

Monitoring of Water Quality, Water Column Mixing and Blooms of Cyanobacteria In Conesus Lake (NY), Summer 2017



**Report Submitted to
The Livingston County Planning Department**

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I. SUMMARY

- The summer 2017 sampling program conducted by SUNY Geneseo extended regular monitoring of water quality in accordance with the Watershed Management Plan and continued to evaluate the link between partial summer water column mixing of phosphorus from the lake depths and the onset of surface cyanobacterial blooms.
- The shallow north basin (12 m), the center basin (14 m) and the southern basin (18 m) showed differences in calculated thermocline depth and water column stability (Schmidt Index), with the shallow northern basin having a deeper thermocline and mixing more readily, and the deeper basin being the most stable.
- Significant partial water column mixing on July 1-3 and Sep 4-5 were associated with increases in surface phosphorus and cyanobacteria colony abundance. The July 1-3 event was preceded by major thunderstorms with high winds and runoff into Conesus Lake, which masked any wind effect. However, the Sep 4-5 mixing event was clearly driven by high winds from the south, along the length of the fetch of the lake.
- Cyanobacterial blooms in 2017 were low in colony and cell number. The dominant forms were multiple species of *Anabaena* (now *Dolichospermum*) that are historically abundant in Conesus Lake. Colonies of *Microcystis aeruginosa* were rarely detected.
- The summer 2017 average total phosphorus concentrations (21.9 µg/L), chlorophyll a concentrations (4.8 µg/L) and Secchi depths (2.3 m) in surface waters at the southern basin long term monitoring site were similar to averages reported by Makarewicz and colleagues in 2009 and 2012. Trophic State Index calculations for 2017 were 48.7, 45.9 and 47.8, respectively, indicating that Conesus Lake continues to be within the range of productivity metrics for mesotrophic lakes.
- Sodium concentrations measured on June 21st were 28-29 mg Na/L at depths of 1, 6 and 10 m and 1m above the bottom. The average reported for was 27.85 mg Na/L. Thus the lake sodium concentration seems to have changed very little in the last 5 years.
- The phytoplankton community species composition and relative abundance for 2015 is reported in Appendix II and compared to historical data from 1972 and 1999.

II. INTRODUCTION

Long term monitoring of Conesus Lake

The Conesus Lake Watershed Management Plan (2003) included provisions for regular monitoring of key lake ecosystem components, including offshore limnological water quality parameters, shoreline macrophyte and filamentous algae biomass, and beach monitoring for microbial pathogens and potentially toxic cyanobacteria. Tracking long term changes in the lake ecosystem is important as these trends form the basis for evaluating the health of the water and provide the baseline by which to evaluate the success of management efforts in the lake and the surrounding watershed.

The last two comprehensive limnological studies of Conesus Lake were conducted in 2009 and 2012 by SUNY Brockport professor Joseph Makarewicz and colleagues (Makarewicz *et al.*, 2009, 2012). Brockport's sampling as well as previous sampling by others agencies including the Department of Environmental Conservation was carried out in the deeper region of the southern basin, which has been designated as the DEC long term monitoring site for Conesus Lake. A 2015 study by our Geneseo group described the limnology of the northern Conesus Lake basin and therefore was not directly comparable to the previous work.

One major goal of this study was to continue the limnological water quality monitoring in Conesus Lake in accordance with the Watershed Management Plan. To achieve this goal we sampled the deep-water southern basin station of Conesus Lake and collected data on several critical water quality parameters, including total phosphorus, soluble reactive phosphorus, nitrate nitrogen and chlorophyll *a* concentrations, Secchi depth, and sodium concentrations to assess the long term effects of road salt applied in the watershed. These data can be compared directly to those collected by Makarewicz and used to calculate updated values for the Trophic Index of Conesus Lake.

Blooms of Cyanobacteria in Conesus Lake

Potentially toxic cyanobacterial blooms pose one of the most serious threats to water quality and recreational use of waters in the Great Lakes watershed. The biggest threat to water use is posed by the species *Microcystis aeruginosa*, which is known to

produce microcystins toxins that have acute and chronic effects on animal health, including humans. Cyanobacterial blooms occur naturally, but their frequency in the Great Lakes watershed has increased since the 1990's possibly due to ecosystem effects of the zebra mussel. However, the exact nature of this relationship is not fully understood (e.g. Vanderploeg *et al.*, 2001; Raikow *et al.*, 2004).

Blooms of cyanobacteria have occurred naturally in Conesus Lake long before zebra mussels arrived in 1992. The species that comprise these blooms have been described (Forest *et al.*, 1978) and include colony-forming *Anabaena* (Makarewicz and Lewis, 2014). *Anabaena* dominated blooms have been a regular summer occurrence in Conesus Lake for more than a decade (Bosch *et al.*, 2015). In some years the bloom have been sparse and short lived, while in other years, surface slicks have covered the northern region of the lake. In 2014 the summer bloom persisted well into September and resulted in multiple days of public beach closings. *Microcystis aeruginosa* blooms are less frequent in Conesus Lake and typically occur in the fall (Makarewicz *et al.*, 2009b).

Bosch and colleagues (2015) studied the relationship between cyanobacterial blooms and summer mixing of the water column in the northern basin of Conesus Lake. The study documented potential connections between turbulence induced mixing of the water column, increases in surface phosphorus concentrations and subsequent cyanobacterial blooms. However, the study was somewhat hampered by the lack of real-time data on lake temperature stratification, and our ability to document thermocline movement using surface deployed equipment was confounded by changes in lake water level. In 2016, Mr. Karl Hanafin of Livonia and the Conesus Lake Association a temperature array system that could be deployed year round *in situ* and relay real time temperature profile data to an internet server. By 2017 Mr. Hanafin had constructed two other arrays for a total of three deployed in Conesus Lake. These arrays were essential in helping us better document the role of water column mixing in delivering phosphorus to surface waters and serving as the trigger for cyanobacterial blooms.

III. METHODS

Conesus Lake is essentially comprised of three distinct basins that are separated by prominent points and differ in depth and volume. The northern basin is demarcated to

the south by Old Orchard Point and Eagle Point, and to the north by the shoreline of the lake. This is the shallowest basin with a typical open water column depth of less than 12 m. South of Old Orchard Point and Eagle point, the central basin is demarcated to the south by Long Point and McPhersons Point. It has a typical open water depth of 13 m and a maximum depth is 13.75 m. To the south of Long Point and McPherson's point is the southern basin, which has the greatest volume and average offshore depth (18 m).

Samples were collected from June 12 to Sept 14, 2017. Hydrolab profiles and water samples were collected from each of the three basins described above. However, we hypothesized that the deeper basins would have more stable water column stratification and therefore were more likely to contribute to internally loaded phosphorus to surface waters, so those two sites were sampled more intensively.

Temperature data

We kept track of temperatures in each of the basins in two ways. Temperature profiles were taken on a weekly or biweekly basis with a Hydrolab 5a sonde deployed from a boat.

To monitor real-time changes in water column temperature and stratification we deployed three temperature arrays, each with temperature sensors spaced at 1 m intervals. The arrays were anchored to the bottom of the lake and extended to a subsurface buoy located 3 to 5 meters below the surface. In this way, the depth of the temperature sensors were not affected by changing water levels nor wave action on the surface and do not interfere with navigation. In addition, being located below the surface prevents ice damage to the arrays, which are deployed throughout the winter. The temperature sensors are rated to be accurate within 0.5 °C over the temperature range of interest. Pre-deployment testing demonstrated significant improvement if single point calibration of the sensors was performed. All existing systems have included this single point calibration. Temperature data is collected by a microprocessor located at the anchor and forwarded using RS 485 protocol over a cable to a second microprocessor located on shore. The shore-based processor uploads to a database system stored in a server at SUNY Geneseo, where it is available for near real-time analysis (<http://iotdb.geneseo.edu/streams/>). One of the arrays (initially deployed in 2016) was

placed in the northern basin at a depth of 10.8 m (Lat 42.812016 N -77.7124023 W). A second was placed in the central basin and anchored at a depth of 14.2 m (Lat: 42.793056 N Long: W77.7178761 W). The southern basin array is anchored at 17.9 m (Lat: 42.7643700 N Long: W77.7138824 W).

The thermocline depth and the relative stability of the thermocline (Schmidt Stability) in each of the three basins was determined over an 8-week period using the LakeAnalyzr package in the statistical program R. The Schmidt stability is a measure of the amount of energy required to bring a lake to a uniform density (J/m^2). To calculate each basin's stability, the area, section depth, volume and temperature at each depth was recorded. A high-resolution map of Conesus Lake was digitized in the program. ImageJ analysis software was used to measure the surface area of each 3 ft depth contour, determining the specific area of the lake for that specific depth. The volume was then calculated by multiplying the surface area of the contour times the average thickness. The precise estimate of thermocline depth for each of the basins was calculated from temperature and depth data.

Water Column Profiles

Water column profiles at the five stations were obtained with a Hydrolab 5a Sonde equipped with sensors for depth (m) temperature ($^{\circ}C$), 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) 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 adherence to the procedures and recommendations of the manufacturer.

Two independent measures of water transparency were recorded. Water turbidity as nephelometer turbidity units (NTU), was measured on site with a Hach 2100P turbidimeter. The Secchi depth was determined with a black and white 20-cm disk.

Laboratory Analysis of Water Samples

Samples were taken from the water column at depths of 1.5, 6 and 10 m and within 1 m from the bottom using a 4.1 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).

For chlorophyll *a* analyses, samples were transported to the laboratory, filtered 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 18 hr 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 using a five-point calibration generated using prepared chl *a* standards (Turner Designs #10-850). A laboratory reagent blank was tested prior to running the analyses.

Analysis of water samples for total phosphorus (TP; EPA method 365.1 Rev 2), soluble reactive phosphorus (SRP; EPA Method 365.3 A), nitrogen in nitrate (NO₃; EPA Method) and sodium (Na; EPA Method 200.7) were carried out at the Life Sciences Laboratory in East Syracuse NY . Sample water for dissolved nutrient analysis was filtered with 0.45-µm MCI Magna Nylon 66 membrane filters and held at 4°C until analysis.

Cyanobacteria Colony Counts and Cell Number Estimates

Preliminary cell counts for some colony types such as small colonies of *Anabaena*, filaments of *Anabaena*, *Oscillatoria* and *Lyngbia*, and *Anabaena* clumps were determined directly from glutaraldehyde preserved samples (2%) at 100x magnification under a compound microscope (Bosch, unpublished data). Other data for colony cell number were obtained from the literature.

Cyanobacteria colonies were counted by subsampling freshly collected samples taken weekly from the skim layer and from 0.3 m in the water column. Subsamples of 0.25 to 1 mL were initially taken from each collection and examined with a Wild stereomicroscope at 20X magnification. If colony numbers were deemed too low for accurate counts, the 300-450 mL field samples were concentrated with a nitex mesh filter

and counted whole. Individual colonies were counted and assigned to various general categories (e.g., *Microcystis*, *Anabaena* clumps, etc.). The number of colonies of the various types was multiplied times the average cell number for each type to obtain an approximate estimate of cell numbers.

IV. RESULTS AND DISCUSSION

Temperature, Stability and Full Mixing of the Water Column

Calculations of the stability of water column stratification using temperature array data are consistent with the expectation that the greater volume and depth of the southern station contribute to high water column stability (**Figure 1**). The calculated Schmidt stability of the south basin was nearly 7.5 x greater than that of the north basin and 4x greater than in central basin station by July. The Schmidt value is calculated in J/m^2 of energy at the surface that is needed to completely mix the water column. This number provides a good basis for comparison of the different basins, but at this point we have not been able to ascertain how wind data can be used in practice to predict the probability of water column mixing.

Calculations of the average thermocline depths indicated that the shallower north basin has the deeper thermocline (**Figure 2**). This means that the depth of routine mixing by surface turbulence (i.e. the “mixed layer”) is deeper in the shallower basin, perhaps because turbulent energy is more readily distributed though its lower volume. By extension of this logic, the shallower basin should mix from top to bottom more readily than the deeper basins. The temporal patterns of mixing observed are consistent with this hypothesis. Specifically, observations that the north basin mixed almost fully multiple times during the season and by Sep. 3 was fully mixed top to bottom, while the other two basins were still stratified (**Figure 3**) are consistent with the idea of a deeper penetration of the mixed layer.

Representative temperature profiles collected with the Hydrolab profiler are shown by months in **Figures 4, 5 and 6**, for the north, central and southern basin, respectively. The north basin profiles depict the thermocline as having a slow rate of temperature change with depth. Temperature translates to water density. Thus, the

density barrier to mixing in the north basin thermocline was less than that in the deeper basins. This observation is consistent with documented incidence of multiple mixing events in the north and the ultimate early breakdown of the thermocline shown by the temporal patterns for August, in **Figure 4**. In the central basin, by contrast, we observed a more pronounced temperature rate of change with depth, and a full mixing of the water column did not take place until after the 5th of September (**Figure 5**), about two weeks after full mixing of the north basin. As expected, the southern basin showed the greatest rate of temperature change with depth (**Figure 6**). The deep water column remained stratified after mixing had taken place in the center station, and in fact did not mix fully until October.

To summarize the seasonal trends described above, full mixing of the water column in the north basin occurred multiple times (after which stratification was reestablished) but after fully mixing by end of August stratification was not re-established. The center basin did not mix fully until after the 4th of September, nearly two weeks later, and the southern basin did not fully mix until October, more than a month after the central basin.

Hypoxia and Internal Loading of Phosphorus in the Hypolimnion

As described in the previous section, the thermocline and thus the density stratification of the central and southern basins of Conesus Lake were generally more stable and the water column in each region was fully mixed later in the season than that of the shallower northern basin. Temperature dependent density stratification of the water column creates a barrier that minimizes exchange between the upper oxygenated regions of the lake (the epilimnion) and the colder dark depths (hypolimnion). In the hypolimnion, microbial metabolism utilizes much of the oxygen. The result of these processes causes the hypolimnion to become hypoxic (low in oxygen levels) and even anoxic (no oxygen). **Figures 7-9** show the oxygen profiles for each of the northern, central and southern basins. It can be seen that the onset of hypoxia occurs later in the northern basin. Moreover, by August 22nd there is some oxygen replenishment to the bottom in the northern station, while the central and southern stations remain anoxic.

The lack of oxygen in the hypolimnion and the accompanying buildup in microbial respiratory carbon dioxide changes the chemical environment in complicated ways. One of the obvious readily measurable changes is a lowering of the oxidation-reduction potential (ORP measured in millivolts), which becomes increasingly negative as oxygen disappears and carbon dioxide increases (**Figures 10, 11, 12**). As the ORP drops below 150 mv and even becomes negative, the chemical environment changes in such a way that phosphorus and other nutrients normally sequestered in the sediment are resuspended into the water column and accumulate in waters of the hypolimnion. This is the phenomenon known as internal loading.

As seen in **Tables 1 and 2**, the concentration of total phosphorus (TP) and soluble reactive phosphorus (SRP) in the hypolimnion increase over the summer due in part to internal loading. By early July in the southern basin and early August in the central basin, TP and SRP near the lake bottom are more than 5x that of the surface layer, and by late August they are 10-20 times higher or more. The concentrations are not as great at a depth of 10 m, but there is still typically 5x more phosphorus there than at the surface. Any mixing of water from below the thermocline should deliver phosphorus to the surface, where supplies are low and greatly limiting to growth of cyanobacteria and other phytoplankton.

Observations of temperature array data revealed several instances of mixed layer intrusion into the hypolimnion followed by increases in surface phosphorus, which we interpret as evidence of partial mixing of the water column. Prominent events occurred during windy days in early July, but those were also days of significant runoff that confound any interpretation of the forces responsible for the mixing. However, data from Sep 3-5 show clear evidence of mixing that we can attribute to several days of sustained high winds reaching 16 mph and gusts of over 30 with little or no accompanying rain or runoff (Wunderground.com data). As shown in **Figure 13** for the central basin, between the 3rd of September at 1600 hr and the 5th at 02:00 hr the thermocline increased in depth by approximately 3 m, indicating that a large volume of colder bottom water with total phosphorus at concentrations of 33-220 µg/L (**Table 2**) had been mixed to the surface. Similarly as shown in **Figure 14**, the south basin thermocline deepened from 8.8 to 10.8 m, delivering large concentrations of phosphorus to the surface (**Table 1**)

Phytoplankton Biomass Elevated After Mixing Events

Data on turbidity, secchi depth, chlorophyll *a* *in vivo* and *in vitro* and numerical abundance of colonial cyanobacteria show a definitive pattern of blooms that is consistent with our observation of mixing and increases in surface water phosphorus. *In vivo* chlorophyll *a* profiles shown in **Figure 15** for the central basin and in **Figure 16** for the southern basin both depict increases over July, peaking on August 1. *In vivo* chlorophyll *a* declined in August and peaked again on September 14. On July 5, and 11th, July 26 and September 12 there were peaks in extracted chlorophyll *a* (**Tables 3 and 4**). These were consistent with increases in cyanobacteria colony number, which peaked in late July and on September 12 (**Table 5**).

Trends in cyanobacterial colony numbers are shown in **Figure 17**. Colony counts in skim or samples from 0.3 m never exceeded 21 colonies/mL. The dominant types were in the genus *Anabaena*. *Oscillatoria*, and *Lyngbia* were also present. Colonies of *Microcystis aeruginosa* were not present in most samples, and when present they were low in number. Overall the cyanobacteria colony numbers in 2017 were low compared to the 2015 blooms, which peaked at 133 and 210 colonies/mL in July and September (**Figure 18**).

Other Indicators of Water Quality: Nitrate, Lake Trophic State and Sodium

As part of the long term monitoring plan we also collected samples for nitrate nitrogen and sodium concentrations. Nitrate levels were generally undetectable at all depths and dates in which collections were made (**Tables 1 and 2**). Only one of forty-two samples had detectable amounts of nitrogen, and the concentration in that sample was barely higher than the limits of detection. These data indicate that phytoplankton growth Conesus Lake may be at least in part nitrogen- limited. Such conditions should favor cyanobacteria such as *Anabaena* that are capable of fixing their own nitrogen from molecular nitrogen (N₂).

Following Makarewicz and colleagues (2009 and 2014) we calculated the Trophic State Index of Conesus Lake on the basis of average summer total phosphorus, average chlorophyll *a* concentrations and average Secchi depth. The values for 2017 of 48.7, 45.9 and 47.8,

respectively, were very similar to those reported by Makarewicz, indicating that Conesus Lake continues to be well within the range of productivity metrics typical of mesotrophic lakes.

Sodium concentrations measured on June 21st were 28-29 mg Na/L at depths of 1, 6 and 10 m and 1m above the bottom. The average reported by Makarewicz for 2014 was 27.85 mg Na/L. Thus the lake sodium concentration seems to have changed very little in the last 5 years.

V. CONCLUSIONS

Indicators of water quality in 2017 including total phosphorus, chlorophyll a and Secchi depth values were comparable to those reported in recent years by Makarewicz *et. al.* (2009, 2014) and continue to place Conesus Lake well within the range of a typical mesotrophic lake. Nitrate- nitrogen levels were extremely low or not detectable throughout most of the 2017 season. At such low concentrations it is possible that phytoplankton in the lake may be nitrogen limited at times. Sodium concentrations were comparable to values reported in 2014. This is a break in a pattern of increasing concentrations in recent years.

A partial mixing event that took place from September 3-5 was followed by spikes in surface phosphorus and subsequently by increases in surface concentrations of chlorophyll a and cyanobacteria colonies. These data support our initial hypotheses that midsummer mixing events may be a trigger for cyanobacterial blooms. We reported previously that these processes are more likely to be at work in the shallower northern basin. However, our findings for 2017 indicate that the instability of the northern basin water column may limit the amount of internal loading in this region of the lake. Partial mixing of the central and southern basin water column later in summer may play a more significant role in sustaining summer cyanobacterial blooms. Our findings not only add to our understanding of bloom formation but also improve our ability to anticipate and prepare for their onset in Conesus Lake.

Another significant finding of this project was that *Anabaena* species were the dominant cyanobacteria in 2017, while *Microcystis aeruginosa*, a frequently toxic species, was never present in high concentrations. *Moreover*, cyanobacteria colony abundances were an order of magnitude lower in 2017 than in 2015.

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Tables

Table 1. Total phosphorus, soluble reactive phosphorus, nitrogen as nitrate, and sodium concentrations in the south basin of Conesus Lake in 2017. Samples were collected over a depth of 18-19 m near the long term monitoring station established by the N.Y. State D.E.C.

Total P ($\mu\text{g/L}$)	6/12	6/21	7/5	7/11	7/26	8/10	8/24	8/31	9/5	9/12
0-3m	9.7	15.0	9.6	27.0	28.0	44.0	27.0	20.0	23.0	16.0
6m	16.0	16.0	19.0	12.0	21.0	22.0	18.0	24.0	19.0	15.0
10m	2.8	7.8	-	11.0	20.0	17.0	12.0	59.0	20.0	20.0
Bottom	15.0	27.0	59.0	290.0	260.0	-	400.0	82.0	150.0	560.0
SRP ($\mu\text{g/L}$)										
	6/12	6/21	7/5	7/11	7/26	8/10	8/24	8/31	9/5	
0-3m	8.4	15.0	6.1	9.1	6.8	11.0	16.0	<2.0	12.0	
6m	18.0	16.0	6.2	6.1	2.3	6.7	6.2	<2.0	9.2	
10m	15.0	7.1	4.1	5.1	11	7.8	9.3	8.4	7.6	
Bottom	27.0	21.0	34.0	54.0	110.0	-	140.0	99.0	82	
Nitrate (mg/L)										
	7/5	7/11	7/26	8/10	9/5					
0-3m	<0.1	<0.1	<0.1	<0.1	<0.1					
6m	<0.1	<0.1	<0.1	<0.1	<0.1					
10m	<0.1	<0.1	<0.1	<0.1	<0.1					
Bottom	<0.1	<0.1	<0.1	<0.1	<0.1					
Sodium (mg/L)										
	6/21									
0-3m	28									
6m	28									
10m	29									
Bottom	28									

Table 2. Total phosphorus, soluble reactive phosphorus, and nitrogen as nitrate concentrations in the center basin of Conesus Lake almost directly offshore of the Geneseo water plant over approximately 13m of water.

Total P (µg/L)	6/12	6/28	7/5	7/26	8/1	8/10	8/24	8/31	9/5	9/12
0-3m	-	12.0	18.0	18.0	20.0	20.0	16.0	25.0	24.0	44.0
6m	-	45.0	22.0	17.0	22.0	19.0	16.0	28.0	28.0	20.0
10m	-	12.0	6.3	17.0	20.0	57.0	24.0	58.0	33.0	28.0
Bottom	-	17.0	13.0	16.0	100.0	110.0	64.0	220.0	230.0	20.0
SRP (µg/L)										
SRP (µg/L)	6/12	6/28	7/5	7/26	8/1	8/10	8/24	8/31	9/5	9/12
0-3m	15	5.8	15	8	4.5	4.2	11	<2.0	7.0	7.6
6m	-	<2.0	6.1	5.3	10	4.5	2	6.4	9.7	4.8
10m	-	7.8	5.1	6.7	9	20	18	18	-	-
Bottom	27	6.1	53	5.4	31	35	29	36	120	-
Nitrate (mg/L)										
Nitrate (mg/L)	6/12	6/21	6/28	7/5	7/26	9/5				
0-3m	<0.1	-	-	<0.1	<0.1	<0.1				
6m	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
10m	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Bottom	<0.1	<0.1	0.11	<0.1	<0.1	<0.1				

Table 3. Turbidity, acetone extracted chlorophyll *a* concentration and Secchi depth for the Southern Basin Station from June 12 to September 12, 2017.

Date	Depth (m)	Turbidity (NTU)	Chl <i>a</i> (µg/L)	Secchi Depth (m)
6/12/17	1	3.01	1.64	1.6
	6	2.37	2.81	
	9	2.65		
	12	1.65		
	18	3.15		
6/21/17	1.5	2.19	2.26	2.1
	6	2.53	2.61	
	10	3.51		
	18	4.13		
6/28/17	1.5	1.69	11.38	2.36
	6	2.19	1.71	
	10	1.64		
	17	4.01		
7/5/17	1.5	3.21	10.07	1.8
	6	3.60	4.495	
	10	3.55		
	18	5.12		
7/11/17	1.5	3.52	17.65	1.8
	6	5.96	4.20	
	10	1.66		
	18	3.14		
7/18/17	1.5	4.53	4.05	1.5
	6	3.64		
	10	2.58		
	18	2.92		
7/26/17	1.5	5.45	12.31	1.2
	6	5.31	1.13	
	10	1.76		
	18	2.14		
8/1/17	1.5	2.08	4.79	1.75
	6	2.17	1.25	
	10	1.67		
	18	3.63		
8/8/17	1.5	2.49	7.27	2.1
	6	1.67	1.12	
	10	1.88		
Table	Continued			

Date	Depth (m)	Turbidity (NTU)	Chl α ($\mu\text{g/L}$)	Secchi Depth (m)
8/16/17	1.5	1.48	1.66	2.6
	6	1.38	2.54	
	10	2.61		
	18	2.06		
8/24/17	1.5	1.33		3.4
	6	1.41		
	10	1.67		
	18	2.21		
8/31/17	1.5	1.97	2.61	3.2
	6	1.26	2.65	
	18	4.72		
9/5/17	1.5	2.74		3.1
	6	1.97		
	10	1.97		
	18	2.14		
9/12/17	1.5	1.49	7.36	4.2
	6	1.88	14.5	
	10	2.95		
	18	3.00		

Table 4. Turbidity, acetone extracted chlorophyll *a* and Secchi depth for the Central Basin.

Date	Depth (m)	Turbidity (NTU)	Chl a (µg/L)	Secchi Depth (m)
6/12/17	1.5	2.07	2.24	2.3
	6	2.19	1.69	
	10	3.13		
	13	4.12		
6/21/17	1.5	1.92	10.12	2.3
	6	2.00	3.75	
	10	1.80		
	13	2.90		
7/5/17	1.5	3.50	15.49	2.0
	6	3.24		
	10	3.08		
	13	3.70		
7/11/17	1.5	2.87	16.10	2.1
	6	2.35	2.26	
	10	1.95		
	13	2.69		
7/18/17	1.5	3.88	5.23	1.8
	6	3.21		
	10	2.90		
	13	2.14		
7/26/17	1.5	3.93	31.3	1.3
	6	3.67	4.4	
	10	2.53		
	18	3.71		
8/1/17	1.5	1.66	1.46	2.6
	6	1.42	0.65	
8/8/17	1.5	2.33	5.57	2.1
	6	1.66	2.43	
	10	3.67		
	13	3.54		
8/16/17	1.5	1.98	0.95	3.3
	6	2.05	0.65	
	10	3.06		
	13	3.72		
8/24/17	1.5	1.43		3.7
	6	1.58		
	10	2.94		
	13	5.54		
8/31/17	1.5	2.07	1.50	3.1
	6	1.99	2.50	
	13	6.11		
9/5/17	1.5	2.95	10.05	2.7
	6	2.01		
	10	2.02		
	13	4.39		
9/12/17	1.5	1.66	29.04	3.4
	6	2.22	33.32	
	10	2.28		
	13	5.62		

Table 5. Cyanobacteria colony counts and estimated cell number per mL. Grab samples were taken from the surface skim layer and at 0.3 m below the surface following standard procedures.

Date of Collection	Center Basin Colonies /mL	South Basin Colonies/mL	Lake Avg Colonies/mL	Estimated Cells/mL
12-Jun	0.5	0.9	--	38
21-Jun	0.0	0.0	0.0	0.0
28-Jun	0.0	0.0	0.0	0.0
5-Jul	0.7	1.7	1.2	43
18-Jul	10.7	4.9	7.8	464
26-Jul	20.0	21.7	20.9	830
1-Aug	10.0	11.7	10.9	233
16-Aug	2.0	4.0	3.0	88
23-Aug	--	0.2	0.2	81
5-Sep	5.0	19.7	12.4	472
12-Sep	2.6	0.1	1.4	8648
14-Sep	0.5	0.2	0.4	1112

Figures

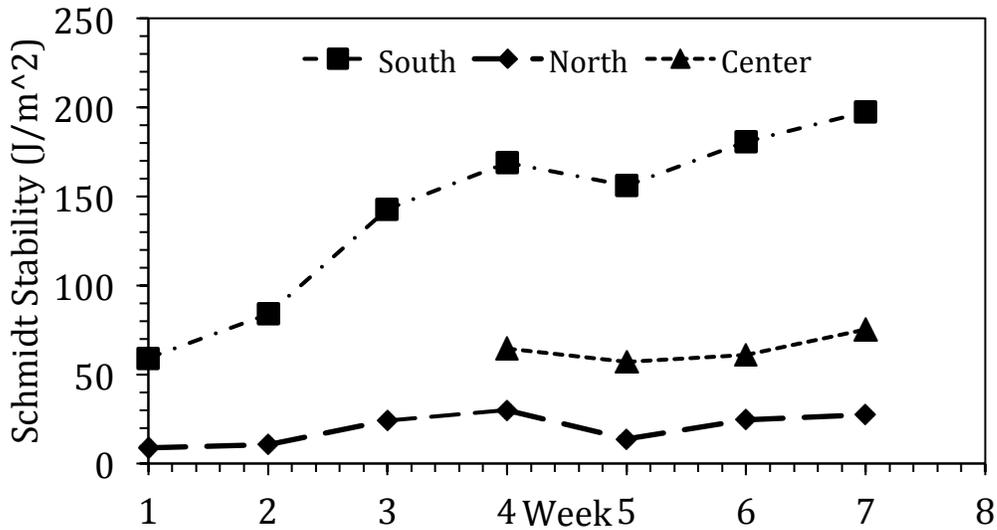


Figure 1. The Schmidt Stability Index calculated for the three basins of Conesus Lake. Weeks 1-7 refer to weeks starting on the following dates in 2017 5/28, 6/4, 6/11, 6/18, 6/25, 7/2 and 7/9, respectively. According to this index, on week 7 (July 9) it would take 7.2 times more energy to create a uniform water column temperature in the southern basin (197.5 J/m^2) than in the northern basin (27.4 J/m^2)

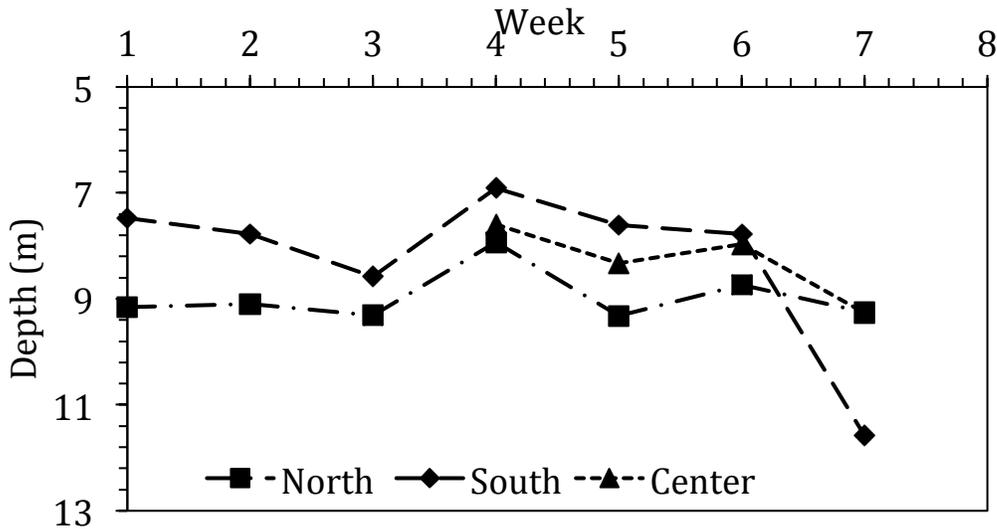


Figure 2. The average thermocline depth was deeper in the northern basin, followed by the central basin, and most shallow in the southern basin. The southern basin's average thermocline depth during week seven experienced a significant drop in depth, more than likely caused by a mixing event occurring in the southern basin on July 13th. Dates are as in Figure 1.

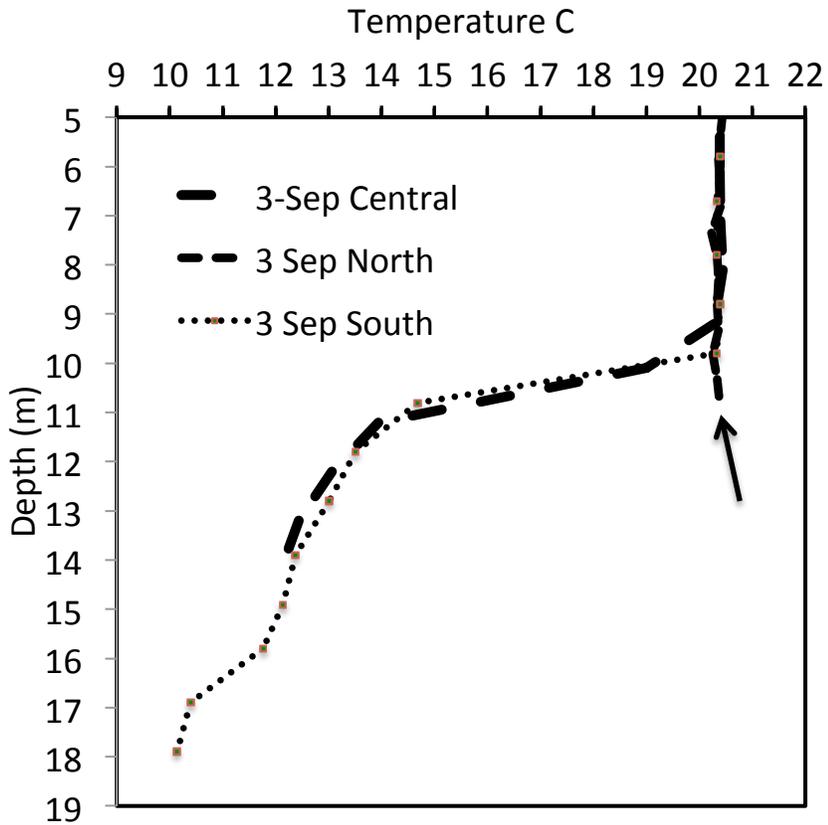


Figure 3. Comparison of temperature profiles on 3 September taken from the three in situ in the shallow northern basin (arrow), which is fully mixed, the deeper southern basin and the intermediate depth central basin. The southern and central basins show full stratification with a strong thermocline.

Temperature (°C)

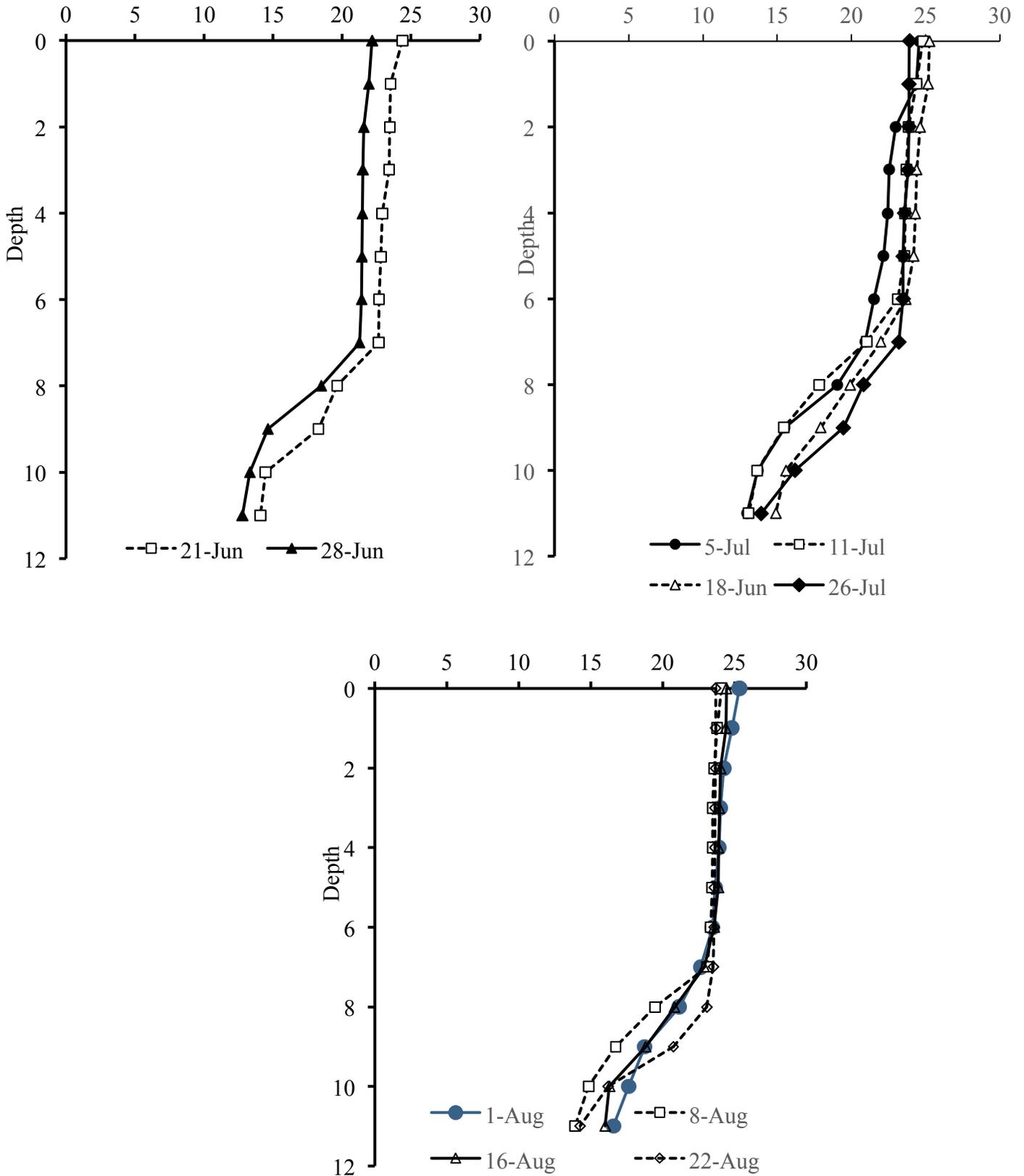


Figure 4. Temperature profiles for the shallow north basin showing a poorly established thermocline that was broken ultimately by mixing in late August.

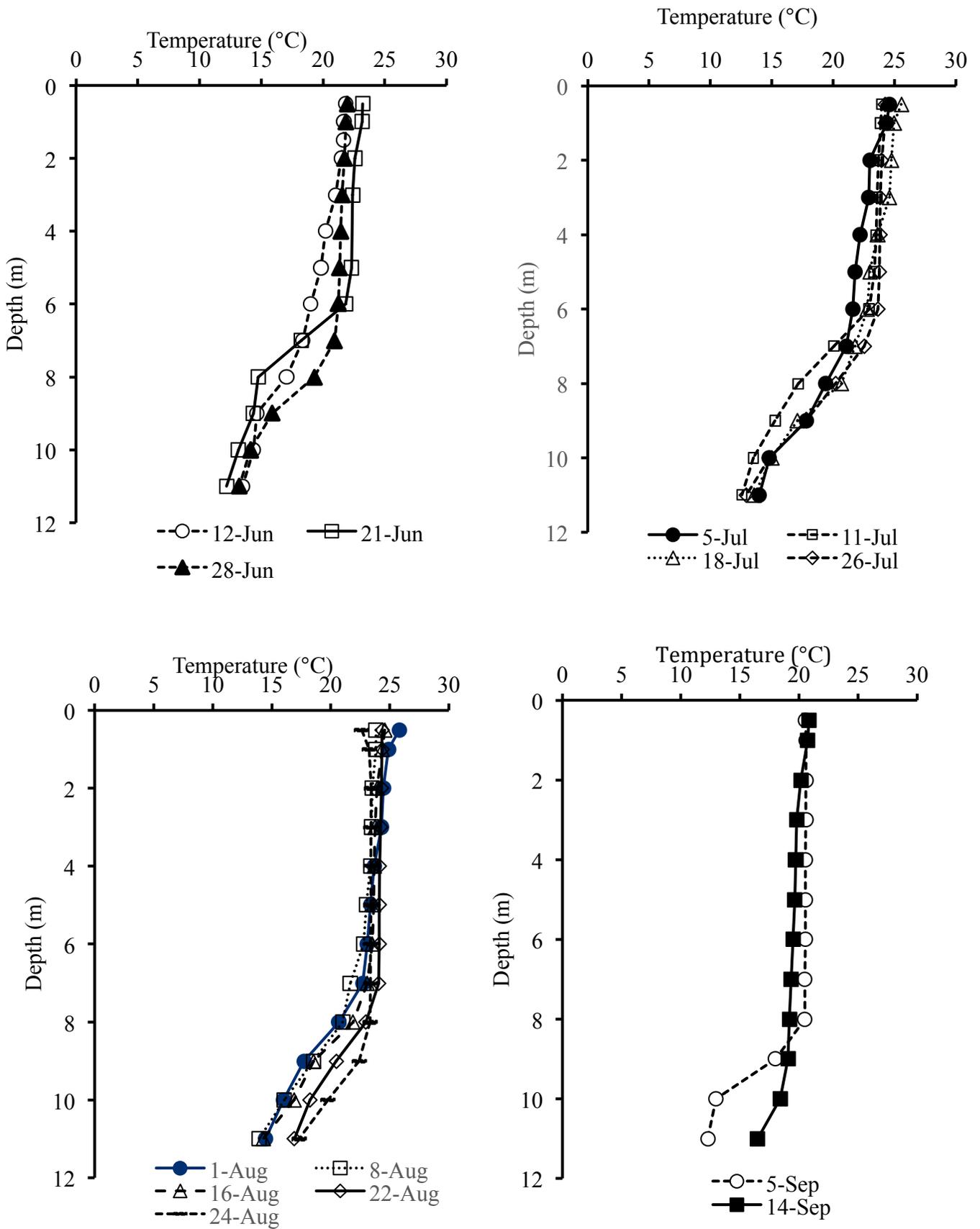


Figure 5 . Temperature profiles for the center basin show clear signs of mixing in early September.

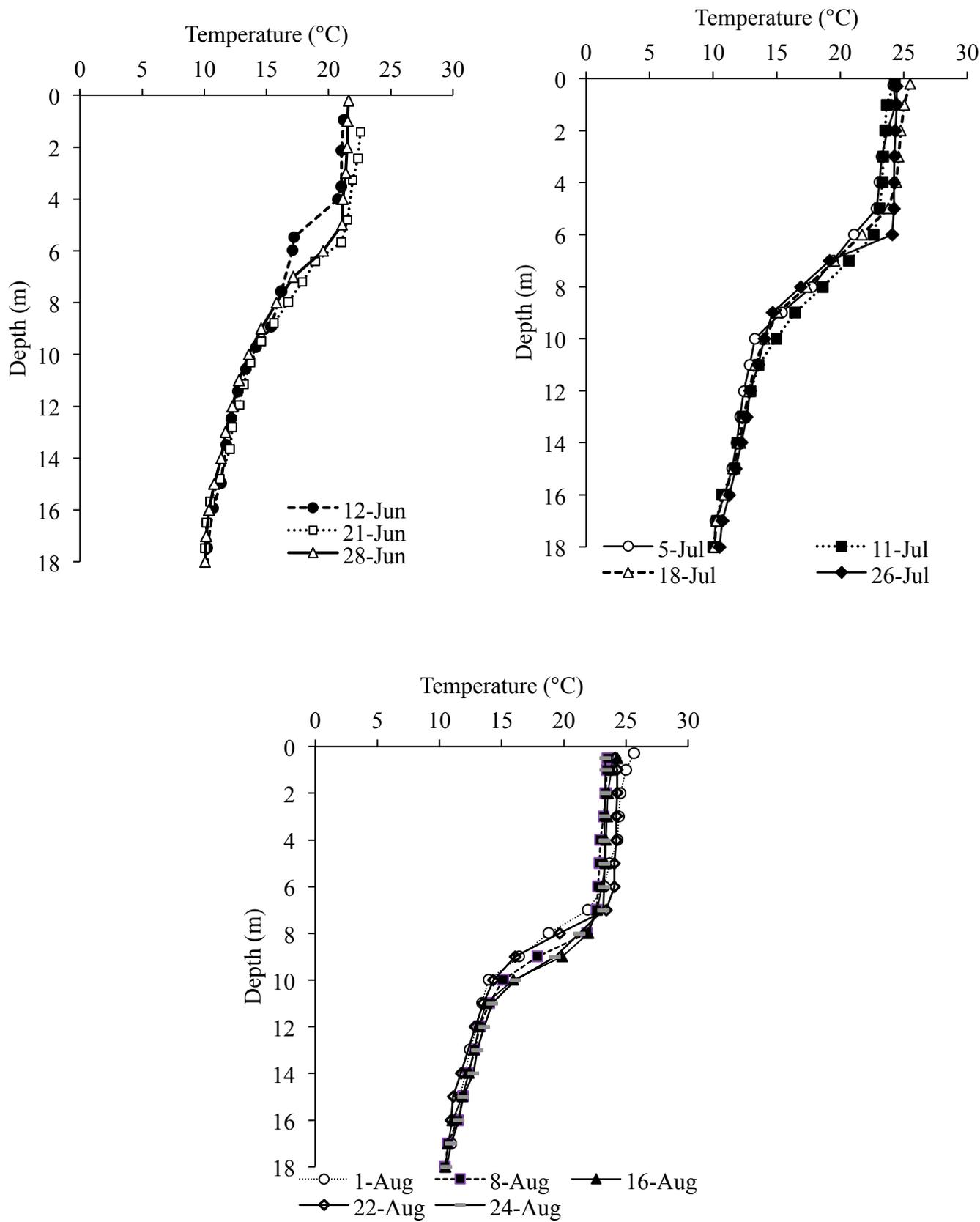


Figure 6. Temperature profiles shown for the southern basin illustrate its stable stratification. The September profiles show the start of thermocline breakdown.

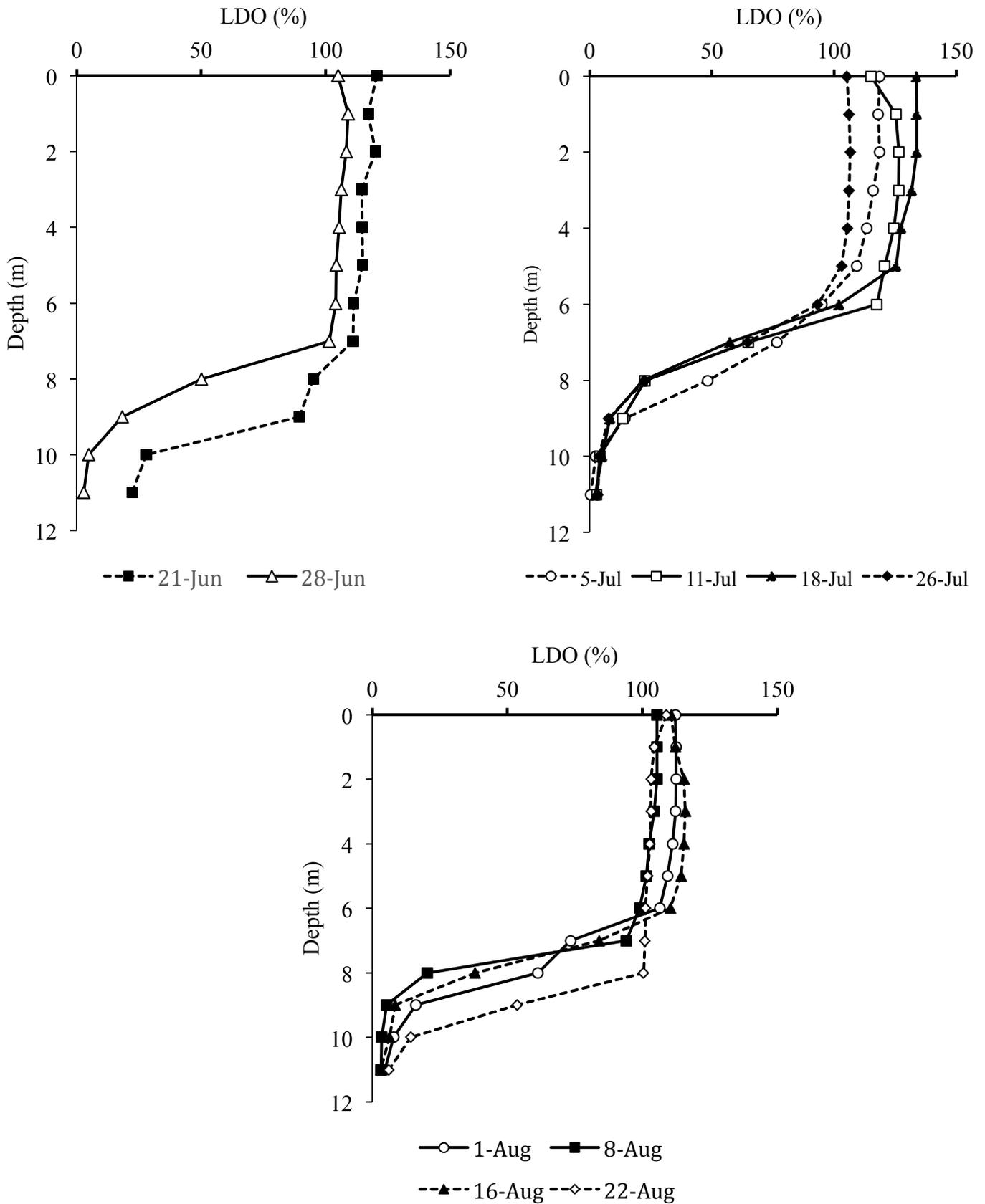


Figure 7. Oxygen profiles for the north basin showing water column stratification and hypoxia below the thermocline. In late August winds caused mixing at this station, which remained fully mixed for the remainder of the season.

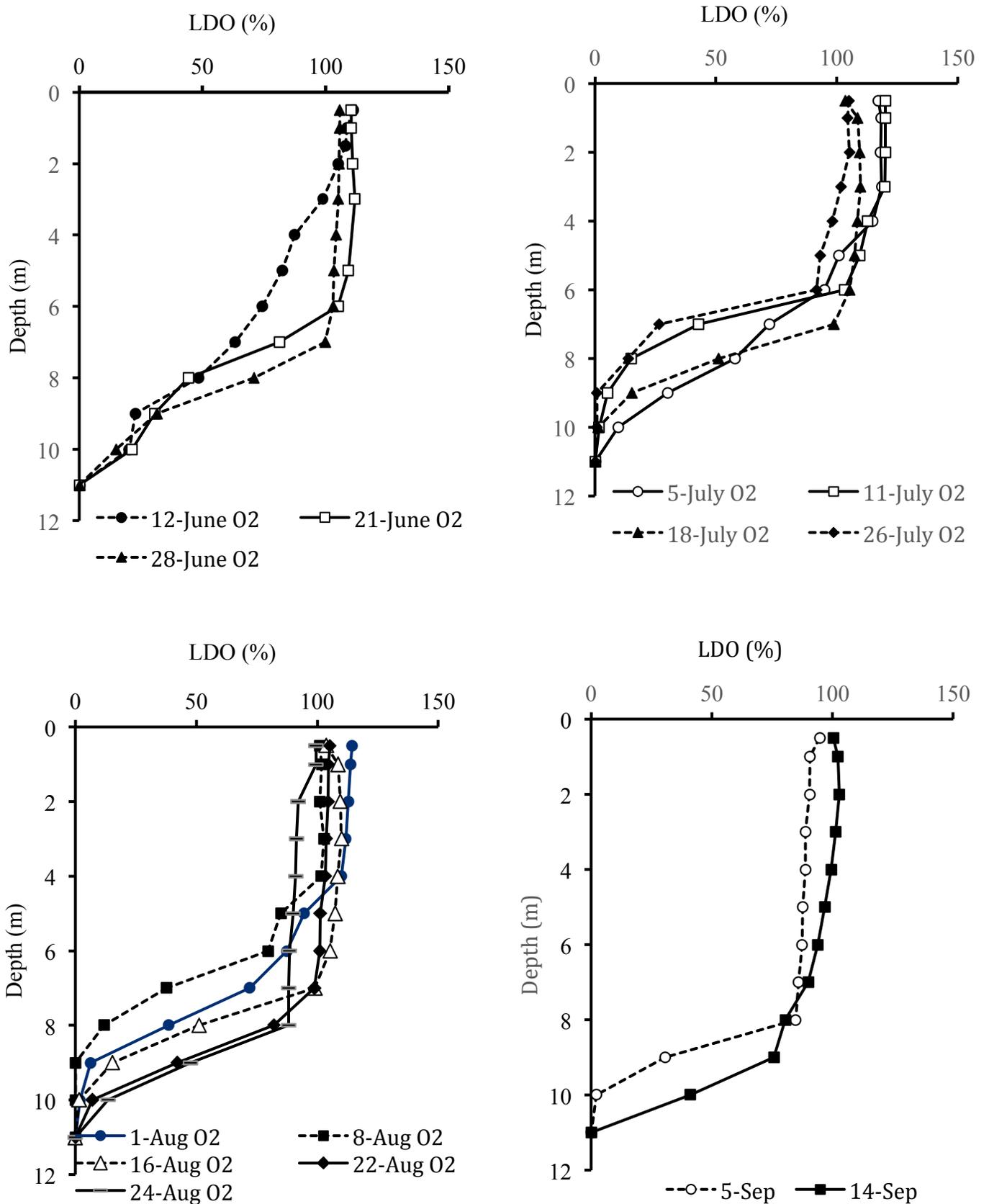


Figure 8 . Oxygen profiles for the center basin show stratification throughout the sampling period but a deepening of the oxygenated layer in September, which indicates that some mixing had taken place.

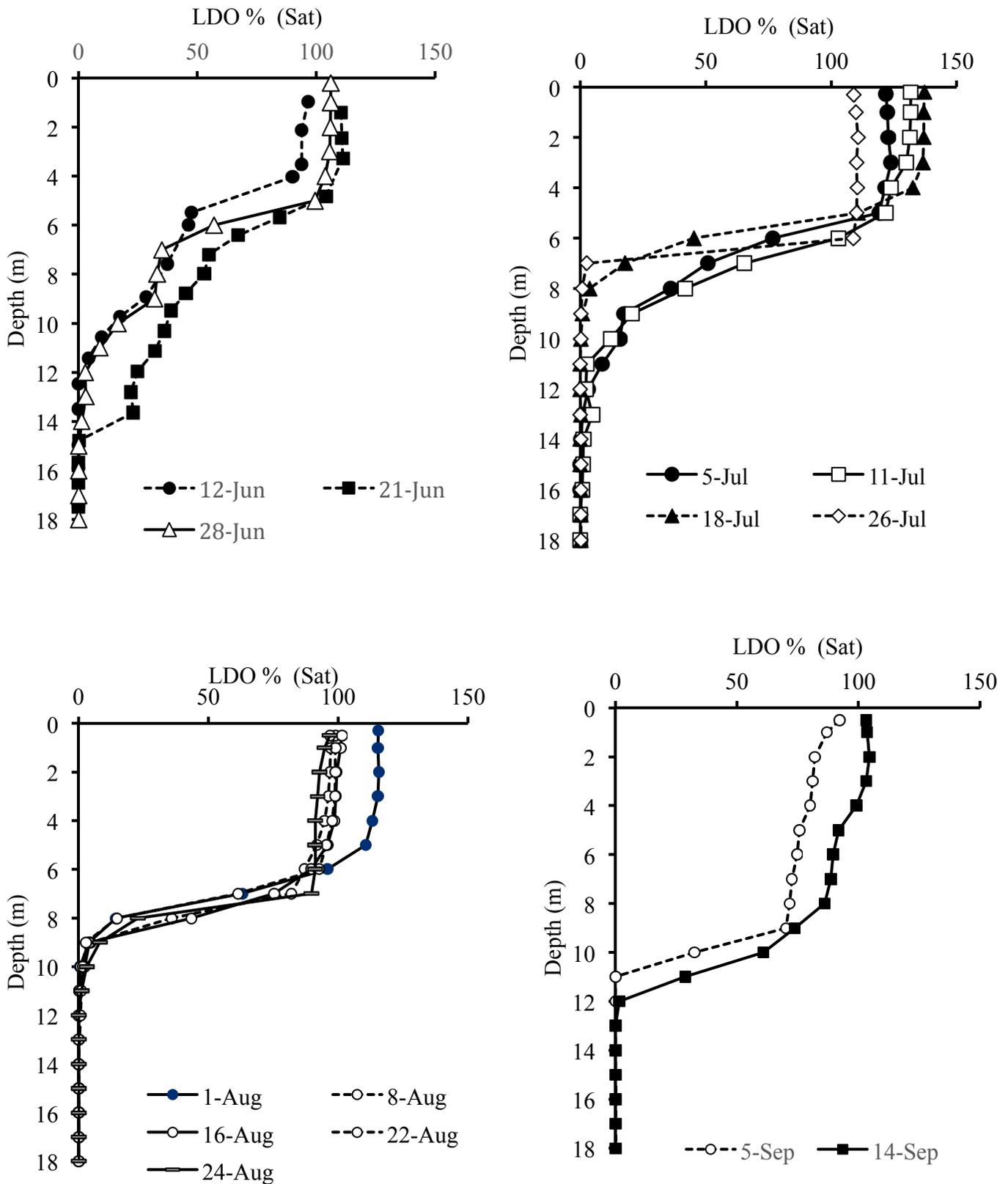


Figure 9 Oxygen profiles for the southern basin show increasingly hypoxic conditions below the thermocline over the sampling period and a deepening of the oxygenated layer in September, which indicates that some mixing had taken place.

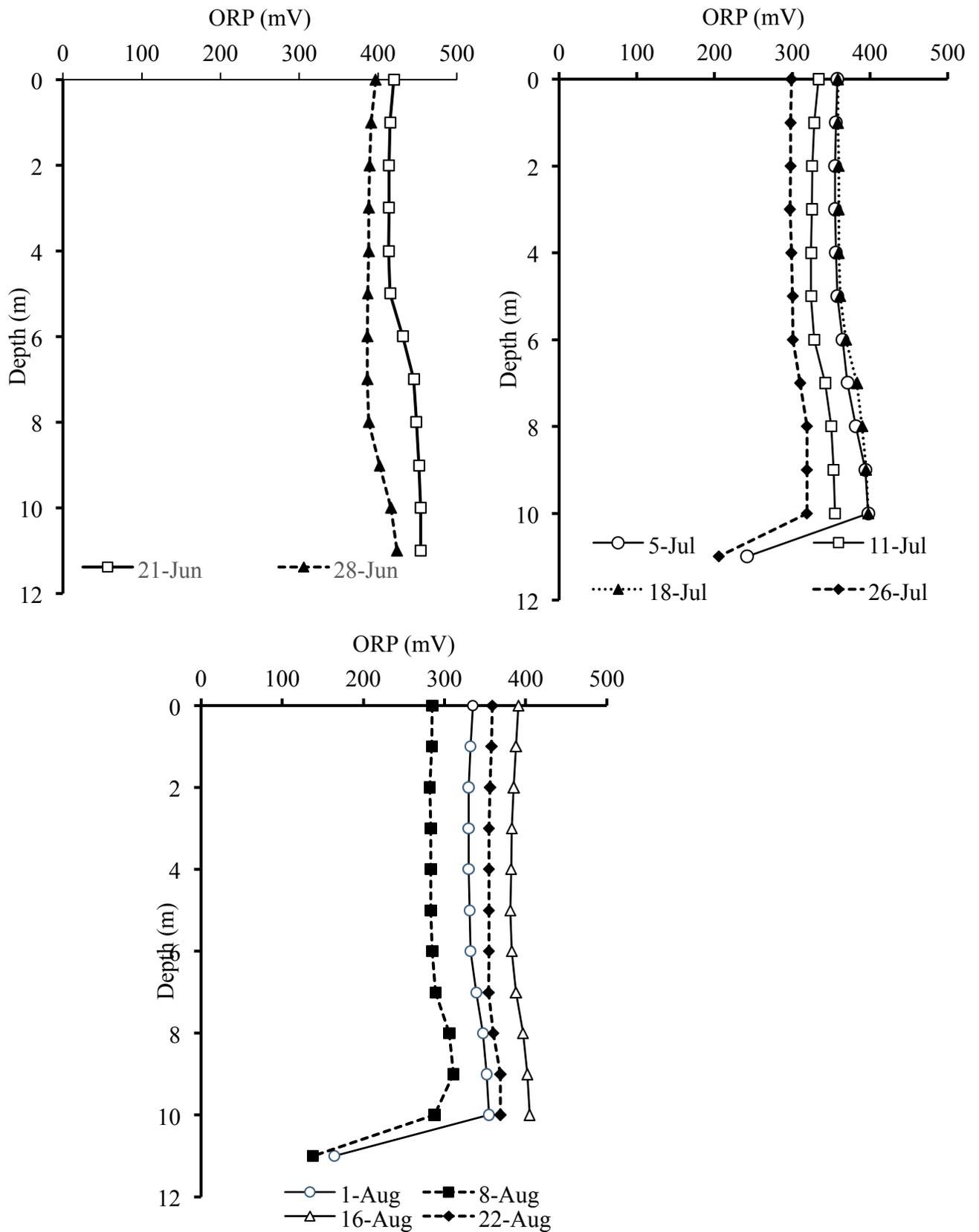


Figure 10. Oxidation- reduction potential values below 150 mV tend to promote internal loading of P. Such conditions existed in early August in the north basin, but repeated mixing did not permit significant P buildup in these shallower regions of the north basin.

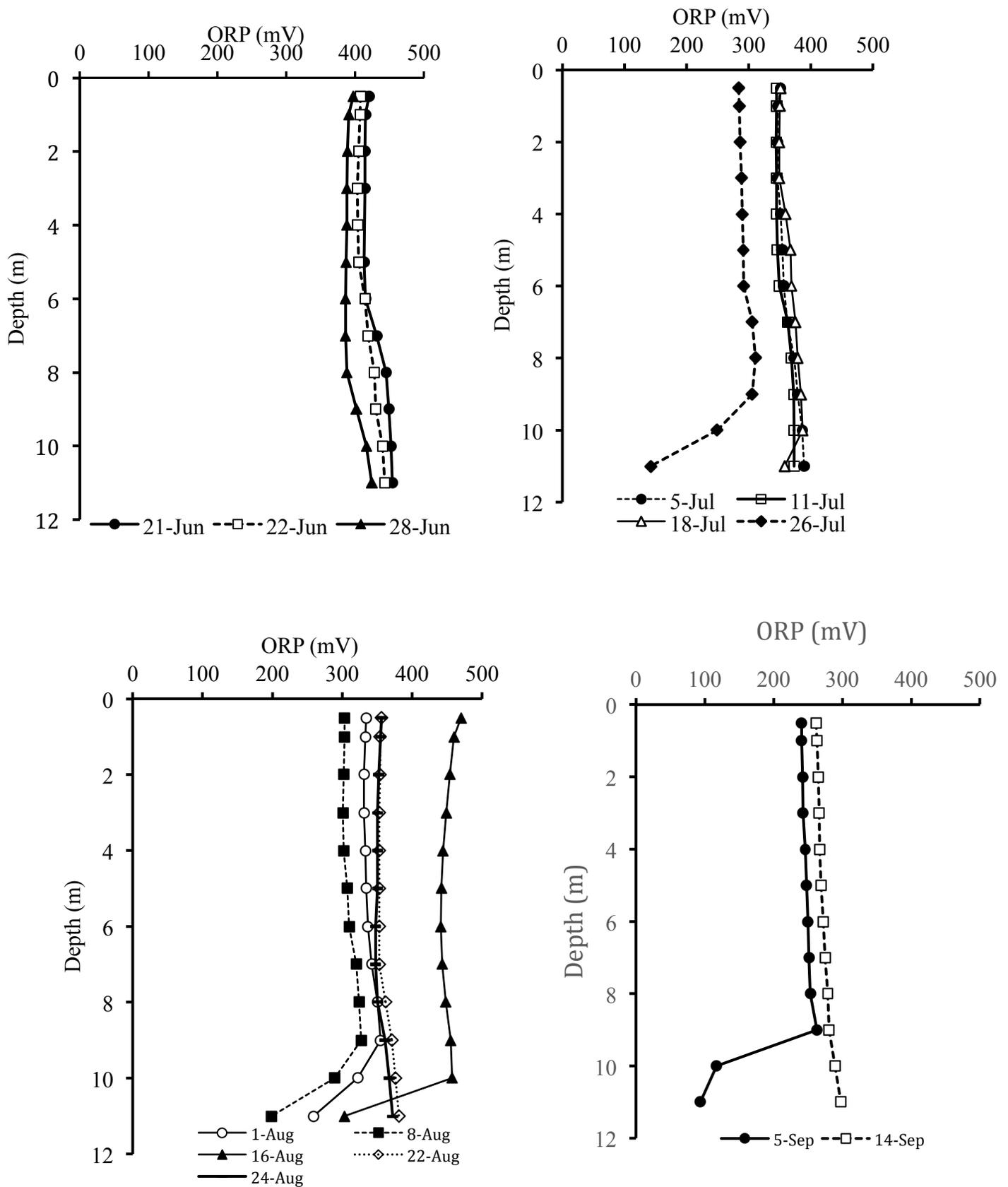


Figure 11. Oxidation-reduction potential values are shown for the central basin. Low redox persisted through most of August into September. After Sep 5, the station mixed and the Redox potential increased.

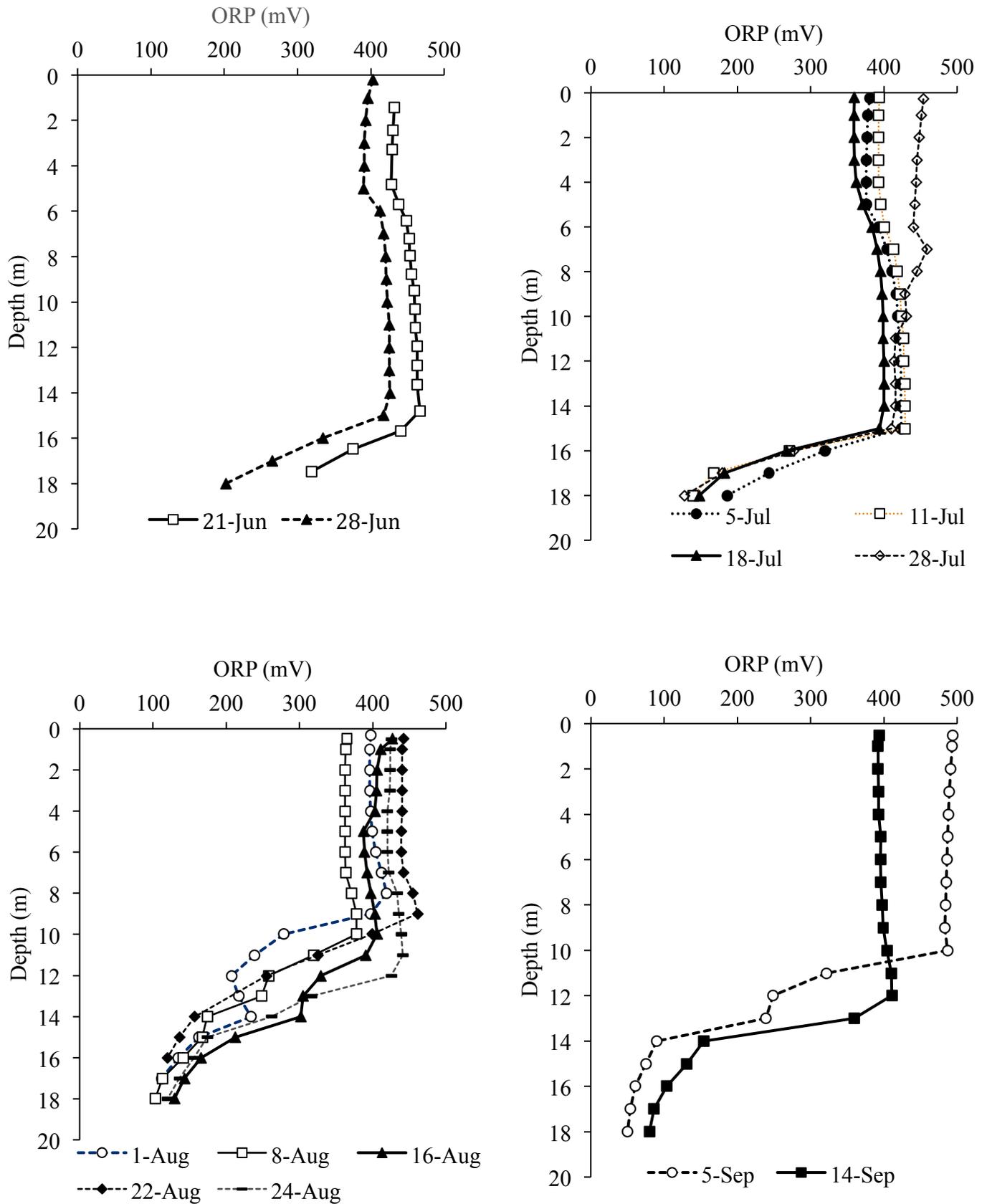


Figure 12. Seasonal patterns of oxidation-reduction potentials are shown for the south basin water column. Low redox values conducive to internal loading were present on June 21.

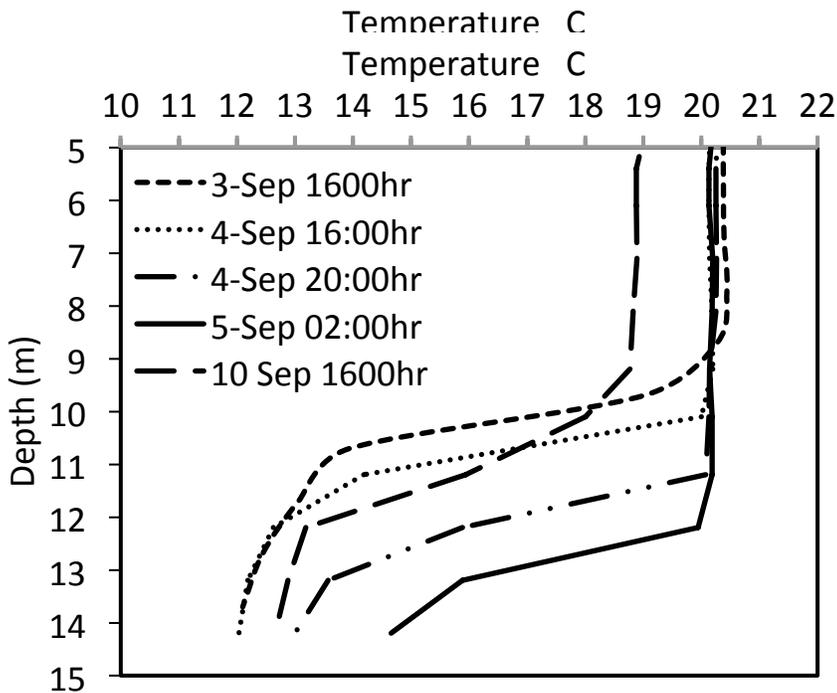


Figure 13. This graph depicts the mixing event that took place in the center basin of Conesus Lake in early September. Between 16:00 hr on the 3rd of September and 02:00 hr on the 5th, the thermocline was pushed downward nearly 3 m by surface turbulence.

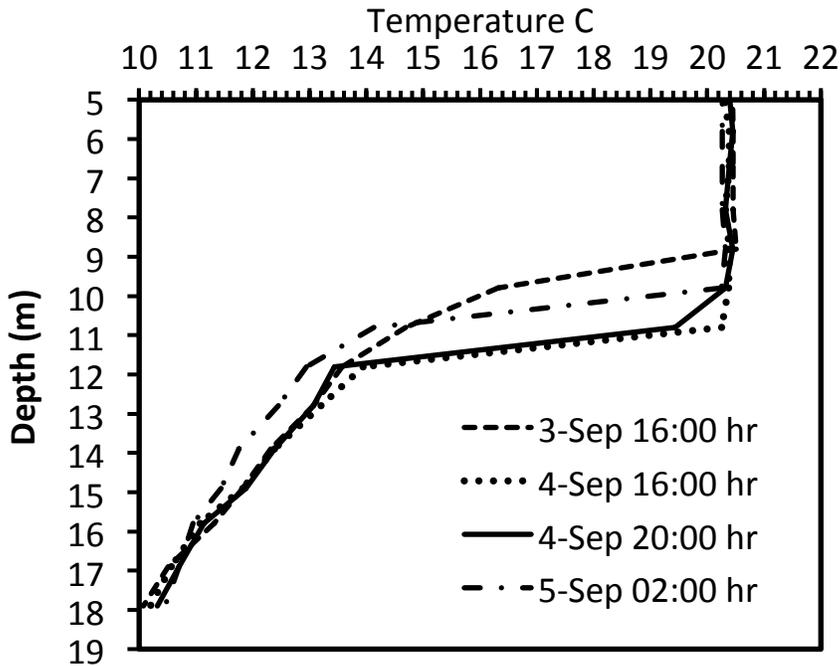


Figure 14. This graph shows temperature profiles for the deeper southern basin during a mixing event in early September. Between 16:00 hr on the 3rd of September and 16:00 hr on the 4th the thermocline moved downward approximately 2 m. Note the different depth scales in Figures 13 and 14.

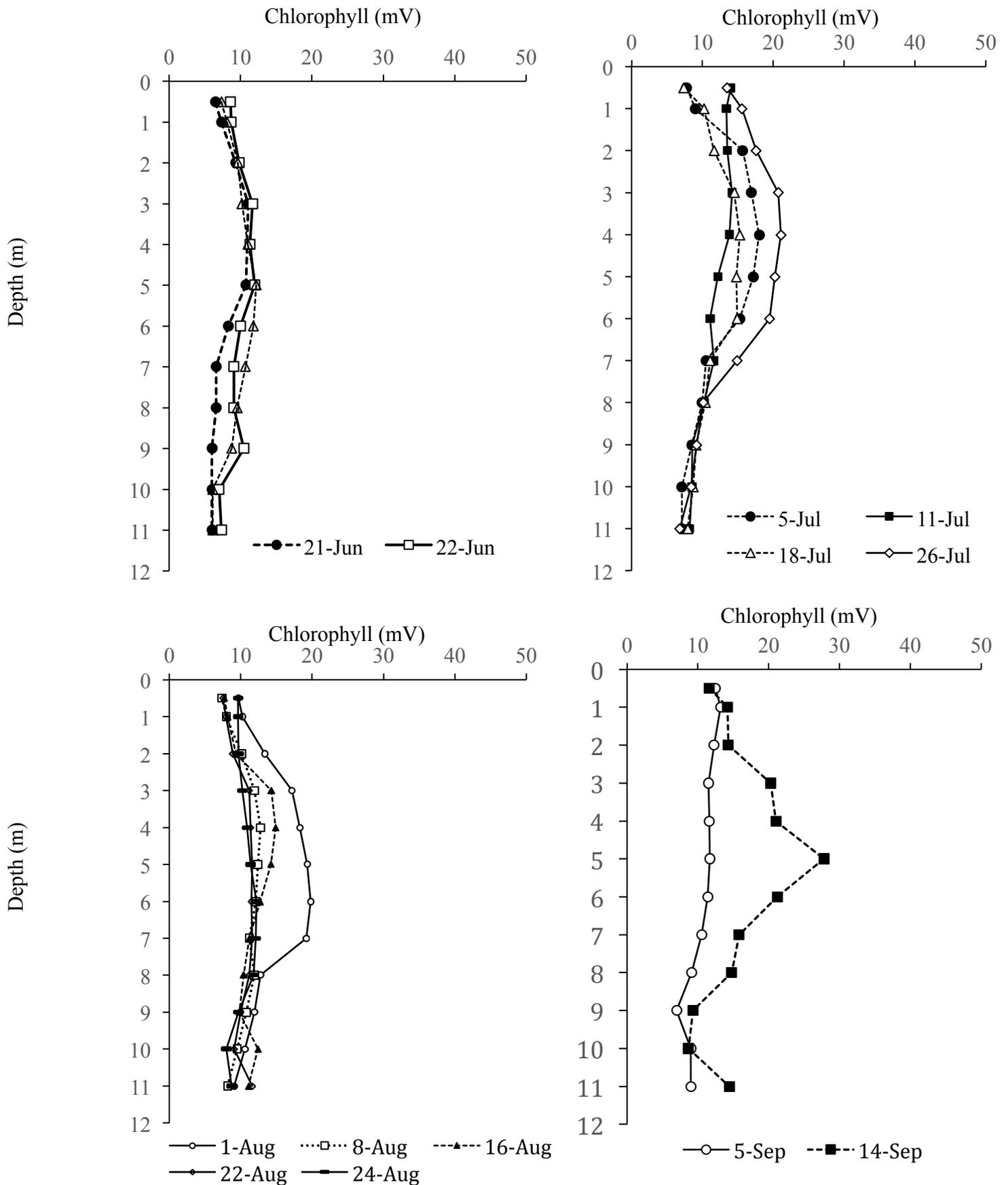


Figure 15. Central station *In vivo* chl *a* profiles show increases in late July followed by lows in August and another increase early September, corresponding to the peaks of cyanobacteria shown in Figure 17.

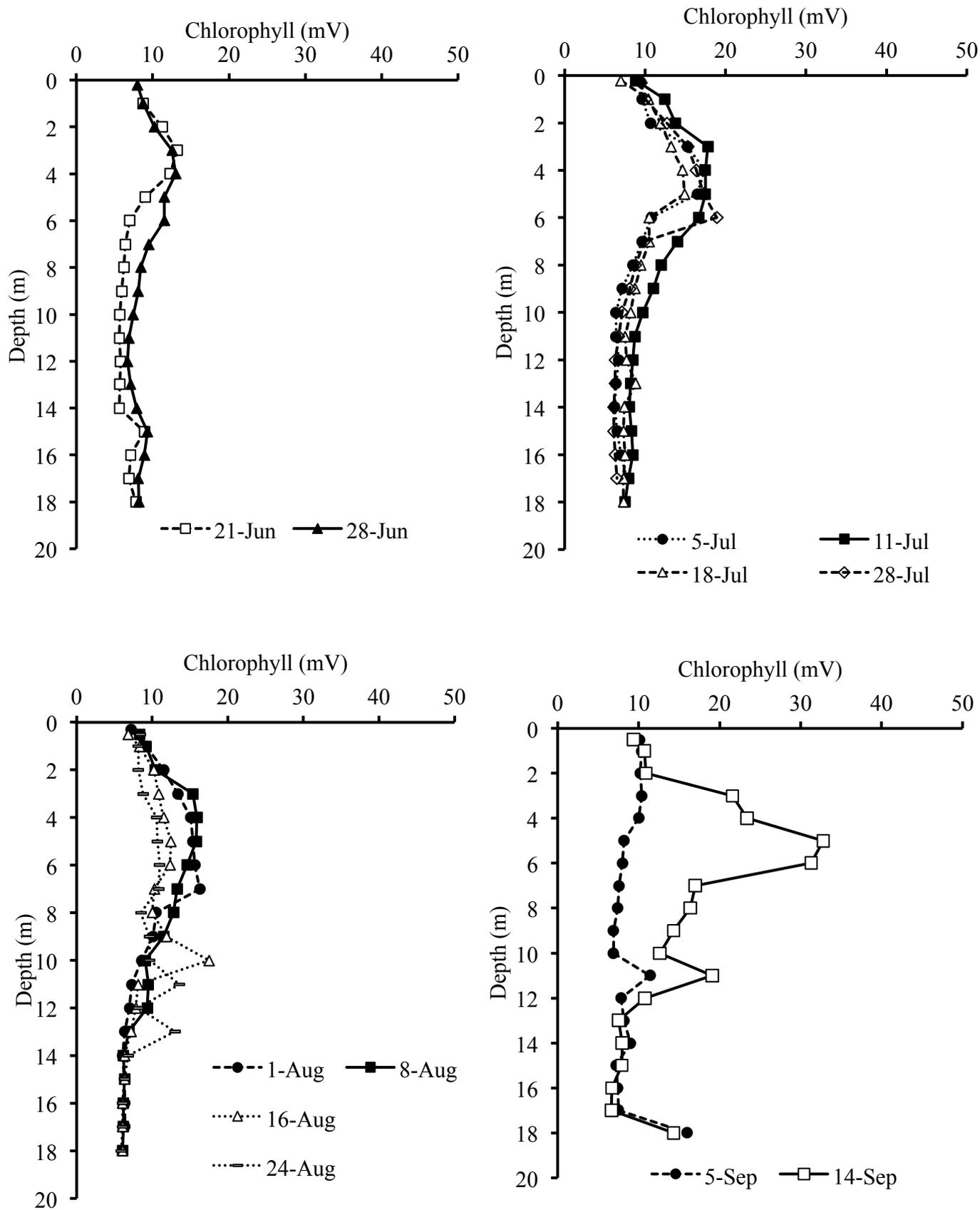


Figure 16. As in the previous figure, *in vivo* chl a profiles for the southern station show increasing phytoplankton chlorophyll during periods that correspond to the two cyanobacteria peaks in Figure 18.

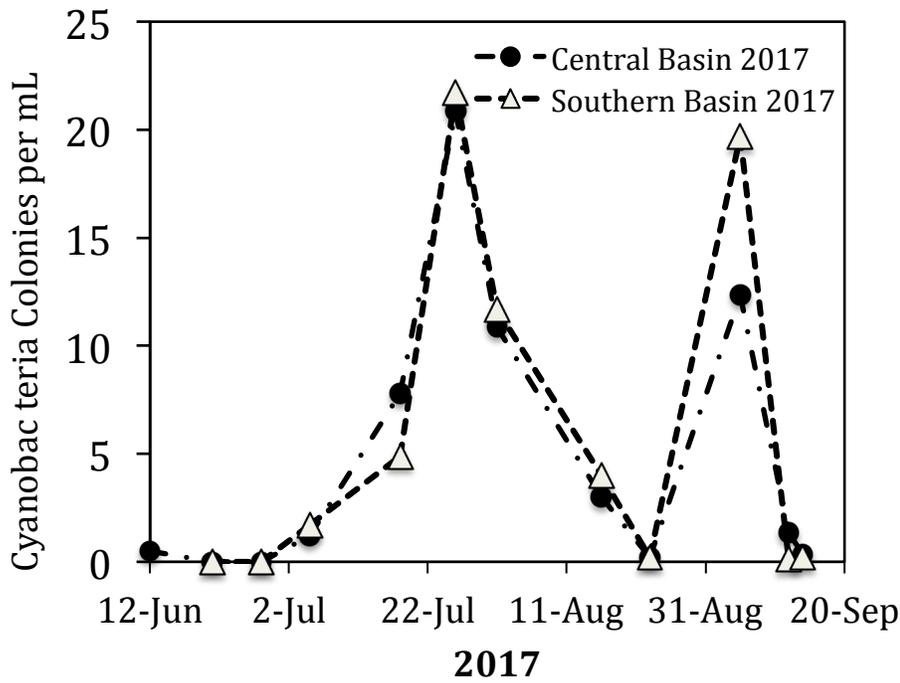


Figure 17. Cyanobacteria colonies per mL for the southern and central basins of Conesus Lake showing two concurrent peaks in abundance for 2017.

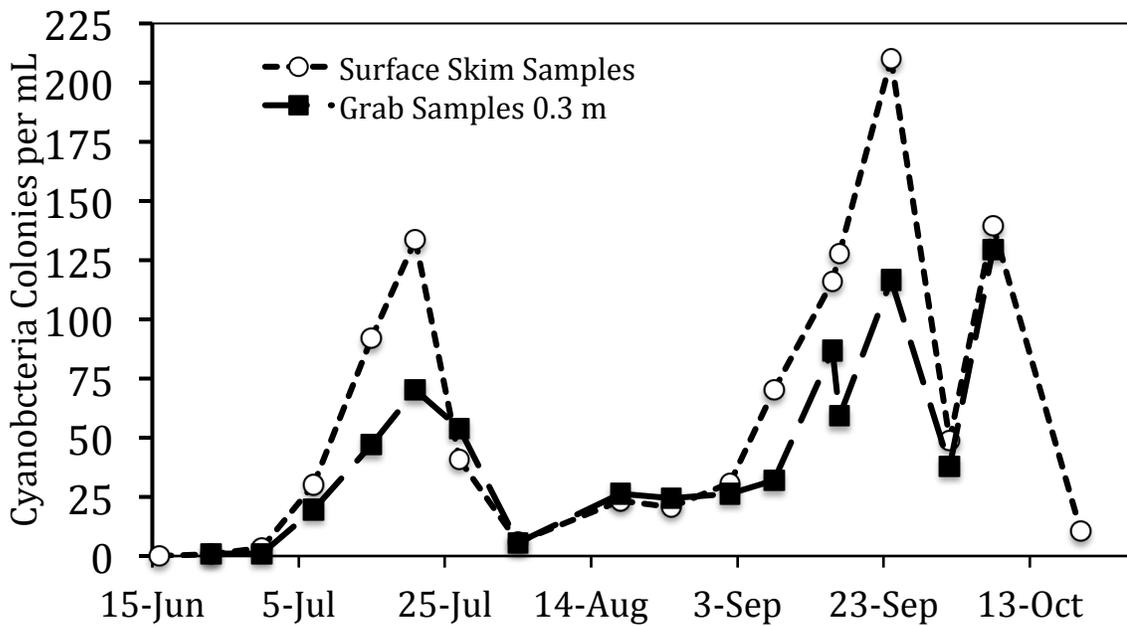


Figure 18. Cyanobacteria colonies for the north and central basins of Conesus Lake from summer 2015. Colony concentrations were much higher in 2015 showing peaks of over 200 colonies per mL that were typically 10 times higher than those in 2017.

Appendix I:

Tables of raw Hydrolab profiles from 15 sampling trips spanning 14 weeks starting on June 12 and ending on September 14, 2017. The profile data include depth, temperature, Oxidation-reduction potential (ORP), specific conductivity, and dissolved oxygen as % saturation and mg/L.

Central Station 6/12/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	LDO% [Sat]	LDO [mg/L]
	0.5	21.84	197	435	111.1	8.14
	1	21.69	194	437	108.8	8.0
	1.5	21.64	192	437	108.1	7.95
	2	21.46	191	437	105.3	7.78
	3	21.03	192	437	98.9	7.37
	4	20.22	195	436	87.6	6.63
	5	19.84	193	437	82.4	6.29
	6	19.02	192	435	74.4	5.75
	7	18.33	195	431	63.3	4.98
	8	17.05	197	431	48.4	3.91
	9	14.62	198	437	22.8	1.94
	10	14.38	197	438	20.4	1.74
	11	13.47	198	441	0	1.01

South Station 6/12/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	LDO% [Sat]	LDO [mg/L]
	1	21.21	187	437	96.5	7.16
	2	21.03	191	437	93.9	6.99
	3	21.04	191	437	93.9	6.99
	4	20.75	196	437	90	6.74
	5	17.21	200	436	47.6	3.84
	5	17.09	201	436	46.3	3.74
	7	16.2	201	437	37.4	3.08
	8	15.38	203	436	28.6	2.4
	9	14.18	204	436	17.5	1.51
	10	13.34	204	437	9.8	0.86
	11	12.72	205	440	4.2	0.37
	12	12.17	205	439	0	0
	13	11.77	205	438	0	0
	14	11.33	205	438	0	0
	15	10.73	207	442	0	0
	17	10.23	205	444	0	0
	18	10.25	191	463	0	0

North Station 6/21/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo</i> Chl a [Volts]
	0.5	23.22	420	433	2735	110.4	7.87	6.5
	1	23.17	415	433	1335	110.4	7.89	7.3
	2	22.57	414	432	774	111	8.02	9.3
	3	22.38	414	433	295	112	8.12	11.1
	5	22.32	413	433	147	109.3	7.93	10.8
	6	21.83	415	431	44	105.1	7.7	8.3
	7	18.22	431	431	49	81.2	6.4	6.6
	8	14.75	445	438	25	44.4	3.77	6.6
	9	14.36	449	437	12	30.6	2.62	6
	10	13.17	452	441	1	21.4	1.88	6
	11	12.17	454	441	1	0	0.99	6

South Station 6/21/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo</i> Chl a [Volts]
	1	22.56	432	432	193	113.5	8.2	8.7
	2	22.33	430	432	101	113.8	8.26	11.2
	3	21.93	429	432	66	114.2	8.35	13.2
	4	21.52	428	432	28	107.2	7.9	12.3
	5	21.05	438	433	93	87.7	6.53	0.9
	6	18.92	448	437	41	70.3	5.46	7.0
	7	17.9	452	438	11	57.9	4.59	6.4
	8	16.77	453	438	23	55.9	4.54	6.2
	9	15.61	456	438	16	48.3	4.02	6.2
	10	14.57	459	438	7	42	3.58	5.9
	11	13.7	460	438	7	39.2	3.4	5.7
	12	13.17	461	439	4	35.1	3.09	5.6
	13	12.8	463	440	3	27.9	2.47	5.8
	14	12.25	463	440	2	25	2.24	5.7
	15	12.05	463	438	1	26.1	2.35	5.6
	16	11.26	467	441	1	3.3	0.3	8.9
	17	10.51	441	443	1	3	0.28	7.1
	18	10.21	376	442	3	3	0.28	6.9

Central Station 6/22/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo</i> Chl a [Volts]
	0	22.83	408	427	777	113.3	8.14	8.6
	1	22.81	407	427	401	113.6	8.17	8.7
	2	22.69	405	427	302	112.9	8.14	9.8
	3	22.54	403	428	147	110.7	8.07	11.7
	4	22.42	404	427	84	108.1	0.83	11.3
	5	22.2	405	426	51	104.9	7.64	12
	6	21.1	414	426	29	97.1	7.22	10
	7	19.89	419	432	22	79	6.02	9.1
	8	17.5	428	429	13	66.5	5.32	9.1
	9	13.56	430	449	3	30	0.32	10.5
	10	13.73	440	437	10.32	27.2	2.36	7
	11	12.82	443	438	3	10.5	0.92	7.3
	12	12.63	444	439	1	6.5	0.58	8.4

Central Station 6/28/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo</i> Chl a [Volts]
	0.5	21.94	397	430	2504	105.7	7.73	7.3
	1	21.89	391	431	1462	105.8	7.74	8.1
	2	21.73	389	430	967	105.4	7.74	9.6
	3	21.54	388	430	526	105.3	7.77	10.2
	4	21.41	388	430	302	104.3	7.71	11
	5	21.34	387	430	151	103.4	7.65	12.2
	6	21.23	386	430	88	102.9	7.63	11.8
	7	20.95	386	432	14	99.8	7.44	10.7
	8	19.29	388	439	7	70.9	5.46	9.5
	9	15.88	402	439	5	31.5	2.61	8.8
	10	14.12	416	440	3	14.9	1.28	6.1
	11	13.22	424	441	2	0	0.85	6.1

South Station 6/28/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo</i> Chl a [Volts]
	0.20	21.59	403	430	2206	106.1	8.03	8
	1	21.54	396	430	1338	106.2	8.05	8.8
	2	21.47	393	430	759	105.9	8.04	10.2
	3	21.36	391	430	455	105.7	8.04	12.5
	4	21.15	391	429	214	103.7	7.93	13.
	5	21.08	390	429	113	99.4	7.62	11.5
	6	19.59	412	437	66	57	4.6	11.5
	7	17.17	418	440	53	35.1	3.07	9.5
	8	15.83	420	437	31	33.1	2.99	8.4
	9	14.57	421	437	19	32.1	2.99	8.1
	10	13.57	423	439	12	16.5	1.7	7.5
	11	12.78	425	440	7	9.2	1.09	6.9
	12	12.27	425	440	5	2.8	0.52	6.7
	13	11.68	425	439	3	3.1	0.56	7.1
	14	11.34	426	441	1	1.4	0.4	7.9
	15	10.8	418	446	1	0	0.28	9.3
	16	10.39	334	453	1	0	0.28	8.9
	17	10.17	266	451	1	0	0.28	8.1
	18	10.05	202	453	0	0	0.29	8.2

North Station 7/5/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo Chl a</i> [Volts]
	0	24.56	358	419	2985	118.6	8.46	8.1
	1	24.37	356	420	1408	118.2	8.46	9.5
	2	22.98	355	418	723	118.6	8.72	12.9
	3	22.53	355	418	297	116	8.61	15.9
	4	22.46	356	417	148	113.2	8.41	16.5
	5	22.16	358	418	87	109.3	8.18	17.1
	6	21.53	365	421	50	94.9	7.22	16.6
	7	20.92	371	423	32	76.7	5.95	10.9
	8	19.07	382	427	19	48.2	3.97	10.2
	9	15.51	394	430	11	14.4	1.46	7.8
	10	13.68	398	433	6	2.6	0.48	7.3
	11	12.98	242	441	4	0.4	0.3	44.9

Central Station 7/5/17	Depth [m]	Temp [°C]	OR P [mV 	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo Chl a</i> [Volts]
	0.5	24.23	284	386	863	104.8	7.53	13.5
	1	24.36	347	418	1338	118.4	8.65	9
	2	22.98	346	418	741	118.1	8.86	15.7
	3	22.9	346	418	320	118.5	8.9	16.9
	4	22.19	351	421	165	114.9	8.76	18
	5	21.78	354	421	89	100.9	7.81	17.2
	6	21.58	356	422	51	94.9	7.4	15.3
	7	21.07	362	423	26	72.1	5.77	10.5
	8	19.4	373	424	17	57.9	4.88	10
	9	17.83	379	426	3	30	2.82	8.5
	10	14.81	386	431	2	9.6	1.28	7.1
	11	13.96	389	433	1	0	0.74	7.1

South Station 7/5/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo Chl a</i> [Volts]
	1	24.39	378	419	235	125.5	8.76	9.6
	2	23.72	377	417	110	125.9	8.9	10.7
	3	23.27	376	417	100	127	9.05	15.3
	4	23.08	376	417	42	124.6	8.92	17.4
	5	22.88	376	419	21	122.1	8.77	16.5
	6	21.07	393	423	13	80	5.95	10.8
	7	19.43	404	426	9	53.8	4.14	9.6
	8	17.77	411	427	5	39	3.1	8.5
	9	15.39	417	428	2	20.4	1.71	7.1
	10	13.29	419	429	2	18.9	1.65	6.4
	11	12.9	421	429	2	11.9	1.05	6.4
	12	12.41	423	432	2	6.3	0.56	6.7
	13	12.12	423	432	2	4	0.36	6.4
	14	11.85	423	432	1	3.4	0.3	6.2
	15	11.49	424	431	0	3.1	0.28	6.5
	16	10.9	319	440	0	3.1	0.28	7.
	17	10.18	243	445	1	3.1	0.29	7.7
	18	10.13	186	448	0	3.1	0.29	4.67

North Station 7/11/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.5	24.8	334	395	2148	115.2	7.97	10.1
	1	24.37	328	393	1357	125.3	8.74	10.7
	2	23.84	326	393	673	126.6	8.93	16.7
	3	23.68	325	394	382	126.4	8.94	16.7
	4	23.63	324	394	171	124.5	8.82	17
	5	23.57	324	394	101	120.8	8.56	17.3
	6	23.12	328	397	59	117.5	8.4	14.5
	7	21.01	342	403	36	64.9	4.83	14
	8	17.85	350	408	21	22.7	1.8	10.4
	9	15.45	353	406	12	13.6	1.14	9.8
	10	13.64	355	411	7	4.2	0.37	11

Central Station 7/11/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.5	23.95	345	394	184	120	8.68	14
	1	23.88	345	394	169	120.1	8.69	13.4
	2	23.7	344	394	92	120.1	8.71	13.5
	3	23.57	345	394	58	119.9	8.57	14.2
	4	23.49	345	395	38	112.9	8.17	13.8
	5	23.34	346	395	33	109.5	8.01	12.2
	6	22.95	349	397	17	103.1	7.64	11.1
	7	20.06	363	402	13	42.9	3.49	11.6
	8	17.16	369	406	20	15	1.46	10.2
	9	15.25	372	409	12	5.2	0.7	8.6
	10	13.5	373	410	6	1.8	0.43	8.5
	11	12.57	373	410	4	0	0.32	8.2

South Station 7/11/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.5	24.29	394	394	2575	135	9.44	8.9
	1	23.64	393	393	1387	135.1	9.57	12.4
	2	23.54	393	393	798	134.6	9.54	13.8
	3	23.4	393	394	366	133.3	9.48	17.8
	4	23.3	393	394	191	127.2	9.06	17.5
	5	23.07	396	396	96	125	8.95	17.5
	6	22.66	401	397	53	106.1	7.65	16.7
	7	20.71	413	401	28	68.7	5.15	14.
	8	18.6	418	404	16	45.2	3.54	12.
	9	16.43	422	409	10	23.9	1.95	11.
	10	14.97	424	408	6	15.3	1.29	9.7
	11	13.57	427	408	5	5.9	0.51	8.7
	12	12.95	427	406	2	5.5	0.48	8.5
	13	12.32	428	407	1	8.1	0.72	8.2
	14	11.89	429	408	1	4.6	0.41	8.
	15	11.66	429	408	1	4.3	0.39	8.3
	16	10.69	271	421	1	4	0.37	8.5
	17	10.28	168	425	0	3.3	0.31	7.9
	18	10.01	139	427	0	3.3	0.31	7.5

North Station 7/18/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0	25.26	359	391	1515	133.6	9.17	9.8
	1	25.18	359	390	876	133.8	9.2	10.1
	2	24.64	360	390	275	133.8	9.29	10.9
	3	24.41	360	389	208	131.7	9.19	16.9
	4	24.31	360	389	159	127.3	8.9	17.6
	5	24.19	362	390	78	125.4	8.78	17.8
	6	23.67	369	393	41	102	7.22	16.3
	7	21.97	383	401	25	57.3	4.19	11.3
	8	19.89	390	407	16	21.7	1.65	11
	9	17.94	395	409	6	8.3	0.66	10.4
	10	15.57	398	405	3	5.1	0.42	9.8

Central Station 7/18/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.5	24.23	284	368	863	104.8	7.53	13.5
	1	24.96	350	389	1418	132	9.33	10.2
	2	24.71	349	389	609	133.2	9.47	11.6
	3	24.59	349	388	363	133.2	9.48	14.5
	4	23.59	359	392	173	101.3	7.4	15.3
	5	22.99	367	394	75	69	5.16	14.8
	6	22.79	369	397	38	68.1	5.12	14.9
	7	21.76	375	398	20	47.1	3.69	11.1
	8	20.66	379	399	12	28.5	2.37	10.4
	9	17.08	384	407	6	4.7	0.63	9.1
	10	15	387	409	3	1.2	0.37	8.7
	11	13.57	358	411	2	0	0.29	7.9

South Station 7/18/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.2	25.48	360	386	2605	137.2	9.59	7.0
	1	25.02	359	386	787	137	9.66	10.4
	2	24.76	359	386	406	136.9	9.7	11.9
	3	24.6	360	387	244	136.5	9.7	13.2
	4	24.41	362	388	153	132.7	9.47	14.7
	5	23.8	371	387	74	110.7	8.03	14.9
	6	21.71	384	392	11	45.1	3.54	10.5
	7	19.57	391	406	4	17.8	1.6	10.5
	8	17.37	395	407	2	3.6	0.54	9.5
	9	15.07	398	409	1	0.9	0.33	8.7
	10	14.06	399	411	1	0.2	0.29	8.2
	11	13.27	399	409	1	0	0.27	7.5
	12	12.83	400	407	1	0	0.27	7.7
	13	12.4	400	408	0	0.1	0.29	8.8
	14	12.13	400	409	1	0	0.28	7.4
	15	11.56	394	412	0	0	0.28	7.3

	16	10.88	267	421	0	0.1	0.29	7.5
	17	10.23	182	427	0	0.1	0.3	7.3
	18	10.08	148	427	0	0.1	0.3	7.3

North Station 7/26/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0	23.9	299	385	1954	105.3	7.41	14.3
	1	23.89	298	385	769	106.2	7.48	16.9
	2	23.88	298	385	357	106.6	7.51	17.9
	3	23.81	297	384	145	106.1	7.48	19.6
	4	23.58	299	386	70	105.5	7.48	20.1
	5	23.49	300	386	40	102.9	7.3	20.1
	6	23.47	301	387	21	93.2	6.62	18.8
	7	23.19	310	393	11	64.7	4.62	16.8
	8	20.81	319	411	6	22.7	1.7	10.4
	9	19.47	319	406	4	7.7	0.59	10.2
	10	16.19	319	411	3	3.8	0.31	9.3
	11	13.93	205	415	2	3.5	0.3	19.3

Central Station 7/26/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0.5	24.23	284	386	863	104.8	7.53	13.5
	1	24.19	285	386	389	104.6	7.52	15.6
	2	23.95	286	386	223	105.2	7.55	17.6
	3	23.83	288	387	123	101.8	7.42	20.7
	4	23.78	290	388	61	98.1	7.12	21.1
	5	23.75	291	387	36	93.2	6.78	20.2
	6	23.64	292	387	19	91.7	6.69	19.5
	7	22.51	306	399	11	26.7	2.14	14.9
	8	20.17	311	410	5	13.8	1.26	10.1
	9	17.79	306	415	3	0.8	0.26	9.2
	10	14.8	249	411	1	0.8	0.27	8.4
	11	12.95	142	415	1	0	0.26	6.8

South Station 7/28/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0.3	24.44	454	383	1275	111.9	7.8	9.5
	1	24.44	451	383	685	112.8	7.86	10.0
	2	24.33	448	383	373	113.5	7.93	12.7
	3	24.25	445	383	158	113	7.91	15.3
	4	24.24	444	383	91	113.2	7.92	16.4
	5	24.22	442	383	40	113.1	7.92	17.3
	6	24.08	440	382	18	111.7	7.84	18.9
	7	19.15	459	411	9	5.5	0.42	9.9
	8	16.88	445	412	6	3.6	0.29	8.8
	9	14.7	429	413	4	3.3	0.28	8.1
	10	14.02	431	413	2	3	0.26	7.1
	11	13.56	416	411	1	2.9	0.25	6.7
	12	12.93	414	410	2	2.9	0.26	6.3
	13	12.63	416	411	1	2.9	0.26	6.3
	14	12.23	416	410	1	3	0.27	6.1
	15	11.78	410	412	1	3	0.27	6.1
	16	11.28	277	419	1	3	0.28	6.3
	17	10.71	180	423	0	3.1	0.29	6.5

	18	10.49	128	427	0	3	0.28	4.38
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North Station 8/1/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0	25.35	335	388	606	112.2	7.69	9.8
	1	24.83	332	388	366	112.5	7.78	10.5
	2	24.23	330	388	212	112.5	7.88	11.5
	3	24.03	330	388	122	112.4	7.89	13.5
	4	23.91	330	390	73	111.1	7.83	16.3
	5	23.62	331	390	43	109.3	7.74	18.1
	6	23.49	332	390	26	106.5	7.56	18.9
	7	22.64	339	394	19	73.4	5.3	18.1
	8	21.17	347	404	10	61.3	4.55	17.2
	9	18.76	352	411	6	16.1	1.25	9.8
	10	17.65	355	411	3	7.8	0.62	10.4
	11	16.57	164	425	2	4.6	0.38	4.1

Central Station 8/1/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0.5	25.82	334	388	694	114.4	7.84	9.7
	1	24.89	333	386	235	113.8	8.11	10.2
	2	24.47	331	388	165	112.8	8.1	13.4
	3	24.28	331	388	96	111.9	8.07	17.2
	4	23.66	333	390	58	110	8.03	18.3
	5	23.38	334	391	35	94.6	6.98	19.3
	6	23.11	337	392	23	87.3	6.49	19.8
	7	22.72	342	395	15	72	5.44	19.2
	8	20.69	350	406	9	38.7	2.57	12.8
	9	17.72	355	415	5	6.3	0.78	11.9
	10	16	322	415	3	1.9	0.44	10.6
	11	14.49	259	417	2	0	0.3	9.1

South Station 8/1/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0.3	25.64	398	388	4061	118.4	8.07	7.2
	1	25.01	396	388	919	118.2	8.15	9.2
	2	24.54	396	387	289	118.7	8.26	11.5
	3	24.4	396	387	230	118.3	8.25	13.4
	4	24.32	397	387	170	116.1	8.11	15.1
	5	23.7	399	389	118	113.6	8.04	15.4
	6	23.23	404	392	77	98.8	7.05	15.6
	7	21.93	412	400	53	66.1	4.84	16.1
	8	18.76	419	413	29	17.5	1.37	10.5
	9	16.41	398	410	17	7.1	0.58	10.1
	10	13.92	279	417	11	3.6	0.31	8.6
	11	13.41	239	417	8	3.4	0.29	7.3
	12	13.04	207	416	5	3.1	0.28	7.0
	13	12.45	217	413	3	3	0.27	6.4
	14	12.1	234	414	3	3	0.27	6.1
	15	11.65	163	420	3	3	0.27	6.3
	16	11.29	135	422	2	3	0.28	6.4
	17	10.95	112	425	1	3	0.28	6.4

North Station 8/8/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo Chl a</i> [Volts]
	1	23.78	284	374	292	105.4	7.44	9.8
	2	23.58	282	374	711	105.5	7.48	15.3
	3	23.49	283	375	545	104.4	7.41	14.8
	4	23.46	283	375	336	102.5	7.28	14.0
	5	23.43	283	375	220	101.6	7.22	13.5
	6	23.36	285	376	124	99	7.04	12.6
	7	23.1	289	378	76	94.1	6.73	11.7
	8	19.47	306	397	43	20.3	1.56	11.2
	9	16.74	311	402	24	5.4	0.44	1.2
	10	14.86	288	405	11	3.5	0.3	9.2
	11	13.91	138	409	6	3.3	0.29	3.7

Central Station 8/8/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.5	23.83	303	375	2420	101.1	7.26	7.4
	1	23.83	303	375	1425	101.8	7.27	8.0
	2	23.52	302	375	806	101	7.37	10.1
	3	23.43	301	375	537	102.7	7.4	11.9
	4	23.35	302	375	298	101.6	7.35	12.8
	5	23.03	307	378	202	84.9	6.29	12.4
	6	22.8	310	380	115	79.7	6.01	12.1
	7	21.65	320	388	80	37.7	2.91	11.2
	8	20.98	324	391	52	11.9	1.03	11.9
	9	18.51	327	398	29	0	0.29	10.8
	10	16.05	289	397	14	0	0.24	9.5
	11	13.95	199	405	8	0	0.25	8.2

South Station 8/8/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	1	23.47	363	378	1696	100	7.1	9.2
	2	23.34	362	378	1002	99.7	7.1	10.4
	3	23.19	362	378	614	99.2	7.08	15.4
	4	22.96	362	380	378	97.7	7.01	15.9
	5	22.86	362	379	222	94.7	6.8	15.8
	6	22.74	362	379	153	90	6.48	14.6
	7	22.66	363	380	91	84.9	6.12	13.3
	8	21.87	371	387	56	38.8	2.84	12.8
	9	17.86	378	401	36	7.6	0.6	11.5
	10	15.09	378	403	15	3.7	0.31	9.1
	11	14.02	319	403	9	3.2	0.28	9.5
	12	13.21	258	404	5	3	0.26	9.3
	13	12.86	248	401	4	2.9	0.25	6.9
	14	12.33	174	405	3	2.9	0.26	6.2
	15	11.91	167	403	2	2.9	0.26	6.3
	16	11.47	141	404	1	2.9	0.26	6.2
	17	10.69	113	411	2	3	0.27	6.2
	18	10.43	103	415	3	3	0.28	6.1

North Station 8/16/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo Chl a</i> [Volts]
	0	24.44	391	385	512	110.6	7.71	10.7
	1	24.39	388	385	325	112.2	7.83	10.2
	2	24.03	385	386	254	115.4	8.11	11.4
	3	23.95	383	385	344	115.9	8.16	12.9
	4	23.89	382	385	145	115.4	8.13	14.0
	5	23.85	381	385	102	114.3	8.06	14.4
	6	23.57	383	386	95	110.4	7.82	13.0
	7	22.91	388	389	88	84.1	6.03	10.6
	8	20.86	397	399	59	38.2	2.85	9.8
	9	18.83	402	407	35	8.5	0.66	9.6
	10	16.3	405	411	13	6.4	0.53	19.7

Central Station 8/16/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.5	24.58	470	386	2526	103.6	7.42	7.7
	1	24.38	460	386	1308	108.7	7.8	8.2
	2	23.9	454	384	1186	109.5	7.93	9.3
	3	23.75	449	384	598	109.9	7.91	14.3
	4	23.68	444	384	267	108.5	7.89	14.9
	5	23.63	442	385	153	107.3	7.82	14.2
	6	23.51	441	386	114	105.2	7.62	12.7
	7	23.08	443	389	77	98.9	7.23	11.2
	8	21.89	448	395	52	51.2	3.97	10.4
	9	18.54	455	406	37	15.3	1.44	9.8
	10	16.9	457	410	16	1.5	0.37	12.4
	11	14.28	303	418	6	0	0.28	11.1

South Station 8/16/17	Depth (m)	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	1	23.84	411	389	319	103.9	7.33	8.3
	2	23.56	406	388	225	102.5	7.27	10.2
	3	23.45	405	389	134	102.2	7.26	10.8
	4	23.38	403	389	97	101.5	7.22	11.5
	5	23.34	387	389	99	98.9	7.04	12.5
	6	23.07	389	389	81	92.6	6.62	12.3
	7	22.69	392	391	59	78.3	5.64	10.3
	8	21.95	398	393	44	46.5	3.4	10.0
	9	19.88	403	404	36	7.3	0.56	11.9
	10	15.94	406	415	22	5.4	0.45	17.5
	11	13.74	391	411	8	3.3	0.29	8.1
	12	13.2	329	410	6	3.1	0.27	7.8
	13	12.77	305	410	5	3	0.27	7.2
	14	12.36	302	410	3	3	0.27	6.3
	15	11.84	213	414	2	3	0.27	6.3
	16	11.04	166	422	2	3.1	0.29	6.1
	17	10.67	143	425	1	3.1	0.29	6.1
	18	10.48	129	427	0	3.1	0.29	6.1

Central Station 8/22/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo Chl a</i> [mV]
	0.5	24.35	356	372	1785	105.2	7.35	7.5
	1	24.34	354	372	1392	104.6	7.31	7.9
	2	24.31	354	373	531	104.5	7.31	8.9
	3	24.21	353	372	449	103.7	7.26	11.2
	4	24.14	353	372	253	103.3	7.24	11.4
	5	24.1	353	372	191	101.3	7.11	11.6
	6	24.09	353	372	128	101.1	7.1	11.5
	7	24.08	353	372	77	98.7	7.09	11.6
	8	22.96	362	377	47	82.1	6.17	11.2
	9	20.47	371	385	35	42.1	3.4	10
	10	18.24	376	395	24	7.1	0.81	9.1
	11	16.93	381	393	9	0	0.41	11.6

South Station 8/22/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [uS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo Chl a</i> [mV]
	0.5	24.16	442	375	1127	99.7	6.99	0.0054
	1	24.31	440	375	847	101.8	7.11	8.0
	2	24.28	440	375	543	101.8	7.12	8.7
	3	24.2	440	376	407	101.6	7.11	9.8
	4	24.2	440	373	323	100.6	7.05	10.4
	5	24.07	439	373	189	98.5	6.91	10.7
	6	24.05	439	372	83	95.5	6.7	10.7
	7	23.38	442	375	49	64.4	4.58	10.1
	8	19.63	455	386	41	17.7	1.36	9.3
	9	16.08	461	394	20	5.9	0.49	9.2
	10	14.35	399	395	6	4.6	0.39	9.5
	11	13.54	325	393	1	4	0.35	36.3
	12	12.88	255	391	0	3.7	0.32	5.3
	14	11.71	157	401	4	2.9	0.27	6.3
	15	11.09	136	405	5	3	0.27	6.1
	16	10.94	120	404	6	2.9	0.27	6.0

North Station 8/24/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/L]	<i>In Vivo Chl a</i> [mV]
	0.5	23.69	359	380	1725	109	7.71	8.3
	1	23.69	358	380	788	104.4	7.39	8.1
	2	23.66	356	380	1007	103.3	7.31	9.0
	3	23.65	355	380	457	103.3	7.31	10.1
	4	23.63	355	379	275	102.9	7.29	10.7
	5	23.6	355	380	194	101.9	7.22	10.6
	6	23.58	355	380	125	101.2	7.17	10.7
	7	23.51	354	380	78	101	7.17	10.7
	8	23.06	360	383	47	100.5	7.19	9.9
	9	20.76	369	390	33	53.7	4.02	9.0
	10	16.23	369	403	15	14.2	1.17	8.6
	11	14.26	276	411	5	6.1	0.53	29.4

Central Station 8/24/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.5	22.64	356	384	621	99.6	7.19	9.6
	1	23.23	355	381	617	99.5	7.1	9.6
	2	23.43	352	380	438	92.2	7.19	9.7
	3	23.42	350	380	221	91.4	7.13	10.2
	4	23.4	350	381	129	90.9	7.11	10.9
	5	23.4	350	381	79	90.1	7.05	11.4
	6	23.38	348	381	65	88.6	6.95	12.2
	7	23.38	348	381	43	88.1	6.91	12.1
	8	23.31	350	382	31	88.1	6.85	11.8
	9	22.39	361	387	19	47.5	4.1	9.7
	10	19.77	367	395	13	13.5	1.72	8.0
	11	17.31	372	392	8	0	0.73	8.7

South Station 8/24/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [µS/cm]	PAR [µE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo Chl a</i> [Volts]
	0.5	23.32	426	382	1546	99.8	7.11	8.4
	1	23.36	424	382	991	97.8	6.96	8.2
	2	23.33	424	381	840	95.8	6.82	8.2
	3	23.29	423	381	412	95.1	6.78	8.8
	4	23.27	420	381	190	94.2	6.71	10.6
	5	23.27	420	381	108	94.2	6.71	10.7
	6	23.26	420	381	82	94.2	6.71	11.0
	7	23.15	422	382	46	92.8	6.63	10.8
	8	21.27	433	389	40	25.9	1.92	8.5
	9	19.32	436	395	30	11.2	0.87	9.6
	10	16.12	439	401	16	6.2	0.51	9.7
	11	14.23	441	406	6	4.1	0.35	13.6
	12	13.6	425	402	2	3.1	0.27	8.2
	13	13.02	316	404	1	3	0.26	13.0
	14	12.75	262	402	1	3	0.26	6.8
	15	11.93	174	409	0	3	0.27	6.3
	16	11.54	156	410	1	3	0.28	6.1
	17	10.93	136	418	1	3.1	0.29	6.1
	18	10.55	120	421	1	3.1	0.29	5.9

Central Station 9/5/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [μ S/cm]	PAR [μ E/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0.5	20.56	241	360	443	94.6	7.26	12.5
	1	20.61	241	360	174	90.7	6.95	13.2
	2	20.58	242	360	105	90.5	6.94	12.3
	3	20.57	243	360	68	88.8	6.78	11.5
	4	20.56	246	360	38	88.8	6.81	11.6
	5	20.56	248	360	16	87.7	6.73	11.7
	6	20.54	250	361	8	87.5	6.72	11.4
	7	20.52	251	361	5	85.9	6.6	10.5
	8	20.5	253	361	3	84.8	6.53	9.1
	9	18.04	263	370	2	30.6	2.57	7.0
	10	12.99	117	387	2	2.2	0.37	9.0
	11	12.29	94	387	1	0	0.26	9.0

South Station 9/5/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [μ S/cm]	PAR [μ E/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0.5	20.29	494	363	285	95.1	7.19	10.1
	1	20.32	493	363	154	89.9	6.79	10.3
	2	20.31	491	363	76	84.8	6.41	10.2
	3	20.31	489	363	55	84	6.34	10.4
	4	20.25	488	363	34	83	6.28	10.
	5	20.21	487	364	23	78.5	5.94	8.2
	6	20.17	486	364	15	77.5	5.87	8.0
	7	20.15	485	364	10	75.4	5.72	7.6
	8	20.14	484	364	6	74.6	5.66	7.4
	9	20.05	483	364	4	72.9	5.53	6.9
	10	18.78	487	371	2	35.4	2.76	6.9
	11	14.97	322	383	1	2.8	0.23	11.4
	12	14.07	249	385	0	2.8	0.24	7.8
	13	13.32	239	383	1	2.8	0.25	8.2
	14	12.66	90	385	1	2.8	0.25	9.0
	15	12.22	75	385	0	2.9	0.26	7.2
	16	11.41	61	392	0	3	0.27	7.4
	17	10.92	54	396	0	2.9	0.27	7.5
	18	10.87	50	397	0	3	0.28	16.0

Central Station 9/14/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0.5	20.85	262	369	320	100.4	8.03	11.6
	1	20.74	263	370	227	102.2	8.33	14.2
	2	20.17	265	372	106	102.9	8.45	14.3
	3	19.8	266	371	76	101.3	8.42	20.3
	4	19.73	267	372	56	99.4	8.21	21.0
	5	19.67	269	372	42	96.8	8.02	27.8
	6	19.49	272	371	30	93.9	7.83	21.2
	7	19.33	275	371	20	90	7.56	15.8
	8	19.18	279	371	12	80.4	6.83	14.8
	9	19.06	281	372	8	75.7	6.49	9.3
	10	18.4	289	377	6	41.1	3.86	8.7
	11	16.53	298	389	4	0	0.67	14.4

South Station 9/14/17	Depth [m]	Temp [°C]	ORP [mV]	SpCond [μS/cm]	PAR [μE/s/m ²]	LDO% [Sat]	LDO [mg/l]	<i>In Vivo</i> Chl a [Volts]
	0.5	20.74	394	372	289	106.2	7.96	9.4
	1	20.4	392	372	195	106.5	8.03	10.7
	2	20.06	392	372	131	107.4	8.16	10.9
	3	19.8	393	372	79	106.2	8.11	21.6
	4	19.64	393	373	51	102	7.81	23.4
	5	19.45	396	373	33	94.7	7.28	32.8
	6	19.3	395	373	18	92.5	7.13	31.3
	7	19.19	396	373	11	91.6	7.08	17.0
	8	19.15	398	375	6	89.1	6.89	16.4
	9	18.94	399	375	6	76.8	5.96	14.3
	10	18.19	404	377	3	63.9	5.04	12.6
	11	16.91	410	386	2	31.6	2.56	19.1
	12	14.59	411	396	1	4.6	0.39	10.8
	13	13.31	360	393	0	2.9	0.26	7.5
	14	12.63	154	398	0	2.9	0.26	8.0
	15	12.36	131	397	0	2.9	0.26	7.9
	16	11.51	104	404	0	3	0.27	6.7
	17	11.12	86	408	0	3	0.27	6.6
	18	10.77	80	411	0	3	0.28	14.3

APPENDIX II. Analysis of Summer 2015 Phytoplankton Community Focusing on Cyanobacteria

Overview

This analysis of phytoplankton species composition for Conesus Lake is centered on samples collected in 2015. Collections were made on July 21, July 28 and September 23, 2015 from the upper 3 m of the water at the south basin. SUNY Geneseo researchers used a 4.1 L Van Dorn bottle to collect the water. A portion of each freshly collected sample was fixed in 2.5% glutaraldehyde final concentration. PhycoTech Incorporated, of St. Joseph, MI 49085 conducted the analyses of species composition. However, the results were not obtained in time to be included in the summer 2015 monitoring report submitted by Bosch and colleagues (2015).

The data trends identified in January 2018 and are submitted in this Appendix. The analysis includes comparison to summer 2015 data trends to previous work by Mills, 1972 and Makarewicz 2000 as reported in the Conesus Lake Watershed Characterization report. We excluded from the overall analysis species of unicellular cyanobacteria (*Synechococcus*, *Synechocystis* and *Chroococcus*) and the green algal family *Chlorococcaceae*. These very small cells (typically <2 microns) and consequently the large densities of these species in our analysis would have obscured any trends in the nanoplankton (2-20 micron) community structure. Moreover, these groups were not included in the work of Mills and Makarewicz (SOCL 2001).

Data Trends

Any comparison of the 1972 study to the more recent work should be done with caution, because our knowledge of the phytoplankton community has improved so much over time and species identifications have changed. Mills reports the diatom *Melosira granulata* as the most common phytoplankter but that species is not present among the abundant species listed by Makarewicz (Table II-a) and it was not identified by PhycoTech Inc. in any of the 2015 samples (Table II-b). The only species listed as common in all three of the surveys were the cyanobacteria *Microcystis aeruginosa*, the chlorophyte *Sphaerocystis schroeteri*, and the cryptophyte *Cryptomonas erosa*. Cyanobacteria in the genus *Anabaena* appear prominently in all three reports, though the species identifications are different. The 1999 survey by Makarewicz shows that *Rhodomonas minuta* and *Oocystis parva* are among the three most abundant species. This is also true for the PhycoTech Inc. survey conducted 16 years later. *Sphaerocystis schroeteri* was the most common species on July 21, 2015, and it was also present in both previous surveys.

Figure IIa shows the relative abundance of the different phytoplankton taxonomic groups in the three surveys. It is difficult to define any reliable trends in the data beyond the fact that chlorophytes, cyanobacteria and

chrysophytes are routinely among the dominant groups in the phytoplankton community. Chrysophytes, while less abundant, are prominent in all three surveys.

Focusing on cyanobacteria, it is obvious that species of *Anabaena*, *Aphanizomenon* and *Microcystis aeruginosa* have been prominent in Conesus Lake for decades. Mills reports *M. aeruginosa* as the third most abundant species in 1972. It is abundant in the Makarewicz collection and among the top ten in the July 21, 2015 collection. While *Microcystis* is common in Conesus Lake, blooms dominated by this highly toxic species have been rare in recent years, with only one toxic bloom having been reported in recent years (Makarewicz *et. al.* , 2009b). *M. aeruginosa* was nearly absent from collections in the 2017 survey (this study). The primary summer bloom formers in Conesus Lake have been species of *Anabaena*, the highly toxic *A. circinalis*, a neurotoxin-producing species (anatoxin, saxitoxin) that is a nuisance world-wide. *A. circinalis* was once again dominant in 2017 (this study).

Table II-c and Figure II-b show the relative contribution of the various species to the cyanobacteria community in Conesus lake for 2015. Omitted from this analysis are the single celled cyanobacteria in the genera *Synechococcus* and *Synechocystis*. The cells of these species are typically less than 2 microns in size and abundances of more than one million cells per mL are not unusual. In 2015, a major bloom of these two species tainted lake water of Conesus Lake a chalky blue green. The PhycoTech survey reports densities of more than a million cells per mL in July. *Synechococcus* and *Synechocystis* are known toxin producers, but they are rarely considered in monitoring of harmful algal blooms (HABs). SUNY Geneseo continues to monitor these species as part of its research effort. In 2017 densities never reached numbers that would be of any concern in monitoring HABs.

The dominant colonial cyanobacteria species in 2015 by cell number were *Merismopedia warmingiana* (25.3%), *Anabaena circinalis* (14.5 %), *A. lemmermannii* (12.7%), *Microcystis aeruginosa* (12.7%) and *Woronichinia naegeliana* (10.9%). Species of *Anabaena* comprised more than 27% of the cell densities, while species of *Oscillatoria* were only 4.5%. A different perspective emerges when the measure of biovolume is considered. Biovolume calculations take into account the size of the cells as well as their abundance. Thus, biovolume is a better indicator of biomass and possibly of the potential for toxin production by species. As shown in Table II-d and Figure II-c, *M.warmingiana* and other small-celled species such as *W. naegeliana* are a negligible portion of the biovolume. As it was in terms of cell number, *Anabaena* and *Microcystis* are important in terms of biovolume. However, the most significant insight to be gained from this analysis is the importance of *Oscillatoria* species, which make up more 70.7% of the biovolume. Species in the genus *Oscillatoria* are known to produce microcystins. Thus, while they may not be prominent in terms of colony counts, *Oscillatoria* could be an important toxin producer and should be considered a species of special interest in future studies of HABs in Conesus Lake and elsewhere.

TABLE II-a This table shows the results of phytoplankton community analyses carried out in 1972 by Mills and in 1999 by Makarewicz and colleagues as reported in the Conesus Lake . The data was modified from that included in the State of Conesus Lake -Watershed Characterization Report (SOCL 2001). Only species that were 1 % or greater of the total cell number are included. Species of cyanobacteria are highlighted in boldface print. The genus *Anabaena* has been renamed *Dolichospermum*.

Species name	1999 % of total cells	Species name	1972 % of total cells
Anabaena macrospora	23.8	<i>Melosira granulata</i>	26.5
<i>Rhodomonas minuta</i>	9.5	Aphanizomenon flos-aquae	19.6
<i>Oocystis parva</i>	6.2	Microcystis aeruginosa	13.1
<i>Cryptomonas erosa</i>	5.1	<i>Tabellaria fenestrata</i>	11
<i>Erkenia subaequiciliata</i>	4.9	<i>Cyrtomonas pusilla</i>	6.3
<i>Peridinium polonicum</i>	4.6	<i>Cryptomonas ovata</i>	5.1
Anabaena spiroides	4.4	<i>Certaium hirudinella</i>	0.7
Aphanizomenon flos-aquae	4.3	<i>Peridinium cinctum</i>	3.7
<i>Mallomonas sp</i>	2.6	<i>Cryptomonas erosa</i>	3.3
<i>Cyclotella ocellata</i>	2.6	<i>Asterionella famosa</i>	3.3
Oscillatoria sp.	2.1	<i>Sphaerocystis schroeteri</i>	1.4
<i>Peridinium umbonatum</i>	1.8	Anabaena flos-aquae	1.0
<i>Fragilaria crotonensis</i>	1.7	<i>Dinobryon serularia</i>	1.0
<i>Fragilaria capucina</i>	1.7	<i>Cyclotella sp.</i>	1.0
<i>Cyclotella</i>	1.7	<i>Cosmarium eniforme</i>	1.0
Microcystis aeruginosa	1.5		
<i>Dinobryon divergens</i>	1.2		
<i>Stephanodiscus niagarae</i>	1.2		
<i>Coleastrum astroideum</i>	1.1		
<i>Chlamydomonas incerta</i>	1.0		
<i>Sphaerocystis schroeteri</i>	1.0		

TABLE II-b. This table shows the relative contribution of the major species of phytoplankton as % of total cell number on July 21, 28 and Sep 23, 2015. The species analysis of Conesus Lake samples was completed by PhycoTech Inc.

Species name	9/23 % of total cells	Species name	7/28 % of total cells	Species name	7/21 % of total cells
<i>Chrysocromulina parva</i>	45.0	<i>Chromulina sp.</i>	50.7	<i>Sphaerocystis schroeteri</i>	21.0
<i>Cyclotella sp.</i>	37.6	<i>Oscillatoria sp.</i>	11.5	<i>Rhodomonas minuta</i>	15.7
<i>Cyclotella ocellata</i>	3.2	<i>Chrysocromulina parva</i>	9.3	<i>Oocystis parva</i>	7.4
<i>Oocystis parva</i>	2.2	<i>Rhodomonas minuta</i>	3.8	<i>Merimospedia warmingiana</i>	6.9
<i>Anabaena circinalis</i>	2.0	<i>Cyclotella ocellata</i>	3.1	<i>Fragilaria crotonensis</i>	4.9
<i>Dispora crucigenioides</i>	1.0	<i>Synedra tenera</i>	3.1	<i>Microcystis aeruginosa</i>	3.5
<i>Chlamydomonas spp.</i>	1.0	<i>Selenastrum minutum</i>	2.8	<i>Woronichinia naegeliana</i>	2.9
		<i>Chlamydomonas spp.</i>	2.8	<i>Stichoglaea olivacea</i>	2.9
		<i>Oocystis parva</i>	2.6	<i>Costerum moniliferum</i>	2.9
		<i>Sphaerocystis schroeteri</i>	2.6	<i>Gleocystis spp</i>	2.5
		<i>Closterium moniliferum</i>	1.4	<i>Gomphosphaeria lacustris</i>	2.0
		<i>Anabaena lemmermanni</i>	1.2	<i>Anabaena circinalis</i>	2.0
		<i>Anabaena circinalis</i>	1.0	<i>Scenedesmus quadricata</i>	1.9
				<i>Scenedesmus cerratus</i>	1.5
				<i>Chlamydomonas spp.</i>	1.5
				<i>Chlosterium monoliferum</i>	1.5
				<i>Chlosterium spp</i>	1.5
				<i>Franceia droescheri</i>	1.5
				<i>Scenedesmus bijuga</i>	1.5
				<i>Cryptomonas erosa</i>	1.5
				<i>Aphanocaspa delicatissima</i>	1.5
				<i>Dyctiosphaerium pulchellum</i>	1.0
				<i>Selenastrum minutum</i>	1.0
				<i>Anabaena lemmermanni</i>	1.0
				<i>Aphanocaspa holsatica</i>	1.0
				<i>Oscillatoria sp</i>	1.0

TABLE II-c. This table shows the species composition of colonial cyanobacteria in Conesus Lake by cell number. The cell number for each species was divided by the total number of cells per mL of sample and multiplied x100 to get percent of total, then averaged for July 15 and July 28, 2015. Picoplankton were excluded from the analysis, as described in Table II-b.

	# cells/mL	# cells/mL	# cells/mL	
Cyanobacteria species	15-Jul	28-Jul	Avg. July	% of cells
<i>Anabaena circinalis</i>	56.46	56.46	56.5	14.5
<i>Anabaena crassa</i>	2.556	1.278	1.9	0.5
<i>Anabaena lemmermannii</i>	28.23	70.577	49.4	12.7
<i>Aphanocaspa delicatissima</i>	42.35	0	21.2	5.4
<i>Aphanocaspa holsatica</i>	28.23	0	14.1	3.6
<i>Gomphosphaeria lacustris</i>	56.46	0	28.2	7.2
<i>Merismopedia warmingiana</i>	197.62	0	98.8	25.3
<i>Microcystis aeruginosa</i>	98.8	0	49.4	12.7
<i>Oscillatoria spp</i>	28.23	14.115	21.2	5.4
<i>Woronichinia naegeliana</i>	84.69	0	42.3	10.9
<i>Pseudoanabaena limnetica</i>	0	14.115	7.1	1.8

TABLE II-d. Biovolume composition colonial cyanobacteria in Conesus Lake. The measured species specific biovolume was divided by the total cell biovolume of the sample per mL and multiplied x100 to arrive at a percent value, then averaged for July 15 and July 28, 2015.

	biovolume	biovolume	biovolume	
Cyanobacteria species	$\mu\text{m}^3/\text{mL}$	$\mu\text{m}^3/\text{mL}$	$\mu\text{m}^3/\text{mL}$	% of biovolume
	15-Jul	28-Jul	Avg. July	
<i>Anabaena circinalis</i>	107,113	47,656	77,385	5.6
<i>Anabaena crassa</i>	158,057	19,757	88,907	6.4
<i>Anabaena lemmermannii</i>	135,636	153,435	144,536	10.4
<i>Aphanocaspa delicatissima</i>	599	0	300	0.0
<i>Aphanocaspa holsatica</i>	3,695	0	1,848	0.1
<i>Gomphosphaeria lacustris</i>	5,872	0	2,936	0.2
<i>Merismopedia warmingiana</i>	181	0	91	0.0
<i>Microcystis aeruginosa</i>	177,896	0	88,948	6.4
<i>Oscillatoria spp</i>	31,041	1,929,886	980,464	70.7
<i>Woronichinia naegeliana</i>	1,995	0	998	0.1
<i>Pseudoanabaena limnetica</i>	0	799	400	0.0

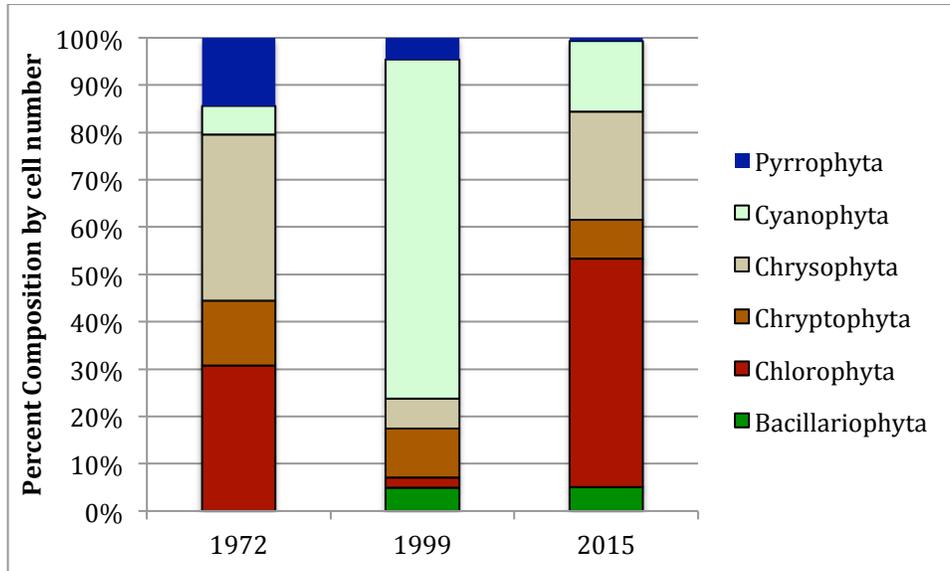


Fig. II-a. Community composition of the phytoplankton in Conesus Lake for 1972, 1999 and 2015 compared by cell number. The 2015 data are averages of July 21 and 28 species analysis. As in tables IIa and b, unicellular cyanobacteria and *Chlorococcacea* green algae were excluded from the analysis because their numbers are so high that they would obscure any trends in the nanoplankton (2-20 micron).

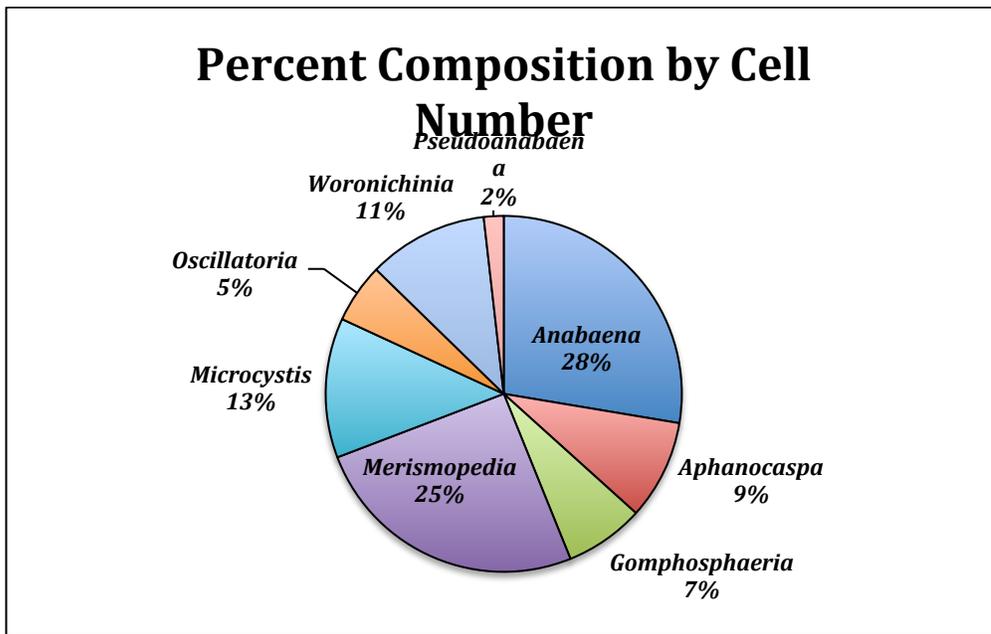


Fig. II-b. This pie chart shows community composition of cyanobacteria genera in 2015 according to cell number, showing dominance of *Anabaena* and *Merismopedia*, followed by *Microcystis*.

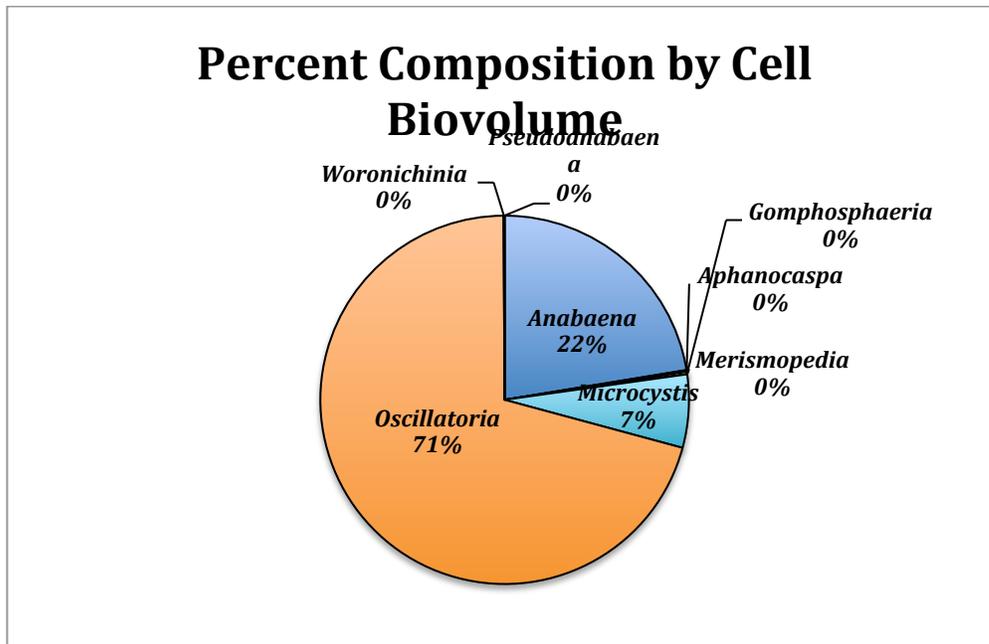


Fig. II-c. This pie chart shows the community composition of cyanobacteria genera in 2015 according to total cell biovolume, showing dominance of *Oscillatoria spp.* *Anabaena* (3 spp) and *Microcystis* (1 spp) are the other two significant groups. The biovolume measurement incorporates cell size as well as cell number and may be a better indicator of total biomass, and thus potential toxin production.