Filtering Farm

NATIONAL AGROFORESTRY CENTER

Pollution

The usefulness — and relevance — of riparian buffers

By Peter Carrels

Jerry Kiihl

Rain is falling steadily on a cool, spring morning as Jerry Kiihl (pronounced Keel) and I tour his farm in northeast South Dakota. It's a busy time for Kiihl, with 1,200 acres to plant, protect, and grow. Spend time with him, and you quickly learn that Jerry Kiihl is a capable multitasker. He's mastered much of the sophisticated technology used to run his agricultural operation. Kiihl uses GPS and computer-assisted programs to apply seed, fertilizers, and other chemicals to his land — technology he calls "precision agriculture." He has four irrigation systems to operate and maintain and several compact tile drain networks placed in strategic locations. He also has a small herd of beef cattle.

Having his work plans derailed by welcome precipitation gives Kiihl an opportunity to show me the riparian buffers he planted and maintains along the Big Sioux River. At the mouth of Stray Horse Creek, where the Big Sioux slices into a steep hillside, the channel is partially shaded by dense stands of willow. One hundred fifty feet wide, some of the buffers in this reach are wooded, some have survived as prairie, and some have been restored to grass.

On that gray, damp morning, we gazed across the land from a bluff. Stretching to the horizon were freshly planted croplands glowing black and wet. Alongside the river, buffer strips glistened green, their perennial vegetation already lush and vibrant. "I've got 75 acres of grass buffers bordering a mile of the Big Sioux," said Kiihl. "I like the wildlife habitat buffers provide. They also protect the river."

Kiihl is paid to maintain these riparian buffers through an easement program, and he even converted a small area of corn to a grassy buffer as part of his easement. He confessed that having buffers on his land is something he'd probably do regardless of payments. "More farmers should be using

them along rivers and streams," Kiihl urged. That's because farm fields can be significant contributors to water pollution.

Polluting the Big Sioux

The Big Sioux River flows south through the prairie hills of eastern South Dakota, then forms the boundary separating southeastern South Dakota and northwestern Iowa before emptying into the Missouri River near Sioux City, Iowa. With a channel stretching 421 miles, the river's expansive watershed includes 9,570 square miles in South Dakota, Minnesota, and Iowa.

When the Big Sioux flows past Kiihl's riparian buffers, it is still a young stream, only 45 miles downriver from its humble headwaters in a series of marshy, prairie potholes. Much of the river's shoreline in this upper section lacks timber or other woody vegetation, which entices farmers to cultivate grain near the channel's edge. That's one of the reasons Kiihl's buffers — and the riparian buffers of his neighbors — are vital. Another reason is that there are a lot of people downstream, and many of them rely on the Big Sioux, including as a source of drinking water.

The top half of the river's watershed was primarily ranch and dairy country just 30 years ago, but the popularity of corn ethanol and high grain prices compelled many landowners to switch farming practices from perennial grasslands requiring no inputs to grain fields regularly doused with synthetic fertilizers and other chemicals.

Agriculture is not the only source of pollution along the Big Sioux River. Three of South Dakota's five largest cities (Watertown, Brookings, and Sioux Falls) are located on the Big Sioux. Sioux Falls, the state's largest city by far, contributes effluent from meatpacking and other industries, municipal wastewater, and residential runoff into the river. However, farming and its non-point pollution sources loom front and center as a widespread concern to river watchers.

Although pollution in the Big Sioux is not breaking news, residents were startled out of complacency in 2012 when the advocacy group Environment America declared the Big Sioux River the 13th dirtiest river in the nation. E. coli, fecal coliform, and suspended solids were the primary culprits. These problems were mostly traced to livestock operations along the river and its tributaries. In the lower reaches of the river, people were told to avoid contact with the water. That was hard to do, considering the river was and remains a popular recreation attraction. Two years later, the Minnesota Pollution Control Agency added to the public's concerns when it warned that nitrate and phosphorus levels in Big Sioux tributaries were troublingly high and biological communities in the lower watershed were stressed.

The news didn't surprise Jay Gilbertson, manager of the East Dakota Water Development District, a regional water agency based in Brookings. Gilbertson has been studying the river for years — and warning about its future if farm runoff and agrochemicals continued to move unchecked into the river and its tributaries. After Environment America's grim assessment, Gilbertson stated in an interview that "the river we have today is a reflection of how we use the land in eastern South Dakota. We live in an agricultural state. Sioux Falls is here, but the rest of South Dakota, and huge parts of the Big Sioux river basin, are farm ground, ranches, and pasture." Although Gilbertson pointed blame at rural and urban sources of pollution, his unvarnished observations about agriculture's impacts disturbed some farmers. Suddenly, the worrisome condition of the Big Sioux was linked to specific pollution sources. But this also offered a potential — though not comprehensive — solution.

Row crops planted all the way to the shoreline can damage water quality.

PETER CARRELS; EAST DAKOTA WATER DEVELOPMENT DISTRICT

Renewed Interest in Riparian Buffers

As the grain-growing boom spreads into the Great Plains, conservation organizations have watched with alarm as native grasslands are plowed under and prairie wetlands drained at a breakneck pace. Conservationists are also concerned that the integrity of water in lakes, rivers, and streams has become increasingly compromised by chemicals and eroding topsoil associated with ever-intensifying industrial agriculture.

Financial pressures and opportunities have also prompted many grain growers to plant crops to the edges of wetlands and waterways. That has renewed interest among conservationists in promoting riparian buffers as a means to protect rivers and lakes from farm pollution.

Riparian buffers — also called filter strips — are vegetated boundaries composed of perennial grasses or woody plants that physically separate cropland from waterways. The primary functions of these buffers are to:

- Reduce the speed of water running off fields toward waterways
- Trap and filter sediment and chemicals carried by runoff
- Prevent pollution from reaching water resources

Width is a factor. Narrow buffers are less effective filters than wider ones. Fifty-foot buffers are considered good; less than 50 feet, not so much. Jerry Kiihl's broad 150-foot buffers are deemed exemplary.

AGRICULTURE'S CAUTIONARY TRENDS

The increasing amounts of land devoted to grain farming in South Dakota and elsewhere on the western edges of the Corn Belt present formidable obstacles to those trying to protect water and land resources.

Corn acres in South Dakota increased from 3.1 million acres in 2002 to 5.4 million acres in 2015. Soybean acres throughout the state expanded from 2.1 to 5.1 million acres during the same time frame. Much of the land accommodating this surge in row crop agriculture was formerly prairie and pasture. This transformation affects natural drainage patterns and soil absorption capabilities and causes increased runoff and erosion. Conventional grain farming also relies on chemical applications, including nitrate fertilizers. It is expensive to clean river water of nitrate contamination, and hypoxia at the mouths of major rivers — caused in great part by fertilizer runoff — is a growing menace to aquatic ecosystems.

The market share of single-nutrient fertilizers (nitrogen only, for example) with high nutrient concentrations increased from 2 percent in 1960 to 22 percent in 2011. The use of nitrate fertilizers also rose 500 percent between 1960 and 2012.

Fertilizer manufacturers are expanding their production facilities, demonstrating confidence that grain farmers will continue this increased usage of nitrogen-based fertilizers. CF Industries, one of the world's largest fertilizer producers, recently tripled capacity at its Port Neal fertilizer plant 20 miles south from where the Big Sioux River empties into the Missouri River. That plant produces ammonia (a building block for nitrogen fertilizer) and granular urea (a solid nitrogen fertilizer). The $2 billion expansion was completed in 2016, and fertilizer production could reach 850,000 tons of nitrogen products per year. The expansion included construction of the largest granular urea warehouse in North America: 210 feet wide and 1,700 feet long. Conservationists point out that the revised pollution discharge permit issued to the Port Neal facility allows for the release of more than one million pounds of ammonia nitrate each year into the Missouri River.

One takeaway from this is that water quality problems related to synthetic fertilizers begin long before a farmer applies these products to the land.

Researchers have verified that grassy buffers most effectively trap particulate pollutants such as eroded soils. One study prepared for the U.S. Department of Agriculture identified the sediment-trapping capabilities of buffers as ranging from 41 percent to 100 percent, depending on the width of the buffer. In fact, the original purpose of buffers was to prevent soil sediment from reaching surface waters, which could diminish channel and pond capacities and smother wildlife habitat. Soil sediment in runoff can also transport animal waste, excess nutrients, pesticides, petroleum products, metals, and other compounds.

Buffers also decrease problems associated with soluble pollutants — ones that dissolve in water, such as nitrogen and phosphorus — moving from cropland to surface waters. Deeper-rooted buffers, such as dense perennial grasses and brushy or woody buffers, can filter pollution moving below the surface toward a river or body of water. This type of buffer can be especially useful in trapping nitrates, which are typically carried in water below the surface.

Riparian buffers also provide food and habitat for an array of wildlife — mammals, birds, reptiles, and amphibians. Contiguous buffers, stretching long distances along waterways, can serve as safe travel corridors for wildlife.

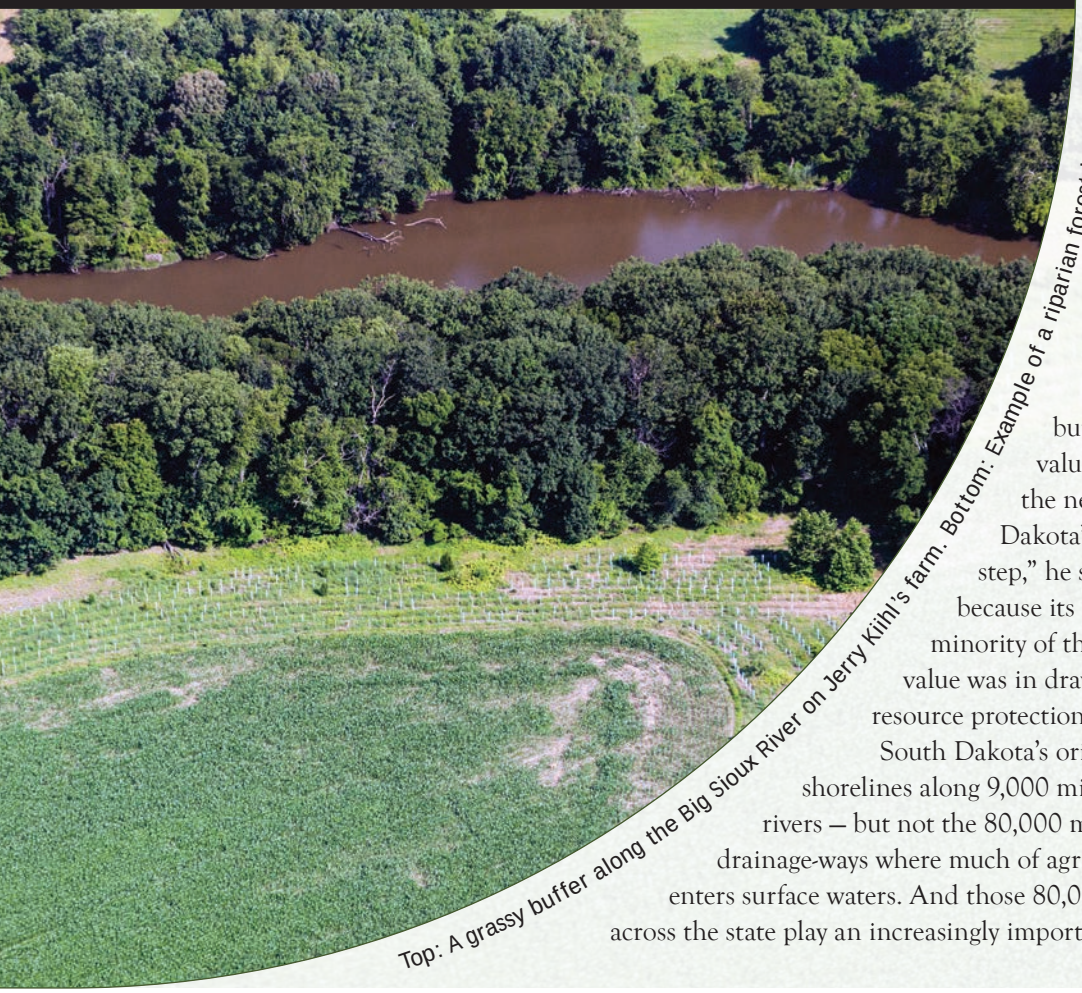
A variety of programs at the national, state, and local levels can help farmers install and maintain buffer strips.

Investing in Buffers

Soon after public awareness about the Big Sioux River's pollution problems escalated, Jay Gilbertson began conducting comprehensive water quality sampling, led efforts to reduce animal-related pollution into the river, and worked with partner groups to reduce other types of pollution. One of those partners was the Northern Prairies Land Trust (NPLT), a nonprofit outfit led by John Davidson, an environmental advocate and emeritus law professor at the University of South Dakota.

John Davidson

PHOTODISC; THOMAS HATZENBUHER



Top: A grassy buffer along the Big Sioux River on Jerry Kiihl's farm. Bottom: Example of a riparian forest buffer.

NPLT's mission is to conserve grassland ecosystems in South Dakota and Nebraska. The organization received a series of grants through the North American Wetlands Conservation Act and invested in strategies that create protections for wetlands and surface waters, including a riparian buffer project to protect the Big Sioux's shorelines and water quality. Some 30 landowners and more than 625 acres of buffer strips are now enrolled in an easement program. Jerry Kiihl was one of the first farmers to join the NPLT buffer program.

According to Davidson, riparian buffers are but a single element in a larger effort. "The goal is to restore fouled watersheds," Davidson explained. "Buffer strips are a practical first step in an incremental program. It is also necessary to protect wetlands, control farm field drainage, and change suburban and urban land use practices."

The momentum surrounding buffer strip development in South Dakota got a boost in 2017 when the state legislature passed a plan offering incentives for landowners to create buffers along some of the state's rivers and large streams. The incentive is reduced property taxes on land containing buffers.

Davidson celebrated passage of the buffer strip measure but believes its value is mostly symbolic in highlighting the need for buffer strips. "South Dakota's buffer law was a very modest first step," he said. "Because it is voluntary, and because its applications were limited to a small minority of the state's watercourses, its principal value was in drawing attention to water quality and resource protection issues."

South Dakota's original buffer measure targeted shorelines along 9,000 miles of identified streams and rivers — but not the 80,000 miles of small streams and grassy drainage-ways where much of agriculture's polluted runoff initially enters surface waters. And those 80,000 miles of small waterways spread across the state play an increasingly important role in agriculture's impact on

water resources. "In South Dakota, we're seeing an intensification of agriculture," Davidson explained. "What were once viewed as farm fields are now treated like factory fields."

First year results of South Dakota's buffer incentive program were disappointing. Only 22 parcels containing 249 acres of land have been enrolled in the program. Most of that interest — almost 75 percent — came from counties along the Big Sioux River. Buffer supporters say the incentive (about $30 per acre) is inadequate and must increase if the program is to achieve a meaningful impact. The 2018 South Dakota legislature improved the buffer bill by allowing county commissions to add additional waterways and lakes to the list of buffer locations eligible for tax relief.

Jay Gilbertson's water monitoring indicates that the Big Sioux has not yet experienced the high levels of nitrates plaguing rivers in Iowa and other Corn Belt states. But testing has revealed worrisome nitrate levels in tributaries flowing from Iowa and Minnesota into the Big Sioux and in the river's lower reaches near its confluence with the Missouri River. Other tests show that the aquifer underlying the Big Sioux River — and hydrologically connected to it — has marginally high nitrate concentrations.

"Right now," said Gilbertson, "nitrate levels in the Big Sioux are manageable. But if commodity prices get stronger, the incentive to install more drain tiles will be greater." Drain tiles present a different water quality threat.

Tile Drain Challenges

Traditional buffer strips are ineffective in reducing runoff and pollutants emanating from tile drains because the drains pass beneath and through the root zones of riparian buffers. No matter how widespread buffers become, tile drain systems will still outlet farm chemicals directly into nearby waterways. Because tile drainage systems and their outlets into rivers and streams are not designated as "point source" pollution, they are not governed by the Clean Water Act, leaving surface waters vulnerable to pollution discharges from these sources.

But agricultural scientists and researchers are making headway with treatments that defend waterways from drain tile flows. One effective approach, called "saturated buffers," allows farmers to circulate drain tile runoff in the subsurface soil and root zones of riparian buffers before it reaches a river or stream. A critical component of saturated buffer systems is a perforated tile distribution line that runs parallel to a waterway and lies beneath an existing riparian buffer. Drain tile moisture and chemicals from farm fields are released from this underground line and are trapped by soils and absorbed by plant roots, reducing migration of the chemicals into surface waters. Saturated buffers can be incorporated into existing buffers or installed when a new buffer is implemented.

A tile drain that outlets into the Big Sioux River.

WILL PARSON, CHESAPEAKE BAY PROGRAM; STEVEN DAHLMEIER; PETER CARRELS

BUFFER STRIPS IN OTHER STATES

Several other states have implemented buffer strip initiatives, including a voluntary program in Nebraska. The Nebraska Department of Agriculture administers a Buffer Strip Incentive Fund, using fees assessed on registered pesticides to help landowners install buffer strips on cropland adjacent to perennial and seasonal streams, ponds, and wetlands. Two kinds of buffer strips are eligible: filter strips of grass (20 foot minimum width) and riparian forest buffer strips with trees and grass (55 foot minimum width). "Rental rates" for buffer strips (annual payments for enrolled land) vary based on whether the cropland is irrigated or not.

Minnesota, on the other hand, passed an ambitious buffer strip law in 2015 that requires 50-foot perennial vegetation buffers along all public waters (lakes, rivers, streams, and wetlands) and 16.5-foot buffers along public drainage systems (ditches). Private ditches are exempt. Landowners can install alternatives to buffer strips as long as the alternative offers equivalent water quality benefits. The Minnesota Board of Water and Soil Resources created a cost-sharing program to cover up to 75 percent of landowners' expenses. —DM

A buffer strip in Iowa.

An additional challenge is that it's difficult to know where saturated buffers are needed because it's just about impossible to track where drain tile systems have been installed. Fifty of South Dakota's 66 counties do not monitor or require permits for drain tile installations. Only two counties in the Big Sioux watershed — about 20 percent of the river basin — participate in some level of drain tile regulation or registration. "There hasn't been much of an effort to monitor drain tile projects or to identify where the systems outlet their runoff," Gilbertson said. This lack of knowledge hobbles efforts to manage and limit water pollution from these artificial drainage systems, making education and outreach even more critical.

The Future of Buffer Strips

John Davidson's assertion that South Dakota's riparian buffer law is primarily useful as a public awareness tool could portend unprecedented and welcome attention to issues related to agricultural pollution and water quality. Jerry Kiihl, John Davidson, and Jay Gilbertson are already working together to prevent degradation of the Big Sioux River. That's a welcome start.

"We're in a potential prevention stage right now," said a hopeful Gilbertson. "Folks in the state are paying closer attention to nitrates, phosphorus, and other farm chemicals. We have an excellent opportunity to adjust agricultural systems to provide for better water quality protections. That includes promoting — and actually using — buffers."

Peter Carrels writes about agricultural, environmental, and ecological issues from Sioux Falls, South Dakota. His essay, "Grassroots Movement for Grass and Roots," profiles an emerging, growing movement of eco-progressive, large-scale farmers on the Northern Plains. That essay appears in the book, Conservation on the Northern Plains: New Perspectives, *published by the Center for Western Studies.*

LEAGUE ADVOCATES FOR BUFFER STRIPS IN NEW FARM BILL

The League is working to address polluted waters by expanding federal and state programs that help farmers and ranchers become better stewards of their land. As Congress writes a 2018 Farm Bill, the League is pressing lawmakers to:

- Expand the Conservation Reserve Program, which pays farmers to take marginal cropland out of production and plant grasses or trees, and to increase the use of the program for high-value practices like buffer strips that protect streams and wetlands from runoff.
- Increase funding for the Agricultural Conservation Easement Program, which funds conservation easements that protect wetlands and native prairies from development.
- Protect long-standing "Swampbuster" and "Sodbuster" policies, which forbid farmers who collect commodity program payments or crop insurance subsidies from draining or filling wetlands, and require that they put in place soil conservation plans for highly erodible soil.
- Focus conservation programs on building soil health by helping farmers plant cover crops, use more diverse crop rotations, better manage livestock on grasslands, and eliminate soil tillage, all of which should reduce runoff from fields and pastures.

For more on the League's work to protect water quality and improve soil health through the Farm Bill, visit *iwla.org/agriculture.* — DH

JASON JOHNSON