Confluence

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Introduction

The term water quality describes a broad spectrum of items related to how we identify water concerns and how we collectively address them. Thus, the term water quality can be confusing and mean different things to different people.

The most widely used definition of water quality is "the chemical, physical and biological characteristics of water, usually in respect to its suitability for a designated use." As we all know, water has many uses, such as for recreation, drinking, fisheries, agriculture and industry. Each of these designated uses has different defined chemical, physical and biological standards necessary to support that use. For example, we expect higher standards for water we drink and swim in compared to that used in agriculture and industry.

Under the authority of the Clean Water Act, States are required to determine the designated uses of streams and develop water quality standards and criteria for those uses. Designated uses and criteria standard can and do vary from State to State but generally follow guidelines provided by EPA. Waterbodies are then monitored by States to ensure that these standards are being met and that a waterbody supports its designated used.

The designated Use concept is fundamental to the Clean Water Act. Thus, we wanted to take an opportunity in this issue to focus on a particular designated water use, aquatic life and habitat. So in this issue, we have highlighted some educational efforts by Purdue's Extension Service to help protect the habitat of the Eastern Hellbender (*Cryptobranchus alleganiensis),* a large salamander found in portions of the Eastern part of the Mississippi River Basin. Populations of these giant salamanders, which can grow to nearly 2.5 feet long and live for 30 years, have decreased dramatically.

Education efforts such as these can help raise awareness and the Hellbender's plight and small changes that we can all make can provide huge and positive changes for the Hellbenders health and home.

Sincerely, your Co-Editors:

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Average "Dead Zone" for Gulf of Mexico Predicted

NOAA

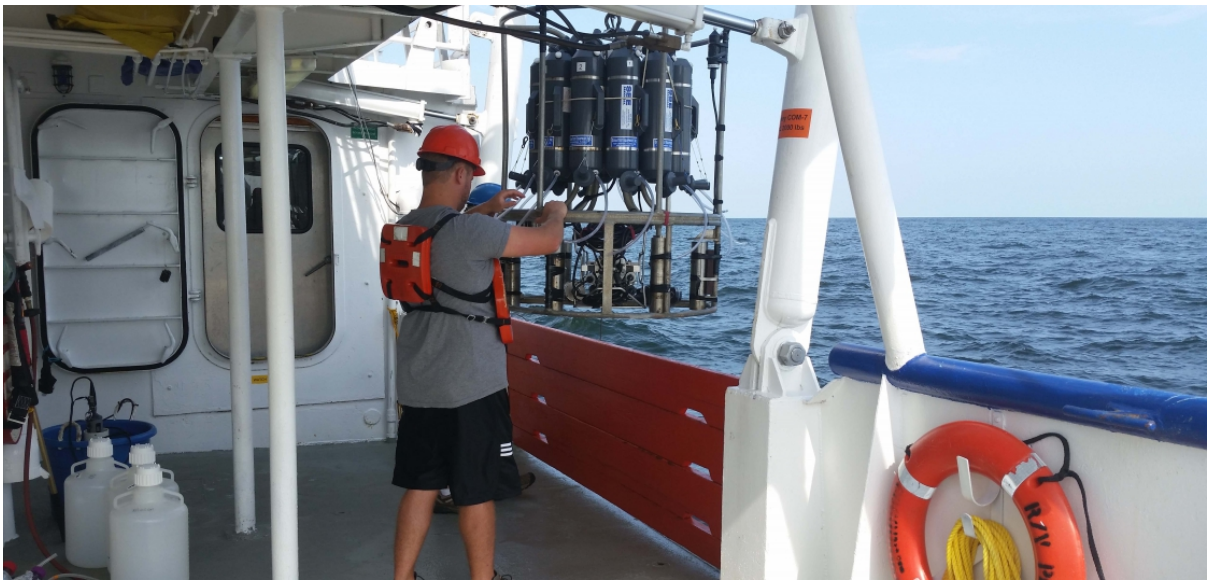
Scientists forecast that this year's Gulf of Mexico dead zone – an area of low to no oxygen that can kill fish and marine life – will be approximately 5,898 square miles or about the size of Connecticut, the same range as it has averaged over the last several years.

The dead zone in the Gulf of Mexico affects nationally important commercial and recreational fisheries. Hypoxic zones or "dead zones" are caused by high levels of nutrients, primarily from activities such as industrialized agriculture and inadequate wastewater treatment.

The low oxygen levels cannot support most marine life and habitats in near-bottom waters. Organisms that can flee the dead zones leave the area, while others which cannot leave are stressed or die of suffocation. Reducing nutrients flowing to the Gulf would help the situation since, under normal conditions, this area contains a diversity of marine life, critical habitats, and a number of key fisheries.

"Dead zones are a real threat to Gulf fisheries and the communities that rely on them," said Russell Callender, Ph.D., assistant NOAA administrator for the National Ocean Service. "We'll continue to work

with our partners to advance the science to reduce that threat. One way we're doing that is by using new tools and resources, like better predictive models, to provide better information to communities and businesses."



The NOAA-sponsored Gulf of Mexico hypoxia forecast is improving due to advancements of individual models and an increase in the number of models used for the forecast. Forecasts based on multiple models are called ensemble forecasts and are commonly used in hurricane and other weather forecasts.

This year marks the second year that a four-model forecast has been used. The four individual model predictions ranged from 5,204 to 6,823 square miles, and had a collective predictive interval of 3,200 to 8,597 square miles. The forecast assumes typical weather conditions, and the actual dead zone could be disrupted by hurricanes or tropical storms. Data from these four models are used to determine and meet the nutrient reduction targets set by the interagency Mississippi River/Gulf of Mexico Watershed Nutrient Task Force.

The ensemble of models was developed by NOAA-sponsored modeling teams and researchers at the University of Michigan, Louisiana State University, Louisiana Universities Marine Consortium, Virginia Institute of Marine Sciences/College of William and Mary, Texas A&M University, North Carolina State University, and the United States Geological Survey. The hypoxia forecast is part of a larger NOAA effort to deliver ecological forecasts that support human health and well-being, coastal economies, and coastal and marine stewardship.

The Gulf of Mexico hypoxia forecast is based on nutrient runoff and river and stream data from USGS. USGS estimates that 146,000 metric tons of nitrate and 20,800 metric tons of phosphorus flowed down the Mississippi and Atchafalaya rivers into the Gulf of Mexico in May 2016. This is about 12 percent above the long-term (1980-2015) average for nitrogen, and 25 percent above the long-term average for phosphorus.

USGS operates more than 2,700 real-time stream gauges, 60 real-time nitrate sensors, and collects water quality data at long-term stations throughout the Mississippi River basin to track how nutrient loads are changing over time.

“By expanding the real-time nitrate monitoring network with partners throughout the basin, USGS is improving our understanding of where, when, and how much nitrate is pulsing out of small streams and large rivers and ultimately emptying to the Gulf of Mexico,” said Sarah J. Ryker, Ph.D., acting deputy assistant secretary for water and science at the Department of the Interior. “The forecast puts these data to additional use by showing how nutrient loading fuels the hypoxic zone size.”

The confirmed size of the 2016 Gulf dead zone will be released in early August, following a monitoring survey from July 24 to August 1, conducted on a NOAA vessel and funded through a partnership between NOAA, Northern Gulf Institute, and the Louisiana Universities Marine Consortium.

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'Dead zone' mapping cruise canceled for first time in 27 years

Mark Schleifstein, NOLA.com, The Times-Picayune

The eight-day research cruise aimed at mapping the size of the summertime "dead zone" along Louisiana's coast has been cancelled for the first time in 27 years. The National Oceanic and Atmospheric Administration's 187-foot ship Nancy Foster encountered engine trouble, agency officials announced Friday (July 29).

The cruise was expected to determine whether researchers were accurate in June in estimating that this year's low oxygen area in the Gulf of Mexico would cover 5,898 to 6,824 square miles. That's the size of Connecticut and a bit larger than the 2015 area of hypoxia.

Hypoxia refers to water that contains 2 parts per million or fewer of oxygen. It is formed when spring floodwaters rich in phosphorus and nitrogen from the Mississippi and Atchafalaya rivers flow into the near-shore waters of the Gulf of Mexico. The nutrients feed large blooms of algae that soon die and sink to the bottom along the shoreline, where its decomposition uses up oxygen.

Fish tend to avoid low-oxygen areas. Organisms that live in the bottom sediment are killed.

This would have been the first time that Louisiana Universities Marine Consortium scientist Nancy Rabalais and her team of hypoxia researchers used a National Oceanic and Atmospheric Administration ship for the cruise. The federal agency made the ship's use a condition of continued funding of the mapping project. The annual cruise is conducted through a partnership of the federal agency, the Northern Gulf Institute and marine consortium.

"Hypoxia in the Gulf of Mexico is a real threat to the ecosystem and all that rely on it," Rabalais said. "We have to continue to focus on nutrient reductions if we are to have healthy and sustainable fisheries. Unfortunately the long-range trend over the past 30 years continues to show little progress towards reducing the dead zone size to the 1,900 square miles that the task force has set."

The Nancy Foster is one of 16 research ships in the federal agency's fleet. It and one other ship are docked for unscheduled repairs, and two more are sidelined for scheduled maintenance, a spokesman said.

The dead zone team had used the RV Pelican and its predecessor, the RV Acadiana, research vessels stationed at the marine consortium at Cocodrie, during 29 of 30 years of cruises. In 1989, researchers conducted an abbreviated mapping effort.

During the cruises, researchers take samples of water at various locations to determine the amount of oxygen at different water levels. They also sample algae and nutrients in the water.

Rabalais said the Nancy Foster was originally supposed to head for the gulf on Sunday, but it broke down then. Then she received notice that the ship would attempt to start an abbreviated version of the cruise on Thursday, but the repairs were not completed in time.

She said the research team checked with three other vessels, including the Pelican. All had already been booked for other research work in other locations.

Rabalais said that even if the Nancy Foster had been used, it's likely that measurements would not have been taken at a number of locations been monitored in previous years. That's because the Nancy Foster's draft is deeper than the Pelican, forcing it to stay in deeper water.

Information from the annual cruises is used to provide a baseline of the extent of hypoxia in the gulf. The data are used by the federal-state Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, which is trying to find ways of reducing the dead zone's size.

The task force had set a goal of reducing the five-year running average of the hypoxic zone to 1,950 square miles by 2015. That has not been met: Between 1995 and 2015, the dead zone has averaged 5,941 square miles.

The June forecast of this year's dead zone is the result of computer modeling that compares the nutrient content of water in the Mississippi and the size of the river flow in May to previous years. The nutrients

come largely from fertilizers that are washed off farmland in the Midwest by spring rains, along with pollutants from sewage treatment plants, septic tanks and industries in the Mississippi's watershed.

According to the U.S. Geological Survey, concentrations of nitrate and nitrite at Baton Rouge were above average this past winter. In May, there were near the highest levels since the agency began measuring them in 1997.

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2016 Wetland Reserve Enhancement Partnership Programs

NRCS' Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands.

For 2016 NRCS is awarding $44.6 million through its Wetland Reserve Enhancement Partnership (WREP) to support 10 wetland enhancement projects on private and tribal agricultural lands in 12 States. Recipients for each project are providing more than $4.3 million in matching funds, bringing the total investment to approximately $49 million. In total, the projects will help to protect, restore or enhance 15,000 wetland acres in critical watersheds across the United States.

Six of the WREP projects are being implemented in the following MRBI states: Arkansas, Indiana, Iowa, Louisiana, Tennessee, and Wisconsin.

The specific MRBI state projects are:

Arkansas: MRBI Wetland Reserve Enhancement Partnership in the Cache River Watershed

The purpose of this project is to improve water quality and restore forested wetlands in a priority focal area of the Mississippi Alluvial Valley (MAV) of Arkansas. Partners will enroll 4,500 acres over three years into the WRE program in priority areas to reduce significant non-point source pollution affecting the Cache and White Rivers, restore 3000 acres to bottomland hardwood forest on newly enrolled easements and restore natural hydrology to 1,500 acres of easement floodplain.

Lead Partner: The Nature Conservancy
Proposed NRCS Investment: $14,658,750
Proposed Partner Investment: $1,059,750

Indiana: Lower Wabash and White River Floodplain Protection

The Wabash River basin makes up approximately 2% of the area of the Mississippi River Basin (MRB) but contributes roughly 11% of the total nitrogen export from the MRB. In addition to providing important habitat for wildlife, floodplains are the last chance to treat water before it leaves a watershed. Project goals are to build on existing efforts of partnerships to reduce nutrient export from the Wabash River and to improve important migratory and wintering bird habitat. By enrolling 400 acres in WRE, this project will help improve both water quality and at risk species habitat in the watersheds.

Lead Partner: The Nature Conservancy
Proposed NRCS Investment: $1,500,000
Proposed Partner Investment: $79,000

Iowa: The Iowa-Cedar Headwaters Wetland Initiative II: Building Wetland Complexes in the Prairie Pothole Joint Venture Region of Iowa within the Upper Reaches of the Iowa and Cedar River Watersheds

This project area is best described as where long-term wetland restoration program in the prairie potholes meets more recent efforts to assist flood-affected landowners in the Iowa and Cedar River watersheds. Through this project, partners can improve both breeding and migration habitat for migratory birds; provide improved water quality within a portion of the UpperMississippi River Basin; and can provide floodwater attenuation that benefits towns and people living in the Iowa and Cedar River watersheds. This project proposes to restore and permanently protect and restore 580 acres of prairie pothole wetlands and associated tallgrass prairie uplands under a combination of permanent NRCS WRE easements (400 acres), State of Iowa Wetland Easements and State of Iowa fee title acquisitions (180 acres). Easement enrollment will be focused within 3 project sites that encompass a set of 5 Prairie Pothole Joint Venture (PPJV) Priority Areas and 2 Ducks Unlimited Living Lakes Initiative Emphasis Areas.

Lead Partner: Iowa Department of Natural Resources
Proposed NRCS Investment: $3,000,000
Proposed Partner Investment: $175,000

Louisiana: Restoring Forested Wetlands to Improve Water Quality and Provide Wetland-Dependent Wildlife Habitat within MRBI Watersheds in Louisiana

Over the next three years, partners will enroll up to 2,100 acres within seven MRBI watersheds in northeast Louisiana in WREP. Multiple benefits will be provided by the project including increasing habitat for fish and wildlife, improving water quality by reducing nutrient and pesticide application, reducing flooding, recharging ground water and providing outdoor recreational opportunities. Significant wildlife benefits include restoration of critical habitat for the Louisiana black bear, migratory waterfowl and wetland-dependent wildlife. Special consideration will be given to historically underserved producers.

Lead Partner: Ducks Unlimited
Proposed NRCS Investment: $5,155,500
Proposed Partner Investment: $544,500

Tennessee: Restoration of Bottomland Hardwood Forests and Wetlands in the Lower Mississippi River Batture, Phase III

The purpose of this project is to achieve more sustainable land and water management in the active floodplain of the Lower Mississippi, thus providing significant ecological, economic and societal benefits. Partners will enroll an additional 5,000 acres into WRE in order to achieve multiple benefits such as improving water quality, expanding habitat for federally protected species, reducing soil erosion and providing additional outdoor recreation opportunities. This is the third phase of work that began in 2012 that is on track to enroll more than 20,000 acres by 2019. The project area includes portions of 35 counties/parishes bordering the Mississippi River in Arkansas, Kentucky, Louisiana, Mississippi, Missouri and Tennessee. NRCS plans to invest almost $12.2 million in this project.

Lead Partner: Mississippi River Trust
Proposed NRCS Investment: $12,191,650
Proposed Partner Investment: $500,000

Tennessee: Wetland Hydrologic Restoration to Reduce Nutrient and Sediment Pollution in High-Priority West Tennessee Watersheds

Partners will enroll between 350-500 acres of floodplain in WRE easements to restore lost floodplain habitats, improve water quality in the Forked Deer River and Gulf of Mexico, and improve fish and wildlife habitat. The project will begin FY17 and extend to FY2020.

Lead Partner: West Tennessee River Basin Authority
Proposed NRCS Investment:$3,000,000
Proposed Partner Investment: $766,819

Wisconsin: Improving Habitat Quality of WRE Properties in Wisconsin by Increasing Participation in Management by WRE Landowners

More than 600 properties are enrolled in WRE and WREP in Wisconsin encompassing more than 60,000 acres throughout the state. The abundant and widespread distribution of WRE properties makes it difficult to secure large-scale shared management agreements as is common practice in nearby states such as Nebraska and Missouri. In order to increase the use of cost-effective management across WRE properties, this project will work to increase engagement in management of WRE properties by landowners.

Lead Partner: Wisconsin Wetland Association
Proposed NRCS Investment: $129,000
Proposed Partner Investment: $129,000

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Calming the Waters

Olivia Norton, University of Arkansas

A new north-central Arkansas hog farm was causing quite a stink and the University of Arkansas Division of Agriculture had a challenge on their hands.

The solution was no further away than a first floor office in the Department of Crop, Soil and Environmental Sciences on the University of Arkansas campus. A fixture in the department and a world authority on water quality and soil chemistry, Professor Andrew Sharpley was given the task of researching the environmental effects of a recently installed hog farm in close proximity to the national scenic Buffalo River.

Originally from Manchester, England, Sharpley earned his bachelor's degree from the University of North Wales, United Kingdom in 1973 and his Ph.D. from Massey University, New Zealand in 1977. With an opportunity to continue researching nitrogen leaching and ozone layer effects, Sharpley took a position with the United States Department of Agriculture-Agricultural Research Service, where he served for a combined 25 years in both Oklahoma and Pennsylvania before taking a faculty position at the University of Arkansas in 2006.

During his time as a professor in the Department of Crop, Soil and Environmental Sciences, Sharpley has become known as an international authority on phosphorus cycling in soil-plantwater systems relating to water quality and managing the impacts of local agriculture on water runoffs. These specialties have proven to be valuable to not only Sharpley's research but now, the state of Arkansas as a whole.

Fast-forward to 2013, Nathan McKinney, assistant director of the Arkansas Agricultural Experiment Station, answered a phone call that would set into motion a large-scale research effort. "The Division of Agriculture received a call from the governor's office requesting us to assemble a panel of experts to

lead research on the water shed surrounding a hog farm located in close proximity to the Buffalo River," said McKinney.

Luckily for McKinney, he didn't have to look far to locate these experts, "Dr. Sharpley spearheads a team of eight to ten individuals, all of whom are considered to be authorities in their fields."

The Buffalo River in northwestern Arkansas is revered by many, as it was the first river in the United States to be designated a National Scenic River. More than 150 miles long, it is a pristine water body in a well-preserved location that draws thousands of nature-loving tourists to its waters each year. When the C&H Hog Farm was placed on a tributary of the river called Big Creek in 2013, the public voiced concerns regarding long-term effects on the river quality.

"Despite there already being agriculture in the watershed, understandably, the concerns were centered around the idea that with a large scale hog farm would come an increased amount of nutrients in the soil causing complications such as an increased amount of algae, slimy rocks, or a change in the fish population," recalled Sharpley. "The individuals with concerns recognized that once the beauty there was damaged, it would be hard to go back, so they called for the farm to be removed."

As 2013 progressed, word of the growing hog farm spread rapidly, catching the attention of many national environmental and water quality advocacy groups from around the country. There were strong opinions forming on either side of the fence, and the controversy was gaining national prominence.

"Sure, there were concerns regarding the river's wellbeing, but on the other side, farmers all around felt that if they had followed the rules and obtained the correct permits, it is their right and their land to farm," said Sharpley. "Unless there was profound evidence that water quality and soil nutrients were changing, you can't shut down an operation solely because you don't like it."

Despite tensions running high among the community, the U of A Division recognized the importance of keeping the task at hand in focus. Sharpley's research team began making regular, weekly visits to the farm, collecting hundreds of samples upstream and downstream.

"When we began what will now be a five-year study surrounding the farm, our main goal was to remain transparent with everyone," said McKinney. "We held open meetings, were accessible to the public for questions and with the research publish quarterly public reports about the findings. While Dr. Sharpley worked with our team to bring in samples, we even brought in experts from outside the state to analyze the data."

Once the go-ahead was given to Sharpley, the investigation was underway.

"Beginning in 2013, we were fortunate enough to receive funding from the state that will help us run the study for the five years, a time span that would allow us to see long term effects," Sharpley said. "We have set up 12 sites across the area to monitor weekly. We set up on Big Creek above the farm to have a sample of water quality entering the farm and also set up below the farm to compare the quality of the water leaving the farm. The samples are analyzed no more than eight hours after being collected, and we comply with very stringent guidelines so that our findings are to be valued and credible."

Throughout their data collection, the investigative team has remained committed to protecting the water quality in Big Creek. Though no problems have been found, the investigative team has worked closely with the farmer to ensure that if a problem were to arise, it could be corrected before reaching the creeks.

“While we have no evidence of leakage so far, we also set up check points along ponds and the creeks that will alert us if there were to be a situation of that sort,” Sharpley said. “The farmers understand the importance of the river and the implications that leaking nutrients would have, so it has been a team effort to ensure that a problem would be caught before it reaches the water sources.”

The U of A Division of Agriculture was commissioned with the challenge of eventually providing the governor’s office with scientifically rigorous data. Not only did this task involve what will be years of extensive monitoring and resources, but it was also important because the findings related directly to the beliefs, values, concerns and livelihoods of individuals in the surrounding community.

Sharpley leaned back in his chair and paused when asked about conclusive results. “The bottom line is no, we haven’t found anything out of the ordinary or alarming. If we had, you would have heard something by now.”

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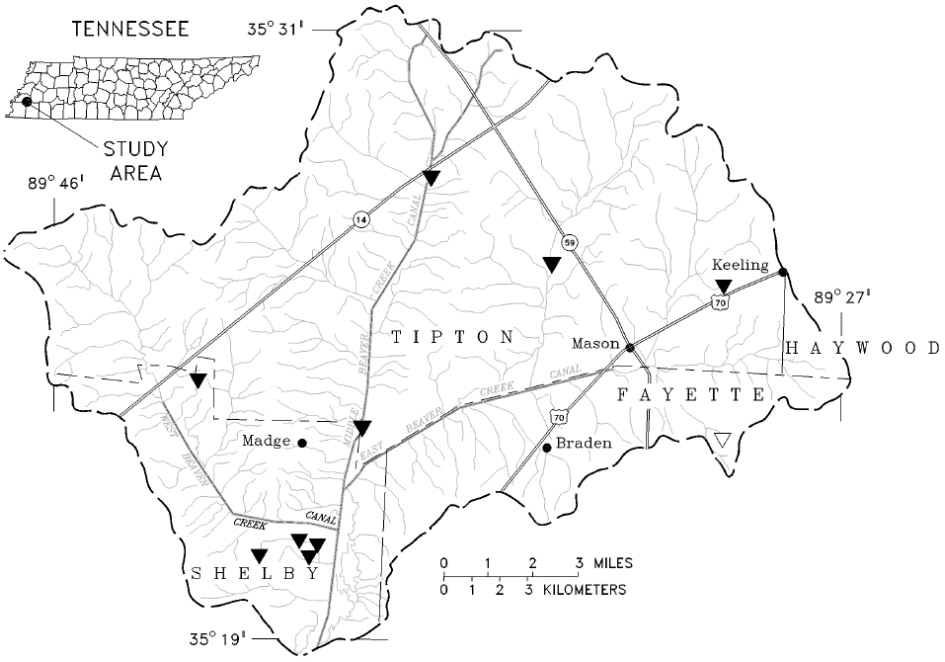
University of Tennessee Beaver Creek Study

The University of Tennessee Agricultural Extension Service

The Beaver Creek watershed drains about 95,000 acres in Fayette, Haywood, Shelby and Tipton counties. Two-thirds is crop land: cotton, soybeans, small grains and corn are the major crops.



Soils in the watershed are very productive but also very erosive; one landowner describes the soils as "...melting like sugar and running like water." EPA identifies soil erosion as one of the biggest ways agriculture may affect water quality. Erosion is a concern because it contributes sediment to surface water and also because eroding soil particles may carry pesticides and fertilizers.

In response to concerns of farm families in the watershed, the Tennessee Department of Agriculture and the US Geological Survey launched an extensive investigation in 1989 on the effects of agricultural practices on water quality and the extent to which best management practices (BMPs) may reduce these impacts. In 1991, Beaver Creek was selected as a Hydrologic Unit Area (HUA) project as part of the US Department of Agriculture's national water quality initiative. The HUA project focused on controlling erosion and associated movement of pesticides and nutrients.

The results of all the efforts, in a nutshell, were to show that BMPs work. Coordinated USDA programs of education, technical assistance and cost-share financing helped many farm families to voluntarily adopt BMPs. Monitoring showed significant reductions in sediment, pesticides and nutrients in the water coming off fields using no-till and other BMPs.

Beaver Creek has gained national attention for its success and the implications of the results. Documents linked to this page discuss Beaver Creek, its implications and BMPs. The final report is a

good place to start. Support for this outreach effort comes in part from Syngenta, the Tennessee Department of Agriculture, and the USDA Cooperative State Research, Education and Extension Service.

Beaver Creek Study Final Report

Background

The Beaver Creek story is unique in several ways:

• started by a local farmer who wanted to know the truth about whether agriculture was damaging water quality
• became, what may have been, the largest voluntary, multi-agency research project in the state
• became a landmark study: many have used Beaver Creek's scientific methods of stream sampling/evaluating as a model

The Beaver Creek Hydrologic Unit Area (HUA) is located in four West Tennessee counties: Fayette, Haywood, Tipton and Shelby (see map, above). That's an area of approximately 95,000 acres, 2/3 of which are croplands: primarily cotton, soybeans, small grains and corn.

The project, which began in 1991, included intensive monitoring to analyze the effectiveness of best management practices. Practices that require planning, effort and money; practices that farmers voluntarily implement; and practices that can protect our finite supply of water.

Remember, the study was designed to scientifically determine whether agriculture in the Beaver Creek HUA was damaging water quality. The findings were remarkable

Scientifically Speaking

With a baseline established, the testing began with 12 monitoring stations in the watershed. Samples were taken at regular intervals **and** every 5 to 15 minutes during rainfall. The samples were then packed in ice and shipped to various laboratories for testing.

Conclusions

• The water coming off no-till fields was remarkably clean.
• "Hungry water" (see below) was a factor.
• No-till does an excellent job keeping soil in place.
• BMPs really work.

With BMPs in place, water from the fields reach tributaries so clean, and moving at such a velocity, that it picks up sediment and silt from the sidewalls and bottoms of creek channels—hungry water. This is the reason the creek continues to look muddy.

Why was the water coming off the fields so clean? Because farmers have been voluntarily using BMPs to keep soil in place. This is significant as sediment is the primary problem in Beaver Creek, and across the nation. The top soils in the Beaver Creek HUA, which are 20-30 feet deep, are loess soils that are erosive in nature. Some describe the soil as "melting" in the rain. That is why keeping the soil, or sediment, in place is so important. The study confirmed that no-till (see picture, left) does an exceptional job keeping the soil in place.

Natural Resources Conservation Service documented (in the Beaver Creek HUA):

- the amount of soil loss, when treated with various BMPs, was reduced from 22 tons per acre per year, to 2 tons
- 75% of producers used no-till by end of study
- 480,000 feet in terraces (that's more than 90 miles!)
- 40,000 feet of diversions
- 280 sediment basins

Studies also found that pesticide/nutrient levels spiked when applied immediately before rainfall (although no hits above EPA standards occurred during the study). That tells farmers to watch weather reports and hold off applying pesticides and fertilizers when rainfall is predicted. By doing this, pesticides are kept in the field instead of being washed into the creek. This protects water quality and saves the farmers money.

Community Improvements

The Beaver Creek study proved that BMP implementation by farmers in the HUA greatly reduced soil loss, which reduced nutrient and pesticide loads into the streams. As a result, Beaver Creek has improved aquatic habitat, wildlife and recreational opportunities within the watershed.

BMPs such as constructed wetlands and riparian buffers (right) were exhibited as cost-effective practices to the community. Today, these practices are commonplace in the HUA.

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Purdue Help the Hellbender

Purdue Agriculture, Purdue University

Eastern hellbenders are the largest salamander in North America. Adults are capable of reaching 29 inches in length; however, most individuals are typically 11-24 inches long. This North American giant salamander has short limbs and widely flattened head and body. A fleshy fold of skin extends along the sides of the body between the front and hind limbs giving them an overall wrinkly appearance. Body color is often variable, ranging from a greenish to yellowish brown. Dark spotting is typically present along the back and tail. Although adults are quite large, they are rarely seen. Hellbenders spend most of their time hiding beneath large, flat rocks during the day and forage for crayfish at night.

Hellbender populations are declining across their range, from Missouri to New York. This decline, which affects the hellbender population in Indiana's Blue River, is likely caused by human influences such as habitat degradation and destruction. The stream-bottom habitat of hellbenders can be degraded by sediment from eroded banks and fields and destroyed when streams are dammed or dredged. Hellbenders are also captured inadvertently by anglers or purposefully for illegal sale in the pet trade. Finally, emerging diseases may be impacting some populations of hellbenders. Specifically, the chytrid fungus (*Batrachochytrium dendrobatidis*) and Ranavirus (family Iridoviridae) are considered to be major threats to the persistence of hellbender populations across their range.

As an amphibian, hellbenders are R-selected breeders, meaning they lay a large number of eggs and only a small portion of those survive to adulthood. Male hellbenders will guard the eggs until they hatch (pictured to the left), but the hellbenders will not reach adulthood until they are 5 to 8 years old. This long life cycle results in many larval hellbenders being unable to survive to adulthood, especially with additional environmental stressors like poor water quality and predation by fish. This is where captive rearing becomes especially useful, as hellbenders are raised in controlled environments until they reach adulthood. However, captive rearing comes with its own challenges.

Many states are developing conservation programs to help the hellbender. These conservation initiatives are diverse and consist of **captive breeding** and head-starting programs, **education programs** that promote awareness, increased protection through state and federal regulations, and strong research collaborations between academic institutions and government agencies (**Hellbender Conservation**, **Hellbender Public Attitudes**, and **Hellbender Repatriation**). Most recently, the Ozark hellbender subspecies, C. a. bishopi, was given protection as **federally-listed** endangered species.

Captive rearing of hellbenders is a strategy used in hellbender conservation efforts as a way of increasing the survival rate of young hellbenders. The hellbender population has decreased by 77% since the 1980s, with habitat loss and water quality being the main causes of their decline. Survival is especially low in young hellbenders, with many dying before they reach sexual maturity or adulthood.

Hellbenders require cold, clean, fast flowing water similar to that which is found in the wild. Eggs are kept in tanks where water flow is continuous in order to prevent disease transmission between eggs. Tanks are also kept in rooms at about 59° F (15° C). Hellbenders are also provided with cover in the form of large rocks and tunnels in order to recreate the large rocks they typically hide under in the wild. Hellbenders are fed crayfish, which is their primary food source in the wild.

Despite being raised in captivity, released hellbenders will still face some challenges when being reintroduced. They will have to scout out good locations for feeding and resting and develop their own home range. A river is quite different from a tank in a lab, with environmental changes like temperatures changes and weather, competition for food, water currents, and predation all being new introduced conditions. Research is being conducted in order to stimulate these conditions in captivity and increase survival after release.

Universities and zoos across the country participate in these captive rearing programs. Eggs are collected from rivers where adult hellbenders spawn, with each female laying 200-400 eggs. The eggs are kept in climate controlled rooms with continuous water flow. After 72 days, the eggs hatch into larvae that still retain their yolk sac for the first few months. After 1.5 years, the hellbender larvae lose their external gills and more closely resemble an adult hellbender. Hellbenders reach adulthood at 5 to 8 years, at which point they are released back into the wild in suitable habitat.

For more information on what you can do to help, visit "Help the Hellbender." Separate tabs for anglers, homeowners, farmers, teachers, and kids found at the top of each page give information about how individuals from each one of these groups can help the hellbender.

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Red River Station Field Day Focuses on Water Use

Mid America Farmer Grower, mafg.net

The LSU AgCenter Red River Research Station just south of Bossier City is known for and is still a leader in greenhouse tomato studies. But the new focus is water resources.

Located only a few miles from the Red River, a major waterway leading to the Mississippi, the 572-acre station has always had an interest in water "as far back as retired U.S. Senator J. Bennett Johnston of Shreveport," said Rogers Leonard, LSU AgCenter associate vice president. "Senator Johnston helped secure funding for research on the Red River because he knew how important it was to this area."

The first field day with a major emphasis on water resources was held at the station on June 15.

"The field day focused on improved water use in agricultural operations – specifically, efficient irrigation practices and reducing the impact of agricultural irrigation on nonpoint-source water pollution," said Pat Colyer, AgCenter Northwest Region director. "Because of the increased demands for water globally, a comprehensive approach will be needed to address the increasing demands on water use in agriculture."

One area of study centers on the invasive aquatic fern giant salvinia, which grows in many Louisiana waterways. Steve Micinski, AgCenter entomologist, said the root system of the salvinia can reach 3 feet in length. Besides presenting a navigation problem, the free-floating weed depletes the oxygen in the water.

"We are using weevils to battle salvinia, and they work well. But they die off each winter in north Louisiana," said Micinski. "AgCenter entomologists are searching the fern's native range in South America in hopes of finding the weevil in areas where the climate is more similar to north Louisiana. If a more cold-tolerant weevil can be located, we eventually hope to release it in north Louisiana."

Changyoon Jeong, AgCenter water quality specialist, reported on his latest study looking at controlling nutrient losses such as nitrogen and phosphorus in row crop fields.

"It is important for agriculture to have nutrient efficiency and protect our watersheds," he said. "One of the strategies to prevent water contamination is use of biochar, which is produced through incomplete burning in the partial or total absence of oxygen. It enhances nutrient retention." This study is being done in a cotton field where poultry litter was applied, he said.

Jeong is also working with researcher Jong Ham, AgCenter plant pathologist, to examine disease management in soybeans through various soil amendments and foliar treatments.

"The addition of biochar and poultry manure to the soil is the major approach for the soil treatments and amendments," Ham said. "The spraying of antagonistic bacteria is for the foliar treatments."

Stacia Davis, AgCenter irrigation engineer, reported on a project comparing different types of soil moisture sensors. “If the plant isn’t getting enough water, it’s expending more energy trying to get the water than it is growing,” said Davis. The soil water potential and volumetric sensors performed differently in northwest Louisiana compared to northeast Louisiana, she said.

Naveen Adusumilli, AgCenter economist, said the water quality team at the station is developing an irrigation app.

“It would provide dollar amounts on what it would cost and the net returns when making irrigation efficiency improvements on a farm,” Adusumilli said. Examples of improvements include using surge valves, flow meters, moisture sensors, fuel engine changes, and a combination of the above.

Syam Dodla, AgCenter soil and fertility specialist, talked about his study comparing furrow irrigation (all rows) and skip-row irrigation (alternate rows).

“Because agriculture is a major consumer of freshwater and the long-term prospect is for a shortage of freshwater, there is an urgent need to develop new conservation strategies,” Dodla said.

Dodla said that one might expect skip row irrigation to save 50 percent of water usage, but it doesn’t.

“The overall benefit of skip row varies, depending on soil type. Though it is well known that the heavy soils have better lateral seepage than light-textured soils, there are still many questions to be answered to better understand the feasibility of skipping a row.”

Blair Buckley, AgCenter agronomist, talked about his studies on drought and flood tolerance traits of soybean varieties.

“We’re looking at some drought-tolerant beans that have a slow wilting trait, and most of the flood-tolerant beans have been wild soybeans,” Buckley said.

Dan Fromme, AgCenter corn, cotton and grain sorghum specialist, said nitrogen management in corn is a challenge because of the rainfall we get in Louisiana. “Don’t put all your eggs in poultry litter as your nitrogen source because some commercial application will be needed.”

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Inexpensive Open-Source Dataloggers for Environmental Monitoring

Alliance of Crop, Soil, and Environmental Science Societies

Conventional systems for the measurement and recording of streamflow and other environmental parameters are often expensive, limiting the number of automated monitoring stations that can be deployed. For instance, continuous streamflow data is not available for many watersheds of the world, especially in developing countries. This hinders the planning of adaptation to floods and droughts that affect many communities.

In a recent article published in *Agricultural and Environmental Letters*, researchers present a new low-cost data recording system. The system is based on emerging open-source hardware technologies (the *Arduino* project) that researchers can customize to read and record information from a range of sensors. In this study, the system was designed so that it is powered by solar panels and can be installed in remote locations.

The research team tested the new dataloggers in the tropics of Costa Rica and deployed the monitoring system at several streams for two years. After overcoming initial challenges, the dataloggers performed robustly, even during the extremes of the tropical rainy season.

The inexpensive dataloggers provide powerful means for extending monitoring networks into data-scarce regions. Furthermore, the adaptable and open-source nature of the system shows great potential for integration into community-based research and citizen science hydrology.

Published April 29, 2016 in *Agricultural & Environmental Letters*, below you'll find the article's core ideas, abstract, and link to the full text .pdf of the complete article.

Developing a Hydrologic Monitoring Network in Data-Scarce Regions Using Open-Source Arduino Dataloggers

Silja V. Hund *a, Mark S. Johnsonab and Tom Keddiec

Core Ideas:

- An innovative low-cost open-source Arduino-based datalogger was developed.
- The datalogger was deployed for hydrologic monitoring in tropical watersheds.
- Arduino datalogger performance was robust after overcoming initial challenges.
- The system has great potential for automated continuous environmental monitoring.

Abstract

Continuous hydrologic monitoring is limited in many regions of the world, creating serious knowledge gaps for water resources managers and scientists. Recent advances in open-source software and hardware technologies, such as the Arduino project, show potential for the development of low-cost (~$100) automated dataloggers required for continuous data collection. We developed an Arduino-based datalogger (the Ecohydro Logger) coupled with water sensors providing digital output to establish a hydrologic monitoring network in the data-scarce wet-dry tropics of Guanacaste, Costa Rica. While we experienced some challenges with a first iteration of our Arduino-based datalogger, an improved version was robust and able to capture long periods of high-frequency stream discharge data. Integration of the monitoring program into the local community was also key to successful deployment, allowing exchange of local knowledge and support. The accessible and low-cost nature of Arduino-based dataloggers can provide a means to extend continuous environmental monitoring into data-scarce regions.

The full text article can be found in .pdf at the following link: Full Text (PDF)

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Illinois Demonstration Farms Partnership Program

Illinois Council on Best Management Practices

The Illinois Council on Best Management Practices (CBMP) is a coalition of agricultural organizations and agribusinesses including Illinois Farm Bureau, Illinois Corn Growers Association, Illinois Soybean Association Checkoff Program, Illinois Pork Producers Association, Illinois Fertilizer and Chemical Association, Syngenta, GROWMARK, and Monsanto. CBMP was founded in 1999.

Mission

Working to assist and encourage adoption of best management practices (BMPs) to protect and enhance natural resources and the sustainability of agriculture in Illinois.

Goals

Identify effective, environmentally sound and economically sustainable BMPs for production agriculture

Increase farmers' voluntary adoption of BMPs through promotion, education, information transfer, demonstration, evaluation, incentives and recognition programs

Communicate with stakeholders the progress made toward BMP adoption

Program Focus

CBMP's focus is on reducing nutrient losses and enhancing nutrient efficiency. Significant resources are dedicated to education and outreach on best management practices to the agricultural community in

eight priority watersheds, including Lake Springfield, Lake Decatur, Evergreen Lake, Lake Bloomington, Vermilion River (Illinois Basin), Salt Fork Vermilion River (Wabash Basin), Lake Vermilion and Lake Mauvaise Terre.

Demonstration Farms

The Illinois Demonstration Farms Partnership program will support the continuation and establishment of water quality monitoring and include farms for both row crop and livestock production, to evaluate the impact of a variety of BMPs, such as nitrogen management, cover crops, conservation tillage, drainage water management and others, on farm operations, soil health, water quality and other sustainability metrics. By collaborating and sharing technical expertise, educational and promotional resources, and in-field personnel, the effectiveness and impact of all of these programs will improve, providing even more support to Illinois farmers in making BMP implementation decisions.

The Illinois Council on Best Management Practices has identified four locations: Lincoln Land Community College in Springfield, Sugar Grove Nature Center in McLean, and Illinois Center College and George Roberts Site both in Peoria County. The sites will add edge of field water quality monitoring to farm scale demonstration sites that have implemented one or more BMPs to improve nutrient management, water quality or soil health.

Lincoln Land Community College (Springfield)

The **Lincoln Land Community College** Demonstration Site is utilizing the college's agricultural fields to educate students, farmers and the general public about conservation practices that can improve water quality and soil health. By partnering with several programs and organizations, the site hosts cover crop plots, tile water monitoring equipment and a bioreactor for a full array of learning opportunities. The site has been serving as a Cover Crop Demonstration site with small plots of many different varieties of cover crops so students and farmers can see them first hand. The site will soon have a paired set of fields with and without cover crops to compare water quality, yield and soil health effects. Water quality monitoring equipment has been installed on the tile drains from the paired fields to capture changes in nutrients being lost from the fields. This year, both fields have been planted in soybean with no nitrogen fertilizer applied to establish baseline levels of nitrate, ammonium and phosphorus. This fall, cover crops will be planted on one of the fields. A bioreactor designed for nitrate removal has been installed to capture the tile drainage from this site and improve the quality of water leaving the site. The bioreactor will also be equipped with water monitoring equipment. As Lincoln Land Community College continues to develop its new Agricultural Watershed Management program, this site will serve as an outdoor laboratory and classroom for students to experience first-hand innovative conservation practices and **develop the technical skills needed to manage them.**

Illinois Central College (East Peoria)

Illinois Central College in East Peoria is utilizing the college's agricultural fields for a variety of cover crop related demonstrations including variety plots and herbicide trials. The Demonstration Farms site will add water quality monitoring to two of the experimental fields. Each of the fields is tiled separately and will capture drainage from either a cover crop or no cover crop treatment area in a corn-soybean rotation. Water quality monitoring equipment is being installed to capture levels of nutrients being lost from the fields including nitrate, ammonium and phosphorus. The cover crop trials were established by Pete Fandel, one of CBMP's Cover Crop Specialists and an Illinois Central College Instructor in the Agriculture program. These sites will be used to host field days for farmers and to provide hands on experience for ICC students learning about conservation, soil health and water quality.

Sugar Grove Nature Center

At the **Sugar Grove Nature Center** near McLean, Illinois, a cover crop demonstration site was established last fall when oats and radish were flown on during a field day. Through the Demonstration Farms program, stream and tile monitoring are being added to capture the nutrient levels coming from both a forested area and from a tile draining a restored prairie area. The site is publicly accessible and will include signage explaining the benefits of cover crops. The site will serve to educate farmers as well as the general public about cover crops, soil health and water quality. This work will be highlighted in conjunction with the Nature Center's educational programs and in conjunction with the continuing Cover Crop Field Days.

George Roberts Site – Trivoli (Peoria Co.)

In Peoria County, a Demonstration Site has been established on the farm of George Roberts. Separately tiled fields of continuous corn have been equipped with flow monitors and automated water sampling equipment. A weather station and soil moisture probe have also been installed and soil samples are being taken periodically across both fields. Nitrogen is being split applied on these fields and in the fall, one of the fields will be planted with cover crops. A pond draining fields directly adjacent to the monitored fields is also being sampled for nitrate at inflow and outflow points. Several nearby tiles have been equipped with continuous flow monitors and are being sampled for nitrate weekly and periodically for phosphorus. One of the tiles drains a continuous soybean field and the other has a home septic system connected to it. There is also a cover crop/nitrogen management trial site nearby that will complement the water quality monitoring site for outreach events. A "field day" was held with the Peoria SWCD in March with positive feedback from the farmers who attended. Ben Herrmann is the field manager for the site.

For more information vist: http://www.illinoiscbmp.org/

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NRCS Conservation Client Gateway

What is Conservation Client Gateway?

Conservation Client Gateway is a secure online web application that gives landowners and land managers, operating as individuals, the ability to track their payments, report completed practices, request conservation assistance, and electronically sign documents anytime, anywhere. Conservation Client Gateway provides users the flexibility to determine when they want to engage with NRCS online and when they prefer in-person conservation planning assistance.

Who is using Client Gateway now?

See this video with four farmers who share how they benefit from Client Gateway:

https://youtu.be/l5mT_5nBk5Q

If you're interested in Conservation Client Gateway, you can get started here:

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/cgate/

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Conference on Ecosystem Services (ACES)

December 5-9, 2016

ACES: A Community on Ecosystem Services represents a dynamic and growing assembly of professionals, researchers, and policy-makers involved with ecosystem services. The ACES 2016 Conference brings together this community in partnership with **Ecosystem Markets** and the **Ecosystem Services Partnership (ESP)**, providing an open forum to share experiences, methods, and tools for assessing and incorporating ecosystem services into public and private decisions.

The focus of the conference is to link science, practice, and sustainable decision-making by bringing together the ecosystem services community from around the United States and the globe. ACES 2016 will bring together leaders in government, NGOs, academia, Native American tribes, and the private sector to advance the use of ecosystem services science and practice in conservation, restoration, resource management, and development decisions.

We hope you will make plans to join more than 500 ecosystem service stakeholders in this collaborative discussion to advance use of an ecosystem services framework for natural resource management and policy.

Register, become a Sponsor, Join the Mailing List, and find out more here:
http://www.conference.ifas.ufl.edu/ACES/

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