

**COMMENTARY:
LACAWAC SANCTUARY AND FIELD STATION: A LONG-STANDING TRADITION OF
RESEARCH, EDUCATION, AND PRESERVATION**

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Lake Lacawac, a National Natural Landmark.



Lake Lacawac, a National Natural Landmark.

Just as Northeastern Pennsylvania residents and tourists enjoy the forests and lakes of the region, so do many students learning about environmental science and ecology. Lacawac Sanctuary and Field Station, a non-profit biological field station, nature preserve, and environmental education center located on the southwestern shores of Lake Wallenpaupack in the Poconos, has been educating and hosting students of all ages for decades. Lacawac was founded in 1966 with the mission of “Research, Education, and Preservation” and includes a well-protected glacial lake, Lake Lacawac as well as more than 500 acres of forest, hiking trails, and historic buildings. These features make Lacawac an ideal outdoor learning laboratory for educating students from kindergarten through graduate school.

For nearly 50 years, Lacawac has accomplished its mission by offering a diverse set of natural areas, facilities, and programs for K-12 and post-secondary educators and students, area residents, scientific researchers, and visitors to the region. By bringing scientists together with the general public, Lacawac provides an excellent opportunity for unique interactions.

Lake Lacawac is a National Natural Landmark and two locations on the property (natural bog and natural ledges area) are designated as Wild Plant Sanctuary’s by the Pennsylvania Department of Conservation and Natural Resources. Lacawac Sanctuary allows public visitors and environmental program attendees to experience unaltered natural areas and to interact with scientists to learn about the natural world and conservation efforts.

Faculty and students from higher education institutions are working on many environmental issues of relevance to the region. Recent research projects at Lacawac have focused on how climate change impacts Pennsylvania lakes, how high deer populations are altering forest communities through their feeding activities, and whether ozone depletion can negatively affect aquatic organisms. Lacawac is also part of the ecologically and economically important Upper Delaware River watershed which delivers drinking water to more than 15 million people.

Research and Education Consortium

Lacawac Sanctuary, Miami University (Oxford Ohio), the Academy of Natural Sciences of Drexel University and Drexel University announced in the fall of 2013 an agreement to form an environmental research and education

¹Accepted for publication December 2014.

consortium. The consortium builds on existing partnerships with leading universities and focuses on cutting-edge global climate-change and water-quality research. The consortium is comprised of higher education institutions, regional school districts, and affiliate partners (state lands, regional land trusts, non-profit conservation organizations).

The consortium currently includes the following colleges and universities: Miami University (Oxford, OH), Drexel University (Philadelphia, PA), The Academy of Natural Sciences of Drexel University (Philadelphia, PA), The University of Scranton (Scranton, PA), and Lackawanna College (Scranton, PA). Land trust members are numerous and offer more than 65,000 acres of lands and waters throughout Pennsylvania that can be accessed by consortium members for research and education purposes.

The Consortium collaborates with its members in conducting scientific research, creating education programs for K-16 audiences, and offering resources and support for early-career scientists, including graduate students and postdoctoral fellows.

Facilities

Lacawac is an ideal location for universities and colleges looking for a research site, a place to study the natural environment, and to bring a class for a field ecology trip. In the past five years, nearly 40 institutions of higher education have used Lacawac for education or research. Lodging for individuals or groups up to 27 people is available in the Historic Great Camp—an Adirondack style hunting lodge and vacation home and complex built in 1903 and listed on the National Register of Historic Places.



Inside the Carriage House at Lacawac.



The dining room in the Lodge.



The Historic Lodge at Lacawac listed on the National Register of Historical Places.

A new year-round, analytical laboratory, supported by funding from the National Science Foundation, was built in 2014. The new lab includes equipment such as a fume hood, water purification system, incubators, fluorometer (to measure algal abundance), UV Vis scanning spectrophotometer, drying oven, muffle furnace, analytical balance, and microscope with camera system. A seasonal lab and classroom are also available on the second level of the historic Carriage House which is in close proximity to Lake Lacawac.

Lake Lacawac

The ecological value of Lake Lacawac was recognized by scientists at the Academy of Natural Sciences in Philadelphia during visits in the 1950's. Because lake access is strictly controlled and the watershed has never been developed, the lake supports an unexploited fish community and a diverse native plant community, including several rare species. In 1968 the National Park Service designated Lake Lacawac as a National Natural Landmark. The lake is an ideal site to use as a control for comparisons with human-impacted lakes. Lake Lacawac is a site used by lake scientists because of its excellent water quality and long-term data record. Since the late 1960's, the lake has been the focus of many scientific papers, graduate theses, and undergraduate projects. Lake Lacawac is considered by many educators and scientists as a "living laboratory".

Under the direction of Lehigh University faculty in the 1980s, Lacawac became a base for many research and educational projects involving investigators and students from multiple colleges and universities. Funding from the Andrew W. Mellon and Geraldine R. Dodge Foundations



Early lake scientists on Lake Lacawac. Clyde Goulden from the Academy of Natural Sciences of Philadelphia (left), a graduate student (center), and Alan Tessier from the University of Pennsylvania (right).

was used to develop and support the Pocono Comparative Lakes Program (PCLP), an informal consortium of scientists from several institutions. The primary focus of the PCLP was a long-term sampling program on three local lakes (including Lake Lacawac) across a productivity gradient. Much of the sampling was conducted by undergraduates supported through the National Science Foundation's REU program. The lake data from these efforts and continued research projects are the core of the long-term dataset.

In 1992, a Lehigh University faculty member began a continuous electronic weather and lake monitoring program that has been expanded several times, continues today, and contributes data to many projects. Numerous Lacawac publications have resulted from work focusing on the impact of ultraviolet radiation (UV) on aquatic ecosystems. Lake mercury evasion research was conducted in the mid to late



Summer undergraduate interns on Lake Lacawac. Chris Cassel from Bloomsburg University (left) and Anne Morgan from Miami University (right).



Lacawac's environmental laboratory.

2000's at Lacawac. Many advances in dissolved organic matter quality and optical metrics have come from research supported by Lacawac Sanctuary. Many Lacawac users have been advancing the concept of using lakes as sentinels of climate change. Lakes are at the lowest position in the landscape and thus provide chemical, biological and physical signals of change including those from the surrounding landscape.

Research and Hub for EONs

Lacawac Sanctuary strives to enhance its national reputation as a field station that facilitates meaningful discovery in the natural sciences and serves as a training ground for field research. Monitoring and conservation-focused research will contribute to a fuller understanding of our ecosystems and environmental change through published works, conferences and other means. Our goals for the upcoming years includes attracting new and established scientists and fostering a stronger field station culture; increasing resources for the research program; enhancing Lacawac's reputation as an institution that helps to launch the careers of new scientists; integrating field station research with educational programs; and organizing more scientific workshops.

Lacawac is a leader in the emerging frontier of large-scale, long-term, ecological observatory networks (EONs). In 2012, the lake became part of the Global Lake Ecological Observatory Network (GLEON, www.gleon.org), a global network of lakes and scientists. GLEON scientists address large-scale questions about lakes using their global network. Lacawac promotes and facilitates high quality training, research, and interdisciplinary interaction in the development and application of EON science. The field station provides a physical facility for EON-related work and runs training workshops to train the next generation of scientists on

these emerging approaches. Lacawac's philosophy is to provide hands-on research and educational opportunities for scientists of all ages.

Lacawac has also been used extensively as a testing ground for new environmental sensors and sensor platforms. Lake Lacawac is the testing site for a prototype of a small, portable profiling buoy equipped with a suite of physical, chemical, and biological sensors that will enable small lakes to be networked to understand regional to continental scale influences of climate change.

Forest

Lacawac has supported a long-term field experiment on the impacts of deer browsing on forest understories. A pair of 0.7 hectare deer exclosures in two different forest types were created in 1994. Exclosure maintenance has been maintained over the past 20 years by local volunteers and undergraduates. Long-term data show differences in plant abundance and diversity inside vs outside the exclosures. In 2011, two additional exclosures were erected (0.8 hectare). The exclosures were placed in areas damaged by high winds and *Adelges tsugae* (hemlock woolly adelgids) with high tree mortality and little regeneration due to heavy deer browsing. One of the new exclosures serves as a control site. The other exclosure is experimental and uses approaches to restore old-growth forest characteristics.

Conferences and workshops

Each year Lacawac hosts numerous scientific conferences and workshops such as the annual fall Lacawac Ecology Conference and Lacawac Ecological Observation Workshop. The Lacawac Ecology Conference began in 2012 and is held annually the end of September. The conference is designed



Lacawac's environmental laboratory.



Entrance to Lacawac Sanctuary and Field Station.

to bring together scientists from across the region. LEC gives scientists at all levels from undergraduate to PhD-level an opportunity to discuss research ideas in an informal setting and to build new collaborations in the Northeast region. The conference is open to faculty and students, and past conferences have been attended by participants from nearly 20 different institutions.

The Lacawac Ecological Observatory Workshop brings together experts on buoy technologies, advanced ecological sensors, continental scale ecology approaches, and management/analyses of large ecological datasets to train students and early career faculty on these cutting-edge approaches in ecology. First held in 2012, LEOW has welcomed a diverse group of participants from many countries and states across the US. Many leaders in the EONs (ecological observatory networks) have presented at LEOW representing many different EONs including NEON (National Ecological Observatory Network) and GLEON (Global Lake Ecological Observatory Network).

Educational Outreach

Lacawac's YES Program complements and enhances students' classroom curriculum year round mainly in a four county geographical area: Lackawanna, Luzerne, Pike and Wayne. These programs meet Pennsylvania content standards while they encourage youth to develop and maintain an awareness, competence and enthusiasm to understand important environmental concerns impacting our local watersheds, bodies of water, and forests.

Lacawac offers various opportunities for schools and school districts:

- Pathways in Ecological Research (PIER): Pathways in Ecological Research is a program for high school juniors to explore science as a career track in emerging areas such as green technologies, ecology, and environmental studies. It aims to prepare students for the rigors of college and increase their chances for admission to top colleges and universities. Students will participate in field trips, learn research methods, conduct and present a research project of their own, and attend a week long summer residency camp.
- Women in Science Project (WiSP): The mission of the Women in Science Project is to attract and retain more women in science fields while fostering their future success. The project components include: Student Role Models (High School), Women in Science Career Camp (High School), Women and Science Conference and Women in Science Luncheon Series.
- Field Trips and Mobile Lacawac: Students participate in an in-depth investigation of the natural sciences at Lacawac's field station and research center.



Participants at the 2013 Lacawac Ecological Observatory Workshop.

Through these interactive classroom experiences, students will develop important scientific skills, from making observations to designing experiments and interpreting data. Lacawac's structured environmental and natural sciences lessons for either small or large groups will also come to the classroom, school auditorium, or other school venue such as an afterschool program.

- Summer Conservation and Leadership Camp: Lacawac offers an engaging and immersive experience for students ages 13-15 in a week-long summer program where they will gain first-hand experience with conservation issues and field and laboratory techniques in the environmental sciences.



Lesley Knoll, Director of Research and Education, teaching about lake zooplankton.



Kristine Wasco a summer intern from Bloomsburg University sampling Lake Lacawac.



Jennie Brentrup, a PhD student from Miami University, deploying aquatic sensors on Lake Lacawac.

Designed to provide a link between curriculum and the real world, Lacawac's outreach to K-12 schools and districts emphasizes a "watershed approach" to appreciating, achieving and sustaining environmental improvements in a hands-on fashion intended to interest and excite students. Today, many schools have limited training and resources to fully develop and explore local water-related and forestry/land issues. Lacawac's education programs are designed to fill this void by providing students, and their teachers, with a critical understanding of local water and forestry/land issues and related environmental and ecological concerns. Lacawac's education programs provide children with a basic knowledge of the water cycle, watershed management, water chemistry, aquatic life, pollution biology, forest growth and regeneration, native plant life, forest life and environmental science that should be part of every student's experience so that they become informed voters, community leaders and policy makers.

Public Education

Lacawac Sanctuary and Field Station also educates the public about our influence on natural ecosystems and the interrelationships with the environment. It does so by offering programs year-round to the general public, teachers and students, and youth and civic groups. Lacawac Sanctuary offers community programs designed to connect people of all ages to the natural world. Lacawac offers seasonal classes related to art, photography, animals, plants, and habitats.

Lacawac's recreational and public outreach programs are designed to increase general knowledge and love of nature; promote healthy outdoor activities and continue the close relationship between the sanctuary and the local community by providing access to our land and allowing enjoyment of

the natural beauty of Lacawac. Our goals are to encourage a more meaningful use of Lacawac through scheduling guided and interpretive walks and other activities throughout the year; increase the capacity of staff and volunteers to maintain trails; and make the recreational programs fiscally self-sustaining.

Our vision is for every Field Station visitor to connect with our landscapes, biological diversity, and cultural history. Through their investigation, we hope visitors will develop a "sense of place" that fosters lasting stewardship of the region and of the environment in general. To accomplish this, we provide opportunities for students and visitors to immerse themselves in the area through experiential learning, research, and the practice of conservation.



Graduate students learning about aquatic sensors at Lake Lacawac.

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