



Changing Landscapes

*Environmental quality through research,
extension and teaching at the
University of Missouri-Columbia*



College of Agriculture, Food and Natural Resources • University Outreach and Extension



Dear friends,

The land-grant university has long stood for the land and its people. It is no wonder that Missouri — with its diverse and abundant fields, woods, water and wildlife — would have the study and care of these natural resources among its top priorities.

Like so many in science today, MU research and outreach personnel are involved in the study of, and education about, the environment at many scales — from the molecular to the vastness of the atmosphere and beyond.

What strikes me about the projects we have showcased in this publication is their impact at an organizational scale we call the landscape. These projects are making a real difference in the Missouri landscape — the real world where citizens live, farm and recreate. The projects are more than theoretical — they are protecting and improving the Missouri environment in a direct way. The ability to make a difference on the landscape scale is at the heart of what a land-grant institution should be doing.

These projects also showcase the collaborative nature of our work. Often, university funding provides a spark for a project or idea. It's the job of the research and outreach faculty on this campus to then bring in additional resources from local, federal and state agencies, granting organizations or private firms, and grow the project to enlarge its scope and impact.

This publication is but the first of many ways in which we will work to inform you about our environmental quality efforts. We're also developing a quarterly newsletter to keep you informed about the latest MU efforts, upcoming events and ideas.

And detailed information is available on our new EQ web site, found at <http://eq.missouri.edu>. There you can look up complete projects, including accomplishments, background information on collaborators, and links for other areas of related topics.



John Gardner, center, talks with MU faculty at the Forage Systems Research Center near Linneus, Mo.

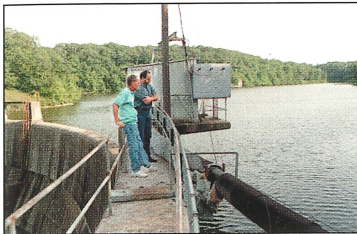
Sincerely,

John Gardner

Associate Dean for Research and Outreach
MU College of Agriculture, Food and Natural Resources

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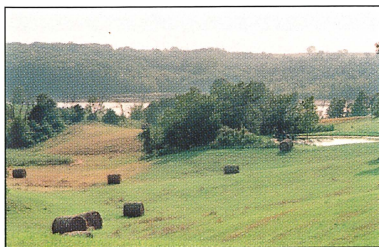
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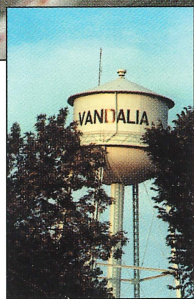
Center for Agricultural, Resource and Environmental Systems provides tools for smarter decision making.

EQ ResourcesInside back cover

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Extension and Agricultural Information, University of Missouri-Columbia

On the cover: The northern edge of Long Branch Lake in north-central Missouri. Photo by Jim Curley.



The story of Vandalia Reservoir might be described as the best-case solution to a worst-case scenario.

"We had a couple of farmers call us and say, 'We've been doing some of these best management practices. What else can we do to keep from getting in trouble?'" remembers Bob Broz, MU water quality specialist.

"They had the desire to do something, but they didn't know how to

make it work." Shortly thereafter, in 1997, the contamination of drinking water supplies in Vandalia, Mo., was approaching unmanageable levels. The city's water plant manager reported that the highest recorded levels of atrazine, a common corn herbicide, were nearly 30 times the allowable maximum of 3 parts per billion.

The town in northeast Audrain County turned to University Outreach and Extension. With the help of MU water quality associate Dan Downing, Vandalia officials developed a strategy to meet with key players in the region

to form a Watershed Management Committee.

By 1999, Downing says with justifiable pride, the levels of atrazine in the reservoir went from a peak of 85 parts per billion to a high of 6 parts per billion. "They can treat that level," he says. "When it's as high as it was before, that's very difficult."

Downing himself had a difficult job just to round up local landowners, agribusinesses, agencies, officials and city residents. "We really had to beat the bushes to reach all the consumers," he says. "We literally went door to

Meeting of the Minds

With a little help from their friends in University Outreach and Extension, people in the Vandalia Reservoir watershed were able to dramatically lower pollution levels in their raw drinking water.

Left: Jim Balmer, left, chief operator of the Vandalia water plant, talks with MU water quality associate Dan Downing while standing on the dam of the city's reservoir in northeast Missouri. Below: The two have been major players in the Watershed Management Committee, which includes city officials, citizens and area farmers.

reduce atrazine levels, Downing says. "The farmers basically talked across the fence." Most of them adopted a two-pass system for atrazine application, which requires less

of the herbicide for each application. "Some of them used alternative mixes using reduced rates of atrazine; some of them completely quit using the product. Some staggered their crop rotation or took some land out of crop production."

Atrazine, a cheap and effective herbicide in corn, should not endanger water supplies if used wisely, Downing says. "When the products are applied, and then it rains hard, the levels in the lake are a lot higher. There's a huge list of variables."

Currently, the Extension Water Quality group is working with dozens of communities, focusing on six in western Missouri to form watershed



management groups. Some of the six face more complicated challenges than Vandalia did, Downing says, citing Smithville Lake near Kansas City.

"Smithville has unfolded altogether differently," he says. "They don't have real clear-cut, tangible results there yet. It's a lot bigger. There are hundreds of farmers plus urban sprawl and explosive growth."

With help from the water quality group, the Smithville Lake Watershed Coalition formed in 1997 and has now applied for nonprofit status, which will make it eligible for government funding to support its efforts.

Downing noted that the problem of atrazine in drinking water supplies has led to court battles in several other states. "There are more amenable approaches in Missouri."

by Forrest Rose

door to get them to that initial meeting. Once we had that meeting, the cooperation was great."

The situation in Vandalia is similar to those in other communities that rely on surface water in danger of contamination from agricultural runoff, Downing says. "The difference in Vandalia was that there was a group of farmers that acknowledged their share of the responsibility and were willing to do something about it."

Fewer than a dozen farmers raise corn in the Vandalia Reservoir watershed, and not a one was hostile to management practices that would

photos by Jim Curley



The Phosphorus Connection

Rules you can live with

Stories by Duane Dailey

Phosphorous is one of the three basic fertilizers, along with nitrogen and potassium, added to agricultural fields, turf and lawns to increase production. Phosphorus is also a component of manure. As agricultural production has increased, there is more potential for phosphorus to be freed into the environment.

Manure, properly applied, is valuable as a fertilizer for agronomic use. It's also a potential pollutant. As water quality issues surface, there is increased regulatory concern from the U.S. Environmental Protection Agency. EPA has proposed extensive and complex regulations, for example, on the manure produced on Confined Animal Feeding Operations (CAFOs). In turn, USDA Natural Resources Conservation Service has mandated phosphorus control guidelines in Conservation Plans, which are required on every farm participating in federal farm programs.

The University of Missouri, through research and outreach, is developing information to make farmers aware of the problems, aid them in reducing phosphorus loss in runoff, and help the government regulators develop science-based rules that can be complied with, without bankrupting the farming operation.

"Everyone is in favor of clean water," says MU agronomist John Lory who has projects measuring phosphorus runoff, developing nutrient management tools for farmers, and writing publications to explain the problem and solutions. "But, not everyone is clear on what it will take to solve the problem," Lory added.

Proper phosphorus use is a complex problem. Variables, such as how



photo by Duane Dailey

Runoff from a small plot is collected in a "rain barrel" to sample nutrient runoff. Research specialist Eduardo Navarro, left, and agronomist John Lory set up a rain machine on soils of known soil test phosphorus. On this fescue pasture on MU South Farm, runoff nutrients are seen in the collected water.



the Connection

Applying phosphorus to pastures yields multiple benefits

While there is surplus phosphorus in some places, there's a definite need for the nutrient in many fields and pastures. Dale Blevins, using lab research at MU and field tests at the Southwest Center, Mount Vernon, Mo., demonstrates multiple benefits of adding phosphorus to pastures.

Blevins started looking for ways to prevent grass tetany, a disease that kills cows grazing lush grass in spring.

The cause was known already to be lack of magnesium in the diet. But, attempts to correct the deficiency with magnesium fertilizer failed. Feeding magnesium, a common preventive, was costly and often ineffective. Some cows just won't lick a mineral block.

Blevins loves research that has real payback for farmers. He and research associate Tim Reinbott soon found that soils growing magnesium-deficient grass were already rich in magnesium. The research question: Why doesn't a plant use what is available?

The MU researchers found phosphorus is key to magnesium uptake. It appears that a molecule of phosphorus unlocks portals in the roots where magnesium enters.

This past spring, 2001, Rob Kallenbach, MU forage agronomist, and his assistant, Ryan Lock, joined in beef-cow grazing trials at Mount Vernon. As the lab work indicated, adding a little phosphorus to pastures in spring great-

ly increases magnesium in the forage — and in cows.

Not only does magnesium guard against tetany, but it bumps forage growth. Grass greens up earlier in March and pastures grow an extra 1,000 pounds of forage per acre. Some tall fescue produces an extra ton of high-quality grazing. Although data is not available yet, it appears cows grazing on phosphorus-enriched pastures wean calves 60 pounds heavier in the fall.

"There's a quick financial return from adding a little phosphorus," Blevins says.

In spring 2002, the MU team plans to apply poultry litter instead of fertilizer to supply needed phosphorus.

the phosphorus is applied, soil conditions, the lay of the land, rainfall, and buffers along waterways all have an impact.

"We must develop options that are economically feasible," says Ray Massey, MU agricultural economist. "Some recommendations might work in theory. But, if the farmer does not have the equipment or the technique is too expensive, the recommendation will not be followed."

Lory and co-workers are developing a Phosphorous Index, which will help farmers determine what fields are best suited for manure application. A flat field (or part of a field) is usually better suited than a steep hillside. A field farther from water frequently poses lower risk than a field along a stream bank. The Phosphorus Index integrates information about the tillage, the hydrology, an erosion index, the soil test phosphorus levels and distance from the nearest surface water.

"These are all numbers that are available to any farmer who has a soil map and a conservation plan for their farm." The index rates the field from high to low on suitability for application of manure and the potential for phosphorus loss to surface water.

the Connection

How much is too much? It depends ...

On hillsides and in fields along streams in southwest Missouri, Peter Motavalli, MU scientist, is probing the soil and analyzing samples. He's studying the phosphorus content across the Ozark landscape and calculating the soil's phosphorus capacity. It's part of a coordinated study to determine the level at which phosphorus is likely to leave the land and enter free-flowing water.

Some parts of the landscape are more suitable for application of poultry manure. Other areas should be avoided.

Along with scientists from Oklahoma State University, the MU scientist is looking for scientific data on which to base regulations — and recommendations to farmers on how and when to apply manure to those fields.

"There's a regulatory mandate to set standards," Motavalli says. "But, there is a lack of specific information on what to base those rules on."

The soil scientists know that there is no "one-size-fits-all" standard. Each

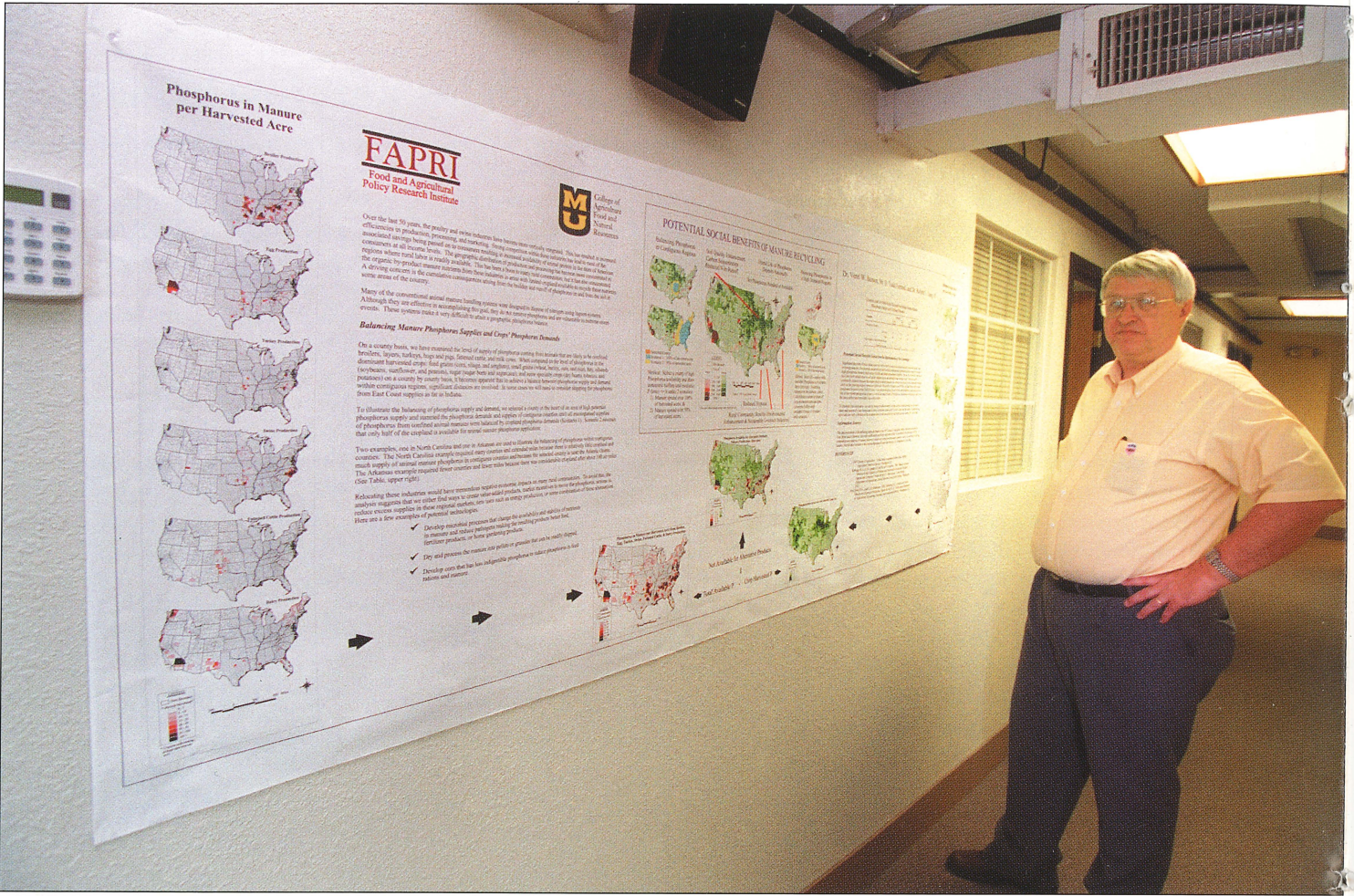
soil type and each topographic feature has different phosphorus holding capacity. This study is the first of many that will be needed to make the rules suitable statewide.

The research is part of a national mandate faced by states. "In Missouri, we're ahead on not just learning what is there, but in putting that information together in a form that can be taken back to the farmers," Motavalli says.

The findings will go into refining the Phosphorus Index being developed by John Lory and colleagues. The index can be taught by staff in University Extension and the Natural Resources Conservation Service, cooperators in the project.

Like many studies at land-grant universities, the new knowledge will be used in the teaching labs and classrooms on campus. Graduate students assisting with the research will become the leaders in this area for the future. "There are going to be a growing number of jobs," Motavalli says. "Our students will be prepared."

photo by Jim Curley



Verel Benson and his co-workers at FAPRI are developing economic models that show the profit potential for supplies of manure-based phosphorus.

the Connection

From a curse to a blessing

Phosphorus out of place can be a pollutant, spoiling fresh water supplies. Phosphorus properly managed is an essential nutrient for forages and crops, increasing yields.

With those basics, Verel Benson is telling Missourians to look at phosphorus as an asset, not a liability.

While phosphorus is now imported into the state as fertilizer, vast supplies of phosphorus are available in manure from the state's increasing livestock and poultry industry.

Benson sees a business opportunity. Convert — i.e., condense — manure into an elemental nutrient. In turn, the nutri-

ent, a valued product, can be moved to where it is needed.

Benson, with the MU Food and Agricultural Policy Research Institute (FAPRI), is developing economic models to show the potential. He has mapped the locations of the high-density supplies of manure-based phosphorus. For example, his maps highlight the poultry areas in southwest Missouri. And, he has mapped the areas where phosphorus is needed.

Missouri phosphorus is at an advantage over the concentrations on the East Coast. It is near the crop fields of the Corn Belt and the Wheat Belt.

The challenge is to create an infrastructure to economically convert the poultry litter and pig manure into a condensed product to transport and apply where needed.

One plan is to burn litter as an energy source (another asset in short supply), then transport the ash, high in nutrients, to crop fields.

Southwest Missouri has large supplies of poultry litter coming from the increasing production of turkeys, broilers and layers. There is nearby need for phosphorus on forages for the area beef cattle and dairy farms. However, the demand for phosphorus fertility on for-

ages is small compared to that for grain growth. Much of the phosphorus on pasture is recycled in place by the grazing animals.

Now phosphorus is imported into the area. Some is in the form of phosphorus fertilizer. However, a major source of incoming phosphorus is in the grains added to feed rations.

Converting that phosphorus into a manageable form would create a haul-back product for the grain producing areas — an ultimate example of recycling.

There's another urgency in developing phosphorus recycling. The end is in sight for mining high-quality phosphorus from the ground. The present U.S. supply, mostly in Florida, is not an unlimited resource. When it is gone, we'd have to turn to other countries.

Benson and his co-workers at FAPRI and other MU departments are working with a wide representation of stakeholders in southwest Missouri to explore the opportunities. Those interested are not only producers and processors, but also the area tourism and economic development leaders. A pilot study is under way in the nutrient dynamics of the Shoal Creek watershed to study inputs and outputs to maintain production and protect the water.

All participants want ways to protect the water in the free-flowing streams and rivers and large clear-water recreational lakes that are major income attractions.

The goal is to change the way of thinking. It's not a problem, but an opportunity.

MU FAPRI has a long history of providing economic forecasts. These are tailored to measure the impact of proposed changes in agricultural policy. Such analysis can prevent unintended consequences of enacting legislation.

Computerized environmental models have been added to the highly refined economic models at the request of U.S. Congress, says Abner Womack, FAPRI co-director. "Increasingly, when we present our projections, legislators ask not only what is the economic impact of this proposed policy, but also: "What is the environmental impact?"

the Connection

Low-phytate corn cuts phosphorus pollution potential

One quick way to cut phosphorus pollution in the state's surface waters is to reduce phosphorus at the source. Research under way at MU shows that feeding new low-phytate grain can reduce phosphorus content of animal manure.

Corn and soybeans now used in pig and poultry diets have high rates of phosphorus that are chemically bound to the grain, unavailable for digestion.

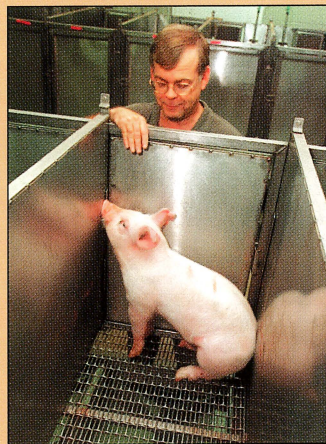
That phosphorus, tied up as phytate, not absorbed by the animal passes through the gut, undigested. That manure becomes a potential phosphorus pollutant.

To compensate for the indigestible phosphorus, pork producers add dicalcium phosphate to the diet. This helps the pigs, but overfeeding the inexpensive supplement increases phosphorus in the manure. There is considerable economic incentive to feed the supplement. There's little incentive to hold back.

A USDA researcher in Idaho discovered a mutant corn plant with grain naturally low in phytate, the indigestible phosphorus.

As hybrid corn seed companies rushed to develop new commercial varieties, using the low-phytate gene, Gary Allee, MU swine nutritionist, obtained grain from the first crop for pig feeding trials. He found the nutritional value of low-phytate corn is high, and the phosphorus content of the resulting animal waste is low.

The MU research indicates that phosphorus in low-phytate corn is five times as available as corn now grown. In their first report of results in the



Gary Allee, MU swine nutritionist

Journal of Animal Science in 2000, Allee and co-authors showed phosphorus excretion was reduced 37 percent.

They also noted that reducing phosphorus content, "makes swine manure more environmentally and economically suitable as a source of fertilizer."

These were not small feeding trials of a dozen pigs. The studies used thousands of head

on commercial farms. "We had sufficient numbers to be very confident of our data," Allee says.

The MU researchers are now studying low-phytate soybeans. "The low-phytate beans are coming," Allee says. So far, his studies show that by using both corn and soybeans with low phytate, the phosphorus excreted in poultry and pig manure can be reduced by 50 to 60 percent.

Eight feeding trials with pigs and poultry have been completed in little more than two years. The results have unexpected benefits. Pigs fed the low-phytate corn without dicalcium phosphate had greater body weight, better feed efficiency, and stronger bones than pigs fed corn with the supplement.

In another bonus, pigs on low-phytate diets had less backfat and a higher percentage of lean. Further studies will examine the improved digestibility of the amino acids.

"From a strictly economic perspective, there's a tendency to continue doing things the way we've always done them," Allee says. "But environmentally, we can't continue the way we were."

The research was funded by EPA grants to a six-state consortium.





Child's Play

Kids learn environmental lessons through water festivals.

Bob Broz says there's one central message in his gospel of promoting water quality: We all live in a watershed. "Getting people involved starts with framing the issue," says Broz, MU water quality program leader. "If people know what is facing them, they are better equipped to make decisions on a local level."

One way to promote healthy watersheds is to start that lesson in grade schools. Kids can make a difference, he says.

MU water quality extension faculty will conduct a series of children's water festivals, starting in 2002, aimed at teaching kids the importance of safe drinking water and a healthy environment.

"We plan to do at least five regional festivals starting next year, primarily for fourth graders," he says.

Locations are likely to include Springfield, Cape Girardeau, St. Joseph and Powell Gardens, which is located outside Kansas City. Other locations may be determined later.



photo by Robert Thomas

The festival project, partially funded by a grant from the Missouri Department of Natural Resources (DNR), will build on a foundation of local festivals that have been conducted by county-based University Outreach and Extension specialists and other cooperating agencies.

Before each children's festival, local teachers will receive lesson plans for their classes, says Patricia Koenigsfeld, recently named festival director.

"We want to show young people how actions in their community can impact the environment and their

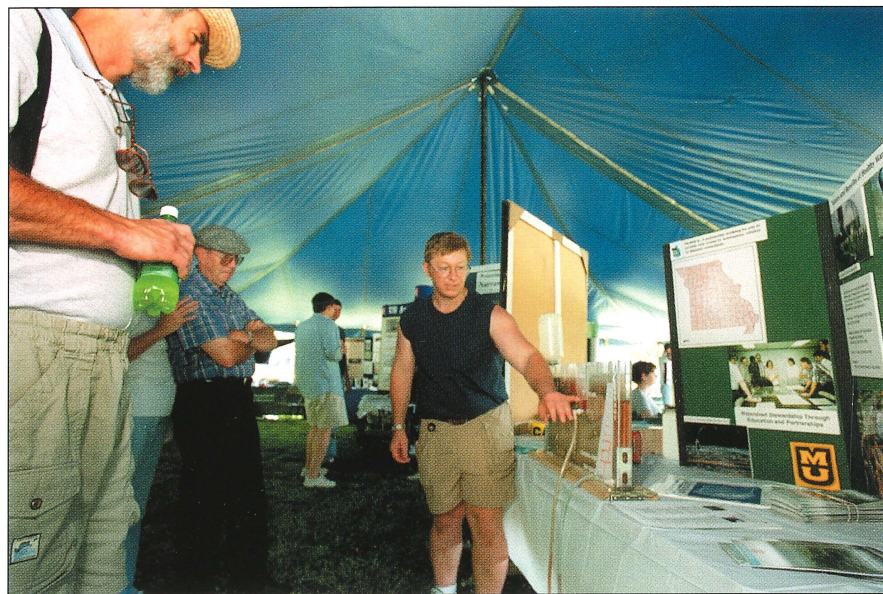


photo by Jim Curley

Above: MU water quality program leader Bob Broz, center, uses the Groundwater Flow Model to explain how water moves through the earth and where it gets stored.
Left: 7-year-old Ryan Calcutt, Columbia, Mo., studies the bubble he's created at the Missouri River Festival in Rocheport, Mo., while Patricia Koenigsfeld, MU water quality festival director, talks to his father.

'We want to show young people how actions in their community can impact the environment and their drinking water.'

Patricia Koenigsfeld, festival director

drinking water," she says. "We particularly want them to learn that their personal awareness and involvement can make a difference."

A typical regional festival will draw from 800 to 1,200 participants. Each festival will include hands-on demonstrations, group activities, and talks from invited speakers.

Logistics for the festivals include finding a facility, transportation and food, assigning presenters and coordinating with area schools, she says.

Community water festivals aimed at adults are also planned in conjunction with some of the children's festivals. The idea is to promote home-based safe environmental practices.

"Getting responsible local citizens involved is the key in decision making

pertaining to sound watershed management," says Broz.

"Education and cooperation on such things as on-site waste disposal or best farming practices to reduce pesticide runoff are better approaches in the long run than regulatory agencies coming in and telling people what to do," he says. He points to extension working directly with communities such as Macon, Smithville, Shelbina and Vandalia in forming locally led watershed alliances.

Vandalia last year received the governor's Pollution Prevention Award for reducing agricultural nonpoint runoff. Shelbina was awarded a grant to evaluate water quality concerns and develop an action plan.

Story by Robert Thomas

Anatomy of a Watershed

Swimmers and boaters ply the waters at the south end of Long Branch Lake, site of a Missouri state park and the source of safe drinking water for the city of Macon. To a casual observer, the lake appears clean and safe.

But Long Branch Lake presents some water quality concerns, and the origins as well as their solutions lie far upstream.

The lake is fed by two streams, the Little Chariton River and Long Branch Creek, that meander through southern Adair County, then widen and join as they reach northern Macon County, carrying with them tons of topsoil and other agricultural runoff. Hundreds of

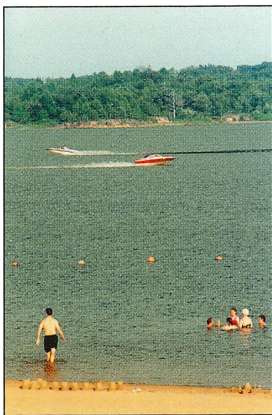
septic tanks empty their untreated contents into the lake. Some heavy metals and other contaminants pollute it, and many native fish cannot survive in its murky water.

"Long Branch is a typical northern Missouri lake," says Bill Kurtz, MU professor of natural resources and director of the Missouri Watershed Initiative. "The water quality is acceptable, and we're trying to protect what's there. On the other hand, it's a fairly complex situation in regard to the high number of identified pollutants. We have to identify the sources of pollutants, then develop ways to reduce them to an acceptable level or eliminate them altogether."

Kurtz heads a pilot project that focuses on Long Branch watershed, the basin surrounding the lake. Water quality originates in this area, because whatever happens in the watershed ultimately affects the lake. The project, begun in 1998, has proved to be an ideal intermingling of scientific research, Outreach and Extension efforts and local citizen input.

"Scientists from different disciplines bring their combined knowledge to bear on a specific watershed," Kurtz says. "We're providing science-based information to help the public and community leaders make decisions about water quality."

Fisheries biologists, water quality specialists, biochemists, agronomists, pathobiologists, economists and regional



Story by Forrest Rose
Photos by Jim Curley





Left: Bruce Lane, University Outreach and Extension livestock specialist, talks to visitors at the Greenley Farm Field Day, Novelty, Mo., about ways to protect streambeds in cattle grazing areas.

Below: The upper reaches of Long Branch Lake offer scenic views but also contain heavy metals and other contaminants. The University is studying the Long Branch watershed, the basin surrounding the lake, in a pilot project aimed at monitoring and improving water quality.

extension specialists have teamed up to provide a comprehensive profile of the entire watershed and to examine its economic impacts and public health implications.

"Our goal is tangible results for the citizens of Missouri," Kurtz says. "I'm amazed by how involved the local communities have been throughout the entire process. We've had input from everyone from Boy Scouts to farmers and merchants. It's what you'd expect when you're stressing a voluntary

approach that stands to benefit all parties." The MU Food and Agricultural Policy Research Institute (FAPRI) determined that gully and streambank erosion accounted for more than 69,000 tons of sediment in the watershed, nearly half of which ends up in Long Branch Lake.

FAPRI researchers found that much of the erosion could be eliminated through grade stabilization structures, grass waterways and the grading and mulching of construction sites, road banks and ditches.

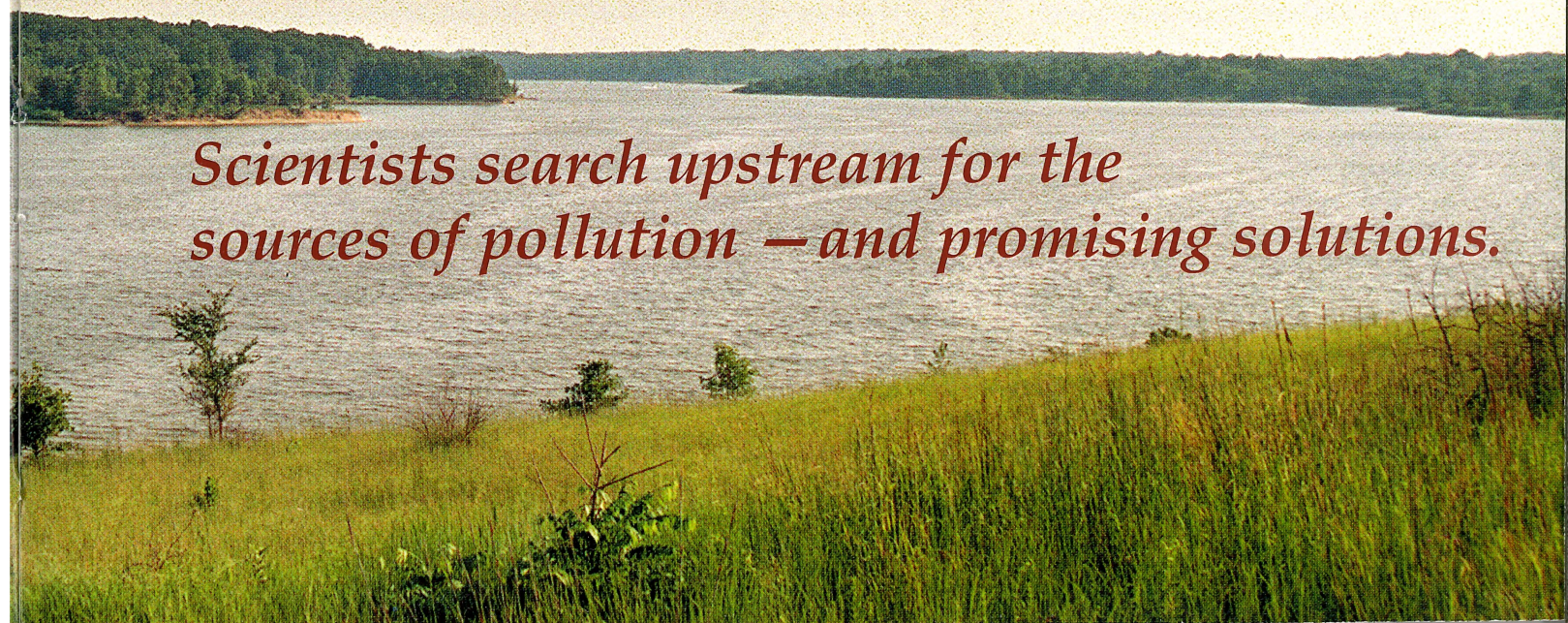
Doug Noltie and Christopher Riggert of the MU School of Natural Resources surveyed the fish in Long Branch Lake and found a dozen different species. Most, they noted, "are able to adapt to low dissolved oxygen, high temperatures, high turbidity and sediment loads." The conditions are most likely explained by the high proportion of row crops in the watershed, they concluded.

Kurtz says that study provoked high interest among the local citizens. "People were concerned about how these practices affect the fish species. When we surveyed for the invertebrates, we found people were really interested in that, too. A lot of the response we've gotten is, 'Now that you're measuring, I can see how that affects water quality.'"

MU veterinary pathologist Andy Carson used DNA analysis to trace pol-

— continued on page 12

Scientists search upstream for the sources of pollution — and promising solutions.





MU Outreach and Extension specialists are studying ways to minimize the impact of agricultural practices along the northern edge of Long Branch Lake.

lution sources, Kurtz says. "He was able to show them: 'This is from horses, this is from cattle, this is human effluent.' It makes water quality really personal; this is what they're drinking."

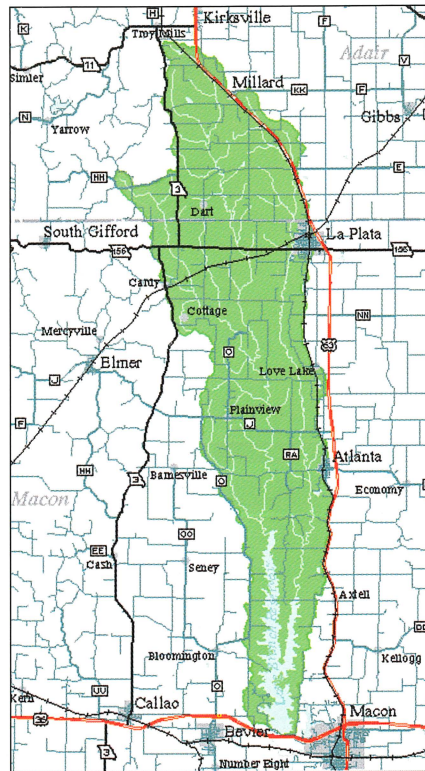
Jack Jones, Gray Henderson, Ranjith Udawatta and David Hammer of the MU School of Natural Resources examined eight sub-watersheds in the area to determine whether tree corridors could decrease agricultural runoff. They found that forested watersheds had 60 percent less sediment runoff discharge than the row-cropped areas.

Extension livestock specialist Bruce Lane is conducting trials to see whether cattle will drink from strategically placed water tanks instead of streambeds, which would minimize bank destabilization and off-site movement of livestock waste.

"We're trying to lure the cattle away from the streams," he told a group of northern Missouri livestock producers.

"This could be a pragmatic alternative to just fencing off the streams, which is just not practical for some folks."

Kurtz says the local steering group saw and understood the problems. Johanna Reed Adams, community development leadership specialist with University Outreach and Extension,



The Long Branch watershed covers 66,537 acres in northeast Missouri and extends from Kirksville to Macon.

facilitated early meetings to identify and describe water quality issues.

"The local group is interested in developing practical, workable solutions," Kurtz says. "They recognize that this is predominantly an agricul-

tural area, so any suggestion has to be welcome."

Steve Anderson and Pieter Los of the MU water quality program are experimenting with barriers of stiff-stemmed vegetative grasses along fields and stream banks. Los says the practice results in between 20 and 70 percent less soil loss. He, too, is impressed with enthusiasm of local producers. "Farmers have actually been coming up to me and asking whether I can help."

The MU Community Policy Analysis Center (CPAC) provided a baseline showing the likely growth of the area's population over the next 10 years. MU Parks, Recreation and Tourism conducted a visitor study of Long Branch Lake.

"Without this tourism industry, those counties would lose approximately \$3 million in retail sales," says Morgan Mundell of CPAC. Kurtz says the project has raised local awareness of the watershed ecosystem and the many factors that affect it. "People want to know not only what's in the water, but where it came from," he says.

"Now, they see somebody's field washed out, or a county gravel road after a big rain, and they know how that can affect their drinking water supply. They really start to pay attention to things like that."

The Missouri Watershed Initiative is funded by University Outreach and Extension through mission enhancement funds and the MU College of Agriculture, Food and Natural Resources, plus an Environmental Protection Agency grant to FAPRI.

The group is now working with public officials and community leaders in southwest Missouri, helping them address concerns about poultry manure and phosphorus.

Plans are also in the works for a Watershed Science and Stewardship Center at MU.

A Flood of Knowledge

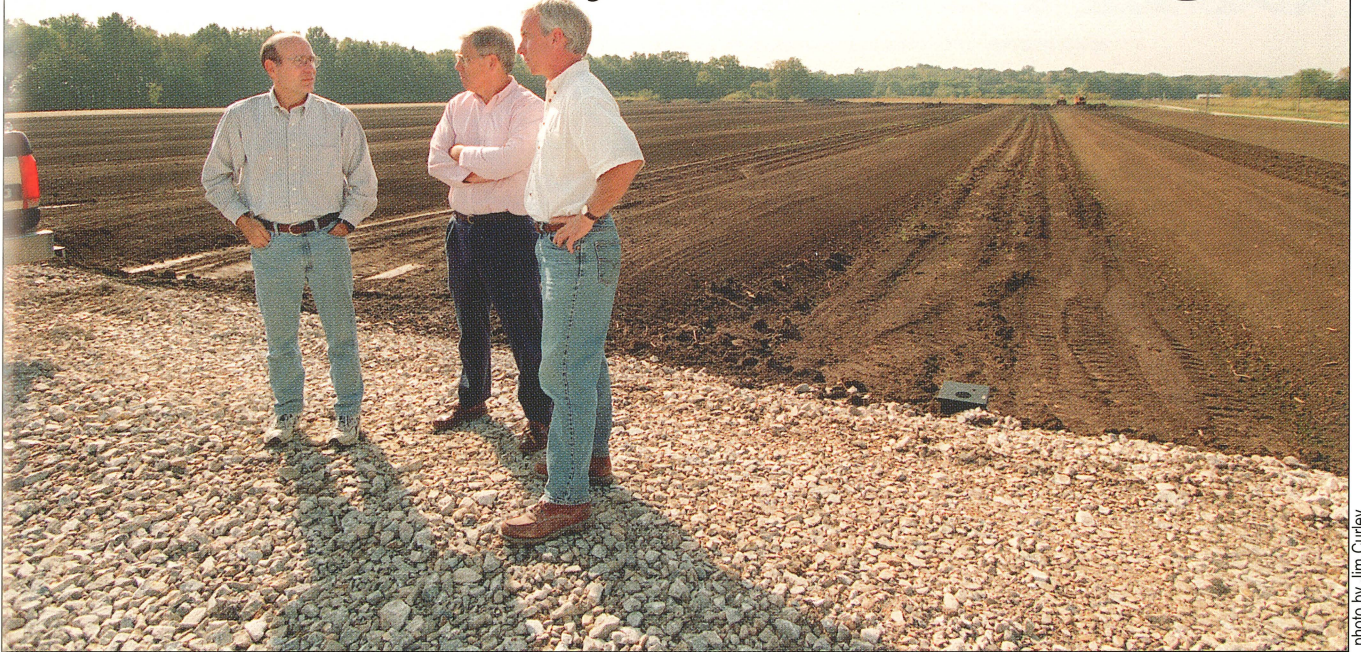


photo by Jim Curley

From left, Bob McGraw, Gene Garrett and John Shopland survey the site of the outdoor field laboratory at HARC, where McGraw is testing how plants stand up to repeated flooding. The experiment is one of many at the center that focus on vegetative buffers and other responsible management techniques.

At the Horticulture and Agroforestry Research Center, MU researchers are developing agricultural practices that are profitable and environmentally friendly.

At the MU Horticulture and Agroforestry Research Center near New Franklin, Mo., ongoing research projects hold the potential to help agricultural producers engage in profitable and environmentally friendly management practices. Much of the research, summarized below, is funded through a six-year \$12 million grant from the Environmental Protection Agency.

■ **On highly erodible soils** on sloping grades, agroforestry professor Gene Garrett has planted trees, shrubs and grasses in rows along the contour. The plants catch and impede soil and debris moving down the surface after rainfall events. The accumulations form low terraces behind the tree rows. Bio-terracing creates buffers that prevent topsoil and agricultural waste from washing directly into streams, lakes and rivers.

■ **Garrett and other MU researchers** have also established a riparian forest

buffer along a segment of Sulphur Creek. The buffer offers a demonstration of riparian strip design, and it also serves a more practical purpose.

Located down the slope from a HARC silvopastoral study area, the buffer will protect the creek from nutrient contamination from grazing livestock. MU animal scientist Monty Kerley is studying the efficacy of riparian buffers in filtering nitrates and phosphates from adjacent livestock fields, comparing results with forested buffers, grassy buffers and no buffers.

■ **Along with Milon George** and Chung-Ho Lin, Garrett is studying various grass species' ability to absorb or degrade agricultural chemicals, a process known as bioremediation. Nonpoint source pollution is perhaps the biggest contributor to water pollution, and because of its scattered origins is among the hardest types of pollution

to deal with. Grasses that can tolerate commercial herbicides and render them harmless through bioremediation could serve admirably in buffer strips along streams and lakes and in grassy waterways between fields.

■ **With a newly constructed** outdoor field laboratory in the Sulphur Creek bottoms, agronomist Bob McGraw is testing how herbaceous and woody perennial plants stand up to repeated flooding. Twelve parallel channels in the bottoms are fed by a pumping system from an adjacent reservoir.

The frequency, timing, flow and duration of flooding can be controlled for each individual channel. The knowledge of how different plants react to flood situations is needed to decide which species are best for cover crops, forage crops and vegetative buffers in a floodplain.

by Forrest Rose

CARES Maps

Missouri's Future

Maps. They've helped guide mankind's decisions since some anonymous cave wall painter first drew directions to the best hunting spot.

Today, technology is enabling the once-simple map to guide land development, protect fragile habitats and public water supplies and track land use trends. At the forefront of this information collection and management is the Center for Agricultural, Resource and Environmental Systems, headquartered on the MU campus.

Want to look at land development trends, superimpose that over public drinking water supplies, and contrast with the best habitat for the bobwhite quail? CARES can do that.

How about pinpointing concentrations of older adults, and contrasting that with locations of damaged rural bridges enroute to closest area medical facilities? With the right data, CARES could do that, too.

"Basically, we help people make smarter decisions," says Chris Fulcher, CARES co-director and one of its founders. The center, started in 1992, has become nationally and internationally recognized for its ability to collect, catalog and manipulate terabytes of geographic information into formats for environmentally smart planning.

At the heart of CARES projects is the science of geographic information systems, or GIS. The computer-based technology enables CARES specialists

to take geographic details—soil type, the elevation of a hill, species of trees around a particular lake—and record that information in computer databases that can later be turned into accurate maps, and mixed and merged into visuals.

"Before GIS, decision makers often pored over pages of text from an environmental impact study before deciding on where to best site projects such as a sewage treatment plant," Fulcher says.

"Even with such studies, it's often difficult for policy makers to take text and numbers and mentally envision the full impact of their decisions.

"We turn those numbers into something people can visualize," Fulcher says.

'... it's often difficult for policy makers to take text and numbers and mentally envision the full impact of their decisions. We turn those numbers into something people can visualize.'

— Chris Fulcher, CARES

"You see how close the creek is to a development, or where drinking water supplies may sit in relation to a potential pollution source." CARES has also become expert in developing interactive web sites and mapping

*Center for
Agricultural,
Resource and
Environmental
Systems provides
tools for smarter
decision making.*

resources. These allow users to play "what if" games, and see the impact of changes in the landscape.

The Center's most international project to-date, with Global Forest Watch, is an interactive web site containing quickly updatable information on the forests in several forest-rich countries, including Canada, Venezuela, Cameroon and Indonesia. The site was created with funding from GFW and World Resources Institute.

The web site combines satellite data and from-the-field information to track changes in forested areas. Cyber visitors can log on, pick a country, and in real-time observe changes in forestation due to logging and development. The interactive forest maps also show which company is logging in a particular spot there and other details about that forest.

"Interactive web sites are a big part of what CARES does," says Chris Barnett, associate director and one of the Center's principal investigators. A

good example is the CARES site itself.

"We designed it so that anyone can log onto the site, visit our map room and make use of the data we've collected through our various research projects," Barnett says.

For example, users can create their own informational map by selecting from a long list of geographic, census and other statistical data. One mouse click then creates a map that can be viewed online, downloaded or printed.

Much of the data contained in the map room is gathered while working with government agencies and other entities to record and map critical environmental information. The Center is currently involved in several projects that will help Missouri agencies monitor public drinking water and other water resources in the state.

"Federal drinking water standards mandate that states accurately assess contamination levels in public drinking water supplies, and assess potential contamination sources within the watershed of surface water sources or within the recharge area of a public well," says Don Scott, environmental engineer with the Missouri Public Drinking Water Program at the Missouri Department of Natural Resources. "We were very fortunate in Missouri to have CARES to help us pull that information together."

In an early collaborative project, CARES data managers helped PDW reduce the num-

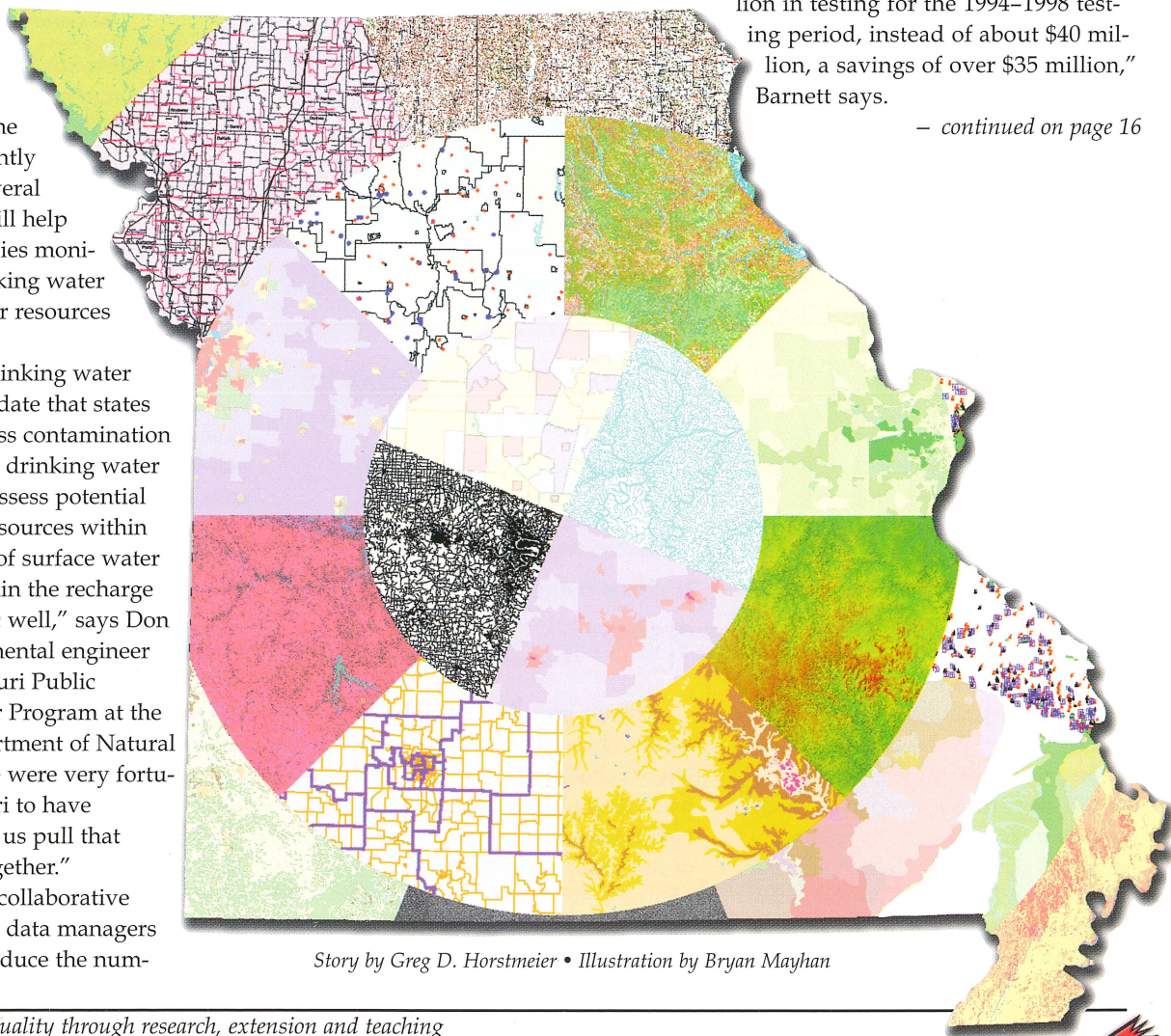
ber of drinking water sources tested for contaminants.

"Some public drinking water sources are more prone to contamination than others," Scott explains. Water supplies near an industrial area, or within a watershed with high use of fertilizers or pesticides, are more likely to have some level of contamination. The tricky question was, which watersheds had high enough potential to be tested, and which, given the surrounding area, were probably clean. Separating the two would save the state millions in unnecessary water tests.

CARES first compiled databases containing information on potential sources of contamination, such as places where a particular chemical is stored or manufactured. At the same time, CARES worked with Public Drinking Water Program staff to map all the water sources in the State. CARES GIS specialists then created threshold scenarios that distinguished between potentially contaminated water supplies and those most likely not to be contaminated.

"The Public Drinking Water Program had to spend about \$4.7 million in testing for the 1994-1998 testing period, instead of about \$40 million, a savings of over \$35 million," Barnett says.

— continued on page 16



Story by Greg D. Horstmeier • Illustration by Bryan Mayhan



photo by Jim Curley

CARES personnel demonstrate the GIS capabilities of the mapping room at the official launching of their web site. This interactive technology enables CARES specialists, and the general public, to enter geographic variables into computer databases that then generate accurate maps.

A related project is the current Source Water Inventory Project, which is answering an Environmental Protection Agency mandate that each state has a thorough inventory of potential water contamination sources.

"The state usually has a record of big potential contaminators—things such as factories or electricity generation plants," Barnett says.

"What EPA wants, though, is as complete a list as possible of all sources that could potentially impact a source of drinking water—gas station tanks, paint stores, veterinary clinics. Those things typically aren't on any existing maps."

A CARES crew is visiting every known public drinking water well and listing all such potential contamination sources within one-half mile of the well. That information will go into a GIS database.

Being a university-based center, CARES also gets involved in researching new theories as well as helping others record existing items. One team of CARES researchers is now examining the impact that small, woody draws have in the natural landscape.

"Woody draws, in nature, are what take surface runoff water from a storm and guide it to streams," Fulcher says.

"Over the years, man has taken a lot of the woody draws in Missouri and cleaned out the trees and vegetation. Total area of woody draws in the state has been substantially reduced," he says.

A CARES crew is visiting every known public drinking water well and listing all potential contamination sources within one-half mile of the well.

There's little interest in saving these draws, he adds, because little is known about what positive effects they have. So CARES is first creating a GIS-based procedure for identifying woody draws from existing maps and aerial photographs. Researchers will next focus in one such system of draws in the Long Branch Lake watershed near

La Plata, Mo., to study the water and erosion that comes through storm runoff water. They will also factor in crop yields or other benefits gained from once-woody draws that have been bulldozed into farmland or other uses. One of the major research objectives is to determine how to make productive (and profitable) use of woody draws without removing the woody cover. One alternative is to plant species of trees, such as curly willows, or shrubs that can be harvested at regular intervals for sale. Curly willows are a fast growing species that are used in the crafts industry.

CARES researchers hope to develop a computer-based modeling program that will show the economic and environmental impact of altering a current woody draw.

"As with other projects we're involved in, we hope this one will help the public look at the total costs and benefits of altering the environment," Fulcher says.

"With that kind of information, society can make decisions in an informed way that was never possible before."



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