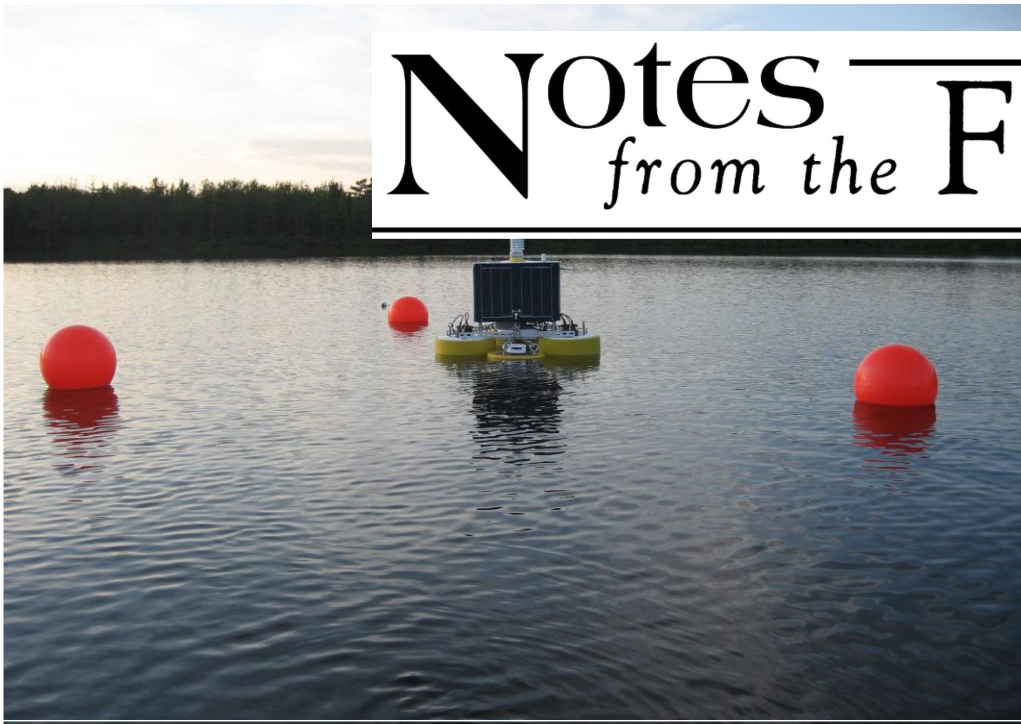


Notes from the FOREST

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

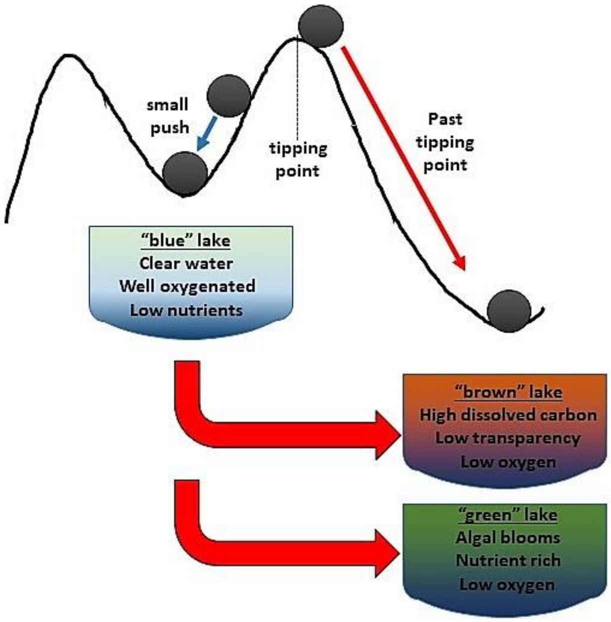
Picture a marble resting in the valley between two ant hills. You can push the marble up the side of one of the hills and it will roll back to its original position. However, if you push the marble far enough, it will reach the peak and roll down the other side, and can't return to its original place 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?

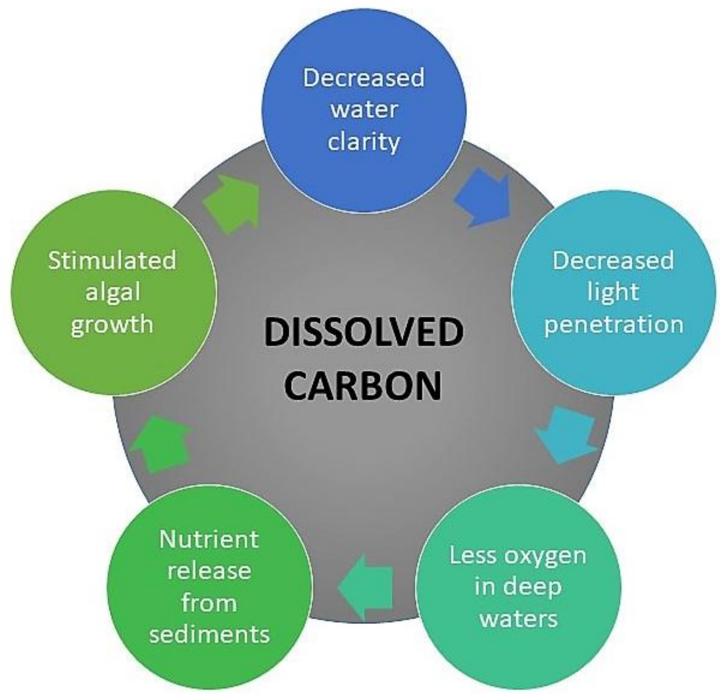
Oxygen is required by almost all lake organisms. The amount of oxygen available in lake water is determined by two biological processes. Photosynthesis (the conversion of carbon dioxide into sugar by algae) produces oxygen while respiration (the metabolism of carbon compounds by organisms for energy) 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.