AT THE CENTER

News and Notes from the
Center for Earth and Environmental Science

Summer 2009

Director's Note

This summer's edition of *At the Center* highlights ongoing significant and innovative work, particularly in algal blooms and water resources research. Much of the summer research focus has been given to frequent sampling of central Indiana's reservoirs to better understand the causes and frequency of algal blooms. The Algae Research Update provides important information on research status but also what residents should know to stay informed. CEES' algal research work has expanded internationally with collaborations from Veolia Water and affiliates to test bloom predicting techniques utilized in central Indiana on waterways in Australia. Our partnership work in watershed alliance networks is continuing with the installation of cost share projects and informational road signs in Eagle Creek Watershed and a host of activity with the Upper White River Watershed Alliance through outreach efforts. We are also working within these watersheds on a new project with the Indiana State Department of Agriculture to identify strategic and appropriate locations for wetland restoration and construction to improve water quality. Education outreach efforts are making an impact in science education for central Indiana's youth through Discovering the Science of the Environment. DSE is geared up for a new season with the start of the school year and staff will be busy with programs throughout the fall. Staff are similarly getting ready for environmental service learning work days with our community partners. We will hold ten projects to engage undergraduate students in ecological restoration efforts on public lands while educating on the importance of environmental stewardship. A new academic year at the university also brings with it additional student projects and courses that will further enhance research and outreach efforts. CEES' flurry of activity is certainly ongoing. Thank you for your interest in our work and please stay in touch. We maintain frequent updates on our website www.cees.iupui.edu so please check in and contact us if you have questions.

Regards,

Lenore P. Tedesco, Director

2009 Algae Research Update

As most of you regular newsletter readers know, our algal research team continues to monitor central Indiana reservoirs for blue-green algae (aka cyanobacteria). We are out on Eagle Creek, Geist and Morse Reservoirs once every two weeks conducting research and monitoring algal populations along with a host of other parameters that we expect will help us understand the specific triggers of blooms, as well as algal population dynamics, and the production of taste and odor causing compounds and algal toxins. Conventional wisdom says that algae prefer hot and dry conditions to really get blooming so we were expecting this to be a relatively quiet algae year. Well – that's why they call it research! 2009 is turning out to be a very active year for algae blooms, taste and odor causing compound production, and yes – even algal toxin production. And the problem is occurring in many parts of the state and the White River.

Morse Reservoir Algae Bloom,
August 11, 2009
Note strong green water color

Algae Blooms: What You Can Do

- Be Informed: Visit the state's website: www.algae.IN.gov for important updates and information on algae blooms in Indiana. CEES will continually update algae research and information on our site: www.cees.iupui.edu
- Be Safe: Shower or rinse off immediately after swimming or other exposure to water and avoid ingesting lake or reservoir water. Avoid entering very green water. Keep pets out of water during algae blooms.
- Be A Partner in the Solution: To eliminate fertilizer runoff from your property, which leads to algae blooms in waterways, avoid the use of fertilizers containing phosphorus and reduce/eliminate the use of other fertilizers*. Sweep up or pick up leaves and grass clippings that go into the street or sidewalks. Pick up pet waste and properly dispose of it. **Note: Organic fertilizers usually contain phosphorus so check labels.*

Here's a quick update of what's happening so far.

1) Geist and Morse Reservoirs are actively blooming with cyanobacteria cell counts well in excess of 100,000 cells/mL. In fact, at the time of this writing (8-15-09) Geist Reservoir has the highest cell counts we have ever measured at well over 600,000 cells/mL of blue-green algae. Cell counts have been elevated in both reservoirs since early July. We have been working closely with the Indiana Departments of Environmental Management, Natural Resources, and Health to provide information on an IDEM website (www.algae.IN.gov) about potential risks associated with recreation in reservoirs with algal blooms. We are using the 100,000 cells/mL as a benchmark for advisories as this is a benchmark used by the World Health Organization to indicate a change to a high probability for acute adverse health effects from recreation.

2) This year, CEES developed laboratory capabilities for measuring microcystin. Microcystin is the blue-green algal toxin that has been found in lakes and reservoirs throughout the state and in the three central Indiana reservoirs. This capability has been providing timely analysis of algal toxin occurrence. During the week of July 24th, we began to measure microcystin levels in Geist Reservoir that were exceeding 6 ug/L. This is a level of note because it is a level used by several other states to post advisories and restrict recreational usage of water bodies. Measuring microcystin at these levels in Geist Reservoir prompted state officials to issue a press release warning the public of the potential health risks.

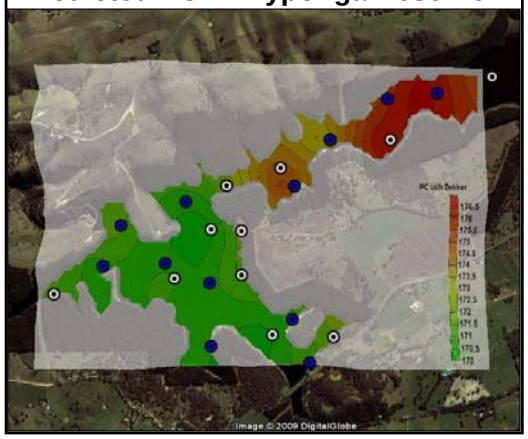
3) At the end of July, Indiana University scientists that conduct the state's Clean Lakes Program, identified a potent algal bloom at a reservoir in Gibson County and were concerned that the bloom could be producing algal toxins. They sent a sample to the CEES lab and we documented microcystin levels of more than 60 ug/L in the sample. The bloom was of the cyanobacteria *Microcystis* that has been shown to be a potent toxin producer in other states and is different from the species that typically form the blooms in central Indiana reservoirs. To our knowledge, this is the highest documented occurrence level of microcystin in the state and suggests that the state needs to develop a comprehensive monitoring program.

4) Colleagues at IDEM and IDNR were notified by the Army Corp of Engineers (ACOE) that they are concerned about significant blooms of blue-green algae, again *Microcystis* blooms, at Salamonie Reservoir. The ACOE is initiating a pilot study there this week (8-15-09) to test for toxins. CEES researchers investigated and sampled the blooms on Salamonie Reservoir on 8-13-09 in an effort to get an understanding of the potential toxin production of these blooms.

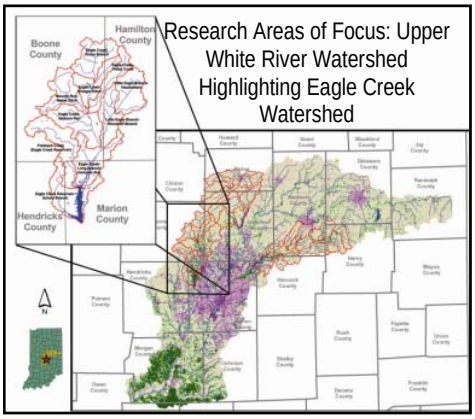
So despite the fact that we have had a relatively cool and wet summer so far, blue green algae continue to impact our state's freshwater resources. These blooms are impacting recreational uses of area reservoirs. There are tips about things you should do if you choose to recreate in waters with high concentrations of algae. Information is at www.algae.in.gov and the CEES website. The most important thing is to avoid ingestion of untreated water and be sure and rinse off when you are finished. Take care of your pets as well. Dogs don't know that they shouldn't drink the water and they also lick their fur when wet – both of which make them susceptible to adverse health effects from blue-green algae blooms. Unfortunately, these blooms are symptoms of poor water quality and specifically excess nutrients. Both nitrogen and phosphorus are nutrients found in fertilizers and both contribute to algal blooms, although research indicates that phosphorus is the primary nutrient that needs to be controlled. These nutrients make their way to our streams, lakes and reservoirs through a multitude of processes. Some of these are regulated point source discharges that include wastewater treatment plant effluent and industrial discharges. Another source is agricultural runoff from both overland flow and tile drains from farmed fields. Our research, as well as a host of other research, shows that agricultural runoff tends to be dominated by nitrate, while urban and suburban runoff is dominated by phosphorus. This phosphorus comes from several sources and is an important contributor is stormwater. Stormwater refers to water that runs off of streets, sidewalks and lawns into storm drains. These storm drains discharge directly to lakes and streams without any treatment and carry high loads of phosphorus. This phosphorus can be managed! It comes from lawn fertilizer, poorly maintained septic tanks, pet waste, and lawn clippings and leaves. Make sure you do your part to minimize or eliminate phosphorus runoff from your property. You can do this by eliminating fertilizers – there is almost never a need for phosphorus fertilizers on your lawn. Don't allow leaves and grass clippings to go into the street and pick up after your pet and properly dispose of pet waste. Check out our website for more information: www.cees.iupui.edu

Hyperspectral Remote Sensing of South Australian Water Resources

Predicted PC in Myponga Reservoir



During February 2009, CEES and Earth Sciences faculty and staff travelled to Australia in partnership with Veolia Water and affiliates to test the phycocyanin pigment sensing techniques conducted in the drinking water reservoirs of Indianapolis in a new location with a history of problematic algal blooms. The IUPUI team rapidly completed a test sampling run in the Murray River, in South Australia, where the river flows into Lake Alexandrina, near Wellington. Prolonged drought conditions have seen the lake dry to 30% of typical water capacity and a species shift toward marine as opposed to freshwater algae. Acquisition of hyperspectral reflectance signatures from the water was assessed to determine whether there were significant similarities or differences to the spectra typically observed in Indianapolis reservoirs. The spectra showed a similar case as Geist reservoir in Indianapolis. All indicators from the first test suggested the spectral reflectance signature would be robust and reliable. Mannun, a site 150 km NW on the Murray River was also tested. Spectra obtained from the Mannum location differed only slightly from Wellington and demonstrated similarities with Indianapolis data. Finally, Myponga Reservoir was chosen specifically as a challenge for the technology. This small reservoir provides ideal algal growth conditions in summer and has problematic algae causing taste-and-odour producing blooms since the 1980's. The spectra proved to be a useful challenge for pigment sensing by spectral reflectance, with a notable peak not previously observed in freshwater reflectance spectra. Predicted phycocyanin distribution was mapped, providing a spatial and temporal record of surface waters. Indicative light penetration was quantified by Secchi disk depth and demonstrated that the spectral reflectance was likely to be sampling the top 1.5 m for Murray River locations and 2-2.5 m for Myponga Reservoir. Filtered water samples are presently being analysed for phycocyanin content via spectrofluorometry, and together with cell counts will indicate the strength of the relationship between phycocyanin concentration and biovolume. These results will confirm the suitability of spectral reflectance for broad-based application in South Australian waters. The advantages to the technology are the lower cost, speed, flexibility and customization. The ability to quickly gather a high spatial data density can have important applications in reservoir management and lake ecology. This project is a partnership with United Water South Australia (Veolia's subsidiary in Adelaide), the government of South Australia, and the Australian Water Quality Center, a federal water agency in Australia. Results should be in soon!



Research Areas of Focus: Upper White River Watershed Highlighting Eagle Creek Watershed

Indiana State Department of Agriculture Wetlands Restoration Planning

The Indiana Department of Agriculture is identifying where wetlands should and could be located on the landscape for the greatest nitrate removal and flood protection. This project is the first phase in a federal farm conservation program to target enrollment of 7,000 acres of land in the Pigeon-Highland, Tippecanoe, and Upper White River watersheds where sediments, nutrients, pesticides and herbicides run off from agricultural land. CEES has played a leading role in helping local, State, and Federal agencies understand the relationship between water quality and land-use in the mixed land-use watersheds that characterize much of Indiana. With modeling expertise from Dr. Meghna Babbar-Sebens, CEES is participating in the study to determine the location and acreage of existing and drained wetland areas and the identification of these wetland areas for restoration and/or new wetlands construction. Final selection of the recommended wetland locations will be done based on various criteria - e.g., soil type, depth to bedrock, depth to groundwater, contributing drainage area, flooding susceptibility, nitrate loss estimates, available land area, adequate water flow (enough baseflow to support vegetation during dry periods), proximity to subsurface tile drainage, etc. CEES experience indicates that it is not enough to simply locate where a wetland can be restored or constructed. The extensive hydrologic modification of the agricultural landscape often requires that high resolution flow path modeling be done to determine the most effective watershed restoration strategies. As part of the initial site selection phase, CEES will identify two to three proposed sites to demonstrate how this tool can be used to improve site characterization. Once potential wetland sites have been identified on the landscape, an assessment of the performance and impact of the proposed constructed/restored wetland on flooding and water quality in the watersheds will be conducted.

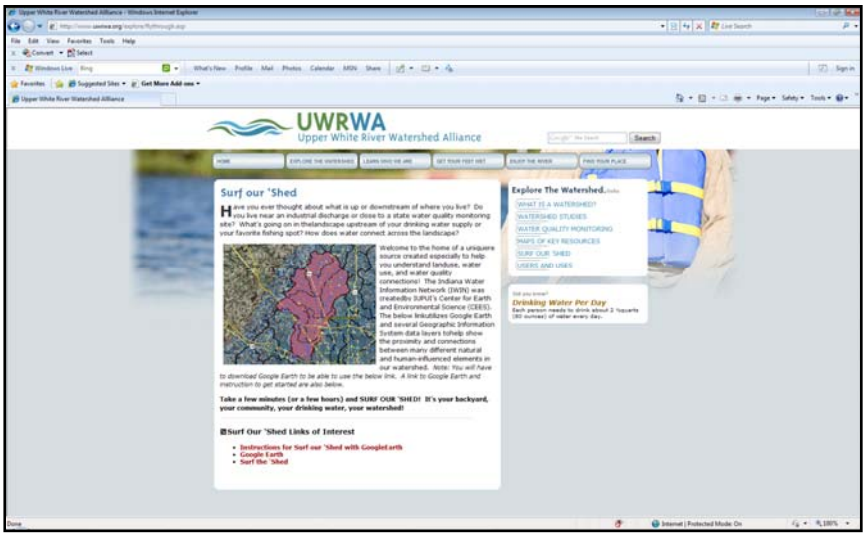
Watershed Alliance Updates

Eagle Creek Watershed Alliance Update

The Eagle Creek Watershed Alliance (ECWA) is continuing to work on water quality education and awareness within the watershed. The Eagle Creek Watershed – "Our Drinking Water" road signs continue to be installed across the four counties in the watershed (Marion, Hamilton, Boone, and Hendricks). Cost share projects also continue to be implemented in the watershed. The raingardens and filter strip project at the Earth Discovery Center in Eagle Creek Park is almost complete. Specialized planting plans have been installed in the series of raingardens and the prairie area will be seeded in the next couple of weeks. The combination of best management practices (BMPs) at this site should reduce almost 365,000 pounds of soil/sediment a year that enter the Eagle Creek Reservoir. That's almost 10 tri-axle trucks of dirt. Also of interest is an ongoing project on a large horse hobby farm and riding stables in the watershed. A Comprehensive Nutrient Management Plan has been completed for this site. Members of the ECWA continue to work with the owners on a multitude of conservation practices including: wetland restoration, drainage improvements, livestock exclusion fencing, and manure management. When the project is complete, it will be the largest cost share project the ECWA has taken on, as well as one of the largest water quality improvement efforts to date!

We are pleased to announce that the 319 grant for the Eagle Creek Watershed Alliance has been renewed starting October 2009 and will continue through September 2012. Efforts will focus on implementing and educating about best management practices to combat agricultural and storm water runoff. Look for updates coming soon at www.eaglecreekwatershed.org.

Upper White River Watershed Alliance



The Upper White River Watershed Alliance (UWRWA) has been through some exciting administrative changes that have strengthened the leadership and improved its reach throughout the watershed. A new thirteen member Board of Directors was elected in June and has not wasted any time advancing the vision of the organization. New grants have been secured for advancements to the new website and for future public involvement activities on the river itself. The grants coupled with a handful of creative, dedicated members of the Technical Committee are working on some new interactive web features focused on stormwater best management practice (BMP) selection and site planning. The UWRWA plans to deliver the first of these within the next few months. Another great addition to the website is an interactive feature called 'Surf Our Shed.' This tool allows users to turn on and off a variety of data sets and make maps of any area in the watershed at any scale in Google Earth. It also includes historic aerial photography and numerous environmental and social features. Visit the site and try it out www.uwrwa.org/explore/flythrough.asp - instructions await you there!

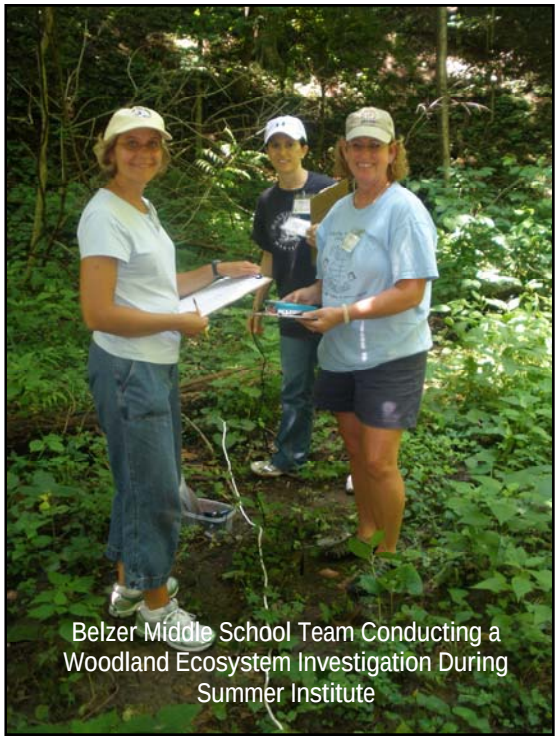
Another exciting development is the completion of a very large public survey related to water quality, storm water, and individual willingness for involvement in watershed stewardship. This information will be used to develop the UWRWA's regional public education program. The annual river clean up on Sept. 12th and an innovative public health workshop on Oct. 15th will keep the UWRWA busy through the fall. Watch for events such as this and other advancing public outreach efforts by visiting www.uwrwa.org or contacting the coordinator at coordinator@uwrwa.org.

Discovering the Science of the Environment

Students from Clay Middle School Measuring Reflectivity and Temperature of the Pond Surface During the *Understanding Global and Local Albedo* Program

With just seven weeks available during the Spring 2009 Discovering the Science of the Environment (DSE) programming season, the DSE trailer program visited 1120 students in 46 classes. Students from Doe Creek Middle School, Boy Scouts of America, Harris Academy, Perry Meridian Middle School, Forest Glen Elementary, Indianapolis Metropolitan High School, Lincoln Middle School, Eastern Greene School Corporation, Clay Middle School and South Grove Intermediate braved unseasonably cold weather, strong winds, heavy rain and hail during a season that gave a whole new meaning to the saying "April showers bring May flowers!"

Despite the inclement weather, students in grades 5 - 12 participated in 19 DSE trailer programs including: Physical and Chemical Water Quality Assessment, Woodland and Wetland Ecosystem Investigation, Wetland Chemical Water Quality Assessment, Woodland Soil Studies, and Woodland Tree Monitoring. In addition, thanks to the efforts of Earth Sciences IUPUI Urban Educators GK-12 Fellows, Andrea Schilling, Allyson Smith and Angie Cowan, we were able to offer and deliver three new programs in Understanding Global and Local Albedo, Soil Biology and Respiration, and Algal Bloom Investigation, respectively. Through this fellowship opportunity and the DSE program, the GK-12 Fellows were able to bring their graduate research to 280 students at local central Indiana schools. For more information on the IUPUI Urban Educators GK-12 fellowship program or to obtain more information on these new programs, please visit: www.cees.iupui.edu. Click on IUPUI Urban Educators GK-12 Program or Discovering the Science of the Environment. DSE is looking forward to the upcoming fall programming season with the start of a new school year and making an impact on science education with this innovative and engaging program!



Belzer Middle School Team Conducting a Woodland Ecosystem Investigation During Summer Institute

The DSE Summer Institute for teachers was held for the third time during the week of June 22-26 at the Eagle Creek Park Earth Discovery Center. Fourteen participants from six teams including Belzer Middle School, Clay Middle School, Danville Community High and Middle Schools, Jameson Camp, Rhoades Elementary School, and Saint Simon School attended the week-long comprehensive training on outdoor laboratory design, creation, and implementation based on principles of ecological restoration and associated environmental education curriculum. The enthusiastic teams came away with a multitude of resources and a strategic action plan for implementing or enhancing outdoor learning programs on their school grounds. Upon completion of the institute, each team is eligible to apply for grant funding from the Dr. Laura Hare Charitable Trust to assist with implementing components from their team action plan. Visit the institute website to learn more: http://www.cees.iupui.edu/Education/DSE/DSE_Institute.htm

Graduate Research: Nutrient Cycling in Midwestern Agricultural Wetlands in Response to Altered Hydrologic Regimes

Allyson JS Smith, MS Student / Dr. Pierre-Andre Jacinthe, Advisor

The export of nutrients (N and P in particular) from intensively managed croplands of the US Midwest has resulted in the eutrophication of surface waters and a host of related ecological problems. Past studies have shown that constructed wetlands are efficient N and P sinks and thus could provide a means of reducing these nutrient exports. With the understanding that the nutrient retention capacity of treatment wetlands depends on soil conditions, antecedent land-use and hydrologic regimes, results of these past studies may not be directly applicable to the Midwest where regional climate is projected to becoming more variable by more frequent wet-dry cycles. In addition, most treatment wetlands in agricultural areas are established on nutrient-enriched soils resulting from several decades of mineral fertilizer application. My project involves performing a mesocosm experiment, using intact soil cores (length: 30 cm; diameter: 10 cm) in order to gain an understanding of the response of Midwestern wetlands to changing hydrologic conditions. Cores were collected from two operating wetlands and a poorly-drained cropland soon to be converted into a treatment wetland. One of three hydrologic conditions (dry, moist, and wet) will be imposed to the cores in the laboratory for four weeks followed by flooding of all cores for a period of four weeks. The fluxes of organic (DOC, DON, DOP) and mineral nutrients (NO_3^-, NH_4^+, PO_4^{-3}) will be measured periodically during the duration of the experiment. Results will be evaluated in conjunction with P distribution in the soils (Fe, Al, and Ca-bound fractions) and with temporal variation in N gas emission, phosphatase activity, redox status and dissolved Fe in the flooded cores.

As a GK-12 graduate fellow working with the Discovering the Science of the Environment education outreach program, biological activity in soils is one portion of my research that is being integrated into the program offerings as an activity. The biological organisms living in soil (the FBI: fungi, bacteria and invertebrates) drive many of the reactions in the N and P cycles in wetlands as well as non-wetland soils. One way scientists quantify soil biological activity is to examine CO_2 production over time. Using quantification and observation skills, students explore soil microbial activity by learning about different types of the FBI, their functions, and explore why the FBI are important for ecosystem regulation. Using Vernier LabQuest scientific handhelds, O_2 and CO_2 sensors, students calculate changes in microbial respiration over time. By measuring soil temperature, moisture, pH, soil texture, and biological respiration, students are able to investigate the productivity of the soil at their school site.

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