



AT THE CENTER

News and Notes from the
Center for Earth and Environmental Science

Fall / Winter 2007

Director's Note

This edition of *At the Center* features recent and upcoming work in water resources research and provides a special report on concerns and research related to blue-green algae and algal toxicity, particularly in light of this summer's hot and dry weather. We have also provided updates on education and outreach programs with highlights from the Eagle Creek Watershed Alliance's second annual Water Celebration and the new offerings from the Discovering the Science of the Environment science education program. Graduate updates and visiting research scientist work are also presented.

As the field season ends, we are reflecting on the season's past projects and gearing up for a new year of research, discovery and information-sharing. We thank our community partners, volunteers, and contributors who help make it all possible. Our program successes are due in large part to community partnerships and contributions. As the year draws to a close, please consider joining or renewing your membership with a tax-deductible contribution to the *Friends of CEES* program. For your convenience, a mail back envelope with a contribution form is included in this newsletter. By joining *Friends of CEES*, you help to ensure our programs remain an important part of environmental stewardship and education for central Indiana. Membership benefits include special programs, field trips, and event updates. Visit www.cees.iupui.edu or email cees@iupui.edu to learn more about the program.

Thank you for your continued support and interest in our work. All the best for the winter season and the New Year!

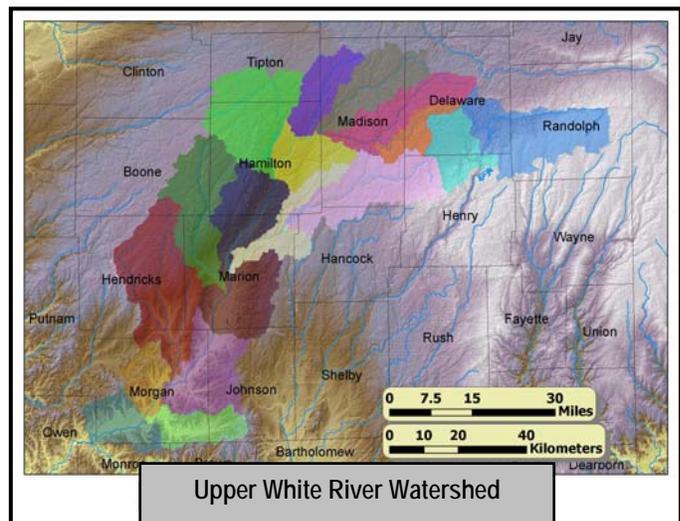
Regards,

Lenore P. Tedesco, Director

Central Indiana Water Resources Partnership (CIWRP)

Research programs within the Central Indiana Water Resources Partnership continue to be diverse and are working to create an actionable understanding of water resource issues in central Indiana that also have broad-scale applicability to water resource challenges. CIWRP research programs can be grouped into analyses related to drinking water reservoir dynamics and assessment and watershed and stream programs.

The work of Drs. Li, Wilson and Tedesco, research staff and current and former graduate students developing remote sensing tools for mapping and understanding the distribution and abundance of blue-green algae in local reservoirs continues. Current work is focused on refining semi-empirical algorithms for predicting algae (Lara Valley) and applying and developing new bio-optical models for enhanced predictive capability (Tony Robertson). Importantly, we are working to enhance the transferability of the remote sensing work to other reservoir systems, potentially globally. This year's work has been focusing on Eagle Creek, Geist, and Morse Reservoirs, and we also added work on Monroe Reservoir to test transferability. We were able to work closely with Veolia Water to provide timely information on the location and relative abundance



of blue-green algae blooms in area reservoirs to aid in management decisions this summer. This work remains an important component of the CIWRP program with great hopes and expectations that we can extend the utility of the application even further.

CIWRP research in the White River and Eagle Creek river systems has begun this year with the goal of documenting the timing and relative abundance of nutrient and other chemical transport in these streams. The Rivers team includes Drs. Vidon and Tedesco, research staff including B. Hall, R.C. Barr, D.L. Pascual, E. Hack, and graduate student J. Johnstone. We were planning to focus on seasonal dynamics during storms when our previous work has shown that most chemicals are transported. This has been a challenging year however, with very dry conditions and very low water levels throughout area streams. Field scientists have a saying – if you want to prevent something from happening – study it. And so it is with this year's river research. We have been unable to sample a storm river flow – because we really haven't had any yet this year. We will continue this work and extend it into next year. We have our fingers crossed that fall, winter, and spring will see the increased precipitation that our friends at the national weather service say is expected. We hope to be very busy making up for lost time.



Complex plant beds on James Lake including White Water Lilly and Spatterdock

New Project: Using Remote Sensing to Map Aquatic Plant Beds in Indiana Lakes

CEES and the Department of Geography received a Lake and River Enhancement grant from the Indiana Department of Natural Resources (IDNR) Division of Fish and Wildlife. The project is evaluating the utility of high resolution QuickBird satellite imagery for mapping emergent plant beds. The QuickBird sensor collects the highest spatial resolution satellite imagery currently available in the public domain.

Working in conjunction with IDNR fisheries biologists and lake experts, the team selected a set of 10 lakes in LaGrange and Noble Counties for image acquisition during the growing season of summer 2007. Project activities consist of mapping the distribution and size of aquatic plant beds. The resulting data will be utilized for a variety of management decisions related to Indiana's lakes and shorelines such as forming regulations, planning restoration projects, and linking fisheries information to emergent bed and shoreline conditions. It is our goal to create a tool to help IDNR

biologists rapidly collect plant bed distribution and composition data over a wide range of lakes.

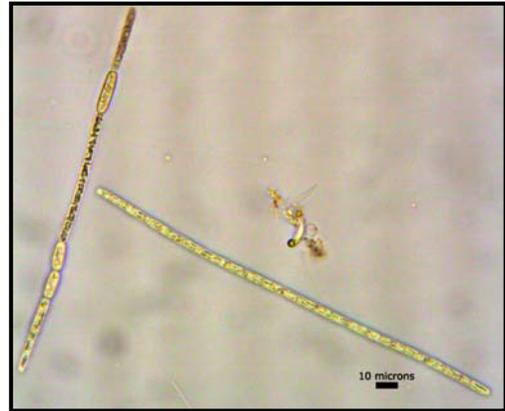
Dr. Tedesco spent several days with IDNR staff mapping and photographing plant beds to serve as image verification. IDNR staff conducted surveys of both above and below water plant beds as well. We acquired one satellite image suitable for use in a portion of the lakes but extensive cloud cover during satellite overflights prevented project completion this year. We are testing algorithms and techniques on the image we have and will collect additional data next growing season. Stay tuned!



**Special Report - Blue-Green Algae and Algal Toxicity:
The Summer of Concern in Central Indiana**

CIWRP research into blue-green algae took on a new level of urgency this summer as drought conditions created very favorable conditions for the proliferation of blue-green algae in area streams and reservoirs. Blue-green algae concentrations in both Eagle Creek and Geist Reservoirs, and the detection of an algal toxin in Geist Reservoir resulted in recreational usage advisories being posted by the Indiana State Department of Health for both reservoirs. CIWRP research and the expertise of CEES researchers (Tedesco, Pascual, and Hack) helped provide information and analyses to state agencies, state legislators, Veolia Water, and area residents.

First a little background on blue-green algae. Blue-green algae (also known as cyanobacteria) occur throughout area reservoirs and streams and have for many years. In general, there are numerous different species present but recent years have seen both an increase in the dominance of some species and the appearance of other species. There remains significant debate in the scientific community about the cause for these increases but several factors are commonly cited including climate warming (some of the species are tropical species), invasive species that are spreading (many were formerly unknown in temperate North America but can be traced to Africa, South America, and Australia), and increasing nutrient enrichment in area reservoirs favoring blue-green algae over other species. Some blue-green algae are capable of producing toxins that have potentially serious human and animal health effects. Toxin production however is quite variable and species known to produce toxins in some areas don't seem to produce it in other areas; and those that do produce toxins, don't produce it all the time. This makes understanding the risk associated with blue-green algae, especially in recreational waters, particularly difficult. Algal toxin exposure is most dangerous through ingestion but skin rashes can also occur. Thus, there are potential risks associated with swimming and other water sports especially when water is accidentally swallowed. There are different risks associated with finished drinking water, but luckily the water treatment process effectively removes the toxins that were found in Geist Reservoir. For this reason, the advisories and concerns for public health have been focused on recreational uses of the reservoirs.



Possible toxin producing blue-green algae from Geist Reservoir *Cylindrospermopsis raciborskii* (left) and *Planktothrix agardhii* (bottom) on a photo graphed through a microscope

A few other confounding factors to consider. 1) The US government has not adopted any standards for measurement of algal toxins or any guidelines for public health related to exposure to algal toxins in either recreational waters or drinking water; 2) there is no statewide program for routine monitoring of recreational waters and there are no state guidelines in place; 3) analyses for algal toxins are very slow – typically taking up to a week for results – and very costly; and 4) the problems associated with blue-green algae in Indiana waters is relatively new and an emerging problem so that responsibilities, communication lines, and specific actions remain uncoordinated and extremely confusing. The World Health Organization has posted guidelines that can be helpful to decision makers and these have been referenced for Indiana concerns. Europe, Australia, and several other countries have guidelines and standards in place.

This summer's hot, dry weather created warm water and high evaporation rates concentrating nutrients and allowing for accelerated growth of blue-green algae. As a result, blue-green algae abundances reached high levels in all the reservoirs but varied in species composition and increased and decreased in abundance over the season in similar patterns to other years. Veolia Water routinely monitors the reservoirs for the presence of blue-green algae especially as it relates to taste and odor compounds in drinking water that are the result of algae growth. CIWRP remote sensing research helps Veolia Water manage algal blooms when they are beginning to create taste and odor problems in finished drinking water. Taste and odor compounds are most frequently managed in the treatment plant through the use of powder-activated carbon. However, if taste and odor compounds appear to be increasing, and reservoir conditions favorable for continued algal growth, Veolia may use algaecides to control algae. Reservoir algaecide treatment requires a permit from IDNR and IDEM and also involves additional reservoir monitoring to protect fish and aquatic life. It was during this permit-induced monitoring prior to a treatment at Geist Reservoir that led to the detection of high cell counts of the potential toxin-producing blue-green algae called *Cylindrospermopsis*. This alga is interesting in that its first reported occurrence in Indiana was in 2001 in Ball Lake, Steuben County. This was alarming as this alga has caused toxin problems in other tropical countries and in Florida and it was these concerns that led IDNR to include documentation and reporting of its presence in the permit conditions.



Remote Sensing Field Work

Interestingly, CIWRP research has been working with international researchers looking at blue-green algae and algal toxins globally. Many of the researchers are affiliated with Veolia Water's international research program. Information coming from this research network is showing that *Cylindrospermopsis* in Europe is not a toxin producer – but in fact other algae are. Yet, there are no provisions for monitoring or reporting those others in Indiana

CIWRP researchers, especially Lani Pascual, have been doing detailed algal identifications in area reservoirs for several years in an effort to try to predict algal blooms. Her work has shown that there are at least five potential toxin producers in area reservoirs, but our work has never focused on determining if there are any toxins. The toxin detected in Geist Reservoir was Microcystin and was found at low levels. This toxin is not related to *Cylindrospermopsis*, but rather, we believe, to *Planktothrix*, a blue-green algae belonging to a different genera. CIWRP researchers have been conducting algal counts and even sending samples to outside laboratories for toxin analyses in an effort to determine which organism(s) is responsible for the toxin and how levels might related to reservoir conditions. Additionally, we have been compiling research and monitoring data from surrounding states and doing analyses to determine what area states are finding in their reservoirs and if they have better information regarding toxin

occurrence and potential producing organisms.

Our work has been important in that we have been able to provide information to state agencies, the Indiana legislature, and the general public. We expect to continue our work in the future and hope to be able to provide solid science data to the public policy arena as Indiana works to set standards and address monitoring needs. We have posted some background information about blue-green algae on our website as well as recordings of comments made at a public meeting for Geist residents. We'll share more information as it is developed.

Discovering the Science of the Environment

With much anticipation of the Fall programming season, the Discovering the Science of the Environment mobile technology trailer eagerly took to the roads of central Indiana! The DSE program traveled from Carmel to Linton teaching both middle and high school students the many scientific wonders their local environment has to offer. Starting the season at Goose Pond Fish and Wildlife Area, just outside Linton, Indiana, approximately 55 fifth graders and high school students from the Eastern Greene Community School Corporation came together with volunteers and chaperones for an entire day of field exploration. Using personal observation skills and scientific monitoring equipment, the students were able to investigate prairie and wetland ecosystems, observe and identify local birds, examine prairie soil properties and composition, and use GPS units to locate study plots and map the existence of invasive exotic plants.



Students at Goose Pond Fish and Wildlife Area beginning their field work at the DSE trailer

Not to miss out on the excitement, approximately 300 seventh grade science students from Creekside Middle School spent two days engaging in bird observations, soil studies and ecosystem interactions. Participating in a DSE classroom visit and a mobile technology trailer program, the students experienced both learning inside the classroom and outside in their local environment. The environmental knowledge gained by the students and the scientific measurements they recorded will influence future decisions made as teachers and students from Creekside undertake a prairie restoration in the months to come.

As winter approaches, Fall programming draws to a close, and the DSE trailer enjoys a few months rest. CEES is happy to welcome Jill Troha! Jill is currently working part-time for CEES as an Education Program Assistant. Preparations have already begun for the upcoming DSE Spring programming season and Jill will be a wonderful asset to the team. Spring programming begins March 1, 2008! To ensure your students are able to participate in programming contact Brooke Furge at bfurge@iupui.edu to reserve your date on the calendar.

We would like to thank and welcome our newest funder of the program, the Hoover Family Foundation, joining Veolia Water Indianapolis, Nina Mason Pulliam Charitable Trust, Eli Lilly and Company, Dow AgroSciences, Duke Energy, and Indianapolis Power & Light Company in support of DSE. Visit www.cees.iupui.edu for program progress, updates, and for scheduling.



Students monitor water quality at Eagle Creek Reservoir

Eagle Creek Watershed Alliance ***Eagle Creek Watershed: I Can Make a Difference!***

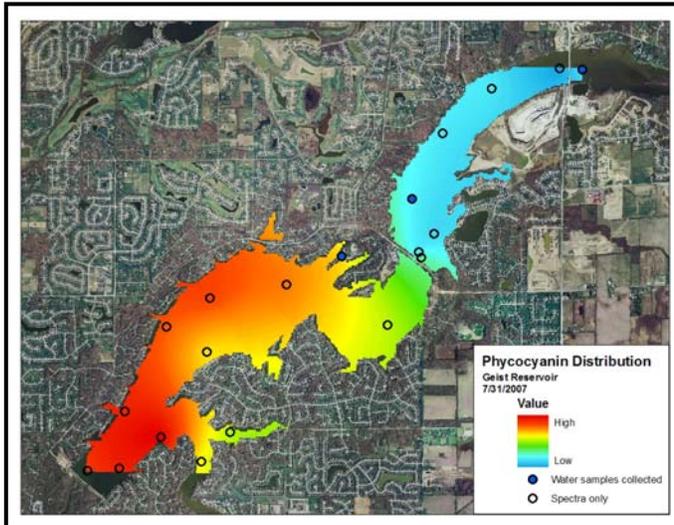
The Eagle Creek Watershed Alliance (ECWA) hosted its second Water Celebration at Eagle Creek Park's new Earth Discovery Center on October 5, 2007. More than 180 students from Eagle Creek Elementary and Fishback Creek Public Academy were engaged in five hands-on learning stations relating to the theme of the event, "The Eagle Creek Watershed: I Can Make a Difference!". Activities focusing on water conservation, water quality assessment, water pollution and understanding watersheds provided students with the tools and information they need to make a difference at their schools and in their community. Through the installation of native plants to create a backyard habitat area at the park, the students made an immediate contribution to the future health of the Eagle Creek watershed.

Expert presenters and representatives from the Center for Earth & Environmental Science at IUPUI, Indy Parks, Indiana Department of Natural Resources, Indiana Department of Environmental Management, Boone and Hendricks County Soil & Water Conservation Districts, Veolia Water Indianapolis, and the ECWA led the student activities. The event was part of *Make a Splash* with Project WET, a nationwide program that facilitates and promotes awareness, appreciation, knowledge, and stewardship of water resources to teachers and students.

The ECWA represents a broad coalition of individuals, volunteers, foundations, utilities, county, state and federal agencies and universities working together to improve water quality and the environment of the Eagle Creek Watershed. Through a 3-year grant from the U.S. Environmental Protection Agency, with assistance from the Indiana Department of Environmental Management, ECWA is implementing a watershed management plan to improve water quality, increase public awareness and encourage stewardship of the watershed's resources. If you would like to join volunteer teams comprising the ECWA, contact Eileen Hack at hacke@iupui.edu.

Visiting Research Scientist **3-Dimensional Hydrodynamic Model of Eagle Creek Reservoir** **Corentin Lefebvre**

The most pressing issue related to Eagle Creek Reservoir, located on the northwest side of Indianapolis, is seasonal algal blooms containing cyanobacteria which can release dangerous toxins and produce taste and odor compounds in drinking water. One of the primary goals of Veolia Water and the City of Indianapolis is to protect the water intake, located in the middle of the reservoir, in order to prevent algae intrusion. Algae grow preferentially in quiet zones of a water body in response to nutrient conditions. Their movements may be controlled by water movement or exchange. The current solution for algae treatment consists of applying copper algicide to a large area around the water intake. In order to manage algal blooms, understanding the hydrodynamics of the reservoir is essential. Corentin Lefebvre from Veolia Water is working in partnership with CEES for one year in order to build a 3D hydrodynamic model of Eagle Creek Reservoir. His research work will provide managers with information related to the efficiency and effectiveness of copper algicide treatment and enhance understanding of reservoir dynamics. Corentin received a Masters degree in Mechanical Engineering from the University of Lyon, France. Prior to coming to IUPUI he spent six months in Australia building a 2D numerical model of straight floodway for the Water Research Laboratory of Sydney.



Graduate Student Updates

Remote Sensing of Blue-Green Algae in Central Indiana Lara Valley

Eagle Creek, Geist, and Morse Reservoirs have experienced degrading algal blooms in the last few years. Of specific concern are blue-green (cyanobacteria) algal blooms which have resulted in surface scum, taste and odor problems, and have the potential to cause low oxygen conditions and toxin production. Controlling bloom occurrence is a priority for CIWRP researchers and Veolia Water, though water sampling and lab analysis are both costly and time intensive. This project refines our ability to use remote sensing to predict blue-green algae concentration in our reservoirs for the purpose of informing water management.

Algae contain colored pigments which give them distinct spectral characteristics. Blue-green algae contain phycocyanin, a pigment unique to cyanobacteria in freshwater systems. Published remote

sensing algorithms developed to detect phycocyanin in inland water systems have been used with good success on Eagle Creek and Morse Reservoirs, with Geist Reservoir being more difficult to predict. It is hypothesized that concentrations of other optically active water constituents are impairing algorithm accuracy. The purpose of this project is to identify and evaluate these confounding water constituents and to build a robust model to assess blue-green algal abundance and distribution in all three reservoirs and help improve transferability to other reservoirs.

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