

Notes *from the* FOREST

Fall 2018
Newsletter

LACAWAC SANCTUARY FIELD STATION & EE CENTER

Are Pocono Lakes on the Precipice of An Ecological Tipping Point?

The Current Focus of Long-Term Lake Research at Lacawac

Picture a marble resting in the valley between two ant hills. You can push the marble up the side of one of the hills and it will roll back to its original position. However, if you push the marble far enough, it will reach the peak and roll down the other side, and can't return to its original place without more pushing in the opposite direction. The peak is a tipping point, beyond which the marble is unable to return to its starting position.

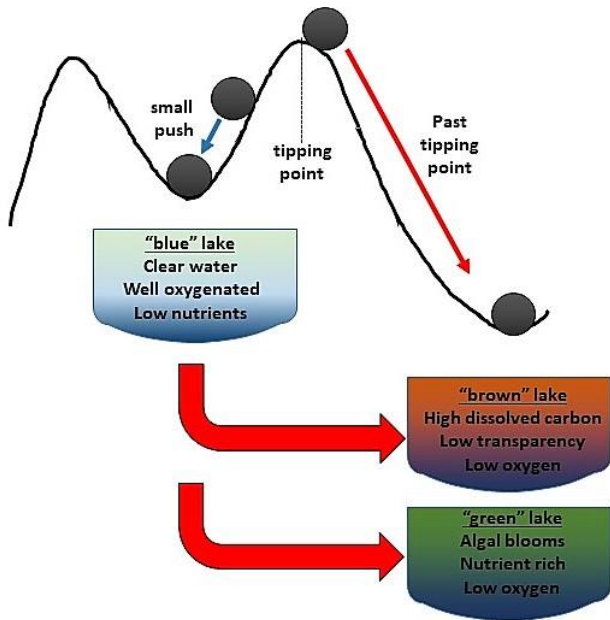
Similarly, ecosystems can be pushed beyond their ability to resist or recover from disturbances or long-term changes. Ecologists refer to this as an ecological tipping point. Ecosystems pushed over a tipping point are changed in fundamental ways that make returning to their original states often very difficult or nearly impossible. This new state is often less aesthetically, economically, and ecologically desirable than the original.

Two research groups led by Drs. Kevin Rose (assistant professor at RPI) and Craig Williamson (professor at University of Miami) received a grant from the National Science Foundation to investigate if lakes can be pushed over an ecological tipping point by a phenomenon called "lake browning".

Lake browning refers the increasing amounts of dissolved organic carbon entering lakes from their watersheds. When it rains, water infiltrates the soil of the surrounding forest and leaches the soluble organic compounds, much like a tea bag

leaches tea into a cup of hot water. This dark brown water then runs off the soil surface and subsurface, carrying dissolved compounds into the lake. Lake browning has been documented in lakes across the Northern Hemisphere and appears to be a global trend (for more information see the Spring 2018 edition of Forest Notes).

Rose and Williamson worry that lake browning may alter the physical, chemical, and biological characteristics of lakes beyond the point of recovery, or beyond the ecological tipping point. They have received a prestigious grant from the National Science Foundation that will allow them to monitor changes in Lake Lacawac and two other local lakes over the next 5 years to investigate the long-term effects of browning and what lakes pushed past the tipping point may look like. The three study lakes represent "brown" lakes with naturally high dissolved carbon concentrations (such as Lake Lacawac), "blue" lakes with well oxygenated, clear water, and "green" lakes with relatively high algal production. They hypothesize that browning will eventually change "blue" lakes into "brown" or "green" lakes. Their reasoning is based on how carbon inputs affect two fundamental characteristics of lakes: oxygen availability and water clarity.



How will carbon inputs affect the amount of oxygen in deep waters?

Oxygen is required by almost all lake organisms. The amount of oxygen available in lake water is determined by two biological processes. Photosynthesis (the conversion of carbon dioxide into sugar by algae) produces oxygen while respiration (the metabolism of carbon compounds by organisms for energy) uses oxygen. Photosynthesis also requires sunlight; therefore, oxygen production only occurs as deep as sunlight penetrates the water column. Below this depth, organisms continue to respire and use oxygen, but no oxygen is produced. The result is often oxygen-rich surface waters and oxygen-depleted deep waters. Rose and Williamson hypothesize that increased carbon inputs will lead to even less oxygen in the deep waters because carbon fuels respiration. More respiration uses up more oxygen.

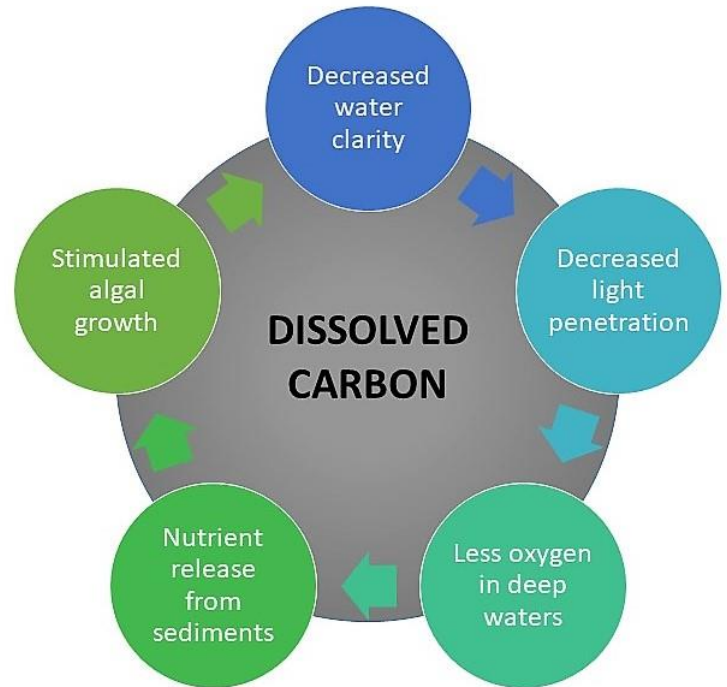
How will carbon inputs affect water clarity?

Carbon inputs can decrease water clarity. The tea bag analogy is instructive here: the longer tea leaves are steeped the more tea (soluble carbon) leaches out and the darker the tea. However, Rose and Williamson hypothesize that carbon inputs decrease water clarity in other ways as well. They propose that adding dissolved carbon to a lake creates conditions that favor algae growth, which also decreases water clarity. Algae flourish in warm, nutrient-rich surface waters. Dissolved carbon compounds absorb heat, acting like an insulating blanket that warms the surface waters. Dissolved carbon compounds often contain nutrients such as phosphorus that act as fertilizers, stimulating algal growth. In addition, the low oxygen conditions created in the deep waters by carbon inputs actually favor the release of nutrients from lake sediments. Nutrients released from the sediments further fertilize the algae. Algal blooms decrease water clarity, which decreases the depth to which light

can penetrate, exacerbating oxygen depletion and continuing this cycle.

How far is too far? Implications of falling over the edge

Rose and Williamson predict that the feedback loop created by browning will push lakes beyond an ecological tipping point. They predict that as browning continues, their "blue" study lake will become locked in the feedback loop and be permanently converted to dark water "brown" or an algae rich "green" lake. It will essentially become a different ecosystem. Indeed, they have already observed a trend of lower oxygen in the deep waters of the blue lake in recent years.



This research has global implications. Lake browning is happening to lakes all over the world. Roughly 25% of lakes affected are "blue" lakes, meaning that if Rose and Williamson's predictions are correct, and many of these are browning, we will see drastic changes in a quarter of our lakes as they fall over the tipping point. These lakes are also among the most valuable, providing recreation, fisheries, and drinking water. Permanent changes to these ecosystems will not only be ecologically disastrous but also cause significant economic losses.

The more we understand how and why lakes respond to browning, the better we can develop effective management plans. The research described here requires a pristine, naturally "brown" lake as a point of comparison and the existence of a dataset that tracks changes in lake ecosystems over decades. Rose and Williamson are able to conduct this vitally important research because of the commitment of Lacawac Sanctuary to preserving the integrity of Lake Lacawac and its watershed and its dedication to scientific research.

Research Highlights 2018

- 15 research projects were conducted at Lacawac during the summer of 2018. These included proposals from undergraduate students, masters and PhD students, and faculty.

Seven different institutions were represented:

- Miami University
 - Dickinson College
 - Lafayette College
 - Kings College
 - University of Scranton
 - Penn State University, Scranton
 - Gannon University
- Lacawac was part of an additional experiment led by the Northeast chapter of GLEON.
 - The Kilham Lab was used a total of 100 days from May-September by 9 different groups.
 - Research was conducted on a wide range of topics including the role of carbon inputs in lake nutrient cycling, the factors causing harmful algal blooms, zooplankton metabolism, the breakdown of dissolved organic matter by bacteria and sunlight, the response of mosquito larvae to UV radiation, turtle physiology and behavior, and the impacts of deer browsing on small mammals, insects, and amphibians.
 - Lacawac hosted field trips from collegiate institutions.

Into the Woods with Environmental Education

The Environmental Education programs at Lacawac focus on connecting students to nature. As author of *Last Child in the Woods*, Richard Louv states, "Environment-based education produces student gains in social studies, science, language arts, and math; improves standardized test scores and grade-point averages; and develops skills in problem-solving, critical thinking, and decision-making." Lacawac's environmental education programs offer students many opportunities to connect with nature through science, with ventures in technology, engineering, art and math. (STEAM).

It is Lacawac's mission to provide environmental education. We have been continually increasing the numbers of students we reach. In 2018 we provided K-12 classroom and field trip programs to 2782 students in 17 schools in 8 school districts. Our goal for K – 2 students is to instill a sense of wonder through discovery activities.

A grant from the Chesapeake Bay Trust helped to fund materials and field trips for a new and innovative program for high school students call Advanced Water Ecology; Making Connections through Inquiry. Two classroom programs and an extensive field trip allowed students to develop and investigation that could be tested using the scientific method at Lacawac. Student teams used research-grade sampling equipment needed to carry out their investigation. Each team completed, analyzed, and presented their findings to their peers and was reviewed by a scientist and faculty. This gave students experience in the process of research.

The summer residential and day camp programs are growing and thriving. We provided 8 weeks of camp to 134 children. The summer began with a week of residential camp at our Conservation Leadership Academy for ages 13 – 15. It was then followed by seven weeks of day camp for children ages 5 – 12. During each week, campers went on adventures through the forest, field and water habitats at Lacawac, they focused on exploration while introducing outdoor and cooperative play.

In a world of technology and screen time it is essential that we give children the opportunities to explore and find wonder in the natural world. As Louv states, "Children need nature for the healthy development of their senses, and therefore, for learning and creativity."

"Research suggests that exposure to the natural world - including nearby nature in cities - helps improve human health, well-being, and intellectual capacity in ways that science is only recently beginning to understand."

– Richard Louv



Lacawac's PLEON Launches Citizen Science Program

By Beth Noman, PhD-

Director of Science and Research



Lacawac Sanctuary hosts the Pocono Lakes Ecological Observatory Network (PLEON), a regional lake monitoring program focused on water quality education and evidence-based lake management. The ecological integrity of Pocono lakes is vital to the economic welfare of the region. PLEON is designed to help landowners make responsible management decisions by providing water quality monitoring, data interpretation, and education. PLEON has provided lake monitoring and educational workshops since 2017. This past summer, PLEON introduced a citizen science program focused on engaging citizens of all ages in monitoring the condition of lakes in the Poconos.

Why is Citizen Science Important?

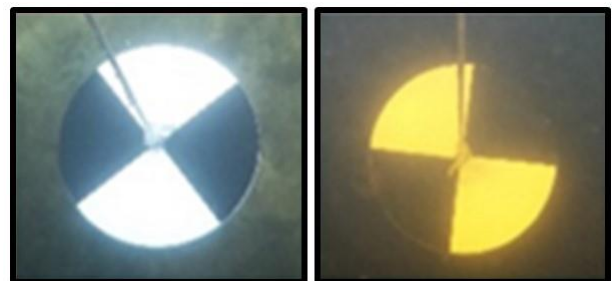
Lakes in the Poconos are largely managed by private homeowner's associations. Many, though not all, of these associations measure water quality variables in their lakes (e.g. water clarity, temperature, nutrients and/or the abundance of algae and aquatic plants) at least once a year, either through PLEON or through for-profit consulting firms. These monitoring programs usually sample at one or two central locations. However, anyone who has spent time on lakes knows that they are dynamic ecosystems and water quality conditions may be different depending on what part of the lake is sampled. One home owner may notice an algal bloom or lily pads near their dock while their neighbors in the next cove have clear water. It can be logistically difficult and prohibitively costly to professionally monitor water quality at several locations within a single lake.

This is where citizen scientists come in. As a homeowner, you know anecdotally the water quality at your shore or dock. This is where you have your morning coffee, where your kids and grandkids swim, where you have evening barbeques. The PLEON Citizen Science Program is designed to help you quantify your observations as scientific data that can be used to monitor the health of your lake. Interesting spatial and temporal patterns emerge when your data is combined with those of other citizen scientists from the same lake. These patterns help guide management of your lake as well as increase our understanding of how lakes across the region are responding to environmental change.

The PLEON Citizen Science Program

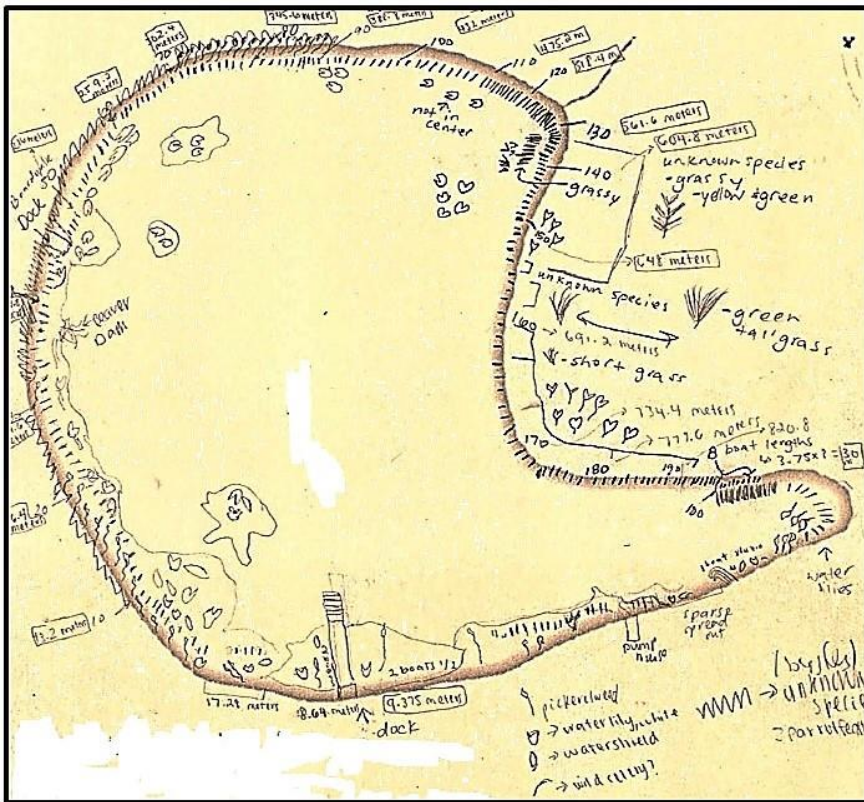
The PLEON Citizen Science sampling protocols have been adapted from a citizen-led environmental observatory designed by Dr. Jennifer Klug, an associate professor of Biology at Fairfield University and her colleagues for Lake Lillinonah¹. PLEON citizen scientists monitor key water quality variables using seemingly simple but quite powerful scientific instruments: a thermometer and a Secchi disk. All organisms have a temperature range in which they are able to survive so the water temperature can indicate what organisms may be abundant or missing from the lake. For example, algae like warm surface waters so temperature can be correlated with algae blooms. The PLEON Citizen Science Program monitors water temperature at a depth of 1 meter using a thermometer.

Water clarity is an important aspect of water quality and is often the first thing people notice about a lake. Decreases in water clarity can be caused by algae blooms, the presence of other particles, or dissolved compounds in water. The PLEON Citizen Science Program uses an instrument called a Secchi disk to quantify water clarity, particulates, and water color. The Secchi disk was invented in 1865 by a Jesuit priest and scientist named Angelo Secchi. It is a flat, weighted, round disk with black and white quadrants. The disk is lowered through the water until it is just out of sight. This depth is called the Secchi depth and is a measure of water clarity. Secchi depth is correlated with water transparency, light penetration and algal growth and is used to classify lakes as highly productive (eutrophic) or unproductive (oligotrophic). PLEON citizen scientists also use their Secchi disk to evaluate the amount and type of particles in the water and the water color.



Secchi disks lowered to the same depth in a clear water lake (left) and a less transparent lake (right). Photo credit: Craig Williamson

PLEON citizen scientists can also monitor nutrient concentrations in their lake by collecting water samples. Phosphorus and nitrogen are used by algae and elevated levels of these nutrients can contribute to algal blooms. Water samples brought to Lacawac sanctuary are analyzed for nitrogen and phosphorus concentration by PLEON scientists. Finally, the PLEON citizen science program provides identification guides for aquatic plants. Participants in the program use these guides to map the location of native and invasive aquatic plants in their lakes. Comparing these maps over time allows homeowners to pinpoint areas where invasive or nuisance plants may be taking root as well as areas where rare or desirable plants may need protection.



Example of aquatic plant map

Data gathered by citizen scientists are analyzed by the Director of PLEON, Dr. Beth Norman, who reports the results to program participants. Data will also be entered into the Lake Observer Mobile App, a global database of lake observations provided by the Global Lakes Ecological Observatory Network.

Join the 2019 PLEON Citizen Science Team

The PLEON Citizen Science Program is off to a great start with data collected from five Pocono Lakes during the summer of 2018. We are recruiting more members for the 2019 season! Becoming a PLEON Citizen Scientist is easy. PLEON provides training in sampling methods as well as kits containing sampling equipment available for purchase at cost. Sampling protocols are easily learned by school-aged children and are perfect for science projects. The program is also great for classes, clubs, and civic associations interested in the environment. For more information regarding the PLEON Citizen Science Program or other services that PLEON offers, visit our website (<https://www.lacawac.org/pleon.html>) or contact Dr. Beth Norman (570-689-9494; beth.norman@lacawac.org).

1Klug, J.L., G.L. Bollard, and R. White. 2017. Tool-kit for implementing a Citizen-Led Environmental Observatory (CLEO) on your lake. CES4Health.info.



Thank You!



Brookfield



Summer Interns 2018

Lacawac hosted three undergraduate interns during the summer of 2018. These interns assisted with many aspects of Lacawac programming, including the PLEON program, aquatic ecology research, public programs, as well as trail and grounds upkeep. They also had the opportunity to share their college experiences with high school students interested in pursuing STEM degrees and to interact with graduate students working on their own research at Lacawac.

Our 2018 interns came from different colleges, different states, and different STEM backgrounds. Angelica Perez graduated from the State University of New York (SUNY) College at Oswego in May of 2018 with a degree in Philosophy-Psychology and minors in Biology and French. Courtney Mitchem is a Junior at Miami University in Oxford OH where she is pursuing a degree in Microbiology. Mikayla Kocan is a Senior at Bloomsburg University in Bloomsburg PA. She is a double-major in Environmental, Geological, and Geographical Sciences and Anthropology. Mikayla's internship was a part of her degree requirements.

Lacawac benefits from interns in many ways but we strive to provide meaningful experiences for our interns as well. It is always gratifying to see students grow and thrive in these positions. Mikayla was kind enough to provide the following description of her internship experience.

"Over the course of the summer I had the wonderful opportunity to become a part of the Lacawac Sanctuary team. I'm a senior from Bloomsburg University double majoring in Environmental, Geographical, and Geological Sciences and Anthropology. I enjoy spending time outside watching wildlife, hiking, kayaking, and skiing, Lacawac was the perfect place for me to spend my summer. For my major in the Geography department it's recommended that we complete a summer internship and when I saw the application for Lacawac I knew it fit my interests. Unlike some of my fellow colleagues in our department also completing internships, I was blessed with being outside almost every day on some of the most beautiful grounds I have ever seen. Everybody from Lacawac Sanctuary was

immediately inviting and the living accommodations were beyond amazing. Everyday this summer was different, the major activity that I worked on this summer

was helping with the PLEON program but I was also able to help out with school field trips, upkeep on the grounds (trails, research projects, etc.), as well as helping with educational programs held on the grounds throughout the summer. I would recommend this internship to anyone who loves being outside and learning about water/ lake management."

Thank you to all of our 2018 interns! We wish you all the best!

Lacawac will be accepting applications for 2019 summer internships in the spring. Applications and deadlines will be posted on our website.



Photo Credit: Mikayla Kocan

Volunteers Wanted

Lacawac is looking for volunteers to fulfill various capacities around the sanctuary.

If you are interested in becoming a trail monitor, garden tender, office helper, lodge house keeper, grounds keeper, project assistant, event host

All skill levels welcome. Please call or visit our volunteer page on our website for more information.

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