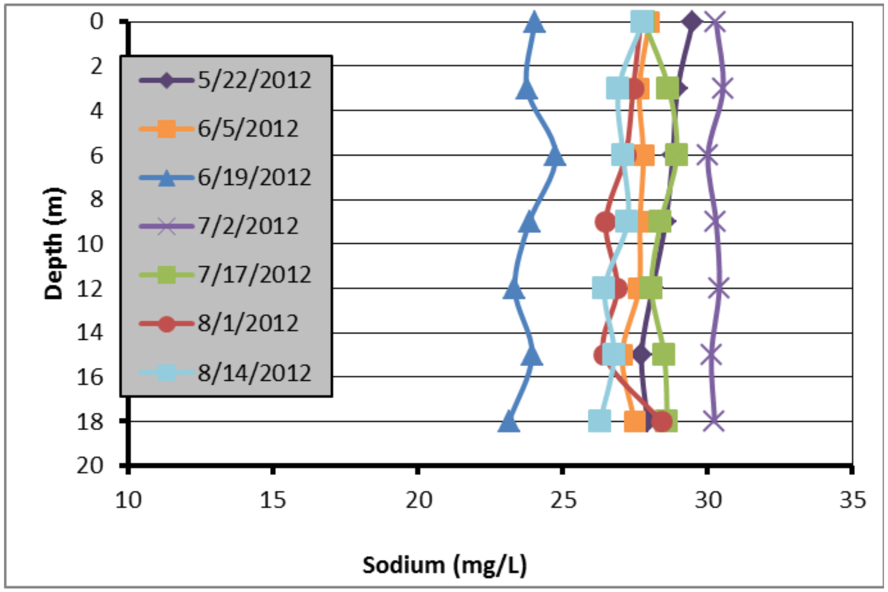

Figure 6. Depth profile of sodium at the deepest location in Conesus Lake from May-August 2012.

Appendix 1. Field and Hydrolab data for the deepest location in Conesus Lake from May to August 2012.

Date	Depth (m)	Temp (^oC)	pH	DO (mg/L)	Chl-a (µg/L)	Secchi Disk (m)
5/22/2012	0	18.78	9.11	10.47	4.1	3.9
5/22/2012	1	18.75	9.11	10.50	5.7	
5/22/2012	2	18.62	9.05	10.43	10.2	
5/22/2012	3	18.27	9.06	10.29	10.5	
5/22/2012	4	16.23	9.10	10.99	13.3	
5/22/2012	5	15.47	9.02	10.85	13.0	
5/22/2012	6	14.48	8.99	10.82	11.8	
5/22/2012	7	14.10	8.94	10.71	10.8	
5/22/2012	8	13.43	8.94	10.69	12.8	
5/22/2012	9	12.54	8.77	10.50	11.8	
5/22/2012	10	12.00	8.60	9.21	14.0	
5/22/2012	11	11.41	8.42	8.38	11.1	
5/22/2012	12	10.85	8.31	7.60	7.0	
5/22/2012	13	10.17	8.11	6.43	4.5	
5/22/2012	14	10.00	8.06	6.13	4.7	
5/22/2012	15	9.88	8.08	5.45	4.1	
5/22/2012	16	9.78	7.93	4.52	3.8	
5/22/2012	17	9.69	7.90	4.44	3.7	
5/22/2012	18	9.42	7.89	4.43	3.4	
5/22/2012	19	9.37	7.89	4.36	3.8	
5/22/2012	20	9.30	7.89	4.29	3.7	
5/22/2012	21	9.24	7.89	4.21	4.0	
5/22/2012	21.9	9.22	7.89	4.06	4.3	

Appendix 1 (cont.). Field and Hydrolab data for the deepest location in Conesus Lake from May to August 2012.

Date	Depth (m)	Temp (°C)	pH	DO (mg/L)	Chl-a (µg/L)	Secchi Disk (m)
6/5/2012	0	18.06	8.85	8.60	3.0	4.0
6/5/2012	1	18.06	8.93	8.62	3.8	
6/5/2012	2	18.03	8.95	8.63	4.7	
6/5/2012	3	17.96	8.97	8.60	4.9	
6/5/2012	4	17.95	8.96	8.50	5.4	
6/5/2012	5	17.93	8.97	8.43	5.6	
6/5/2012	6	17.91	8.94	8.41	5.6	
6/5/2012	7	17.88	8.90	8.24	3.2	
6/5/2012	8	17.28	8.79	7.87	2.8	
6/5/2012	9	14.54	8.41	7.04	3.1	
6/5/2012	10	12.93	8.28	6.68	2.9	
6/5/2012	11	11.38	8.08	4.98	2.4	
6/5/2012	12	10.77	8.03	4.62	2.0	
6/5/2012	13	10.33	8.03	4.82	1.9	
6/5/2012	14	10.13	7.96	4.20	1.8	
6/5/2012	15	9.84	7.87	3.86	1.9	
6/5/2012	16	9.45	7.73	1.01	1.7	
6/5/2012	17	9.40	7.71	1.02	1.6	
6/5/2012	18	9.31	7.70	0.92	1.6	
6/5/2012	19	9.30	7.71	0.91	1.6	
6/5/2012	20	9.28	7.68	0.86	1.9	
6/5/2012	21	9.28	7.68	0.66	1.7	
6/5/2012	21.6	9.25	7.68	0.47	1.7	

Appendix 1 (cont.). Field and Hydrolab data for the deepest location in Conesus Lake from May to August 2012.

Date	Depth (m)	Temp (^oC)	pH	DO (mg/L)	Chl-a (µg/L)	Secchi Disk (m)
6/19/2012	0	20.56	9.00	8.58	3.8	3.8
6/19/2012	1	20.55	9.02	8.49	4.1	
6/19/2012	2	20.48	9.08	8.44	5.2	
6/19/2012	3	20.13	9.01	8.27	6.7	
6/19/2012	4	20.10	9.00	8.27	6.8	
6/19/2012	5	20.05	9.00	8.18	5.4	
6/19/2012	6	19.94	8.99	8.06	4.9	
6/19/2012	7	19.80	8.99	7.97	5.4	
6/19/2012	8	18.99	8.79	7.31	5.7	
6/19/2012	9	13.14	8.00	4.03	5.0	
6/19/2012	10	12.42	7.95	3.85	3.9	
6/19/2012	11	11.82	7.96	4.06	3.3	
6/19/2012	12	11.57	7.89	3.10	3.1	
6/19/2012	13	10.91	7.84	2.67	3.1	
6/19/2012	14	10.68	7.85	2.86	2.7	
6/19/2012	15	10.46	7.82	2.64	2.3	
6/19/2012	16	10.08	7.77	1.51	1.8	
6/19/2012	17	9.82	7.68	0.13	1.6	
6/19/2012	18	9.70	7.68	0.01	1.7	
6/19/2012	19	9.60	7.68	0.00	1.2	
6/19/2012	20	9.59	7.71	0.00	1.2	
6/19/2012	21	9.52	7.81	0.00	1.3	
6/19/2012	21.9	9.54	7.84	0.00	1.2	

Appendix 1 (cont.). Field and Hydrolab data for the deepest location in Conesus Lake from May to August 2012.

Date	Depth (m)	Temp (°C)	pH	DO (mg/L)	Chl-a (µg/L)	Secchi Disk (m)
7/2/2012	0	23.80	9.30	9.38	5.8	1.9
7/2/2012	1	23.77	9.33	9.44	6.6	
7/2/2012	2	23.59	9.39	9.54	10.3	
7/2/2012	3	23.50	9.33	9.48	10.9	
7/2/2012	4	23.45	9.32	9.40	11.8	
7/2/2012	5	23.43	9.30	9.22	11.3	
7/2/2012	6	23.40	9.29	9.14	12.4	
7/2/2012	7	23.17	9.19	8.50	12.7	
7/2/2012	8	21.74	8.87	6.79	7.5	
7/2/2012	9	17.05	8.11	3.00	4.8	
7/2/2012	10	13.06	7.87	1.47	3.1	
7/2/2012	11	12.06	7.84	1.12	2.9	
7/2/2012	12	11.69	7.80	0.38	2.9	
7/2/2012	13	11.30	7.80	0.36	2.5	
7/2/2012	14	10.84	7.77	0.16	1.6	
7/2/2012	15	10.57	7.77	0.14	1.6	
7/2/2012	16	10.23	7.74	0.08	1.5	
7/2/2012	17	9.81	7.82	0.00	1.2	
7/2/2012	18	9.67	7.86	0.00	1.2	
7/2/2012	19	9.61	7.89	0.00	1.1	
7/2/2012	20	9.59	7.91	0.00	1.2	
7/2/2012	21	9.54	7.94	0.00	1.3	
7/2/2012	22	9.54	7.95	0.00	1.2	

Appendix 1 (cont.). Field and Hydrolab data for the deepest location in Conesus Lake from May to August 2012.

Date	Depth (m)	Temp (^{o}C)	pH	DO (mg/L)	Chl-a (µg/L)	Secchi Disk (m)
7/17/2012	0	26.56	9.26	8.81	4.5	2.2
7/17/2012	1	26.50	9.26	8.79	6.0	
7/17/2012	2	26.41	9.23	8.71	7.9	
7/17/2012	3	26.30	9.18	8.49	8.8	
7/17/2012	4	26.26	9.18	8.52	8.5	
7/17/2012	5	26.25	9.17	8.42	9.4	
7/17/2012	6	20.48	8.10	1.02	3.7	
7/17/2012	7	17.79	8.05	0.03	3.1	
7/17/2012	8	15.44	8.04	0.00	2.9	
7/17/2012	9	13.28	8.03	0.00	3.0	
7/17/2012	10	13.11	7.99	0.00	3.1	
7/17/2012	11	13.02	7.95	0.00	2.7	
7/17/2012	12	12.50	7.89	0.00	2.1	
7/17/2012	13	11.55	7.80	0.00	1.7	
7/17/2012	14	10.85	7.78	0.00	1.6	
7/17/2012	15	10.67	7.80	0.00	1.7	
7/17/2012	16	10.30	7.91	0.00	2.4	
7/17/2012	17	9.88	7.96	0.00	2.1	
7/17/2012	18	9.79	7.96	0.00	2.0	
7/17/2012	19	9.72	7.95	0.00	2.0	
7/17/2012	20	9.64	8.02	0.00	2.1	
7/17/2012	21	9.53	8.01	0.00	2.0	
7/17/2012	21.4	9.52	8.04	0.00	1.9	

Appendix 1 (cont.). Field and Hydrolab data for the deepest location in Conesus Lake from May to August 2012.

Date	Depth (m)	Temp (°C)	pH	DO (mg/L)	Chl-a (µg/L)	Secchi Disk (m)
8/1/2012	0	24.82	9.15	7.27	4.9	2.8
8/1/2012	1	24.80	9.13	7.25	6.2	
8/1/2012	2	24.77	9.12	7.21	7.1	
8/1/2012	3	24.72	9.05	7.09	9.3	
8/1/2012	4	24.68	9.05	6.93	9.5	
8/1/2012	5	24.66	9.04	6.87	9.3	
8/1/2012	6	23.96	8.51	3.99	6.3	
8/1/2012	7	22.11	8.13	0.79	3.9	
8/1/2012	8	20.31	8.08	0.00	2.5	
8/1/2012	9	17.79	8.09	0.00	2.5	
8/1/2012	10	15.71	8.07	0.00	2.4	
8/1/2012	11	13.78	8.01	0.00	2.6	
8/1/2012	12	12.62	7.98	0.00	6.5	
8/1/2012	13	12.07	7.95	0.00	1.8	
8/1/2012	14	11.64	7.92	0.00	1.5	
8/1/2012	15	11.14	7.90	0.00	1.7	
8/1/2012	16	10.38	7.93	0.00	1.6	
8/1/2012	17	9.92	8.00	0.00	1.5	
8/1/2012	18	9.85	7.99	0.00	1.4	
8/1/2012	19	9.79	7.99	0.00	1.4	
8/1/2012	20	9.80	8.01	0.00	1.4	

Appendix 1 (cont.). Field and Hydrolab data for the deepest location in Conesus Lake from May to August 2012.

Date	Depth (m)	Temp (^oC)	pH	DO (mg/L)	Chl-a (µg/L)	Secchi Disk (m)
8/14/2012	0	24.81	9.33	8.56	5.2	2.1
8/14/2012	1	24.41	9.34	8.56	6.8	
8/14/2012	2	24.35	9.32	8.52	8.0	
8/14/2012	3	24.33	9.31	8.49	9.3	
8/14/2012	4	23.82	9.16	7.58	10.0	
8/14/2012	5	23.74	9.07	7.02	9.3	
8/14/2012	6	23.61	8.76	5.52	7.1	
8/14/2012	7	23.42	8.50	4.40	7.4	
8/14/2012	8	22.60	8.29	2.49	6.1	
8/14/2012	9	19.67	8.06	0.07	3.5	
8/14/2012	10	16.27	8.08	0.00	2.9	
8/14/2012	11	14.27	8.03	0.00	3.9	
8/14/2012	12	13.02	7.99	0.00	2.7	
8/14/2012	13	12.50	7.98	0.00	1.8	
8/14/2012	14	12.13	7.97	0.00	1.6	
8/14/2012	15	11.28	7.93	0.00	1.5	
8/14/2012	16	10.66	7.94	0.00	1.4	
8/14/2012	17	10.52	7.93	0.00	1.4	
8/14/2012	18	10.17	7.94	0.00	1.3	
8/14/2012	19	10.00	7.94	0.00	1.3	
8/14/2012	20	9.93	7.93	0.00	1.4	
8/14/2012	21	9.88	7.89	0.00	1.5	
8/14/2012	21.6	9.80	7.86	0.00	1.4	