

Study of Selected Limnological Parameters In Conesus Lake (NY) Following Heavy Precipitation and Runoff in Spring 2011



Report Submitted to
The Livingston County Planning Department

by

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I. Summary

- . The primary goal of this study was to investigate whether the high amount of precipitation and subsequent runoff in April and May 2011 had a prominent effect on the limnology of Conesus Lake during the early summer period of production in the ecosystem. A second goal was to determine whether the runoff resulted in a high biomass production by filamentous algae that populate the nearshore. The study was conducted over a limited time frame and is not intended to take the place of the more comprehensive limnological surveys conducted regularly as part of the Watershed Management Plan.
- Water column profiles were taken over the deepest parts in the south basin of Conesus Lake on June 24 and 28, and July 5 and 19. Comparisons of nutrient and chlorophyll *a* concentrations, water transparency, and other physicochemical characteristics of the water column to historical records for June and July showed that 2011 was not consistently different from previous years. One possible exception was a bloom of phytoplankton detected on July 19. Secchi depths were 1-0 -1.1 m, average surface turbidity was 8.36 NTU, and average chlorophyll *a* was 8.91 micrograms per liter, all of which are unusually high for Conesus Lake. Whether this lake-wide bloom was a response to the high springtime rainfall or to more limited weather events in July could not be ascertained.
- Qualitative observations at three study sites along the nearshore in June and July revealed that the areal coverage of filamentous algae was exceedingly high. Macrophyte beds were widely covered with algae and the growth of the pervasive Eurasian watermilfoil may have been suppressed. Because there was no surface macrophyte canopy, the filamentous algal mat remained well below the surface where it could not be measured quantitatively by the surface quadrat method used in previous studies.
- Much of the nutrient supply delivered by runoff from the abundant springtime rainfall may have been intercepted nearshore, where it triggered extensive blooms of filamentous algae. In the open water regions of the lake, nutrient levels were not consistently high and other aspects of the water column ecosystem were within the range measured in previous years.

II. Introduction

In April and May 201 the Rochester, N.Y. region experienced the highest rainfall totals in at least 11 years (**Table 1, Figure 1**) with total precipitation in April reaching an all time record. Between April and May there were 12 days with daily rainfall totals of at least 0.3 inches in Rochester. According to data from Makarewicz *et al.* (2011), in the Conesus Lake watershed these rains were responsible for periods of high stream discharge and nutrient loading that continued into late May, when the stream runoff study was completed. The heavy rains in spring were followed by a relatively dry June and July, in which only two days exceeded 0.3 in of rainfall (**Figure 2**).

In shallow temperate lakes the spring season is typically a period of high plant productivity, a time when nutrient delivery by runoff and by mixing of the water column is high, when herbivore populations in the system are still increasing, and when ample sunlight and warmer temperatures create a perfect environment for photosynthesis (Kalf, 2002 p. 323-325). By late spring and early summer, runoff has decreased and a strong thermocline physically separated surface waters from nutrient sources in the hypolimnion. Low epilimnion nutrient concentrations limit plant production and herbivore populations are sufficiently dense to suppress plant biomass. The lake enters a “clear phase” that may persist well into summer or autumn.

Individual lake ecosystems do not always follow this idealized seasonal pattern of production and one does not have to look beyond Conesus Lake to find exceptions. Forest *et. al.* (1978, pg. 177) summarized the work of Ed Mills (1975), in which Mills showed that the peak in algal biomass and chl *a* concentration occurred in mid July, weeks after water column stratification had developed (see Figs 7-8, 14-15) and following a period of very low phytoplankton biomass in June. The 1972 “spring bloom” appears to have been delayed to summer when, according to conventional wisdom, the lake should have entered a “clear phase”. A similar pattern to that documented by Mills (Forest *et. al.*, 1978) is also evident in seasonal data for Conesus Lake reported by Makarewicz and colleagues for 2004 and 2009, when peak chl *a* concentrations occurred in late June and July.

There are many reasonable explanations for the relatively late (summer rather than spring) development of phytoplankton blooms in Conesus Lake during some years.

In this study we consider two possibilities. The first is that the phytoplankton could be responding very rapidly to nutrient pulses delivered either by runoff or wind-driven mixing of the water column in June and July. The second is that a time lag exists in the response by phytoplankton communities to pulses of nutrients delivered in spring. A possible agent for this delay might be light limitation caused by sediment runoff and heavy cloud cover during extended periods of rainfall activity.

In this study we surveyed the limnology of Conesus Lake during late June and July 2011 to establish the pattern of stratification, nutrient availability, and phytoplankton biomass. The results were compared to data from previous years to identify any unique trends in 2011. The ultimate goal of the project was to determine whether the extensive precipitation and runoff in April and May 2011 had a prominent effect on the limnology of Conesus Lake several weeks later, in early summer. We also studied whether the production of filamentous algae nearshore would be enhanced by the runoff from the intensive spring rains. Sampling in Conesus Lake was conducted over four dates in late June and July. Profile data from a single sampling on July 12 in Hemlock Lake is included with the Conesus Lake data to provide a baseline for comparisons and as a reference for future studies in the Finger Lakes.

III. Methods

Sampling was conducted on June 24, 28 and July 5 and 19 in Conesus Lake and on July 14 in Hemlock Lake. The sampling station on Conesus Lake was in the south basin between Cottonwood Gully to the west and the Excelsior Springs area to the east (Long. 77° 43.070' Lat. 42°45.360') at a depth of approximately 18 m. This corresponds to the South Central Central station in a previous study by Bosch and Makarewicz (2003) and to the principal sampling station established by the N.Y. State Department of Environmental Conservation in previous studies. The sampling station on Hemlock Lake was on the southwestern sector of the south basin in approximately 24 m of water.

Water Column Profiles

Water column profiles were obtained with a Hydrolab 5a Sonde equipped with sensors that determine depth (m) temperature (°C), photosynthetically active radiation (in

μ Einsteins per m^2 per seconds at wavelengths of 400-700 nm), chlorophyll equivalents (as millivolts, mV), conductivity (μ Siemens per cm), dissolved oxygen (mg per liter and % saturation), pH, and redox potential (mV). With the exception of the on board fluorometer, all sensors in the sonde were calibrated within a few hours of sampling, in strict adherence to the procedures and recommendations of the manufacturer.

Three independent measures of water transparency were recorded. Water turbidity as nephelometer turbidity units, or NTU, was measured on site with a calibrated Hach 2100 P turbidimeter. The Secchi depth was determined using a black and white 20-cm disk. Lastly, we calculated an average attenuation coefficient (n) for the water column on each date using light data from different depths in the epilimnion according to the following formula:

$$I_z = I_o * e^{-nz}$$

where I_z is irradiance at depth z , I_o irradiance at a shallower depth, z is difference in depth as meters and n is the attenuation coefficient. We solve for (n) as follows:

$$n = (\ln I_o - \ln I_z) / z$$

The magnitude of this coefficient is the slope of the light extinction curve and describes the rate at which light is attenuated per m of depth. More turbid waters attenuate light more rapidly and have a higher (n).

Laboratory Analysis of Water Samples

Integrated samples were taken from a depth of 0-3 m by using clear plastic tubing to draw up water from the different depths. Samples were also collected from the water column at depths of 5 and 7 m and within 1 m from the bottom using a 5 L Van Dorn water sampler. Immediately upon collection water for laboratory analyses was stored in amber bottles and held in ice for transport. All sample containers were rinsed with the water being collected prior to sample collection. In general, all procedures followed Standard Methods for the Analysis of Water and Wastewater (1999).

Analysis of *in vivo* pigment concentrations (chl *a* and phycocyanin) were carried

out on freshly collected samples with a Turner Trilogy laboratory fluorometer (Turner Designs) fitted with module #7200-043 for chl *a* analysis (Excitation λ 485 nm, Emission λ 685 nm) and #7200-044 for phycocyanin (Excitation λ 600 nm, Emission λ 640 nm). The units of fluorescence are reported as relative fluorescence units (rfu) because the fluorometer was not calibrated for *in vivo* determination of chl *a* concentration. Samples corresponding to those analyzed *in vivo* (~ 975 ml) were filtered immediately through a Whatman GF/F fiber filter and stored at -20 °C for subsequent analysis of extracted chl *a*. For extraction the filters were immersed in alkalized 90% acetone, broken up using a tissue grinder and extracted for 10 hrs in a refrigerator. We followed EPA guidelines (method 445.0) for *in vitro* determination of chl *a* and phaeophytin (USEPA Revision 1.2, 1977) using the acidification method for the Turner Trilogy fluorometer. The fluorometer was calibrated within a week before the start of analysis using a five-point calibration generated using a chl *a* standard extracted from *Anacystis nodulans* (Sigma-Aldrich # C6144). Duplicate (independently collected) samples were analyzed from each depth (there were a few exceptions due to errors in processing). A laboratory reagent blank was tested prior to running the analyses.

We experienced some unusual pigment contamination from test tube stoppers while extracting a set of samples collected on July 5. Consequently there are no empirical values for those samples. Instead we used measurements of *in vivo* fluorescence to estimate the corresponding chl *a* concentration based on the following relationship:

$$\text{Chl } a (\mu\text{g} \cdot \text{l}^{-1}) = 0.019 * (I) + 1.082$$

I : *in vivo* rfu on Turner Trilogy fluorometer

This relationship was determined empirically by correlation analysis (Spearman's Rank Correlation, SigmaStat software, Systat Corporation) comparing measurements of sixteen field-collected samples processed during this study.

Analysis of water samples for total phosphorus and soluble reactive phosphorus (TP, SRP; APHA Method 4500-P-F), and nitrate (NO_3^- ; APHA Method 4500- NO_3 -F) were carried out at the Water Chemistry Laboratory, The College at Brockport, State

University of New York (NELAC – EPA Lab Code # NY01449). Sample water for dissolved nutrient analysis was filtered immediately on site with 0.45- μm MCI Magna Nylon 66 membrane filters and held at 4°C until analysis. Quality control procedures for all chemical analyses are described in a number of reports from the laboratory (e.g. Makarewicz *et al.*, 2011) and are not detailed here.

Surveys of the Nearshore

We proposed to quantify the biomass of filamentous algae along the shoreline at three different sites that had been monitored since 2000 as part of the U.S.D.A. project on Conesus Lake and under the Conesus Lake Watershed monitoring plan with funding from the Livingston County Planning Department. The methods used to quantify filamentous growth along shore were developed for the U.S.D.A. project and used successfully to quantify long-term growth trends in Conesus Lake. They have been described in detail in a number of publications (e.g. Bosch *et al.*, 2009a) and technical reports.

The published method is effective when there is a significant macrophyte canopy that allows the bulk of the filamentous algal growth to be near the surface, where it can be photographed for the digital quadrat analysis that is used to estimate % cover, a proxy for biomass (Bosch *et al.*, 2009a). Unfortunately the macrophyte beds had not developed into a surface canopy in much of Conesus Lake by the end of July, and in fact there was little canopy formation through the growing season in 2011.

We visited the three sites routinely during our sampling trips and recorded qualitative observations on the extent and condition of the macrophyte beds and the associated algal cover. The three sites that were monitored were Sand Point Gully, North Gully Cove and Cottonwood Gully. The macrophyte beds at these sites have been surveyed regularly since 2000 and as recently as 2010 (Bosch *et al.*, 2010).

IV. Results and Discussion

Water Column Characteristics

Data from water column profiles taken in Conesus Lake on June 24, 28 and July 5, 19 and in Hemlock Lake on July 12, are shown in **Figures 3-9**.

The trends for temperature with respect to depth and time (**Figure 3**) show a progression of surface warming and an accompanying development of a strong thermocline at a depth of approximately 7 m. The thermocline creates a density barrier to mixing, effectively separating the water column into three vertical zones: A warm and well lighted epilimnion, a deep, dark, and colder hypolimnion, and a transitional area of rapid change known as the metalimnion. During summer stratification in Conesus Lake the thermocline is typically at depths of 7-8 m, and that was the case in 2011 (**Figure 3**). The limitations to mixing created by the thermocline inhibit the exchange of oxygen and carbon dioxide between the epilimnion and hypolimnion, profoundly affecting the limnology of the water column. As large amounts of organic material sink from the surface zone and accumulate in the hypolimnion, aerobic microbial metabolism results in depletion of oxygen (**Figure 4**) and a build up of CO₂. The increasing concentrations of dissolved CO₂ causes a shift in the water carbonate balance reaction, thereby reducing the pH (**Figure 6**). Meanwhile, the loss of oxygen shifts the chemical balance between oxidation and reduction reactions, lowering the redox potential (**Figure 6**) to a point that in eutrophic lakes the late summer redox potential becomes negative. These phenomena, as documented in 2011, are all typical for Conesus Lake (SOCL 2001) and other shallow productive lakes in temperate regions.

Conductivity is a measure of the dissolved ions in water. It is commonly used as an indicator of lake trophic status, with the more eutrophic lakes having a higher conductivity. The conductivity profiles for the four sampling dates in Conesus Lake are interesting in that they appear to follow weather patterns (**Figure 7**). Profiles for June 24 and 28 showed the highest conductivity at 415 and 407 $\mu\text{S} \cdot \text{cm}$. This was after consecutive days of moderate rainfall on June 22-24 of 0.41, 0.31 and 0.18 inches reported for Dansville and 0.94, 0.16, 0.07 inches for Rochester. The July 5 profile, taken after a nine day period of virtually no rainfall, shows the lowest conductivity with values in the epilimnion consistently at about 337 $\mu\text{S} \cdot \text{cm}$. Moderate levels of conductivity on July 19 followed a day of unsettled weather but very little precipitation locally (0.1 for Dansville, 0.3 in. for Rochester,) on July 18. It is possible that high winds may have created sufficient turbulence to cause some mixing of the water column, accounting for the slightly elevated concentrations of SRP in the epilimnion on July 19.

Wind velocities were above average on July 17-18 with gusts reaching speeds of 19-21 mph due to thunderstorm activities.

The water conductivity in Conesus Lake during July was 40% higher than in Hemlock Lake, which is to be expected given the differences in trophic status between the two ecosystems.

The concentrations of key plant nutrients such as inorganic phosphorus (SRP) and NO_3^- are only a minor component of the ion pool that determines lake water conductivity and are not expected to follow the trends seen in the conductivity data. Levels of NO_3^- on all sampling dates were generally below the limit of detection (**Table 2**), as typical for a lake known to be nitrogen limited (Forest, 1977, SOCL 2001). SRP concentrations in the epilimnion were highest on July 19 after an extended period of very little rainfall (but following two days of higher than normal winds) and they were lowest on June 24 following two days of moderate rainfall (**Table 2**). Overall, water column SRP concentrations were less than $2 \mu\text{g} \cdot \text{l}^{-1}$ on all sampling dates. The concentrations of TP in the epilimnion were also highest on July 19 (**Table 2**) as a result of a major algal bloom that was well established by that sampling date (see chl *a* data below).

A comparison of TP and SRP concentrations in the upper 5 m to data collected by Dr. Makarewicz and colleagues since 2001 shows that 2011 levels were not unusual for the late spring/early summer period (**Table 3**). In fact a case can be made that SRP concentrations were low in 2011, even during the June sampling dates that followed the heavy runoff in April and May.

Concentrations of TP and SRP in surface waters were typically three times higher in Conesus Lake than in Hemlock Lake. In contrast, NO_3^- concentrations were usually below detectable levels in Conesus Lake ($<0.01 \text{ mg} \cdot \text{l}^{-1}$) whereas they were low but detectable in Hemlock Lake, averaging $0.165 \text{ mg} \cdot \text{l}^{-1}$. That NO_3^- may be more available for plant growth at Hemlock Lake is an interesting trend considering the proximity and similarities of the two lakes and the fact that Conesus is more eutrophic. It may be that, with a higher supply of phosphorus and greater plant production in Conesus Lake, the demand for NO_3^- is greater, whereas SRP may be the more limiting nutrient for plant growth in Hemlock Lake.

In stratified lakes, the deposition and subsequent decomposition of organic matter from surface waters combined with chemical release of P from sediments (internal loading) leads to a progressive build-up of phosphorus and other chemicals in the hypolimnion, particularly closest to the lake bottom. This progressive increase can be seen in Conesus Lake over the four sampling dates in 2011 (**Table 3**). On June 24, TP and SRP at 1 m off the bottom were 12.9 and 1.1 $\mu\text{g} \cdot \text{l}^{-1}$, respectively. By July 19, the concentrations had increased to 362.8 and 169.9 $\mu\text{g} \cdot \text{l}^{-1}$. The peak TP concentrations near the bottom were similar to those reported in 2009 by Makarewicz and Lewis. However, at 47%, the amount of phosphorus in the form of SRP was nearly twice as high in 2011. This difference may be due simply to annual differences in the timing of seasonal events (e.g. development of anoxia on the lake bottom, fallout from surface algal blooms) that deliver phosphorus to bottom waters. For example, by August in the study by Makarewicz and Lewis (2009), SRP accounted for 80-100% of the TP near the bottom. Similarly, in a 2003 study by Bosch and Makarewicz, the average TP and SRP concentrations were only 83.9 and 61.1 $\mu\text{g} \cdot \text{l}^{-1}$ from July 16-31 but by Sept. 11 the concentrations had increased to 563.1 and 367.3 $\mu\text{g} \cdot \text{l}^{-1}$, with SRP representing more than half of the total TP pool, as it did in July 2011. Without a complete series of measurements throughout the stratification period it is difficult to compare the extent of internal loading of P between years.

Measures of water transparency, including Secchi depth, turbidity, and light penetration, serve as indicators of algal biomass in lakes, and along with chl *a* concentrations provide an accurate picture of production in the water column. As expected, all indications are that Hemlock Lake waters are the more transparent (**Table 4, Figure 8**). For the greener Conesus Lake, we documented two periods of low water transparency and high chl *a* concentrations, with an intervening period of relatively clear water. Secchi depths were shallow and the turbidity and average water column attenuation coefficient were high on June 24 and 28. Conditions were even more extreme on July 19, while on July 5 the water was relatively clear. Turbidity values for the epilimnion on 19 July were extremely high at the surface (8.36 NTU) and averaged 5.87 NTU. Replicate measures and re-calibration of the turbidity meter confirmed these values. Moreover, it can be seen that the turbidity reading was low for the near-bottom

sample that was taken only a few minutes later. The high turbidity, shallow Secchi depth, and high attenuation coefficient match our own perception that a bloom of extreme magnitude was in progress on July 19.

The trends established by analysis of water transparency are reinforced by trends in chl *a* distribution obtained with different methods. Results of our analysis of extracted chl *a* concentrations indicate that on June 24 there was a maximum of $8.22 \mu\text{g} \cdot \text{l}^{-1}$ in the 0-3 m integrated sample. The average chl *a* for the epilimnion was $5.32 \mu\text{g} \cdot \text{l}^{-1}$ (**Table 5**). On July 19 the maximum and average epilimnion chl *a* were 9.76 and $6.51 \mu\text{g} \cdot \text{l}^{-1}$. Comparable measurements during the relatively clear period in early July were $4.63 \mu\text{g} \cdot \text{l}^{-1}$ and $4.46 \mu\text{g} \cdot \text{l}^{-1}$. Profile measurements taken *in vivo* shown in **Figure 9** are consistent with the extracted chl *a* data in showing that the highest chl *a* concentrations occurred on July 19 with maximum values at a depth of 5 m. Unfortunately due to technical difficulties we do not have an *in vivo* profile for June 24. However, the June 28 and July 5 profiles are also consistent with the extracted chl *a* data, particularly in showing that the maxima for those dates were at 0-3 m and at 7 m, respectively.

Yet another way to estimate chl *a* concentrations *in vivo* is with a laboratory fluorometer fitted with appropriate filters. These laboratory units have a greater precision than the units mounted on the profilers. Conversely, the profiling fluorometer provides a spatial resolution that is not feasible with the lab units. The relative fluorescence unit (rfu) equivalents for chl *a* recorded *in vivo* with a Turner Trilogy laboratory fluorometer are shown in **Table 6**. Corresponding extracted chl *a* in $\mu\text{g} \cdot \text{l}^{-1}$ are included in this table for comparison. The two measurements are in strong agreement, indicating that *in vivo* estimates can serve as a good proxy for extracted values when the latter are not feasible (**Figure 10**). The correlation coefficient between extracted and *in vivo* chl *a* is 0.94 and the relationship is highly statistically significant (Spearman's Rank Correlation Analysis, $p < 0.001$). As expected for the less productive Hemlock Lake, the data are much lower in magnitude than those of Conesus Lake but fall well within the line defining the correlation between *in vivo* and extracted measurements.

Also shown in **Table 6** are *in vivo* estimates of phycocyanin concentrations. Phycocyanin is an accessory pigment to chl *a* that is found primarily in cyanobacteria (blue-green algae). The fluorescence sample values we recorded range from 761-1801

rfu. They are low to moderate compared to measurements of more than 8,000 rfu obtained from surface slicks of cyanobacteria sampled later in summer (Bosch pers. observation). One problem with estimating phycocyanin concentrations *in vivo* is the high variability in analytical replicates. This may be an inherent shortcoming caused by the patchiness of colonial cyanobacteria in water samples. More rigorous quality control measures such as increasing analytical replication would improve our confidence in this method. The most significant conclusion that we can draw from the 2011 measurements is that the July 19 phytoplankton bloom was not dominated by cyanobacteria.

The 2011 values for Secchi depth, turbidity, and chl *a* generally fall within a range that can be considered normal for Conesus Lake (**Tables 4, 7**). The only exception is the July 19 measurements taken in the midst of an extensive algal bloom. To our knowledge the average Secchi depth of 1.05 m on July 19 is lower than any other reported before 1978 (Forest et al. 1978; also compiled by Pucket, 1989). The shallowest Secchi depth we could find in the more recent literature was an isolated report of 1.3 m for late May 2004 (Makarewicz *et al.* 2004). Similarly we found several records of turbidity higher than 4.0 NTU in surface waters, but none higher than 5.0 NTU, whereas the average for Conesus Lake was 6.82 NTU.

Interestingly, incidences of chl *a* measurements greater than the maximum of 9.36 $\mu\text{g} \cdot \text{l}^{-1}$ we report for July 19 are not uncommon for Conesus Lake (SOCL 2001, Makarewicz and Lewis 2009). Such discrepancies between the magnitudes of the various indicators of water transparency and the extracted chl *a* concentration are enigmatic. One possible extenuating factor might be the presence of the pigment phaeophytin, the degradation product of chl *a*, in the water column. As with chl *a*, phaeophytin would absorb and deflect light and reduce water transparency. The combined chl *a* - phaeophytin concentration at 5 m on July 19 was 14 $\mu\text{g} \cdot \text{l}^{-1}$, a value that is more consistent with the magnitude and uniqueness of the water transparency data. That the average phaeophytin concentration on July 19 was nearly 60% that of chl *a* may be an indication that the extensive phytoplankton bloom we sampled was on the decline.

Benthic Filamentous Algae

The absence of a macrophyte surface canopy at the Sand Point, Cottonwood Gully and North Gully Cove study sites made any attempt to quantify the percent cover of filamentous algae impractical. However, qualitative observations made during each sampling date at each of these sites were quite revealing. Starting in June we observed that the macrophyte canopy below the surface was covered widely with a dense mat of filamentous algal growth. This mat was especially prominent in the Sand Point study site and in parts of North Gully Cove. The filamentous algal cover was widely distributed in the Cottonwood Gully site but it was not as dense as in the other two sites. Over the next few weeks the filamentous algal mat slowly deteriorated and by July 19 there was a mixed cover of living algae and detritus material that continued to shade the macrophytes beneath. The macrophyte canopy was still below the surface in most places and subsequent observations indicate that it never reached the height seen in other years during the USDA study from 2000-2009 (Bosch et al., 2009b)

V. Conclusions

We found no conclusive evidence to support the hypothesis that ample rains of April and May 2011 and consequent runoff of nutrients from the watershed had a significant effect on the limnology of the water column in Conesus Lake in late June and July. It seems, rather, that amidst all the seasonal changes taking place, the ecosystem responds on a time scale of days (not weeks or months) to events such as runoff and wind-induced mixing that deliver pulses of nutrients to the epilimnion.

In the nearshore, where slower growing and longer-lived filamentous algae dominate early spring algal production (Bosch et al. 2009a), the April-May runoff appears to have triggered a massive bloom, producing a thick mat of filamentous algae that covered the macrophytes along shore and may have suppressed the seasonal development of macrophyte beds. The nearshore bloom was well established by late June and waned in early July, but the residual algal-detrital cover seemed to negatively impact the development of the macrophyte beds well into July.

It may be that much of the nutrient supply delivered by runoff from the abundant springtime rainfall in 2011 was intercepted nearshore, where it triggered extensive blooms of

filamentous algae. In the open water regions of the lake, nutrient levels were not consistently high and other aspects of the water column ecosystem were generally within the range measured in previous years.

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VII. Tables

Table 1. April through August precipitation record for Rochester from 2001-2011. The rainfall total in April was an all time high and combined April-May totals were the highest in the last 11 years. Conversely, June and July had very low rainfall totals. Data is from the NOAA National Weather Forecast Office in Buffalo, NY.

Rochester, NY	April	May	June	July	August
2001	1.19	2.66	1.84	1.8	4.3
2002	3.44	5.87	4.29	1.59	0.84
2003	1.27	4.56	2.23	2.26	4.15
2004	3.48	4.53	3.11	6.35	3.68
2005	4.43	1.24	2.44	3.36	5.1
2006	2.18	1.77	3.72	8.02	2.75
2007	3.64	0.24	2.3	2.31	0.81
2008	1.94	1.41	2.59	3.91	2.97
2009	2.2	3.3	6.25	4.32	1.63
2010	1.56	2.55	5.94	5.7	2.68
2011	5.81	4.8	1.45	1.81	5.61

Table 2. Concentrations of total phosphorus (TP), nitrate, and soluble reactive phosphorus (SRP) over deep water in the South Basins of Conesus Lake and Hemlock Lake. Water nutrient analyses were conducted at the Water Chemistry Laboratory, The College at Brockport, State University of New York.

Lake	Date Collected	Depth (m)	TP ($\mu\text{g P/L}$)	Nitrate (mg N/L)	SRP ($\mu\text{g P/L}$)
Conesus	24 June	0-3	23.8	N.D.	0.5
		7	15.6	N.D.	0.5
		17	12.9	0.15	1.1
	28 June	0-3	18.6	N.D.	1.4
		5	18.4	N.D.	1.5
		7	10.3	N.D.	1.2
		18	22.7	0.13	3.5
	5 July	0-3	23.2	N.D.	0.1
		5	20.5	N.D.	1.0
		17	99.8	0.01	69.2
	19 July	0-3	32.0	0.01	1.8
		5	24.5	N.D.	1.0
17		362.8	N.D.	169.9	
Hemlock	12 July	0-3	8.4	0.16	0.7
		7	7.0	0.17	0.3
		22	6.5	0.31	1.7

Table 3. Multi-year record of total phosphorus (TP) and soluble reactive phosphorus (SRP) at depths of 0-3 m and less than 1 m off the bottom in the deepest parts of Conesus Lake. All values are in units of micrograms per liter. ($\mu\text{g} \cdot \text{l}^{-1}$). Pre-2011 data were obtained from reports by J. Makarewicz and coworkers (2000, 2003, 2004, 2009).

	June 20-30				July 1-15				July 16-31			
	0-5 m		18 m		0-5 m		18 m		0-5 m		18 m	
Year	TP	SRP	TP	SRP	TP	SRP	TP	SRP	TP	SRP	TP	SRP
2001	17	7.5	24	< 5	27	3.8	30	<5	17	4.2	15	<5
2003	-	-	-	-	16.2	1.9	15	2.6	21.6	3.2	83.9	61.1
2004	24.5	4.0	-	-	38.3	1.9	-	-	22.7	2.1	-	-
2009	25.8	3.9	36.2	11	24.9	0.9	95.9	67.3	20.2	2.42	397.2	98.2
2011	21.2	1.0	17.8	2.3	23.2	0.1	99.8	69.2	32.0	1.8	362.8	169.9

Table 4. Table showing Secchi depths, turbidity, and water column attenuation coefficients for Conesus Lake and Hemlock Lake in 2011.

Lake	Date	Depth (m)	Secchi Depth (m)			Turbidity (NTU)	Light Atten.
Conesus	24-Jun	0-3	2.0	2.1	2.0	-	0.71 ± 0.04
	28-Jun	0-3	2.8	2.9	3.0	-	0.59 ± 0.16
	5-Jul	0-3	2.9	3.0	2.9	2.04 ± 0.16	0.63 ± 0.01
		5				1.94 ± 0.01	
19-Jul	0-3	1.0	1.1	1.1	8.36 ± 1.11	0.83 ± 0.02	
	5				5.27 ± 0.47		
	7				3.97 ± 0.45		
	17.5				1.45		
Hemlock	12-Jul	0-3	3.9	4.0		1.63 ± 0.29	0.37 ± 0.09
		5				1.85 ± 0.62	
		7				2.59 ± 0.13	
		22				0.72	

Table 5. Concentrations Chl *a* in μg per liter for three depths in the epilimnion. The mean and standard deviation, and the coefficient of variation are shown for each depth. July 5 data are estimated from *in vivo* fluorescence values.

Extracted Chl a $\mu\text{g} \cdot \text{l}^{-1}$					
	Conesus 6-24	Conesus 6-28	Conesus 7-5	Conesus 7-19	Hemlock 7-12
0-3 m	7.82	5.38	3.09	5.28	3.13
	8.22	4.6	2.99	6.21	2.2
Mean	8.02	4.99	3.04	5.75	2.67
S.D.	0.28	0.55	0.07	0.66	0.66
C.V.	3.53	11.05	2.33	11.45	24.68
5 m	4.8	3.94	4.48	9.76	2.96
	5.69		4.63	8.06	3.31
Mean	5.25		4.56	8.91	3.14
S.D.	0.63		0.11	1.20	0.25
C.V.	12.00		2.33	13.49	7.89
7 m	3.23	2.39	4.97	5.31	3.95
	2.14		6.60	4.44	4.62
Mean	2.69		5.79	4.88	4.29
S.D.	0.77		1.15	0.62	0.47
C.V.	28.71		19.92	12.62	11.06

Table 6. Chlorophyll *a* and phycocyanin pigments measured *in vivo* with a Turner desktop fluorometer. The units are reported as relative fluorescence units (rfu). Corresponding extracted Chl *a* values (mg per liter) are shown for comparison.

Lake	Date Collected	Depth (m)	<i>In Vivo</i> Chl <i>a</i> (rfu)	Extracted Chl <i>a</i> + ($\mu\text{g} \cdot \text{l}^{-1}$)	<i>In Vivo</i> Phycocyanin (rfu)
Conesus	6/28/11	0-3	171, 205	4.60, 5.38	1220, 1051
		5	110	3.94	1257
		7	89	2.39	1801
	7/19/11	0-3	315, 302	6.21, 5.28	848, 1056
		5	309, 415	8.06, 9.76	774, 910
		7	210, 199	5.44, 5.31	838, 888
Hemlock	7/12/11	0-3	119, 86	3.13, 2.20	1092, 975
		5	99, 117	2.96, 3.31	780, 1267
		7	147, 154	3.95, 4.62	789, 761

Table 7. This table shows a multiple-year record of average turbidity and chl *a* for the central station of the south basin in Conesus Lake at depths 0-5 m. Pre-2011 data were obtained from reports by J. Makarewicz and coworkers (2000, 2003, 2004, 2009).

Year	June 20-30		July 1-15		July 16-31	
	Turbidity	Chl <i>a</i>	Turbidity	Chl <i>a</i>	Turbidity	Chl <i>a</i>
2001	0.55	8	0.75	8	1.20	10
2003	-	-	1.42	-	1.43	-
2004	1.75	13.8	1.59	11.5	-	3.1
2009	1.53	7.3	1.60	6.2	1.73	6.2
2011	-	5.3	1.99	5.9	6.82	7.3

VIII. Figures

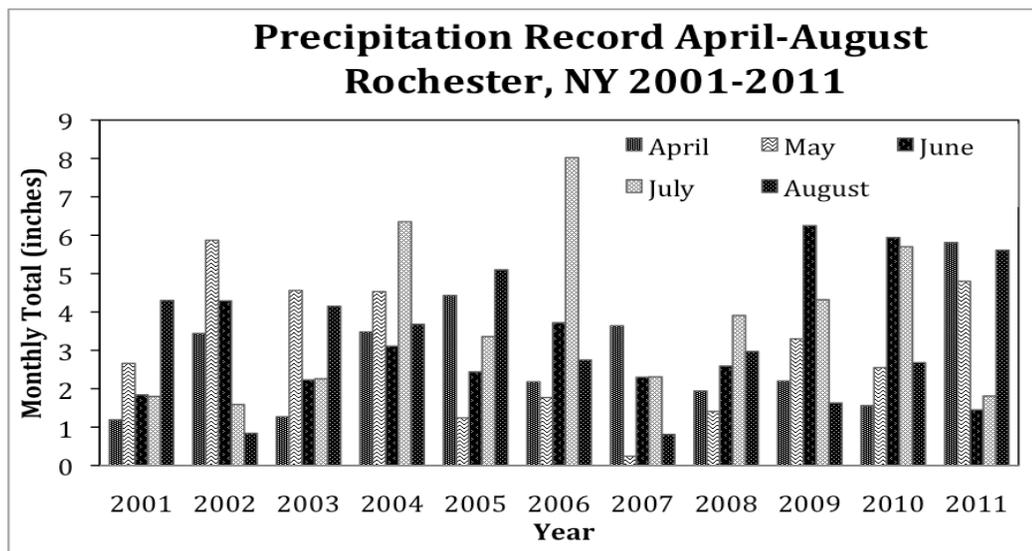


Figure 1. Monthly precipitation for April-August in Rochester New York over the last 11 years. Rainfall in April 2011 was an all time record for the month and the combined precipitation for April through June were the highest in the last 11 years.

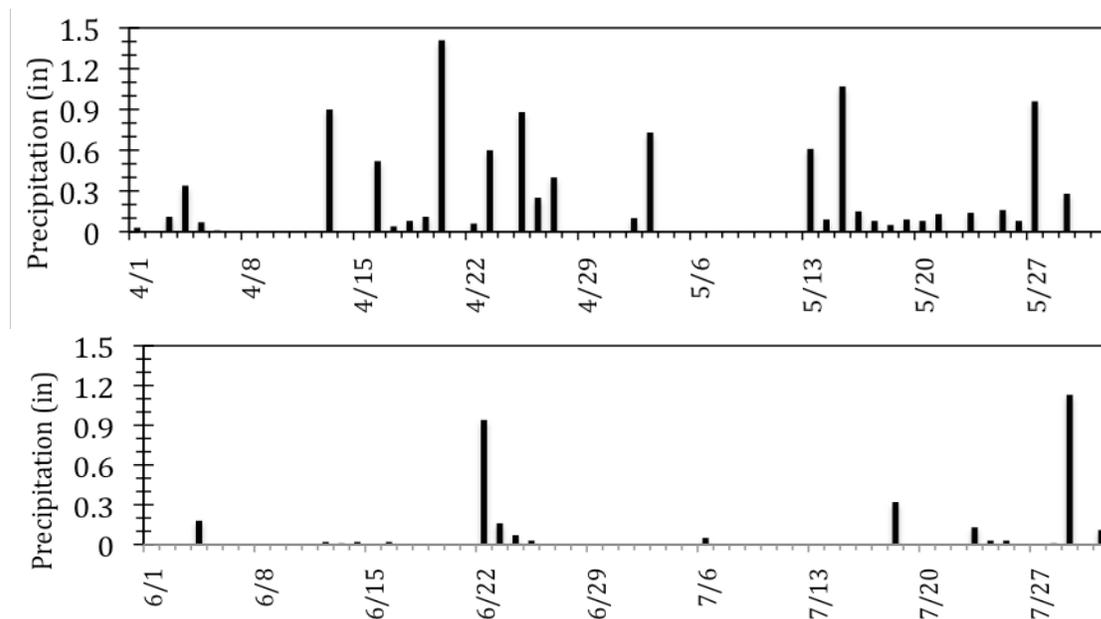


Figure 2. Daily precipitation in Rochester for April through May (top) and June through July (bottom) in 2011. Events were recorded prior to our June 24 and July 19 sampling dates for both Rochester and Dansville.

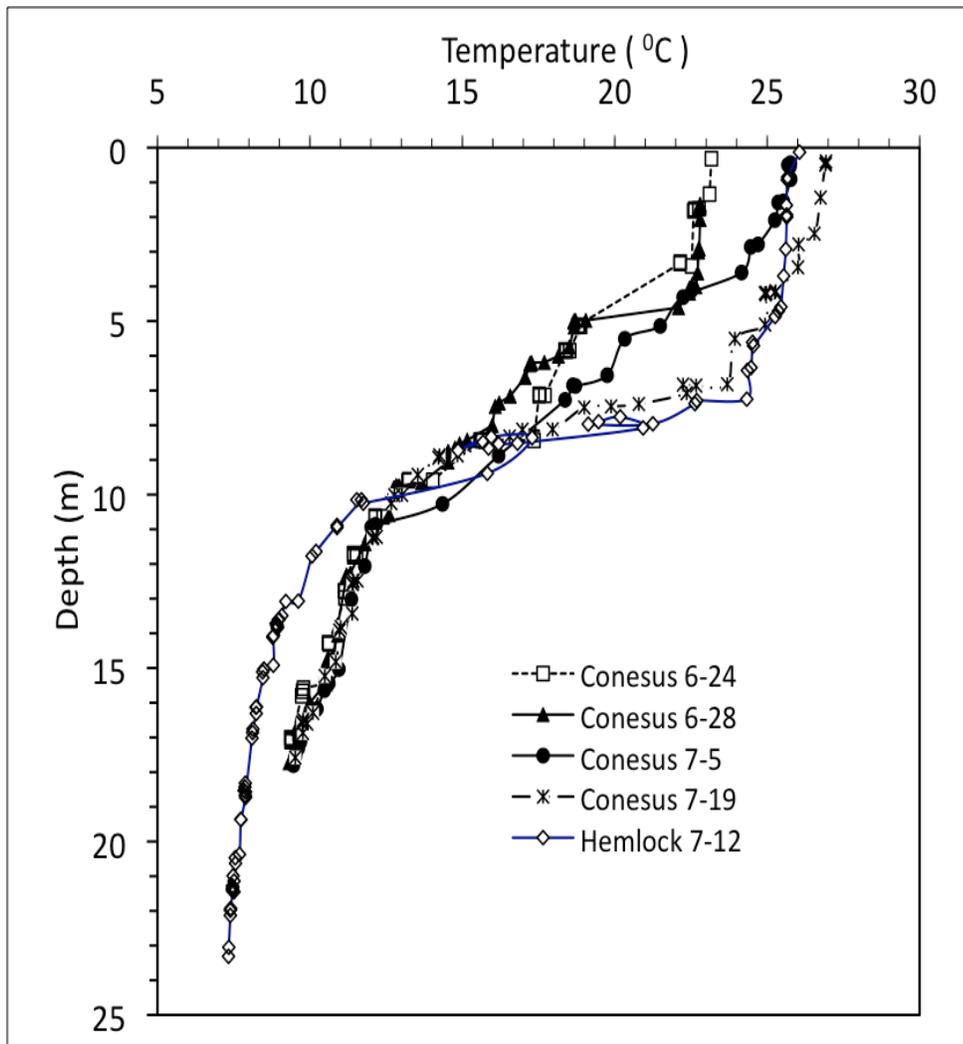


Figure 3. Temperature profiles for Conesus and Hemlock lakes. The Conesus Lake time series shows the warming of surface waters and strengthening of the thermocline from late June to July.

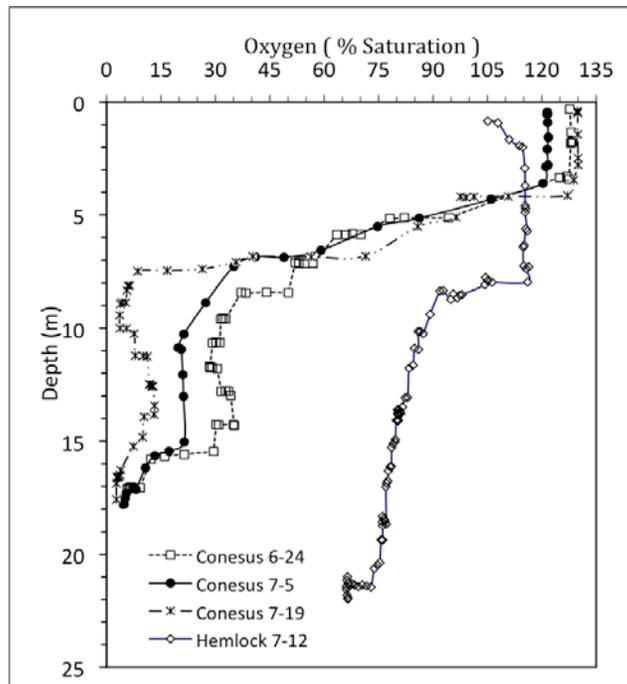
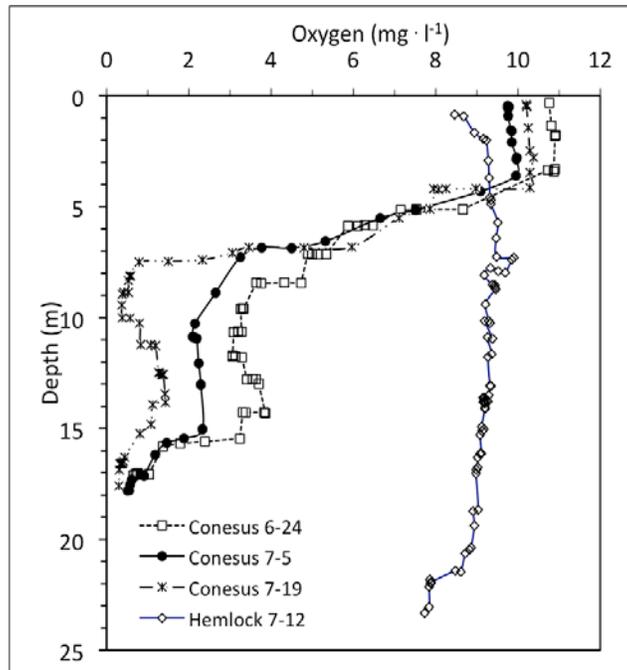


Figure 4. Profiles of oxygen concentration (top graph) and oxygen saturation (bottom) for Conesus Lake and Hemlock Lake. The hypolimnion in Conesus Lake becomes increasingly depleted of oxygen in this progression. June 28 values were nearly identical to those of June 24 and are not included.

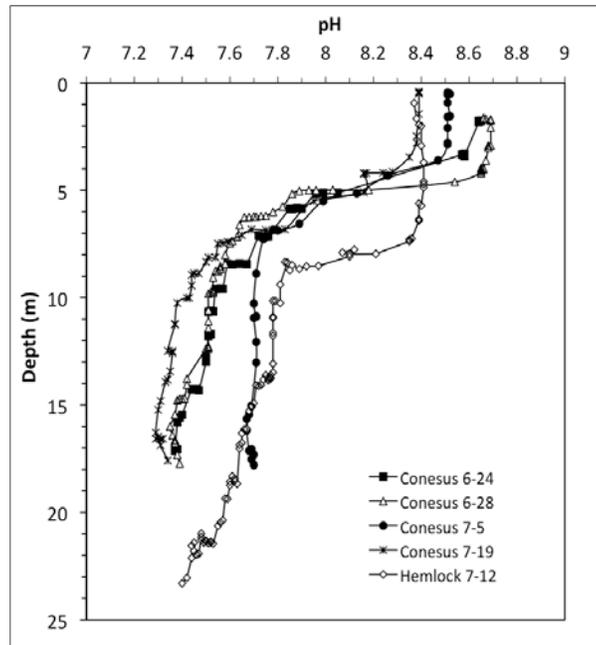


Figure 5. Profiles of changes in pH with depth. pH values decrease below the thermocline over the period of stratification, due in large part to the buildup of carbon dioxide in the hypolimnion.

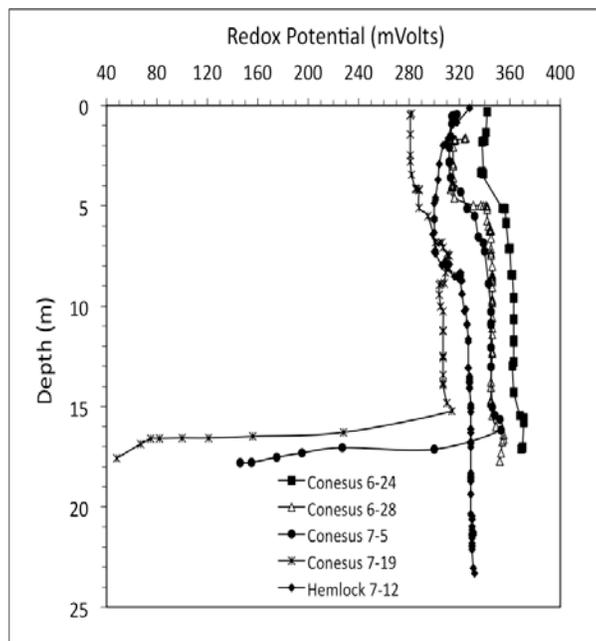


Figure 6. Profiles of redox potentials for Conesus Lake and Hemlock Lake. The low redox potentials near the bottom in the July Conesus Lake samples are an indication that nearly all the dissolved oxygen at those depths has been consumed.

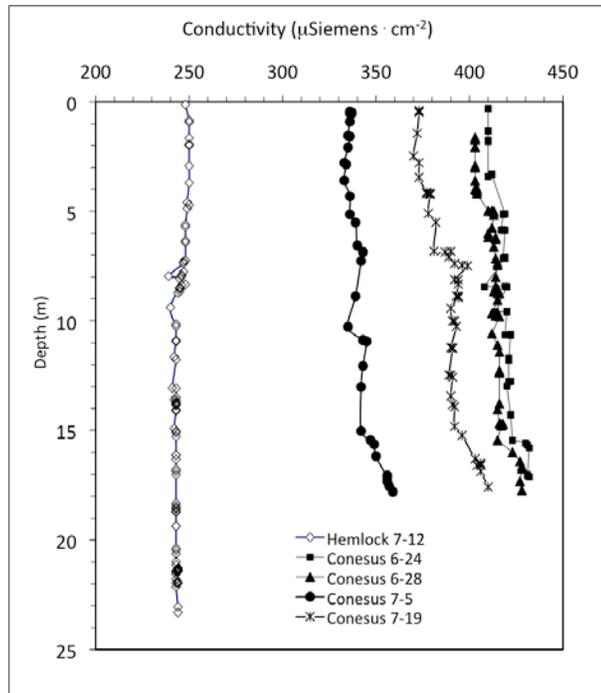


Figure 7. Conductivity profiles reflect trends in concentrations of dissolved ions. In July conductivity values for Conesus Lake were ~30% higher than those of Hemlock Lake.

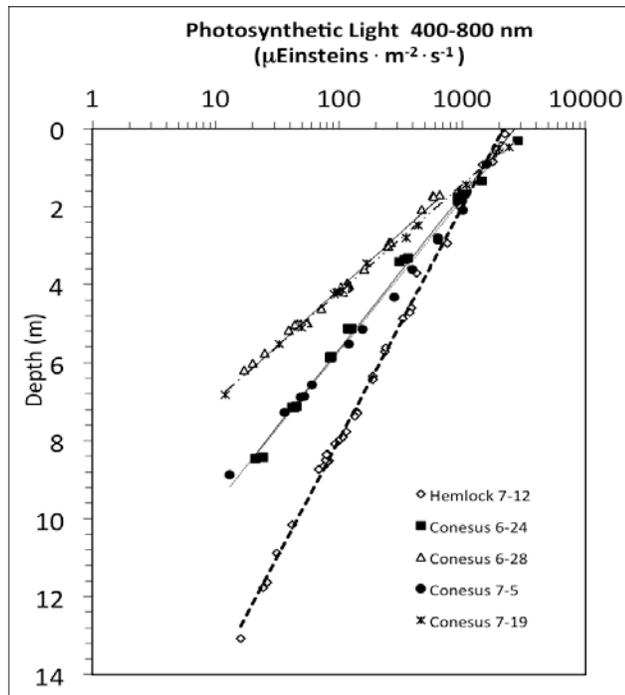


Figure 8. Light penetration into surface waters of Conesus Lake and Hemlock Lake shown on a log scale for light. The more turbid waters of Conesus Lake attenuate light more rapidly.

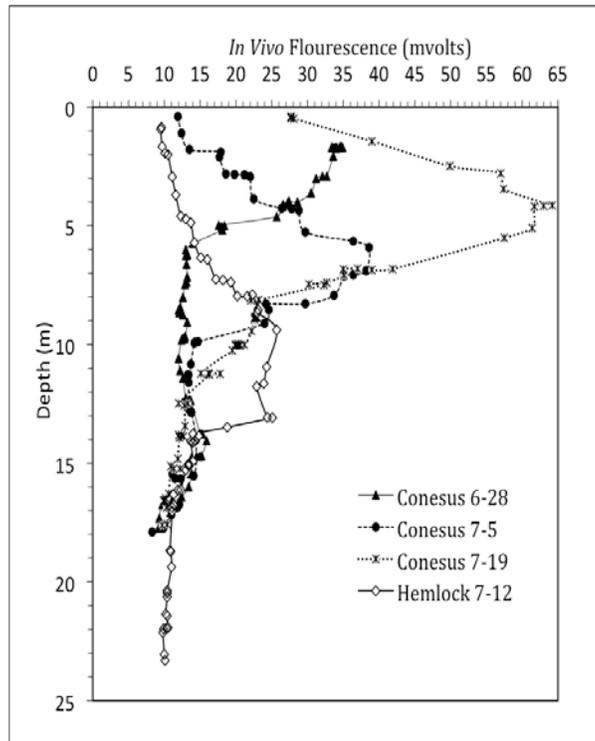


Figure 9. Profiles of chl *a* measured *in vivo* using a Turner fluorometer on a Hydrolab profiler. The data trends are shown in millivolts. These curves are reliable indicators of relative amounts of chl *a* and changes with depth.

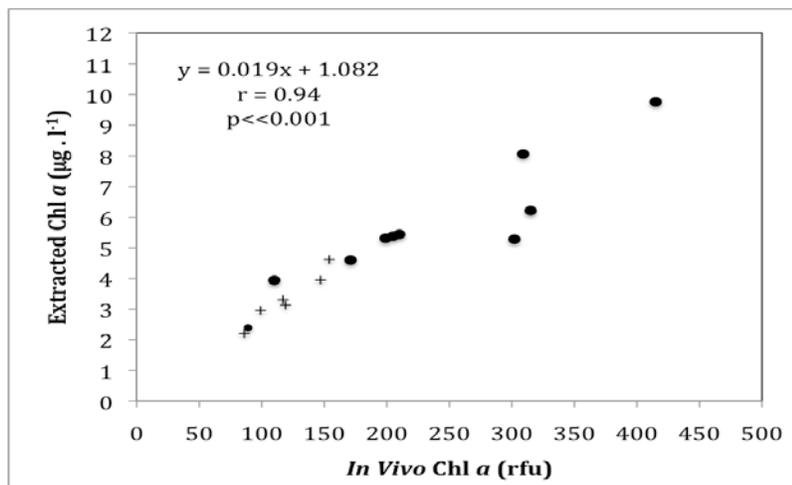


Figure 10. Correlation analysis of the relationship between extracted chl *a* and *in vivo* chl for Hemlock (+) and Conesus Lakes (●). A Spearman's Rank Correlation analysis revealed that the relationship was highly significant ($r = 0.94$, $p < 0.001$)

Appendix I. June 24 profile taken over a depth of 18 m in the south basin, Conesus lake.

Depth (m)	Temp [°C]	pH	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	Chl a [mVolts]
0.32	23.17	8.66	342	410	2843	127.7	10.76	-
1.34	23.11	8.66	341	410	1435	128.1	10.81	-
1.76	22.76	8.65	340	410	913	128.5	10.91	-
1.77	22.62	8.64	339	410	989	128.3	10.92	-
1.82	22.59	8.64	338	410	926	128	10.9	-
3.41	22.52	8.58	339	410	311	127.5	10.87	-
3.3	22.15	8.58	338	412	365	126.9	10.9	-
3.34	22.14	8.57	337	412	341	124.9	10.73	-
5.12	18.8	8.05	354	419	118	94.3	8.66	-
5.12	18.84	7.99	355	418	125	82.1	7.53	-
5.15	18.88	7.96	356	418	121	78.1	7.15	-
5.85	18.52	7.9	357	417	87	70.1	6.47	-
5.83	18.37	7.88	357	418	86	67.8	6.28	-
5.87	18.41	7.86	357	418	84	66	6.11	-
5.86	18.38	7.85	357	419	84	63.5	5.87	-
7.14	17.71	7.76	359	418	42	56.9	5.34	-
7.15	17.52	7.75	359	419	43	54.6	5.14	-
7.14	17.54	7.73	360	419	43	53	4.99	-
7.11	17.52	7.72	360	419	45	52	4.89	-
8.44	17.35	7.67	361	408	24	50.1	4.73	-
8.42	15.65	7.64	362	419	24	44.1	4.32	-
8.45	15.64	7.61	362	420	21	38.4	3.76	-
8.43	15.58	7.59	362	420	23	37.1	3.64	-
9.59	14.03	7.57	363	414	13	32.8	3.33	-
9.57	13.25	7.56	363	420	13	32.1	3.31	-
9.6	13.22	7.54	363	420	13	31.5	3.26	-
10.64	12.4	7.53	363	419	7	31.2	3.28	-
10.62	12.14	7.52	363	422	8	30.2	3.2	-
10.66	12.15	7.51	363	422	7	29.2	3.09	-
11.76	11.53	7.51	363	421	5	28.5	3.06	-
11.7	11.43	7.52	363	421	4	28.4	3.06	-
11.75	11.44	7.51	363	421	3	29.1	3.13	-
11.79	11.44	7.51	363	421	2	30.5	3.29	-
12.79	11.16	7.5	363	421	0	31.6	3.41	-
12.77	11.13	7.5	363	422	0	32.8	3.55	-
12.78	11.14	7.5	363	421	0	33.6	3.63	-
12.98	11.15	7.5	362	420	0	34.2	3.7	-
14.31	10.63	7.47	363	422	0	35.2	3.86	-
14.27	10.61	7.46	363	422	0	35	3.83	-
14.28	10.62	7.45	363	422	0	30.9	3.38	-
14.27	10.62	7.44	363	422	0	30.2	3.31	-
15.45	10.52	7.4	368	423	0	29.5	3.24	-
15.58	9.79	7.39	371	430	0	21.4	2.39	-
15.67	9.76	7.38	371	431	0	16	1.79	-
15.8	9.73	7.38	371	432	0	12.2	1.37	-
17.06	9.4	7.37	370	431	0	9.2	1.03	-
17.01	9.37	7.37	370	431	0	6.7	0.75	-
17.06	9.38	7.38	370	431	0	6.2	0.7	-
17.12	9.38	7.37	369	432	0	5.7	0.65	-

Appendix II. June 28 profile taken over a depth of 18 m in the south basin, Conesus Lake.

Depth (m)	Temp [°C]	pH	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	Chl a [mVolts]
1.63	22.8	8.66	325	403	472	130.3	11.05	37.4
1.67	22.8	8.67	324	403	452	130.3	11.06	35.6
1.7	22.78	8.69	317	403	658	130.4	11.07	34.9
1.74	22.8	8.69	316	403	589	130.6	11.08	34
2.07	22.8	8.69	315	403	471	130.6	11.08	32.6
2.92	22.75	8.68	315	403	264	130.3	11.07	32.1
3.01	22.75	8.68	315	403	250	129.8	11.02	31.2
3.61	22.72	8.67	315	403	160	129.2	10.98	30.5
3.99	22.54	8.66	315	403	120	127.6	10.88	28.6
4.05	22.45	8.65	314	404	116	124.7	10.65	27.2
4.09	22.45	8.65	314	404	112	124.1	10.6	26.6
4.19	22.45	8.65	313	404	107	123.5	10.55	26.5
4.61	22.09	8.54	316	395	72	123.1	10.53	25.7
5	18.67	7.96	339	413	49	65.5	6.03	18.4
5.03	18.66	7.89	342	413	44	55.5	5.11	18
5.17	18.67	7.86	342	413	39	54	4.97	18.1
5.75	18.51	7.82	342	412	25	48.4	4.46	14
6.01	18.15	7.78	343	410	20	47.1	4.38	13
6.19	17.69	7.75	344	410	17	41	3.85	13.2
6.2	17.27	7.73	344	414	15	39.6	3.75	13.2
6.23	17.27	7.71	344	414	13	38.5	3.64	13.1
6.25	17.22	7.68	345	414	11	35.8	3.4	13
6.26	17.22	7.66	344	414	11	34.7	3.29	13.1
6.62	17.06	7.64	345	413	9	33.8	3.22	13.1
7.16	16.57	7.63	345	414	6	33.3	3.2	13.2
7.36	16.21	7.61	345	415	5	29.5	2.86	13.1
7.46	16.08	7.6	345	415	5	28.9	2.81	12.9
8.01	15.98	7.58	346	414	4	28.5	2.77	12.6
8.43	15.16	7.58	346	414	3	25.4	2.52	12.2
8.54	14.91	7.56	346	415	3	24.9	2.47	12
8.66	14.76	7.56	346	413	3	24.5	2.45	12.1
8.76	14.54	7.55	346	416	2	24.2	2.43	12.6
9.06	14.53	7.53	346	415	2	23	2.31	13.2
9.66	13.66	7.53	346	412	2	22.8	2.33	12.9
9.75	12.93	7.53	346	414	2	22.9	2.38	12.6
9.77	12.9	7.53	346	414	0	23	2.39	12.8
9.81	12.75	7.51	346	416	0	23.8	2.48	12.4
10.58	12.6	7.51	346	412	0	24	2.52	12
11.42	11.81	7.51	346	416	0	24.2	2.59	12.6
12.28	11.32	7.51	346	416	0	24.5	2.64	13
12.36	11.2	7.51	346	416	0	25.1	2.71	13.7
14.05	10.91	7.42	345	415	0	24	2.62	15.9
14.69	10.74	7.41	345	416	0	24.3	2.65	15.2
14.72	10.59	7.39	345	418	0	20	2.19	14.5
14.77	10.57	7.38	345	417	0	16.2	1.77	13.8
15.45	10.51	7.37	346	415	0	15.7	1.72	13.8
16	10	7.35	349	423	0	12.6	1.4	13.4
16.41	9.82	7.36	355	427	0	9.5	1.06	12.4
16.63	9.61	7.37	355	428	0	8.5	0.95	11
16.75	9.59	7.37	354	428	0	6.4	0.72	9.7
17.32	9.5	7.38	353	427	0	5.9	0.66	9.3
17.73	9.32	7.39	352	428	0	5.4	0.6	9.2

Appendix III. July 5 profile taken over a depth of 18 m in the south basin, Conesu Lake.

Depth (m)	Temp [°C]	pH	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m²]	LDO% [Sat]	LDO [mg/l]	Chl a [mVolts]
0.45	25.76	8.51	318	336	2095	121.5	9.75	12.1
0.54	25.74	8.51	317	336	1876	121.6	9.77	11.9
0.5	25.68	8.51	317	336	2094	121.6	9.78	12.1
0.49	25.7	8.51	316	337	2077	121.5	9.77	1.26
0.51	25.75	8.52	315	336	1899	121.5	9.76	12.1
0.54	25.75	8.51	314	337	1925	121.4	9.75	11.8
0.91	25.77	8.51	314	336	1584	121.6	9.76	11.9
1.55	25.53	8.52	313	335	1087	121.8	9.83	12.5
1.58	25.36	8.51	313	336	997	121.8	9.85	13.7
2.09	25.25	8.51	312	335	1007	121.5	9.85	15.2
2.79	24.7	8.51	312	333	639	121.7	9.97	21.2
2.86	24.46	8.51	312	334	640	121.1	9.96	21.1
3.6	24.16	8.47	313	333	394	120.3	9.95	21.7
4.31	22.24	8.26	321	336	282	106	9.09	28.2
5.14	21.49	8.13	326	336	155	86.2	7.51	28.2
5.51	20.33	7.99	332	339	121	74.7	6.65	33.7
6.56	19.75	7.89	335	340	60	59.1	5.32	56.2
6.87	18.71	7.8	339	343	49	48.9	4.5	32.1
6.85	18.63	7.78	339	343	52	41	3.77	37.7
7.27	18.37	7.74	340	342	36	35.1	3.25	36.6
8.88	16.19	7.71	343	339	13	27.3	2.65	31.1
10.27	14.35	7.7	345	335	6	21.3	2.15	12.1
10.87	12.15	7.71	345	343	5	19.7	2.09	13.3
10.89	12.11	7.71	345	343	4	20.1	2.13	13.5
10.94	12.01	7.7	345	345	4	20.6	2.19	13.5
12.06	11.8	7.71	345	343	1	21	2.24	13.3
13.02	11.36	7.71	345	342	0	21.2	2.29	13.3
15.03	10.95	7.69	346	342	0	21.4	2.33	19.6
15.44	10.62	7.68	348	347	0	17.2	1.88	15.2
15.64	10.47	7.67	352	349	0	13.3	1.46	10.8
16.18	10.23	7.67	353	350	0	10.7	1.18	9.6
17.13	9.69	7.68	300	356	0	8.1	0.91	10.1
17.05	9.64	7.69	227	356	0	7.3	0.82	10
17.31	9.62	7.7	195	356	0	5.4	0.61	9.7
17.53	9.53	7.69	175	357	0	5.1	0.57	9.7
17.79	9.44	7.7	155	359	0	4.8	0.55	9.8
17.8	9.46	7.7	146	359	0	4.6	0.51	15.4

Appendix IV. July 19 profile taken over a depth of 18 m in the south basin, Conesus Lake.

Depth (m)	Temp [°C]	pH	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m²]	LDO% [Sat]	LDO [mg/l]	Chl a [mVolts]
0.49	26.91	8.39	281	373	1980	129.9	10.21	28.1
1.44	26.75	8.39	281	372	1081	129.9	10.25	39.0
2.48	26.55	8.38	281	370	443	130	10.29	49.9
2.79	26.03	8.38	281	373	349	130	10.38	57.0
3.45	26.01	8.35	282	373	167	128.8	10.29	57.4
4.14	25.28	8.28	285	377	108	127.1	10.29	67.2
4.18	25.25	8.24	286	377	99	110.8	8.98	61.7
4.19	24.97	8.17	288	378	96	101.3	8.25	61.4
4.23	24.95	8.16	288	379	92	99.1	8.07	61.1
4.19	24.93	8.16	288	379	94	97.6	7.95	61.4
5.1	24.93	8.16	288	378	84	96.4	7.86	61.4
5.51	23.94	7.95	295	382	33	85.8	7.11	57.5
6.82	23.69	7.83	301	381	12	71.4	5.96	41.9
6.86	22.67	7.75	304	387	12	56.4	4.8	39.0
6.83	22.24	7.69	306	390	13	40.3	3.46	35.0
7.08	22.36	7.65	307	389	10	35.7	3.06	35.1
7.39	20.79	7.59	310	392	8	26.4	2.33	32.7
7.46	19.88	7.57	311	396	8	16.7	1.5	30.2
7.49	19	7.55	312	399	7	8.6	0.79	32.2
8.12	17.96	7.54	312	392	5	6.4	0.59	23.2
8.13	16.97	7.51	311	394	5	5.9	0.56	22.1
8.33	16.55	7.5	309	394	4	5.6	0.53	23.0
8.87	14.84	7.47	308	393	3	5.3	0.53	22.8
8.87	14.25	7.45	305	394	3	4.2	0.42	22.8
8.94	14.22	7.44	304	394	3	3.8	0.38	22.6
9.43	13.54	7.44	304	390	2	3.6	0.37	22.2
10.01	13.02	7.43	305	391	2	3.7	0.38	21.2
10.02	12.77	7.42	305	392	2	5.5	0.57	20.0
10.25	12.67	7.38	307	393	0	7.6	0.8	19.5
11.22	12.19	7.37	307	390	0	7.9	0.83	15.1
11.23	12.07	7.37	307	391	0	10.1	1.07	17.8
11.26	12.06	7.37	307	391	0	11.2	1.19	16.3
12.48	11.56	7.34	307	389	0	11.7	1.26	12.0
12.49	11.43	7.36	307	390	0	12	1.29	13.3
12.57	11.41	7.36	307	391	0	12.4	1.34	12.8
12.57	11.39	7.36	307	391	0	12.8	1.38	12.8
13.43	11.39	7.35	307	390	0	13.2	1.42	12.9
13.82	11.01	7.34	307	391	0	13.1	1.43	12.4
13.92	10.97	7.33	307	392	0	10.3	1.12	12.1
14.82	10.85	7.31	310	392	0	9.9	1.08	11.9
15.23	10.49	7.3	314	396	0	7.4	0.81	11.3
16.29	10.1	7.29	228	403	0	3.9	0.44	10.6
16.49	9.78	7.3	156	406	0	3.7	0.41	10.2
16.57	9.75	7.32	121	406	0	3.5	0.39	10.1
16.57	9.76	7.29	100	406	0	3.3	0.37	9.9
16.59	9.76	7.31	82	406	0	3	0.34	9.9
16.6	9.91	7.31	75	404	0	2.8	0.32	10.0
16.87	9.77	7.31	67	406	0	2.7	0.31	10.3
17.58	9.52	7.34	48	410	0	2.7	0.3	9.7

Appendix V . July 12 profile taken in the south basin of Hemlock Lake over a depth of 24 m.

Depth (m)	Temp [°C]	pH	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m²]	LDO% [Sat]	LDO [mg/l]	Chl a [mVolts]
0.85	25.67	8.31	318	250	1763	105.1	8.46	9.6
0.93	25.66	8.37	314	250	1471	107.9	8.68	9.7
1.66	25.63	8.38	311	250	1076	111	8.94	10.1
2	25.64	8.4	307	250	967	114.7	9.23	11.6
2.93	25.61	8.4	304	250	761	115.3	9.28	12.3
3.7	25.54	8.41	303	250	427	115.4	9.3	13.7
4.59	25.45	8.41	301	249	387	115.4	9.32	14.2
4.71	25.37	8.41	301	250	372	115.5	9.34	15.1
4.87	25.26	8.41	300	249	330	115.4	9.34	16.0
5.71	24.55	8.4	300	248	235	116	9.51	18.2
6.34	24.47	8.39	300	248	189	115.1	9.47	19.3
7.29	22.69	8.35	300	247	141	116.4	9.9	22.3
7.38	22.63	8.35	301	247	135	115.7	9.85	23.1
7.96	21.25	8.21	306	239	102	116.1	10.16	23.0
8.08	20.93	8.1	310	245	93	104.3	9.18	21.7
8.66	15.86	7.89	320	245	76	96.7	9.44	23.9
8.73	14.86	7.85	322	244	68	94.9	9.46	22.9
9.39	15.82	7.81	322	240	20	94.3	9.21	22.2
10.25	11.75	7.81	324	243	16	87.3	9.32	28.0
10.95	10.89	7.78	326	243	17	86	9.38	18.3
11.64	10.2	7.78	327	242	26	84.5	9.36	18.8
11.77	10.07	7.78	327	243	24	83.4	9.27	14.0
13.08	9.21	7.78	327	243	10	82.3	9.34	14.3
13.49	9.08	7.78	328	243	12	81.6	9.29	14.0
13.77	8.91	7.77	328	243	12	81.1	9.27	13.8
13.85	8.93	7.76	328	243	7	80.5	9.19	13.7
14.11	8.78	7.72	328	243	2	80.3	9.2	13.4
14.92	8.8	7.7	329	242	2	79.6	9.12	13.4
15.03	8.49	7.69	329	243	1	79.5	9.17	13.0
15.11	8.45	7.69	329	243	1	79	9.13	12.3
15.28	8.46	7.68	329	243	0	78.6	9.08	11.9
16.13	8.23	7.66	329	243	0	78.2	9.08	11.3
16.31	8.24	7.65	329	243	0	77.7	9.02	11.1
16.76	8.13	7.65	329	243	0	77.5	9.02	11.1
16.86	8.12	7.64	329	243	0	77.2	8.99	10.8
17.02	8.1	7.64	329	243	0	77	8.98	10.9
18.67	7.88	7.63	329	243	0	77.1	9.03	11.0
18.73	7.89	7.6	329	243	0	76.1	8.91	10.9
19.37	7.74	7.59	329	243	0	76.1	8.94	10.4
20.37	7.69	7.57	329	243	0	75.3	8.86	10.2
20.63	7.56	7.55	330	243	0	73.8	8.72	10.5
21.36	7.46	7.52	330	244	0	70.5	8.34	10.3
21.43	7.47	7.51	330	244	0	69.4	8.21	9.9
21.93	7.4	7.47	330	244	0	66.5	7.88	10.1
21.96	7.4	7.46	330	243	0	66.5	7.88	10.2
22.13	7.39	7.44	330	243	0	66.2	7.84	10.0
23.05	7.34	7.42	331	244	0	66.1	7.84	10.3
23.31	7.33	7.4	332	244	0	65.1	7.73	9.6

