Monitoring and Managing Mississippi Delta Watersheds

All water bodies are dynamic systems shaped by time, the surrounding environment, and human intervention. At the Agricultural Research Service's National Sedimentation Laboratory in Oxford, Mississippi, scientists are identifying the interplay of factors that—for better or worse—affect water quality in the Yazoo River Delta and beyond.

Water Quality and Ecology (WQE) research leader Martin Locke and colleagues have kept tabs on the Beasley Lake watershed for more than a decade. This watershed, which drains into an oxbow lake some 20 miles east of Greenville, Mississippi, is part of the nationwide Conservation Effects Assessment Project (CEAP). In 2003, the Natural Resources Conservation Service (NRCS) partnered with ARS to measure the environmental benefits of CEAP-related practices used by private landowners participating in conservation programs.

When the Beasley Lake watershed studies first began, most of the fields within the watershed were farmed for cotton. But a range of factors, including federal and state farm programs, resulted in a shift in land use. Local farmers now produce a mix of corn, soybeans, rice, and catfish.

Other landowners have stopped cultivating field crops altogether. Instead, they are participating in another NRCS initiative, the Conservation Reserve Program (CRP). This effort supports farmers who convert environmentally sensitive acreage to vegetative cover, such as beneficial grasses, wildlife habitat, trees, or riparian buffers.

Watching the Watershed

WQE researchers monitored the lake for a range of biological, chemical, and physical factors and evaluated runoff from edge-of-field sites. They also installed vegetated buffer zones and slotted inlet pipes to slow water flow and trap agricultural chemicals and sediments in field runoff.

"We've seen improvements in water quality that are the direct result of changes in how the land is being used," Locke says. Farmers began to cut conventionally tilled row-crop production while increasing their reduced-till cultivation of genetically modified crops. As a result, herbicide use diminished and soil-erosion rates declined.

WQE ecologist Scott Knight found that Beasley Lake has improved in clarity, plankton growth levels, and fish stocks over the past 11 years. As sediment deposition declined, the chocolate-brown water became almost clear. The lake's phosphorus levels decreased when farmers began to adopt conservation-management practices. Pesticide levels equaling or exceeding 0.1 parts per billion also dropped significantly.

As water quality in Beasley Lake began to improve, so did fishing for blue sunfish, redear sunfish, and largemouth bass—much to the delight of local residents. "Mississippi folks like to hunt and fish," Knight notes wryly.

As part of their research, the team used watershed data collected by the United States Geological Survey to develop a model called "Annualized Agricultural Non-Point Source Pollutant Loading." The data, obtained over several years, included levels of pesticides and other pollutants in field runoff.

In 2006, Locke led WQE scientists in a new round of CEAP studies in six Beasley Lake subdrainage areas with similar topographies and soil types. Three sites were cropped in reduced-tillage soybean, and the other three sites are forested buffers and are in the CRP. Locke and WQE agricultural engineer Bobby Cullum are now evaluating runoff from all six sites for sediments, nutrients, and pesticides.

STEPHEN AUSMUS (D1306-9)

In a constructed wetland at Beasley Lake, agricultural engineer Bobby Cullum (left) collects water samples as ecologist Matt Moore uses a multimeter to record water quality to determine how well the wetland filters pollutants.

STEPHEN AUSMUS (D1305-32)

In studies to evaluate the effects of conservation buffers on nutrient retention and water quality in Beasley Lake, soil scientist Martin Locke (front left) and biologist Wade Steinriede examine a soil sample collected from a row crop area adjacent to the lake. In the background, technician John Massey operates a survey-grade GPS system to document sampling locations in the buffer area.

This information will allow them to refine their observations of how changing land use from cropping to CRP affects edge-of-field water quality.

Rougher, Tougher Buffers

WQE ecologist Matt Moore decided to conduct more indepth research on using vegetated buffers to mitigate pesticide levels in runoff. He carried out a series of studies using constructed wetlands near Beasley Lake that consisted of a sediment-retention pond and two vegetated wetland "cells."

The rectangular cells were densely vegetated with water smartweed, johnsongrass, and alligator weed. Together, the two cells and the pond measured 590 feet in length by 98 feet in width. The team also set up 10 stations at various points within the constructed wetland to collect water samples from a simulated runoff event. The water they used during their 4-hour "storm" was removed from Beasley Lake and spiked with sediment and the pyrethroid insecticides lambda-cyhalothrin and cyfluthrin. These pesticides are typically used in corn, cotton, soybeans, rice, and wheat production.

The researchers pumped the water into the wetland and began collecting water samples after 15 minutes. They continued sampling for the next 55 days as water availability permitted; some sampling stations were dry after 7 days. Samples of sediment and wetland plants were also collected at intervals for 55 days.

The results indicate that the plants took the prize when it came to impounding pesticides. Over the entire 55-day sampling interlude, around half the average concentration of lambda-cyhalothrin was found in plant matter. Slightly less than half the average concentration was found in the sediment, and only a small fraction of the pesticide was found in the water.

The wetland plants also effectively trapped some 75 percent of the average mass of cyfluthrin introduced into the constructed system. Water samples held about 18 percent of the pesticide, and sediment held only about 7 percent. The sediment-retention pond kept less than 1 percent of the overall mass of both pesticides.

After analyzing their results, Moore and his team estimated that a constructed wetland would need to be 705 feet long to capture significant amounts of lambda-cyhalothrin and 682 feet long to protect against cyfluthrin.

"The plants do an excellent job of cleaning up those pesticides," Moore says. "If the plants can lock up the chemicals, that means we're keeping them out of the water and the sediment. We're really pushing plants for pesticide remediation."

"The work we're doing here on water quality is useful for local producers, but the effects are felt throughout the Delta," Locke says. "Anything we can do to protect our local watersheds from agricultural pollutants helps protect water quality all the way to the Gulf of Mexico."—By **Ann Perry,** ARS.

This research is part of Water Availability and Watershed Management, an ARS national program (#211) described on the World Wide Web at www.nps.ars.usda.gov.

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Ecologist Scott Knight inspects and weighs a common carp while biologist Terry Welch records data. A wide range of fish species are collected from Beasley Lake in an effort to determine the overall health of lake ecology.