Lake Monitoring Data Summary

2017-2018

Pocono Lakes Ecological Observatory Network

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PLEON

POCONO LAKE ECOLOGICAL OBSERVATORY NETWORK

Table of Contents

What is PLEON?

The **P**ocono **L**ake **E**cological **O**bservatory **N**etwork is a regional lake monitoring program focused on educating the public and lake associations on water quality and lake management.

Our goals:

Empower the public to better understand and manage their freshwaters.

Create a community of scientists, students, environmental educators, and landowners to work together in improving the ecological state of Pennsylvania's lake ecosystems.

Complement a traditional lake consultant by providing ongoing monitoring data on lakes and ensuring that land owners fully understand the advantages and limitations of different lake management approaches.

Why PLEON?

Lakes are ecological treasures that form the economic backbone of tourism in the Pocono region. They provide both recreational enjoyment as well as critical habitat for a variety of wildlife, including plants and animals.

Lakes are complex ecosystems, and effective management requires good data as well as an understanding of the physical, chemical, and biological characteristics of lakes and their surrounding catchments.

Despite their aesthetic, recreational, and environmental importance, we know little about water quality in our Pocono lakes. Neither the state nor regional counties offer regular surveys to provide data essential for good management of these complex ecosystems. Increasing concerns about harmful algal blooms throughout the region make responsible lake management of central importance to the health of these ecosystems and the people, pets, and wildlife that depend on them.

Who is PLEON?

PLEON is based at Lacawac Sanctuary and Biological Field Station and is administered by Lacawac's Director of Science and Research. The program has a scientific advisory board consisting of experts in freshwater science.

Chief Scientist & Director	Dr. Beth Norman Director of Science and Research, Lacawac Sanctuary *Expertise: ecosystem ecology, nutrient cycling, eutrophication, trophic interactions*
Chief Scientific Advisor	Dr. Craig Williamson Ohio Eminent Scholar of Ecosystem Ecology & Professor of Biology, Miami University of Ohio *Expertise: effects of UV on lake communities, lake responses to climate change, >30 years studying Pocono lakes*
Scientific Advisory Board	Dr. Janet Fischer Professor of Biology, Franklin and Marshall University *Expertise: lake food webs, plankton community dynamics, >20 years studying Pocono lakes*
	Dr. Elizabeth Rielly Assistant Professor of Biology, Holy Family University *Expertise: freshwater plants, aquatic nutrients, macroinvertebrates, citizen science programing*
	Dr. Sarah Princiotta Postdoctoral Associate, Murray State University *Expertise: plankton diversity, plankton community dynamics, Lake Lacawac*
	Lauren Knose PhD Student, Department of Biology, Miami University of Ohio *Expertise: algae identification, harmful algal blooms, cyanotoxins, public health*

How PLEON works:

A team of PLEON scientists and interns will give your lake a "check-up." We offer pre-formulated packages and à la carte options, allowing you to create a program specific to your needs.

Summary of PLEON lake monitoring database: 2017-18

A. Description of PLEON Lakes

PLEON has monitored 10 Pocono lakes since 2017. These lakes are located in Pike, Wayne, and Monroe County. PLEON lakes range from ~80,000-900,000 m^2 (average = 330,000 m^2) in surface area, ~1,500-8,000 m (average = 3,000 m) in shoreline and from 2-23 m (average = 7.13 m) in maximum depth (Figure 1).

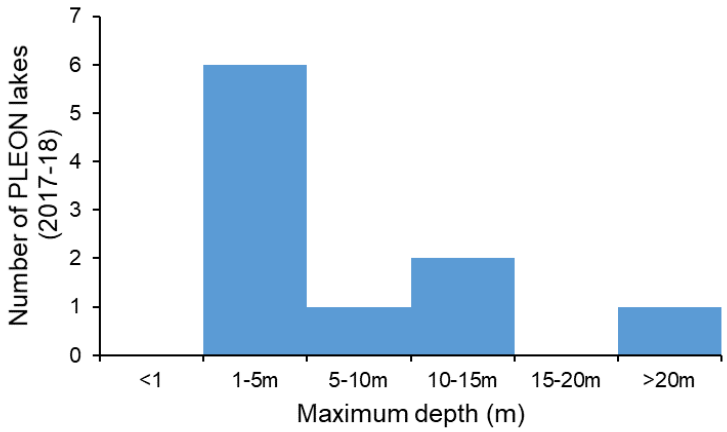

Figure 1. Distribution of PLEON lakes according to maximum depth (m).

B. Secchi Depth

Eutrophic, mesotrophic, and oligotrophic lakes are represented in the PLEON dataset. However, the majority of PLEON lakes are either eutrophic (7 lakes) or mesotrophic (2 lakes; Figure 2).

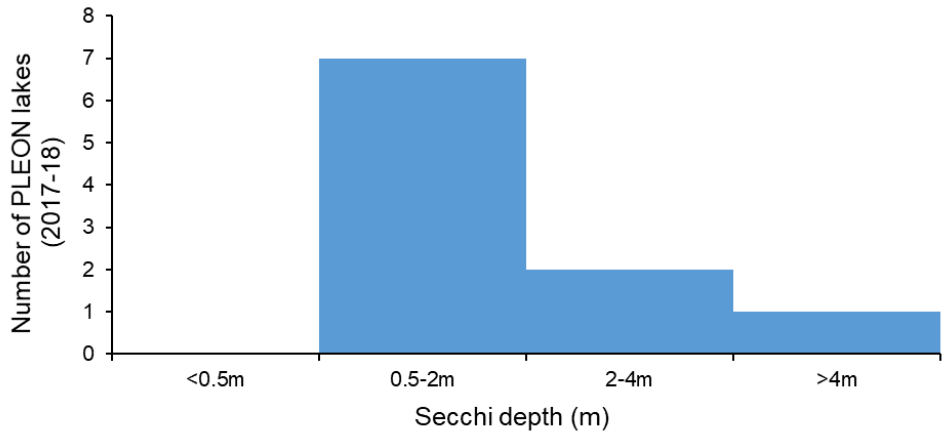

Figure 15. Distribution of PLEON lakes according to summer (June-August) Secchi depth. When Secchi depth was sampled more than once in a single lake, the average is shown. Secchi depth categories (from left to right) correspond to hypereutrophic, eutrophic, mesotrophic, and oligotrophic classifications.

C. Surface temperature, Dissolved Oxygen, Conductivity, pH

Average surface temperatures in PLEON lakes generally increased from 2017 to 2018, although different lakes were sampled in each year (Table 1). There was a greater range in surface temperatures in the 2018 dataset compared to 2017. Average dissolved oxygen concentration at the surface was relatively similar across years. Average conductivity and pH at the surface showed an increase over time.

Table 1. Surface water temperature during the summer (depth of 0.5-1 m) in PLEON lakes. Note that different lakes were sampled in 2017 and 2018. When lakes were sampled more than once, all readings were included in the average.

	Temperature (°C)		Dissolved Oxygen (mg/L)		Conductivity (µS/cm)		pH	
	2017	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Mean	23.7	25.5	7.82	7.78	54.6	64.2	7.15	7.62
Maximum	27.1	29.6	12.76	9.08	164.3	139.6	8.02	8.75
Minimum	18.7	18.8	5.90	6.47	10.7	18.8	5.82	6.18

D. Nutrients

PLEON lakes are distributed across a range of epilimnetic TN and TP concentrations (Figure 3).

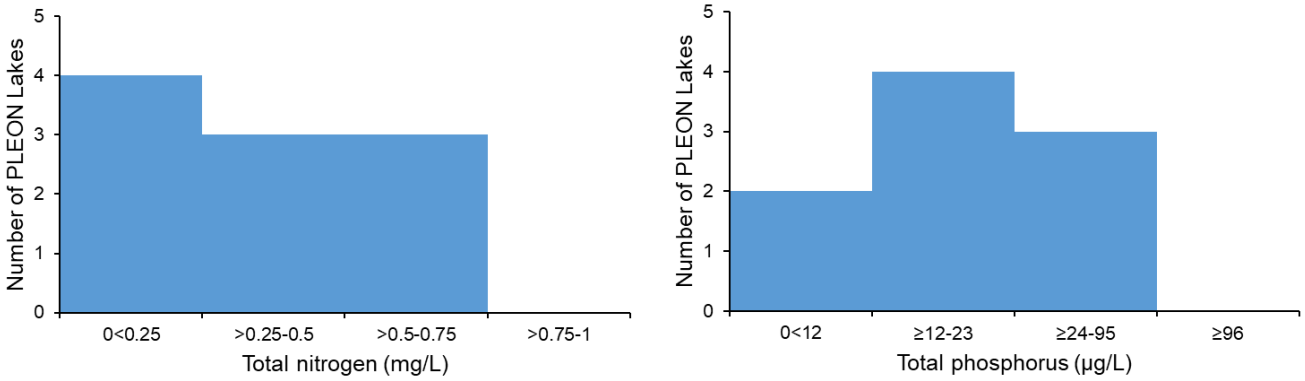

Figure 3. Distribution of PLEON lakes according to summer average TN and TP concentration measured at 0.5 m. TP categories (from left to right) correspond to oligotrophic, mesotrophic, eutrophic, and hypereutrophic classifications.

E. PTOX Cyanobacteria

Potentially toxigenic (PTOX) cyanobacteria taxa were found in several PLEON lakes in 2017 and 2018 (Table 2). Several genera seem to be common in all lakes sampled during August, including, *Dolichospermum*, *Aphanizomenon*, and *Microcystis*. These genera seem to have been more widely distributed across lakes in 2017 than 2018, although different lakes were sampled during each summer.

Table 2. Number of PLEON lakes with PTOX cyanobacteria found in PTOX screens.

	2017					2018			
	M	J	J	A		J	J	A	S
Aphanizomenon sp.	1	0	1	3		1	1	0	1
Aphanizomenon/Cuspidothrix sp.	1	0	0	0		0	0	0	0
Aphanizomenon/Sphaerospermopsis sp.	0	0	0	0		0	0	1	0
Chrysosporum sp.	0	1	0	0		0	0	0	0
Chrysosporum ovalisporum	0	0	1	0		0	1	2	0
Cuspidothrix sp.	1	1	0	0		0	0	1	0
Cuspidothrix issatschenkoi	0	0	0	0		0	1	1	1
Dolichospermum sp.	1	1	1	3		1	1	2	0
Dolichospermum planctonicum	0	0	0	0		0	0	2	0
Dolichospermum smithii	0	0	0	0		1	1	1	1
Microcystis sp.	1	1	1	3		1	0	0	0
Microcystis wesenbergii	0	0	1	2		0	0	2	0
Nostocalean genera	0	0	1	0		1	1	0	0
Planktothrix sp.	0	1	1	0		0	0	0	0
Woronichinia naegeliana	0	0	0	1		0	0	0	0
# of lakes screened	**1**	**2**	**5**	**4**		**2**	**2**	**6**	**1**

PLEON has conducted 49 PTOX screens since May 2017. Based on the recommendation of Greenwater Laboratories, many of these screens have been tested for specific toxins (Table 3). Microcystin/nodularins are the only toxins that have been found above the minimum detection limits in PLEON lakes. However, it is important to note that recommended testing for all toxin classes have often been declined.

Table 3. Summary of PTOX screens tested for toxin concentration across PLEON lakes (2017-18).

Toxin	# recommended for testing	# tested	# < MDL*	# ≥ MDL*	Mean concentration (ng/mL)	Range (ng/mL)
microcystins/nodularins	23	18	6	12	15.3	0.16-129
cylindrospermopsin	14	9	9	0	-	-
anatoxin-a	13	10	10	0	-	-
saxitoxin	13	10	10	0	-	-

**minimum detection limits*

Description of Field Sampling Methods

Temperature, dissolved oxygen, conductivity, and pH were measured using a handheld YSI Professional Plus multiparameter instrument fitted with a polarographic dissolved oxygen probe and a pro series pH probe. Probes were calibrated in early June 2018. Probes were lowered through the water column starting at the surface (probes just under water, “0 m”). Readings were recorded in the field every 0.5-1 m.

Secchi depth was taken from the shady side of the boat using a Secchi Disk standard to freshwater sampling.

PTOX samples were collected at elbow depth from two locations within each lake. Samples were kept cold and shipped overnight to Greenwater Laboratory for analysis.

Nutrient samples were collected from 2-3 depths in each lake, representing the epilimnion, metalimnion (if present), and hypolimnion as determined from temperature profiles taken on the same day as sample collection. Nutrient samples were acidified with sulfuric acid and kept cold until analysis by the CAWs lab of Miami University of Ohio,

Description of PLEON vendors

A. GreenWater Laboratories

PLEON sends PTOX samples to GreenWater Laboratories for PTOX screening. Samples are kept cold in the field and sent to GreenWater Laboratories within 30 hours. GreenWater Labs provides the following description of the screening process:

“A one mL aliquot of each sample was prepared using a Sedgewick Rafter cell. The samples were scanned at 100X for the presence of potentially toxigenic (PTOX) cyanobacteria using a Nikon Eclipse TE200 inverted microscope equipped with phase contrast optics. Higher magnification was used as necessary for identification and micrographs.”

B. Miami University Center for Aquatic and Watershed Sciences

PLEON nutrient samples are analyzed by the Center for Aquatic and Watershed Sciences laboratory at Miami University.

Total N analyzed using Method 116. Total P analyzed using Method 112.

Glossary

Anatoxin-a: A neurotoxin produced by some cyanobacteria, including members of the genera *Microcystis*, *Aphanizomenon*, *Planktothrix*, and *Cylindrospermum*. Considered dangerous for humans and pets.

Bacillariophyta: a group of phytoplankton commonly called diatoms. Their cell walls contain silica and they often appear gold or brown in color. Prone to boom and bust cycles of growth.

Carlson’s trophic state index: An index designed by R. E. Carlson in 1977 that ranks lakes on a scale of 0-100. The index is based on algal biomass and can be calculated using Secchi depth, chlorophyll concentration, or phosphorus concentration.

Conductivity: the ability of a solution to conduct electricity (also called specific conductance). Dissolved materials increase the conductivity of water so this variable can indicate the amount of dissolved solids. Sea water, for example, has a conductivity of 50,000 µS/cm.

Cyanobacteria: a group of photosynthetic bacteria commonly found in freshwater phytoplankton communities. Some taxa are capable of fixing nitrogen from the atmosphere. Some taxa produce secondary metabolites that are toxic to humans.

Cylindrospermopsin: a liver and kidney toxin produced by some cyanobacteria.

Dissolved oxygen: The amount of oxygen gas dissolved in water. This variable is important because oxygen is required for respiration by lake organisms. Dissolved oxygen enters water via diffusion at the water surface and through the process of photosynthesis, of which oxygen is a waste product.

Epilimnion: The surface layer of a thermally stratified lake. The epilimnion is mixed by waves and wind; therefore the temperature is fairly uniform throughout this layer. The lower boundary of the epilimnion is determined by a rapid change in temperature. This layer is typically more oxygenated than the lower layers.

Eutrophic: trophic state describing productive lakes. Eutrophic lakes are typically high in nutrients with low transparency.

Hypereutrophic: trophic state describing highly productive lakes. Hypereutrophic lakes have extreme levels of excess nutrients and have very low transparency.

Hypolimnion: the deep waters of a thermally stratified lake. The hypolimnion consists of cold water that does not mix with the warmer epilimnion. This layer can be depleted in oxygen due to the absence of photosynthesis.

Mesotrophic: trophic state describing lakes with intermediate productivity. Mesotrophic lakes have intermediate levels of nutrients and intermediate transparency.

Metalimnion: the middle layer of a thermally stratified lake defined by the rapid change in temperature with depth. This is the transition layer between the epilimnion and hypolimnion.

Microcystin: a group of toxins produced by some cyanobacteria genera including *Microcystis* and *Planktothrix.* Microcystins are liver toxins that can be harmful to humans and pets.

Oligotrophic: trophic state describing lakes with low productivity. Oligotrophic lakes are nutrient poor and have high transparency.

pH: a measure of hydrogen ions on a logarithmic scale from 0-14. Values above 7 are considered basic and values below 7 are considered acidic. Lake organisms have specific pH tolerances.

Phytoplankton: Planktonic microscopic organisms that use sunlight to convert carbon dioxide to sugar in a process called photosynthesis. The base of lake food webs, phytoplankton provide food for zooplankton and some fish. Phytoplankton also drive nutrient cycling and produce oxygen.

Potentially Toxic (PTOX) Cyanobacteria: cyanobacteria groups that are known to have the capability to produce toxins that are harmful to humans and pets.

Saxitoxin: a neurotoxin produced by some cyanobacteria genera including *Aphanizomenon* and *Planktothrix.* Exposure can be harmful to humans and pets.

Secchi depth: a standardized value of water transparency measured using a flat disk with black and white quadrants called a Secchi disk. Secchi depth is positively correlated with transparency.

Zooplankton: planktonic animals found in lake water. Zooplankton are critical to lake food webs, feeding on phytoplankton and dead organic matter and providing food for fish and other large lake organisms.