

Summer 2010

Understanding the Role of Phosphorus in Lakes

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Laker News

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SUMMER 2010

FROM THE PRESIDENT

Welcome to the Summer 2010 issue of the CLA's Laker News. I hope you all enjoyed this year's wonderful spring season, and are looking ahead to summer and another beautiful season on Conesus Lake.

WELCOME to our new Directors
When we periodically ask for residents to consider their ability and desire to become CLA Directors, it's always gratifying to hear from neighbors who are willing to give something back to the lake. Since our last newsletter, I'm pleased to announce that three individuals have joined the CLA Board. Don Denney, Joanne White and Chris Willoughby, all from Livonia, joined the Board in May and are well on their way to becoming active, formal participants in our work on behalf of the lake. When you see these neighbors, please take time to thank them for their willingness to not be bystanders.

As always, thank you for YOUR support

As I write this in mid-May, over 1,050 individuals and families have returned their 2010 CLA membership dues. Of these, 42 are new members.

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Christi Severson, a graduate student in Environmental Science and Biology at the College at Brockport State University of New York, recording water quality parameters from the depths of Conesus Lake during the summer of 2009.

Understanding the Role of Phosphorus in Lakes

The role of phosphorus as the most important cause of excess plant growth and related water-quality degradation in lakes (collectively known by the term eutrophication) has been the focus of several stories in past issues of this newsletter. Readers may be surprised to learn that less than 40 years ago there was great controversy among experts as to whether excess carbon, nitrogen, or phosphorus was the most important cause of the eutrophication phenomenon. The stakes in the outcome of this debate were high as eutrophication was a serious problem in North American inland waters during the 1960s. The critical evidence that swayed the argument toward phosphorus came in the early 1970s from

experiments carried out in small, remote lakes in northwestern Ontario, Canada. Researchers, lead by David Schindler of the University of Alberta, added large amounts of phosphorus experimentally into lakes that were also low in carbon and nitrogen, and in a matter of weeks the lakes were converted from pristine to a highly eutrophic state.

In retrospect, it was reasonable to assume that phosphorus would be more limiting than nitrogen or carbon to a lake's plant growth. Lake waters generally contain large supplies of dissolved carbon in chemical forms readily accessible to plants. Nitrogen can be changed from its most abundant

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Phosphorus *From page 1*

chemical form (N₂) into biological forms (ammonium, nitrate) within the lake by blue-green algae, thus providing an internal source. The only natural source of origin for biologically usable phosphorus in lakes is erosion followed by runoff from the surrounding terrestrial environment. Any enhancements in the delivery of phosphorus from land to water are bound to invigorate plant growth.

The fate of phosphorus once it enters the lake is a complex story involving transformations from biological to non-biological forms and back, transfers from one level of the food web to another, sequestration in lake-bottom sediments, and more. To begin to understand the dynamics of phosphorus it is useful to consider the lake as two different systems: the inshore and the offshore. These two lake systems are fundamentally different from one another in terms of their fauna, flora, food web dynamics and, of course, their utilization of phosphorus.

In the offshore system drifting unicellular algae known as the phytoplankton (diatoms are an example) are the dominant plants. The phytoplankton is eaten by myriad microscopic animals collectively known as the zooplankton (water fleas, copepods, rotifers), which in Conesus Lake can attain abundances of more than 1,500 per gallon of water. The zooplankton is food for small fishes such as the alewife, which are then eaten by walleye and other open-water predatory fishes.

The coastal zone community is a very different from the offshore community. In most temperate lakes the dominant coastal plants are rooted macrophytes (lake weeds) and filamentous (multicellular and string-like) algae that live on the weeds and on rocks along the shoreline. The few herbivores that eat these plants include insect larvae and small crustaceans. These small invertebrates are, in turn, eaten by coastal fish species (sunfish, for example) and by the juveniles of open-water fishes that take refuge in weed beds.

One of the most important differences between the offshore and coastal communities has to do with their immediate sources of phosphorus. Of course, both systems are affected by lake-wide water



SUNY Geneseo professor Sid Bosch is shown here in the midst of an area of shoreline that is covered by filamentous algae.

nutrient concentrations. However, for the offshore phytoplankton, phosphorus released from deep-water lake sediments can augment supplies normally available in the water column. Generally referred to as "internal loading," this phenomenon is initiated when oxygen-depleted conditions along the lake bottom release phosphorus held chemically in the sediments. Concentrations of phosphorus in the bottom waters of Conesus Lake during periods of internal loading are nearly 200 times higher than in surface waters. A fraction of this phosphorus (exactly how much is unknown) is ultimately delivered by the spring and fall turnovers to surface waters, where it is largely responsible for fertilizing the spring and summer algal blooms in Conesus Lake and other temperate lakes.

In contrast to the nutrient dynamics of the phytoplankton in the offshore zone, the coastal macrophytes, and especially the filamentous algae nearshore, can augment in-lake phosphorus supplies directly from runoff entering the lake in stream and overland flow, and in the groundwater. The blooms of filamentous algae seen along Conesus Lake's shoreline following spring runoff events provide evidence of this relationship.

The ecological separation between the offshore and coastal lake communities

has been blurred by the invasion of zebra mussels, to the detriment of water quality along the shoreline. Adult mussels reach an abundance of more than half a million animals per square meter in shallow water and constitute a major ecological force in the coastal zone. They are also very effective filter feeders, and the food they prefer are the phytoplankton in the water column. By means of their constant feeding, zebra mussel populations ingest huge amounts of phytoplankton biomass from the water column. Ultimately a significant portion of the ingested phosphorus is delivered to the coastal region in the form of fecal matter. The interception, retention, and recycling of nutrients by zebra mussels was first reported in the Great Lakes and coined "the nearshore phosphorus shunt" by Robert Heckey of the University of Waterloo (Canada). A consequence of this very important phenomenon has been to increase the amount of phosphorus available to nearshore plant communities, producing eutrophication along the coastal zones. In Lake Erie and Lake Ontario, this eutrophication has taken place even as conditions in the offshore have improved in response to control of external phosphorus loading.

Zebra mussels may have changed Conesus Lake in the same way. Following the first

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Todd Shuskey, a biology teacher at Perry High School and member of the SUNY Geneseo research SCUBA diving team, prepares to collect sediment cores that will be used in sediment phosphorus determinations.

Ecological trends in the south basin of Conesus Lake:

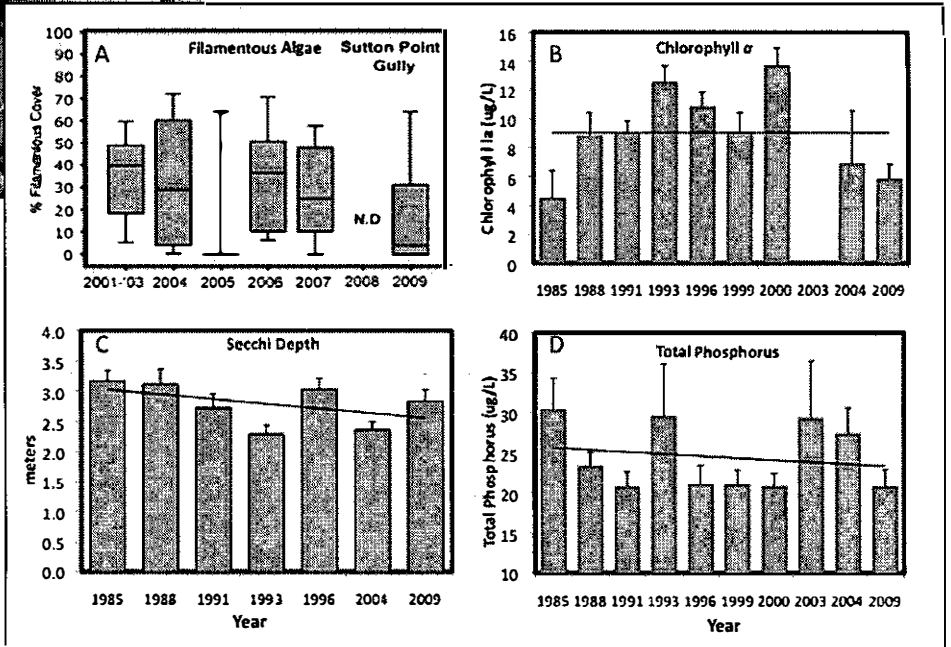
Graph A – Box plots showing the percent of lake surface by covered by filamentous algae along the shoreline of Sutton Point. The box incorporates 75% of the data points and the line across the box is the median (ND=no data).

Graph B – Average and standard error of summer chlorophyll concentrations in an offshore station. The straight line is a statistical best fit.

Graph C – Water clarity as indicated by secchi depth (plot as in B).

Graph D – Total (particulate and dissolved) phosphorus concentrations (plot as in B).

population bursts during the mid-1990s major blooms of filamentous algae were observed along the shoreline in Sutton Point, McPherson Cove and other shoreline areas. These blooms that cover as much as 20% of the shoreline on average are now a recurring phenomenon (see Graph A) and one of the major agents of declining water quality along the shoreline. Because the onset of the blooms typically follows spring or early summer rains, we believe it is the combined effect of the zebra mussel phosphorus shunt and external nutrient loading that trigger these events.



In contrast to the decline of shoreline water quality described above, conditions in the offshore zone of Conesus Lake have remained fairly consistent or have improved somewhat compared to years before the zebra mussel invasion. Average summer chlorophyll concentrations decreased after 1993 (with the exception of the summer of 2000) and were fairly low in 2004 and 2009 (see Graph B). Chlorophyll concentration is a proxy for phytoplankton biomass, and is expected to decline when large populations of zebra mussels invade a water body. Overall, a statistical trend line incorporating data from 1985 to 2009 show no net positive or negative change in chlorophyll levels. Secchi depth (an indication of water clarity) and total phosphorus concentrations in the lake have remained fairly constant or have decreased slightly (see Graphs C and D).

In summary, we believe it is important to regard the lake proper as two separate habitats, the offshore and the coastal zone. Over the last 15 years conditions along the coastal zone in Conesus Lake have deteriorated significantly, following a trend that has been documented in the Great Lakes and other Finger Lakes after the invasion of zebra mussels. Meanwhile the offshore zone has remained mildly eutrophic over the last 25 years (high in nutrients and algal biomass). While this is an undesirable state in terms of water quality, monitoring data provides no indication that the offshore system is becoming increasingly eutrophic.

These observations have implications that should help in developing priorities for lake management. As demonstrated through our USDA-funded research project in Conesus Lake, coastal plant growth

can be reduced by keeping nutrients and soils in the watershed and out of the lake. Thus, long-term strategies that focus efforts on permanent management of agricultural practices, phosphorus use in lawn fertilizer, stream erosion, septic tank efficiency, and other such nutrient control measures are promising in terms of bringing rapid improvements to near-shore water quality. Management practices such as alum application intended to reduce internal loading and stocking of walleye to manipulate the food web and reduce phytoplankton biomass are also necessary if we are to improve the open-water regions of the lake, but it is important to realize that these practices are not expected to have a significant impact on the coastal zones.

Professors Sid Bosch, SUNY Geneseo and Joe Makarewicz, SUNY Brockport

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