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Creating A BUFFER

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Ron walks along the lane leading from his farmstead to his fields. It's 6 a.m. and the cool breath of the summer morning feels fresh and stimulating. Ron and his sleepy-eyed grandson, hitchhiking on his "grampa's" shoulders, are scouting for wildlife as they approach their farm stream. Just the day before they had seen a doe and her two fawns, six mallard ducks and four pheasants. Other birds and small animals were mentally added to their early morning "game of wildlife inventory." A game of life and enjoyment they would not have been able to play if Ron had not been receptive to change. Ron walks to the edge of his northern most cornfield. He turns south, visually inspecting the habitat of trees, shrubs and native prairie grasses along his stretch of Bear Creek. Just a short time ago this same view looked very different. Ron is very pleased with what he sees and knows that his bufferstrip system is helping to prevent soil erosion and excess fertilizer and pesticides from polluting Bear Creek and affecting his downstream neighbors. Ron and his grandson enjoy their walks mostly because they enjoy the wildlife, the many sights, sounds and colors of their bufferstrip, and a revitalized Bear Creek.

The land along a stream that floods annually or periodically is known as the floodplain or riparian zone. Under natural conditions this land and the "natural" vegetation growing on it acts as a buffer to trap sediments from any upslope erosion. For streams associated with most agricultural land it also serves to filter and buffer fertilizers and pesticides. A mixture of plants provide a "textured surface" to slow down surface runoff causing the soil to be trapped in the vegetation and the water to soak into the soil. Once the water enters into the soil, nutrients from fertilizers and pesticide residues in the water are taken up by the plants or broken down by soil organisms. Thus, these natural plants and the soil act as a "living filter" to clean potential pollutants from the water before they reach the stream, and to stop eroded soil from entering the stream. These streamside riparian buffers also provide valuable wildlife habitat. Twigs and leaves, as they decompose, provide nutrients to minute aquatic organisms important as food for larger aquatic species. Branches from fallen trees and exposed

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Is the bufferstrip system working? In a word, Yes! Rapid change in vegetation, appearance and aesthetics that the Risdal project site has undergone since planting in the spring of 1990 is evident by the comparison shots taken in 1990 and 1994. The trees, shrubs and switchgrass are growing well. The whole system has literally "jumped" out of the ground and is functioning like nature's filter.

roots provide necessary habitat. Shade from streamside trees and shrubs help keep the waters cool for a healthy in-stream environment.

In Iowa, as throughout the Midwest, farmers have cleared many of these naturally vegetated riparian areas for crop production. They have also used the land along the stream for grazing by fencing livestock into these areas. Stream channels have been straightened and crop fields drained by tiles. These practices have bypassed the living filter and increased the flow of streams causing accelerated bank erosion. With this land use for crops and livestock production have come the benefits of plentiful and inexpensive food. However, there have been unintended "costs" to the environment that threaten the public via polluted water and clogged flood-control structures.

Removal of the riparian vegetation has reduced the natural function of this "buffer zone" to trap sediment, and to reduce or stop fertilizer, manure and agricultural chemicals from entering the surface water of our streams, or more importantly, from entering our groundwater.

Based on many discussions with farmers, it is clear that the Iowa farmer and the agricultural sector recognize and accept the responsibility of land stewardship. They are actively involved in actions to minimize unintended environmental impacts such as non-point source (NPS) pollution while maintaining (or enhancing) farm profitability. Iowa farmers have taken many positive steps toward effectively reducing soil erosion, and controlling the inputs of nitrogen, manure and pesticides to ***agronomic*** crops. Farming practices such as minimum tillage, conservation tillage, use of grassed waterways and terraces reduce soil erosion and other NPS pollutants.

Upland conservation practices and riparian bufferstrips are complementary. If upland conservation practices are not employed, then a buffer strip system may not be enough to keep agricultural-based non-point source pollutants from the stream.

Helping Nature Recreate a Natural Buffer Zone

Based on experience and guided by the results of others, we recommend a system that consists of three components: a planted strip of trees, shrubs and grasses on the bank of a stream (the field-edge-stream connection); streambank stabilization (bioengineering) units installed down the bank edge and into the water; and small constructed wetlands which intercept tile flow from adjoining crop fields.

The Tree, Shrub and Grass Component

Combinations of trees, shrubs and grass vegetation offer the greatest protection for the stream and encourage natural processes that remove NPS pollutants before they can enter the stream. The width of this vegetation along the bank can vary from perhaps as narrow as 33 feet to as wide as 100 feet. The rule is -- the greater the slope of the adjacent cropland, the wider the strip needs to be to function properly. Also, certain sandy soil types, regardless of slope, need wider buffers. A bufferstrip, adjacent to pastureland, can be narrower where the major function is bank stabilization.

The central Iowa model, for which there is real data on its effectiveness, has a total width of 66 feet. It has five rows of trees planted next to the creek with four feet between trees and six feet between rows. The model can be adapted by dropping a row of trees and increasing the width of shrubs or grasses. By using a mixture of fast-growing species such as silver maple, cottonwood hybrids, willow and green ash, any stream in need can quickly be revegetated. To promote biodiversity, two shrub rows next to the rows of trees are recommended. Red-osier dogwood, ninebark, Nanking cherry, and nannyberry are several that have worked well in the model. A 24-foot-wide strip of switchgrass -- a deep-rooted perennial "prairie grass" -- should be planted next to the shrubs and adjacent to the crop fields. A mixture of warm-season prairie grasses also can be used.

Streambank Stabilization

As much as 50 percent of the soil sediment carried in our Iowa rivers comes from streambank collapse. Soil bioengineering involves using live plant material (typically willow) placed into the streambed and bank, and bundles of trees as "revetments" anchored at the toe of the bank in the water. The bundled trees (Eastern redcedar works great) absorb energy from the fast-flowing water, physically trap debris and soil, and allow the willows to be placed through the bundles to help anchor both into the streambank. Soil bioengineering should be applied on the inside bends of severely eroding stream banks. If the bank height is more than 12 to 15 feet tall, the bank needs to be reshaped to reduce the vertical drop. Bundled dead silver maple and tree willows have been used successfully on several hundred feet of previously eroding streambank in Bear Creek. (See "Streambank Stabilization Success --Willow Posts" by Kimberly K. Coulter in the May/June 1995 issue of the *Iowa Conservationist.*)

Constructed Wetland

The third component of the bufferstrip system involves creation of small wetlands. The idea is to use the natural water "purification" processes of a wetland. Basically the wetland works by providing annual organic matter (cattails) for millions of microbes to live -- consuming the nitrogen entering with the tile water. Based on wetland research from Iowa State University, the rule of thumb for sizing a constructed wetland is one acre of wetland for every 100 acres of row crop ground drained by the tile line.

We recognize that it may not be possible nor prudent to develop a small wetland association with every tile line entering a stream. But there are opportunities to place many along our small Iowa streams.

Making It Happen in Iowa

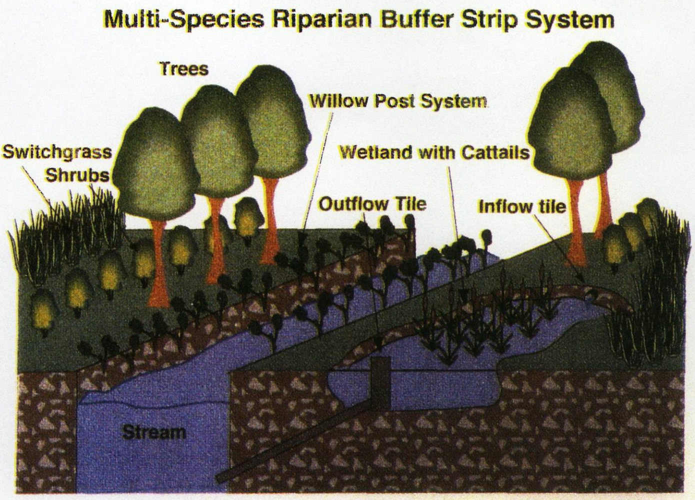
Just a few miles north of the central Iowa town of Roland a 3/5-mile stretch of Bear Creek is being revegetated with an innovative combination of trees, shrubs and warm-season grasses. It is stabilized by streambank bioengineering, and with a small constructed wetland is protected from tile water laden with excess nitrogen and atrazine,. All of this is being developed and studied on the Ron Risdal farm by a group of Iowa State University researchers. The project was first funded in 1990 by the Leopold Center for Sustainable Agriculture, and more recently by the Iowa DNR (EPA 319 non-point pollution control money) and the USDA.

The Bear Creek watershed is located mostly in Story County and totals about 17,700 acres. This watershed is drained by Bear Creek, which flows south from the headwaters in Hamilton County for 22 miles before it empties into the Skunk River several miles south of Story City. Bear Creek also has more than 17 miles of major tributaries, which drain hilly to level corn and soybean fields.

Another mile of this bufferstrip system has been installed on the Lon Strum farm just upstream from the Risdal farm. Another half-mile stretch being installed on farmland owned by Jordan Larson. This bufferstrip system is being adopted by other farmers in this watershed and throughout the Midwest.

Infiltration and Roots

The proper functioning of the system depends on many things below ground. We have documented that within just three years after establishment, the infiltration rate in the switch-



▲ **The third component of the bufferstrip system involves creation of small wetlands and use of their natural purification process.**

grass, shrubs and trees was four to five times greater than in the corn/soybean field immediately adjacent. In other words, water soaks into the soil of the bufferstrip at rates of four to five inches per hour while only soaking in at one to one and one half inches per hour in a cultivated field.

The quantity and distribution of roots beneath the bufferstrip was compared to that beneath the corn and soybean fields. Under the corn and soybean fields down to about four feet, less than 400 pounds (dry weight) of roots per acre were found. Compare that to the roots under switchgrass and willow of nearly 14,000 and 18,000 dry pounds per acre, respectively. There were 10,000 pounds under silver maple and 8,000 pounds under the cottonwood hybrid. Even the shrub species (ninebark and red osier dogwood) had more than 4,000 pounds per acre of root biomass. In contrast, root biomass below typical cool season grasses such as brome and fescue had just more than 2,000 pounds of roots. All of this root biomass is very important in increasing infiltration and acting as "action sites" where microbes, soil particles and pollutants in the soil water "get together" and the pollutants are made "user friendly."

Water Quality

Changes in water quality below the bufferstrip and in the stream are being measured by more than 80 wells from 16 inches deep to 300 feet deep. Concentrations of nitrate-nitrogen and atrazine in the crop fields and under the bufferstrip have been closely monitored. The results reveal the bufferstrip is functioning as expected. High nitrate-nitrogen levels that exceed the EPA's safe drinking water standard of 10 parts per million (ppm) have been founds in the soil water below corn and by the time the water is sampled below the bufferstrip the levels are typically near two ppm. The same reductions occur for atrazine.

Wildlife

Wildlife is important to the Risdals and to us. Wildlife represents an added benefit from this system, one with great value in a highly modified agricultural landscape. In 1994 bird species were studied using the project site, a channalized portion along Bear Creek with a narrow strip of reed canarygrass and brome, and a one-year old riparian bufferstrip further upstream on Bear Creek. The results were exciting. A total of only eight bird species were observed during the study period last summer in the channalized section. Within the newly planted riparian bufferstrip system upstream, the number of species increased to 24, and within the four-year old Risdal bufferstrip the total was 30. The species diversity has increased dramatically. Additional sitings of shorebirds and waterfowl are occurring along Bear Creek and in the wetland.

Soil Bioengineering

The streambanks where the revetment material was placed and the tree willow posts planted are being stabilized. These sites have withstood the 1993 floods without additional movement of Bear Creek into the bufferstrip. The use of live and dead plant material to help "control" bank collapse is a relatively low cost ($5 to $7 per linear foot), effective alternative for landowners to consider. One word of caution -- do check with the Iowa Department of Natural Resources (phone: 515/281-6615) and the Rock Island District of the US Army Corps of Engineers (phone: 309/794-5367) for a permit to install this component. It is easy to get the permit, just don't forget to ask for it prior to stabilizing your streambank.

Wetland Functioning

Even within the first year of establishment, the constructed wetland has demonstrated its considerable potential as a "sink" for NPS nitrate in agricultural ecosystems. Except during high flows and during cold seasons, much of the nitrate entering the wetland was removed before the water entered Bear Creek. Bacteria within the wetland sediments and attached to live and dead plant material transform this nitrate into harmless nitrogen gas through a process called denitrification. It is expected that the wetland will get even better at removing nitrate and other agricultural chemicals as dead plant material builds up. The wetland will continue to be monitored and measured for its effectiveness.

Costs and Management

It costs between $350 and $400 per acre to install the bufferstrip component. To help reduce the initial cost there are currently two sources of cost-share money. The Stewardship Incentive Program administered by the Forestry Division of the Iowa DNR can cost share 75 percent, up to $315 per acre. In Story County, Pheasants Forever cost-shares an additional 15 percent. You may wish to contact your district forester and local chapter of Pheasants Forever to see if assistance can be given.

We estimated $20 per acre per year needs to be spent on upkeep. Weeds can be controlled by mowing the area between the tree and shrub rows for the first two or three years. The prairie grasses (switchgrass) will have to be removed or burned on a two or three year rotation. You may want to stagger the burning of each side of your bufferstrip so there will always be wildlife cover on at least one-half of the buffer. Depending on the tree species planted and your goals beyond water quality improvement, you may want to harvest trees for on-farm biomass for energy or grow high quality hardwoods such as oaks and black walnut for your heirs.

The soil bioengineering component costs around $7 per linear foot, if you have an available source of revetment tree material, use small diameter willow posts and don't have to shape the bank. It will cost more, perhaps double, if not.

The riparian zone is the last area for intercepting and processing non-point source pollutants before they enter a stream. One of the best management techniques for the riparian zone is to maintain a vegetative cover that has an extensive and dynamic root system and is capable of processing large quantities of water and agricultural chemicals, while also trapping sediments moving from adjacent crop fields. Trees, shrubs, and grasses, often the vegetation that was originally cleared from the riparian zone, provide such a cover. Tree-shrub-grass bufferstrips improve the in-stream environment and provide wildlife habitat, as well as an aesthetically pleasing diversity in the landscape.

Soil bioengineering can stabilize streambanks that otherwise continually erode into highly productive crop fields. Trees are able to reduce the rate of stream bank collapse because their permanent roots extend into the soil and their stems provide increased frictional surface during flood flows. Additionally, trees reduce in-stream sediment load and water temperatures, while providing organic debris that is a food source for aquatic organisms.

Small constructed wetlands offer an important extra dimension of protection of a stream by removing nitrate and other agricultural chemicals from tile inflows. They also provide additional wildlife habitat that enhances biodiversity and aesthetics of the agro-ecosystem.

Mixtures of trees, shrubs and grasses provide good habitat for wildlife which may be desired by the landowner and the public. Most of Iowa's forests, prairies and wetlands were cleared for agricultural purposes. What is left, for the most part, are small, fragmented and isolated ecosystems. Movement of wildlife between these systems is difficult because of the wide open crop spaces that provide little cover. The use of mixed tree-shrub-grass buffer strips along streams can provide corridors of cover and habitat for wildlife movement. And, the use of a variety of vegetation provides diversity for wildlife use.

The bufferstrip system also holds large quantities of carbon dioxide that should help stabilize the global warming phenomenon. For example, wood is about 50 percent carbon. This carbon is stored in the stems of trees in the plantations until the wood is decomposed or burned. Compared with annual crops, this carbon storage is long-term. Such long-term storage reduces carbon dioxide in the air, thus reducing the greenhouse effect.

Riparian bufferstrip systems can provide many products while protecting Iowa's streams and providing diverse landscapes where people like Ron and his grandson can enjoy the beauty and solitude of a cool summer morning.

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