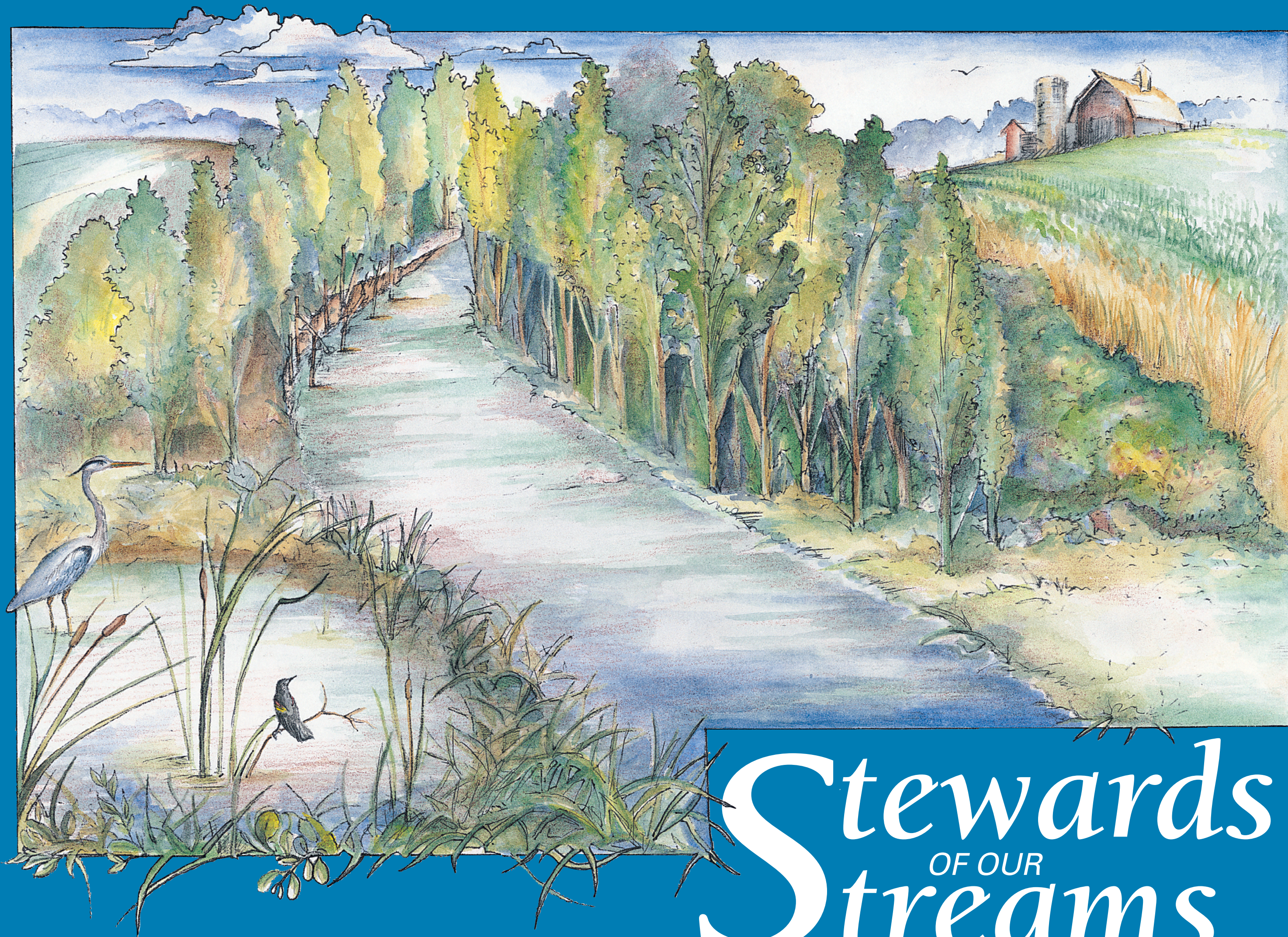

Stewards OF OUR Streams

Riparian Buffer Systems

Streams lined with tress, shrubs, grasses, and abundant wildlife contribute to more than a beautiful landscape. Restoration of the land's natural riparian buffer system can improve water quality, prevent soil erosion, and build diversity that has been lost with modern land uses.

IOWA STATE UNIVERSITY
Extension and Outreach

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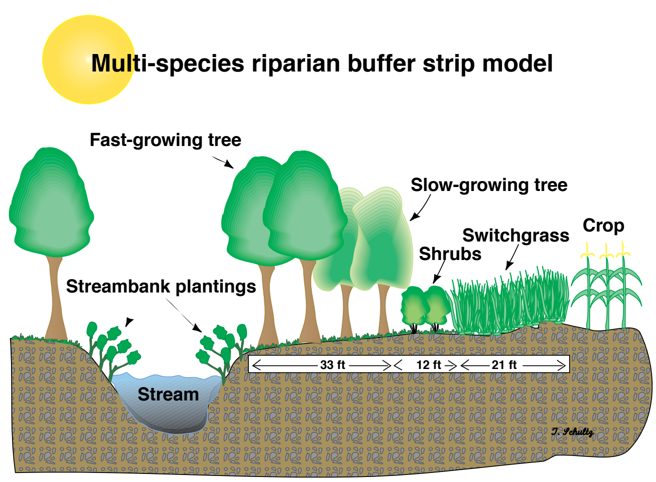
From tiny creeks to major rivers, all waterways have a riparian zone, commonly known as the floodplain. The riparian zone stretches along each waterway and is as wide as where annual or periodic flooding occurs. The riparian zone is the waterway's buffer. Under normal conditions, this land and the "natural" vegetation growing on it traps sediments from upslope erosion, and filters out fertilizers and pesticides used on adjacent farmland. This area may thrive as a very wet area that supports trees, shrubs, grasses, cattails, and other species, or be occasionally wet and support species that can grow under changeable conditions. In the Midwest, riparian zones support well-known trees such as willow, silver maple, cottonwood, green ash, black walnut, and river birch; shrubs such as serviceberry and dogwoods; and grasses such as prairie cordgrass and reed canarygrass. Most streams in Midwestern agricultural regions now cut deeper into their channels than 150 years ago and, as a result, can support many upland species of trees, shrubs, and grasses if a 3- to 4-ft. deep, well-drained soil exists. Riparian zones also support cattails and bulrushes in calm backwaters and oxbows of large rivers.

Under natural conditions, riparian zones extend along creeks, streams, and rivers, providing a network of vegetation vital to the terrestrial and aquatic ecosystems. These areas are "living filters" for both surface and subsurface water. They trap and modify soil sediment and agricultural chemicals, including nitrates, phosphates, herbicides, and pesticides before these pollutants can enter streams. They stabilize streambanks by reducing bank erosion and by slowing stream meandering across pasture and row crop fields. They also increase the water-holding capacity of soil, which moderates flooding and recharges groundwater supplies. Riparian zones are important terrestrial wildlife habitat and control the aquatic ecosystem of small- to mid-sized streams.

Within the last 50 years, natural vegetation of most Midwestern riparian zones has been cleared and replaced by row crops, converted to grazed pastures, or planted to narrow strips of cool-season grasses. Stream channels have been straightened and deepened, and many field tiles that carry agricultural chemicals, such as nitrogen and atrazine, now drain directly into streams. These modifications reduce the length of time that water stays in the soil, where it can be cleaned by the "living filter" of plants and microbes. These changes also have dramatically increased the quantity and speed of water moving in stream channels, which provide more energy for erosion and, in turn, reduces water quality. Stream channels cut deeper to handle increased water flow, which accelerates streambank erosion.



The natural benefits of a riparian (or river) zone can be re-created by planting strips of trees, shrubs and grasses, and stabilizing streambanks, shown above, as well as constructing small wetlands to capture tile flow from nearby fields. Source: Iowa State University, 1995.

While restoration of all natural riparian zones may not be economically or socially acceptable, re-creation of streamside buffer systems along many miles in the riparian zone is possible. A re-created riparian zone managed as a buffer strip system can be established in areas that have been cleared of native vegetation and are no longer functioning properly. This system consists of 66- to 100-ft. wide buffer strips planted to trees, shrubs, and perennial prairie grasses; streambanks stabilized by willow and shrub plantings, and small, constructed wetlands to capture tile flow from agricultural fields.

Restoration and management of existing vegetated areas can lessen, and perhaps reverse, many water quality and environmental problems and, at the same time, increase the quality of life for humans and wildlife. This publication reviews what happens when riparian buffer protection is lost, the benefits of a properly functioning riparian zone, and ways to restore these areas into a healthy system.

Loss of buffer protection

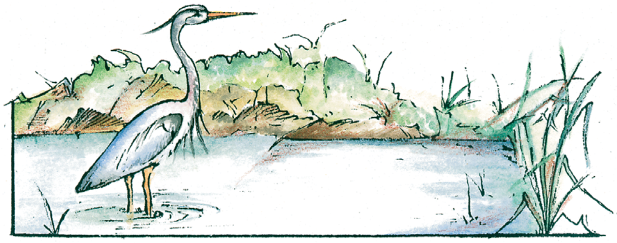
Loss of part of an ecosystem affects everything else in that system. This can be seen with the disappearance of natural riparian zones, which has resulted in increased non-point source (NPS) pollution of surface and ground water, streams that are wide, deep and flood-prone, and loss of wildlife habitat throughout the Midwest. This loss of buffer protection contributes to serious environmental problems.

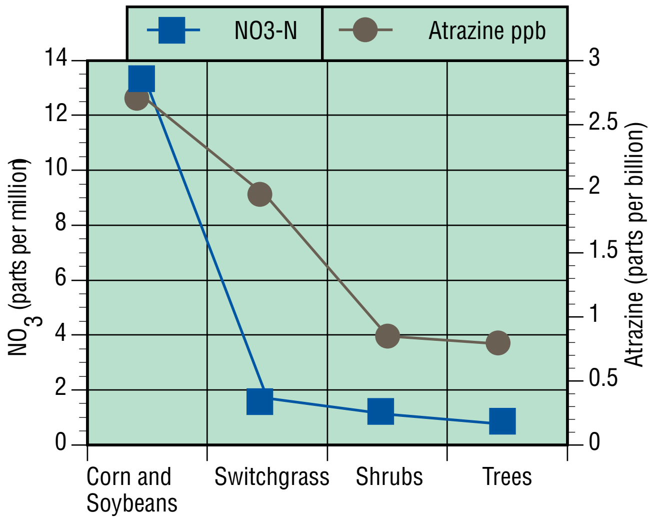
• *Increased water pollution*

NPS pollution does not come from a specific source such as a sewage lagoon outlet pipe or a smokestack. Instead, NPS pollution is a general presence of pollutants, such as soil sediment, fertilizers, pesticides, and herbicides, whose specific source is difficult to pinpoint. This type of pollution is a serious concern in the Midwest because water in many streams is unfit for human consumption, livestock, or recreational use, and these streams cannot support fish or other aquatic life that they once did. Studies have shown that more than 60 percent of the nation's water pollution is NPS pollution. Estimates may be even higher in the Midwest due to its largely rural population and few heavy industries.

Sediment. Sediment in stream water is produced by storm runoff from fields, collapsed streambanks, or "dust" blown in from adjacent fields. According to the U.S. Department of Agriculture, 64 percent of sediment found in streams is from crop and range land. A large amount of sediment entering a stream can kill aquatic plants, an important food source, by blocking sunlight. It can disrupt feeding and reproduction of many fish species by covering the natural gravel stream bed. Heavy sediment loads gradually fill the channel, which contributes to increased flooding. Sediment also must be removed from drinking water.

Fertilizers. An excess of nitrogen or phosphorous may cause accelerated growth of algae and other aquatic plants, producing algae blooms in surface waters. This dense plant growth reduces oxygen available to other aquatic life. Nitrate, the form of nitrogen that moves most easily from agricultural fields into streams, also is dangerous to human and animal health. When dissolved in drinking water, nitrate is converted to nitrite, which makes hemoglobin cells in the blood unable to carry oxygen. This condition causes brain damage and death by suffocation in babies under six months of age and newborn livestock.





Trees, shrubs, and grasses filter out much of the nitrate and atrazine residues before they reach water supplies. Source: Iowa State University, 1993

Because of these problems, the U.S. Environmental Protection Agency (EPA) has established 10 parts per million (ppm) as the allowable limit for nitrate in drinking water. This level often is exceeded in Midwestern states, especially during late spring and summer months. Field tile lines, a major source of high nitrate water, often have nitrate concentrations of 15 to 25 ppm, and have been measured as high as 80 to 90 ppm during the growing season.

Usually phosphorus is attached to soil particles and, thus, enters streams with eroded soil from surface runoff. It is not found in field tile water in significant amounts.

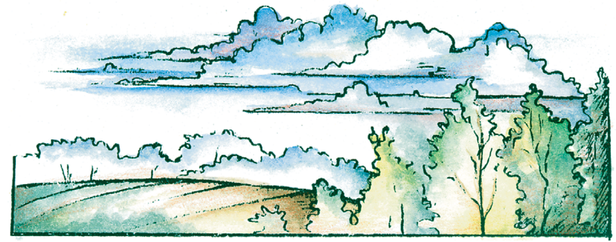
Pesticides and herbicides. Pesticides and herbicides are poisons that disrupt natural biological processes and they are effective in controlling unwanted pests and weeds. After application, many pesticides and herbicides are bound to soil particles, thus, if soil erodes from a field and enters a stream, the pollutant also will enter. Their presence in a water system can be lethal and is difficult to predict or trace. A 1985 study

found eight pesticides in groundwater that supplies public wells in 31 Iowa counties. Another survey showed 53 percent of Iowa wells had detectable pesticide residues.

• *Increased soil erosion*

In Iowa, 1992 data collected for the National Resources Inventory (NRI) show the statewide average soil erosion loss still exceeds 6 ***tons*** per acre per year, and many areas have loss rates as high as 25 tons per acre per year. These same soils would lose only 200 to 400 ***pounds*** per acre per year if covered with natural forest or prairie vegetation. In the Midwest, it is common to have more than 90 percent of a watershed used for row crop agriculture. Many areas, where farmers have used conservation practices such as reduced tillage, grassed waterways, strip or contour cropping, and terraces on at least 40 percent of the land, still experience some of the highest erosion rates.

Significant gains have been made in Midwestern agricultural practices that reduce soil erosion, but the biggest NPS pollutant to enter streams is soil sediment from erosion. This loss of soil and reduction in water quality from NPS pollutants produce agricultural systems that are not



likely to show long-term sustainability on certain soils and landscapes.

• *Loss of habitat*

As human population and living areas increase, wildlife is squeezed into ever smaller patches of habitat. In the Midwest, where only one in 10 acres is not used for either crop or pasture production, additional habitat can be critical to certain game and non-game wildlife species. Tile drainage that increased the amount of tillable land and allowed for bountiful harvests has dramatically reduced wildlife abundance and diversity. In North Dakota, 60 percent of the natural wetlands have been drained, compared to 90 percent lost in Iowa to agriculture and other uses.

The loss of these wetlands has removed natural ecosystems that were capable of supporting many wildlife species, reducing excess nutrients, degrading pesticides that move through a watershed, and of acting as "sponges" to reduce flooding. Where wetlands have been allowed to develop again naturally or be restored under programs such as the Wetland Reserve Program (WRP), wildlife have flourished.

Benefits of a healthy buffer system

Natural and restored buffer areas serve critical functions for nature and humans. The landowner benefits from production of biomass for forage, energy, timber, native prairie seeds, or berries and nuts from trees and shrubs. The landowner also benefits from improved fishing, hunting, and wildlife habitat. All residents in a watershed, and society in general, benefit from improved water quality, lower costs of cleaning sediment from major reservoirs and rivers, and increased diversity for wildlife. Properly functioning riparian zones also can sequester, or hold, more carbon than annually cropped fields or cool-season pastures. Natural and restored riparian areas improve the quality of life for rural and urban citizens alike.

• *Soil quality and water quality are improved.*

The most important function of a buffer system is to reduce NPS pollution. Above ground, the dense stems of native prairie grasses, shrubs, and trees physically slow surface runoff from fields and out-of-bank floodwater, which causes sediment to be dropped on the soil rather than in the waterway. Sediment from adjacent fields that ends up in the buffer strip also keeps phosphorus and pesticides, which are bound to soil, from entering the stream. Below ground, roots improve soil porosity that allows more surface runoff to soak into the soil. Native trees, shrubs, and prairie grasses develop significantly deeper and greater root masses than crop plants and cool-season grasses.

The result is improved soil quality and streambanks that resist collapse. The extensive root system of natural plant communities adds organic matter to the soil as roots die and are replaced. This organic matter acts as a food source for microbes that reduce nitrogen, break down pesticides, and help build large pores to allow water to percolate into the soil.

Woody roots provide strength against streambank collapse. The combined activity of nutrient uptake and storage by the plants and microbial breakdown of chemicals is the "living filter" that reduces NPS pollutants. Water that

Before buffer strip restoration…

Two months after trees, shrubs and grass are planted…

Four years later.

In only four years, a buffer strip has transformed this stretch of Bear Creek in central Iowa into a thriving ecosystem that provides wildlife habitat, improves soil and water quality, decreases flood severity, and replenishes groundwater supplies.

by-passes the soil system's "living filter," such as drainage from a tile system, can be filtered if it enters a constructed wetland.

• *Streambanks are stabilized.*

Streambanks in healthy riparian zones are stabilized by permanent woody roots and, to a lesser extent, by deep roots of prairie grasses. All streams tend to move across a floodplain, cutting outside corners of stream bends. This cutting causes the bank to erode, which is a major source of sediment. Removing permanent vegetation and replacing it with row crop agriculture or intensively grazed cool-season grasses accelerates the streambank cutting and slumping process. Native riparian zone species such as willows, silver maple, cottonwood, and green ash thrive under these conditions, and can reduce streambank erosion. Use of Eastern red cedar, bundles of other cut trees, and willow plantings on the bank itself can rapidly reduce streambank erosion and limit stream meandering.

• *Flood severity is decreased.*

Massive flooding in 1993 showed that changes in the Midwestern agroecosystem had accelerated flow of water to streams and actually increased flooding. Cultivation of more than 90 percent of the land surface, tile drainage, and intensive grazing of riparian zones all contributed to increased flow of water to streams. Channelization of many streams reduced the length of previously meandering streams, cut water storage capacity of those streams, and caused water to flow more rapidly and flood more extensively.

Healthy riparian zones can reduce severity of flooding during heavy rains in three ways:

1) The stream's natural characteristics are preserved. Vegetation on and above the streambank provides friction against moving water, which slows it down so water is not delivered downstream as quickly. Water that floods into such an area also re-enters the main channel slowly. A meandering stream increases the storage potential of the channel, once again, slowing water movement and reducing flood potential.

2) Native trees, shrubs, and grasses route water under ground.

The dense stems of prairie grasses, shrubs, and trees in the riparian zone further slow water, allowing it to infiltrate into the "soil sponge." Root systems of this vegetation keep pores of the soil open so that two to three times more water can enter the soil compared to a soil used for cultivation or grazing. Water in the soil is released slowly into the stream.

3) Transpiration of plants reduces water in the soil.

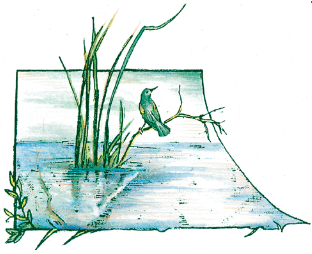
Trees, shrubs, and prairie grasses use large amounts of water in transpiration. Several thousand gallons per acre of water are used by plants each day, thereby drying the soil and making more room in the "soil sponge" for floodwater. The transpiration process also is responsible for taking large amounts of nutrients and chemicals into plants where much of it is locked up in storage.

• *Groundwater supplies are replenished.*

The rich organic matter in the soil of natural riparian zones allows large amounts of water to percolate to deeper water aquifers. The extended contact of water with the "living filter" of roots and soil microbes that thrive below a healthy riparian landscape cleans nearly all agricultural chemicals from the water before it moves to deeper aquifers. These groundwater reserves, or aquifers, are important sources of drinking water throughout the Midwest. The restored riparian buffer system being evaluated in central Iowa on Bear Creek has shown to remove 80 to 90 percent of nitrate-nitrogen and atrazine in the shallow groundwater prior to entering the stream.

Planting cool-season grasses along creeks allows overland water flow and streambank collapse.

Three years later, the same area along Bear Creek has been stabilized by planting willow cuttings, trees, and shrubs.



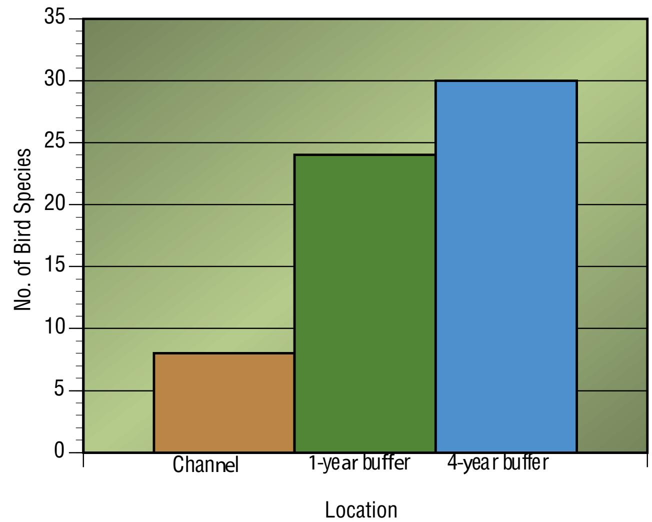
• *Wildlife habitat is improved.*

Natural vegetation in a riparian zones improves habitat for both wildlife and fish, and may be the only habitat in an agroecosystem. A recent Iowa study compared songbird use of a four-year-old restored riparian buffer strip system with a neighboring stretch of channelized stream with row crop production within 10 to 15 feet of the channel bank. Over a 10-day sampling period, 30 different songbird species used the restored buffer area, whereas, only eight used the channelized stretch of the stream. The restored buffer system also provided excellent habitat for pheasants and Hungarian partridges, valuable game species in the Midwest.

The width and length of a buffer strip area is important because it provides corridors of travel for different wildlife species. A landowner can encourage wildlife by planting a variety of plant species. Species should be selected on their potential for cover and food, as well as the flowering and fruiting seasons. A diversity of size, shape, and species of plants will ensure the greatest variety of wildlife.

Riparian vegetation also improves in-stream habitat. Vegetation reduces the amount of sunlight that reaches the stream, creating cooler temperatures required by many aquatic species. Leaves, branches, and other plant litter fall into the stream and provide an essential source of food, hiding places, and reproductive sites for aquatic species.

In cold-water streams, overhanging prairie grasses provide hiding places for fish while allowing sunlight into streams. Along such streams, trees might be set back from the edge of the bank to allow native grasses to flourish.



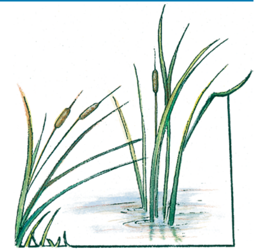
A four-year-old buffer area supported 30 species of birds, compared to a neighboring stretch of channelized stream that supported only eight species. Source: Iowa State University, 1994

• *Other products may be harvested.*

Riparian buffer strip areas can be designed to harvest products such as hay from switchgrass; sawtimber from oaks, black walnut, and ash; chip material for pulp; biomass for energy; landscape mulch from fast-growing species such as willow, cottonwood, or silver maple; salable native grass and forb seeds; nuts from species such as walnut and hazelnut; and berries from chokecherry, Nanking cherry, and elderberry. Hunting rights also could be leased for game species to provide annual cash income from the area.

Ways to restore riparian buffers

Restoration of a 66- to 100-ft. wide riparian buffer strip on land that presently is cropped or heavily grazed can provide many of the same benefits provided by a natural



riparian zone. A restored, or managed, riparian buffer strip system may be done in three ways, depending on the region and its location within a watershed.

Landowners can use any or a combination of these three components to create a riparian buffer: 1) a multi-species buffer strip (the tree-shrub-grass component); 2) a streambank stabilization area (the vegetative bioengineering component), and 3) a small, constructed wetland at field tile outlets (the wetland component).

Multi-species buffer strip component

A minimum vegetative buffer strip of 66 ft. wide on ***both*** sides of the stream is needed where row crops are grown. This width is needed to trap sediment and provide enough time for water moving across the area and into the soil to interact with the "living filter." Ideally, the strip should consist of four or five rows of trees planted parallel and adjacent to the stream, then one or two rows of shrubs, and a 20- to 24-ft. strip of native warm-season prairie grasses.

Cool-season grasses used in lawns and most pastures do not provide sufficient stems and roots to be effective. In grazed pastures where streambank stabilization is the major concern, the buffer strip can be 20 to 30 ft. wide

This model buffer strip along Bear Creek has four rows of trees, several rows of shrubs and a 24-ft. wide warm-season grass strip adjacent to field crops.

and livestock should be kept out of the area. The strip can accommodate rotational grazing and controlled water access.

Streambank stabilization component

Live and dead plant material (trees, shrubs, and grasses), fiber matting, and rock can protect bare streambanks that are easily eroded by the current. Collapsing banks produce up to 50 percent of the sediment in streams. The goal of streambank stabilization is to re-shape streambanks with permanent vegetation. It involves placing live plant material, typically willow, into the stream bed and bank, and anchoring bundles of dead trees, such as Eastern red cedar or small hardwoods, as "revetments" at the toe of the bank in the water. A narrow band of large rocks also can be used in place of the dead plant material. The bundled trees absorb fast-flowing water, physically trap debris and soil, and allow willows to be placed among the bundles to help anchor both into the bank.

Only the inside bends of severely eroded banks should be stabilized. Vertical banks more than six ft. high should be re-shaped with equipment, such as a backhoe, to produce a 2:1 slope before installing plant material.

Wetland component

If the adjacent field crop is drained by tile, a small wetland can be constructed within the 66- to 100-ft. buffer strip where tiles enter the stream. The idea is to use the natural water "purification" processes of a wetland. Basically, the wetland works by providing annual organic matter from cattails for millions of microbes to live. These microbes consume nitrogen and immobilize many of the herbicides that enter the wetland with the tile water.

Based on wetland research at Iowa State University, the general rule for sizing a constructed wetland is one acre of wetland for every 100 acres of row crop drained by the tile line. To construct a wetland, excavate a small depression near the tile outlet and install a water outflow structure to control water retention time and level. Cattails and bulrushes are planted in the depression, surrounded by a berm that can be planted to prairie grasses and forbes

Financial installation assistance

Restoration of riparian zones often qualify for government and non-government cost-share assistance. In addition, many of these areas can qualify for reduced property taxes. See your district forester or soil conservationist for further information.

Summary

Restoration and management of riparian buffer areas provide many benefits—for the landowner, downstream residents, as well as the rest of the ecosystem. Whether in their natural or in their restored and managed state, riparian buffer systems are true stewards of our streams.

For more information

The riparian zone management model described in this publication is being developed by Iowa State University and the Leopold Center for Sustainable Agriculture. This interdisciplinary team has research and demon-stration sites in central and northwestern Iowa. Field days and guided tours of these sites are available.

This three-year-old wetland was constructed at a field tile outlet along Bear Creek in central Iowa.

Wetland plants improve water quality and provide wildlife habitat.

For more information, contact the Department of Forestry at 251 Bessey Hall, Iowa State University, Ames, Iowa, 50011; phone: (515) 294-1458; fax: (515) 294-2995; electronic mail address: rshultz@iastate.edu. For information specific to your locale, contact your U.S.D.A. Forest Service representative or extension forester.

For specific information about design or financing of riparian buffers, get other publications in this series at any ISU Extension office. They are:

• Stewards of Our Streams: Multi-Species Buffer Strip Design, Establishment and Maintenance, Pm-1626b, and

• Stewards of Our Streams: Maintenance of Riparian Buffers, Pm-1626c.

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