ANC93-017

Stewards of our Streams

Buffer Strip Design, Establishment, and Maintenance

Maintaining a forested or prairie buffer along creeks, streams, and rivers provides more than just a beautiful landscape. The right combination of trees, shrubs, and native grasses can improve water quality by removing sediment and chemicals before they reach the surface water. A properly cared for buffer area also can moderate flooding, recharge underground water supplies, prevent loss of soil by erosion, and preserve wildlife habitat. Also trees selected for rapid growth or other characteristics can provide landowners with valuable biomass, timber, and nut crops.

A well designed buffer system may include not only a multi-species buffer strip established on the land parallel to the stream, but also plantings that stabilize the streambank and wetlands constructed at field tile outlets to treat drainage water.

This publication will discuss how to design, plant, and maintain a multi-species buffer strip, which is an important part of the riparian, or river, ecosystem. Techniques recommended in this publication are being studied at Iowa State University and Leopold Center for Sustainable Agriculture demonstration plots in central and northern Iowa. The research is part of a multi-year project to show how to restore Midwestern riparian buffer systems, most of which have been lost to agricultural and urban development.

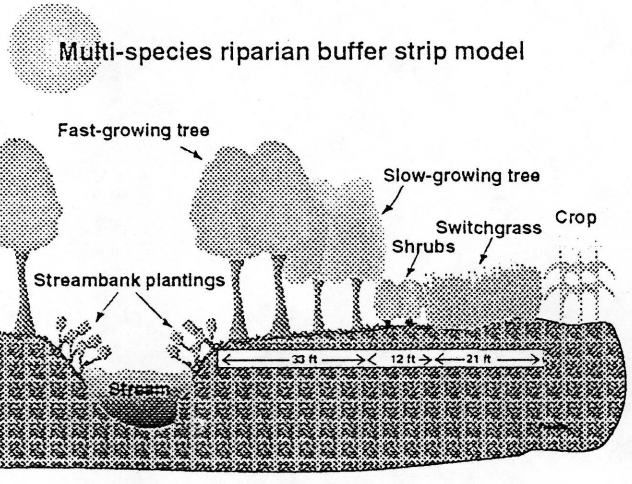

Figure 1. The natural benefits of a riparian (or river) zone can be re-created by planting strips of trees, shrubs and grasses, and stabilizing streambanks, shown above, as well as constructing small wetlands to capture tile flow from nearby fields. Source: Iowa State University, 1995.

How to design a buffer strip

General requirements

The most effective riparian buffer strip has three zones of vegetation, each planted parallel to the stream (see Figure 1). The zone adjacent to the stream is a minimum 30 ft.-wide strip of trees (four to five rows), then a minimum 12 ft.-wide zone of shrubs (one or two rows). Farthest from the stream next to cropland is a minimum 20- to 24-ft.-wide strip of native warm-season grasses.

This combination of vegetation, arranged in zones, helps protect the stream more than planting any one species. Trees and shrubs provide perennial root systems and long-term nutrient storage close to the stream. The warm-season grass provides the highest density of stems to slow surface runoff from adjacent fields. The design can be modified to fit the landscape and the landowner's needs, for example, by replacing shrubs with more trees, substituting some of the trees with shrubs, or expanding the grass zone (see "Other species combinations" on page 3 of this publication). When the width of the tree zone is less than 30 ft., the buffer strip is less functional than one with a wide tree zone. The width of the buffer strip also can be adapted to straighten tillage boundaries along meandering streams or waterways (see Figure 2, next page).

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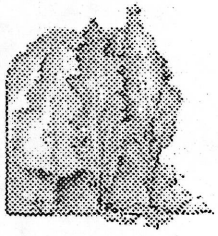


Tree zone (next to the stream)

Four or five rows of trees are recommended in this zone. Table 1 shows trees best suited for this zone. Trees nearest the stream (the first, second and possibly third rows) are selected for their ability to quickly develop deep roots that can increase bank stability. The best choices are bottom land species adapted to the area that have a rapid growth rate such as silver maple, willow, cottonwood, green ash, and box elder. The species must be tolerant of wet conditions.

In the outer area of the tree zone (rows three through four or five), high-value hardwoods such as black walnut, red and white oak, and white ash can be planted to produce timber. If the water table is at least three feet below the surface for most of the growing season, plant hardwood species that require good drainage. If the site has poor drainage, select hardwood species more tolerant of wet conditions.

Other selections can be based on native vegetation in surrounding woodlands. Figure 3 shows a design for a stream that runs east and west. Slower growing species, such as black walnut and green ash,should be planted in southern rows on the south side of the buffer strip to minimize shading from faster growing species. Plant trees in lots of 10-50 trees to increase the diversity of the planting. Eastern red cedar in the two outside rows provides winter cover for wildlife.

Table 1. Suggested tree species for riparian buffers

Species	Rapid growth (nearest stream)	Biomass production	Timber (good drainage)	Timber (poor drainage)	Conifer (wildlife habitat)
Hybrid poplar	X	X			
Cottonwood	X	X		X	
Hybrid willow	X	X			
Black willow	X	X			
Silver maple	X	X		X	
Box elder	X	X			
Basswood			X		
Black walnut			X		
Red oak			X		
White oak			X		
White ash			X		
Green ash	X	X		X	
Black ash			X	X	
River birch	X			X	
Shellbark hickory			X	X	
Hackberry			X	X	
Ohio buckeye			X	X	
Sycamore	X	X		X	
Swamp white oak			X	X	
Eastern white pine			X		X
Eastern red cedar					X

Source: Iowa State University

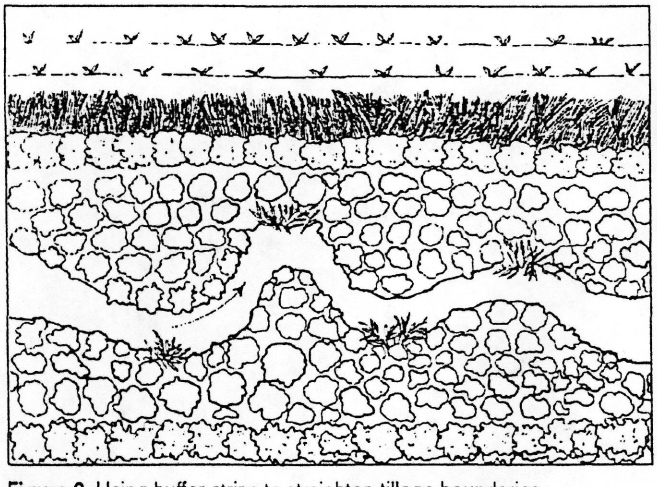
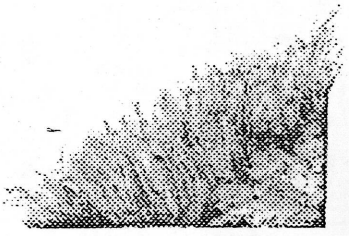


Figure 2. Using buffer strips to straighten tillage boundaries.
Source: Iowa State University

Shrub zone

Shrubs in this zone also develop a perennial root system and add diversity and wildlife habitat to the ecosystem. The multiple stems of shrubs also slow floodwater when the stream leaves its channel. One or two rows are recommended. Shrub species grown on ISU test plots: chokecherry, gray dogwood, hazelnut, nanking cherry, nannyberry virburnum, ninebark, and red osier dogwood. Other shrubs native to Iowa that may be used include: bebb willow, blackhaw, buffalo berry, eastern wahoo, hawthorn, Peachleaf willow, pin cherry, roundleaf dogwood, rusty blackhaw, sandbar willow, serviceberry, silky dogwood, speckled alder, and wild plum.

Select species adapted to the soil site conditions in the area. Use a mix of species either by planting a different kind of shrub in each row or by block planting. A mixture enhances diversity and prevents loss of benefits if one species fails. Shrubs used on ISU test plots are readily available from nurseries, easy to establish, and have a moderate to fast growth rate.



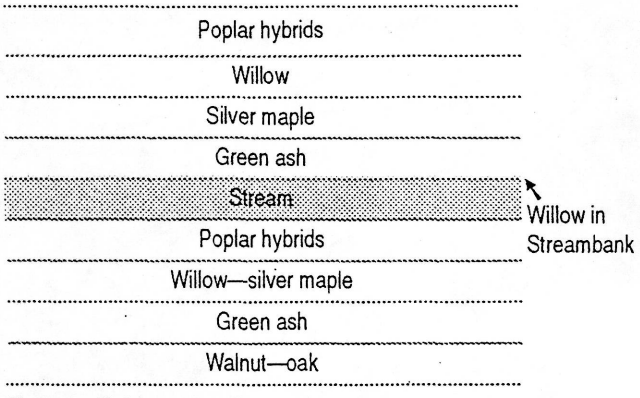


Figure 3. Multi-species filter strip. Source: Iowa State University

Grass zone (next to cropland)

The warm-season grass zone is located on the outside of the buffer strip nearest the field crop. A minimum 20-24-ft. width is recommended. Switchgrass is preferred because its dense, stiff stems intercept and retain heavy surface runoff. This slows the overland flow of water, allowing sediment carried by water to be deposited in the buffer area and water to infiltrate.

Switchgrass produces an extensive and deep root system, much of which is replaced annually, providing large amounts of organic matter to the soil. Organic matter improves soil quality by increasing infiltration rates and microbial activity.

Where surface runoff is not a major problem other permanent warm-season grasses, such as Indian grass, big bluestem and little bluestem, can be used but a 10-ft. switchgrass strip still might be planted at the edge of the crop field. Mixing other warm-season grasses with switchgrass hybrids is not a good idea because the switchgrass will usually out-compete other grasses.

Native forbs also may be part of the mix, especially if they are seeded in clumps with the other native grasses. Native warm-season grasses provide stiff, upright stems and, therefore, function best to intercept and dissipate the energy of surface runoff. Cool-season grasses, like brome and fescue, tend not to remain upright under the flow of water. These grasses also produce as much as eight times less root mass than the native grasses and do not improve soil quality as quickly or as much as the same planting of warm-season grasses.

Other species combinations

The combinations described provide the most effective buffer strip, but they are not the only species combinations that will provide water quality, habitat, and timber benefits. Site conditions, surrounding land use, owner objectives, and cost-share program requirements also should be considered in determining combinations of species for a buffer strip.

Here are other possibilities that could provide riparian buffer protection, although they have not been thoroughly tested throughout the region.

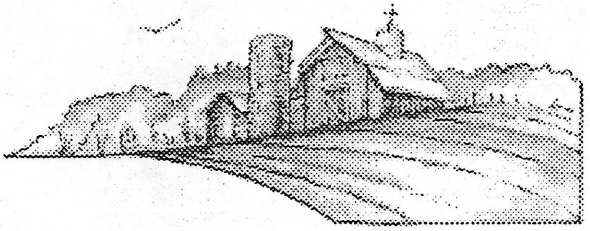
- Replace shrub rows with trees, or tree rows with shrubs, to match timber or wildlife habitat considerations. In either case, permanent woody roots are maintained. A mixture of species should be used.
- Plant all zones to warm-season prairie grass. The zone closest to the stream could include a mixture of grasses and forbs. Some bank stabilization may be needed (i.e., willow planted in the streambank) to provide long-term stability. This system will not provide as many benefits as a multi-species design but it may be most effective in an area that is rotationally grazed. The buffer strip must be fenced to exclude livestock, regulate stream crossings, and move watering sites away from the stream. A portion of the buffer strip could be planted with a dense, cool-season grass such as fescue and orchard grass, which might be more palatable forage that could be harvested. Always maintain at least a 16-ft. strip of switchgrass adjacent to the stream edge.
- Broadcast or randomly plant a seed mixture of trees and shrubs in both tree and shrub zones to naturalize the planting and avoid rows. This might reduce the cost of planting seedlings.
- In urban areas, plant warm-season grasses over the entire area and small groups of shrubs and/or trees to provide a diverse, natural look. Recreational facilities such as hiking or bike trails can be incorporated into the system. Design with care to avoid erosion problems often associated with runoff from trails.

Width of buffer strip

Test plot research shows that buffer strips should be at least 66 ft. wide on each side of the waterway. A wider strip is needed when adjacent fields increase in size, soil permeability decreases, or slopes increase. A buffer strip less than 66 ft. wide cannot hold water in the root zone long enough for chemical reactions to occur and water quality to be improved. To make a buffer strip wider than 66 ft., increase the width of the tree and shrub zones.

Width of the buffer strip depends on the area's purpose, slope, and use of adjacent land. Here are several guidelines:

- If you only want to remove sediment from surface



runoff, 50 ft. may be sufficient on slopes of 0 to 5 percent.
- If surface runoff is a major concern in urban settings, a 50 ft.-wide buffer strip should be effective.
- If wildlife habitat is important, widths of 100 to 300 ft. provide a suitable travel corridor or transition zone between the aquatic ecosystem, upland agricultural land, and urban/suburban areas.
- The U.S. Department of Agriculture Forest Service and the Natural Resource Conservation Service (NRCS) recommend a width of at least 95 ft. for a buffer strip.
- Recommended widths according to the NRCS land capability classes are 95 ft. for classes I, II, and V; 120 ft. for classes III and IV; and 170 ft. for classes VI and VII.

How to plant a buffer strip

Site preparation

Trees, shrubs, and grasses normally are established in the spring, although site preparation should begin the fall prior to planting. Prepare the site by eliminating competing perennial vegetation in 3-ft.-wide to 4-ft.-wide strips or circles into which trees or shrubs will be planted. Fall tillage and/or herbicide application (such as glyphosate) can be used. If the area where switchgrass will be planted is in sod, kill the sod with a herbicide in the fall and repeat in spring, if needed, and then drill directly into the killed sod. Use care, however, when applying herbicides in the riparian zone because chemicals can go directly into water supplies.

If the planned buffer area has been used for row crops, disk the ground in the spring and seed the area where trees and shrubs will be planted with a mixture of 5 lb. perennial rye and 7 lb. timothy per acre. These cool-season grasses are less competitive with trees and shrubs than other species. Check with your NRCS office for recommended grass species. Disk and pack the area that will be planted to switchgrass in the buffer strip. Use 10 lb. switchgrass per acre. Mow two to three times the first year to control broadleaves.

Replace any clay or perforated drainage tiles running through the buffer strip with solid PVC tile. Once the buffer strip is established, tree roots can plug non-PVC or perforated PVC tiles. If tiles cannot be replaced, plan to plant a strip of cool-season (waterway mix) grasses or very shallow-rooted shrubs above the tile. This strip should be at least 30-40 ft. wide, centered over the drainage line.

Plant materials

Trees and shrub seedlings and/or unrooted cuttings can be obtained from various forest nurseries. Order plants early to get desired species and type of planting stock. Consider ordering 10 to 15 percent more trees and shrubs than what you think you will need. The additional plants can be planted in a nearby "holding" area and used for replacement plantings.

Plant trees and shrubs as soon as possible after receiving them. If planting must be delayed, keep plants cool and moist. Always use high quality stock, and try not to use stock with inadequate root systems (most quality hardwood seedlings should have a minimum of four to five large lateral roots, or more, if possible).

Soak unrooted cuttings for 24 hours in water before planting. Soak rooted seedlings 2-4 hours before planting.

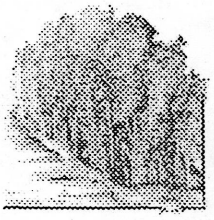
Layout

Tree rows should be 6-10 ft. apart. Depending on species and desired results, leave 4-8 ft. between each tree within the row. If production of biomass for energy is a goal, then use closer spacing between rows and within rows. For timber production, use the wider spacing between rows and within rows. Shrub rows should be 4-6 ft. apart and, depending on species, leave a 3-6 ft. space between plants within the row.

Space plants far apart so that the area can be maintained by mowing or narrow-band herbicide treatments along plant rows the first three years.

Planting

Trees and shrubs should be planted in early spring (between March and May, depending on the region) using one- to two-year-old seedlings of most species and rooted or unrooted cuttings of hybrid poplar and willow. Machine, auger, or shovel planting tech-



niques can be used. Root collars of seedlings should be slightly below the soil surface. Make sure planting holes are closed and the soil around the root or cutting is firm. For unrooted cuttings, plant deep enough to leave only 1-2 buds above ground.

Use a prairie seed drill to plant warm-season grasses and forbs. Use 8-10 lb. switchgrass seed per acre, and plant by late June. Seed can be drilled into killed sod, or into disked and packed soil.

How to maintain a buffer strip

Weed control

Weed control is essential for survival and rapid growth of trees and shrubs in a buffer strip. Options include 4-6 inches of organic mulch, weed control fabrics, shallow cultivation, or preemergent herbicides. Non-chemical weed control techniques are preferred because chemicals can quickly enter the water system in riparian areas. For larger plantings, preemergent herbicides, such as Goal, Surflan or Oust, may be needed for weed control (always read and follow label instructions). Glyphosate can be applied as a shielded spray for post-emergent weed control.

Continue weed control until woody plants occupy the area, normally 2 to 3 years. For more information about weed control, contact your state service forester, or state extension forester.

Mowing

The grass between the tree and shrub rows in buffer strips must be mowed once or twice during the growing season to identify row locations. Late fall mowing also removes rodent habitat that helps minimize plant damage during winter months.

During the first year, cut warm-season grasses to about 4 inches when weed growth exceeds 12 inches. Mow the area again in mid- to late-September to a height of about 8 inches. Mowing reduces competition from weeds in the warm-season grasses and helps them become established during their first year. If possible, burn the grass zone in early spring each of the first five years.

Inspect the area after every major storm. Repair washed out areas and replace plants damaged by heavy surface runoff or floodwater as soon as possible.

Long-term management

Buffer strips must be monitored and managed to maintain the area's maximum benefit of water quality improvement. They should be inspected at least once a year, and always within a few days after severe storms for evidence of sediment deposit, erosion, or concentrated flow channels.

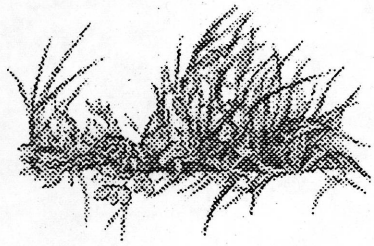
After the first five years the grass zone in the buffer strip can—and should probably—be harvested or burned on an annual or biannual basis. Periodic or regular removal of biomass promotes dense upper plant and root growth, which is needed to improve soil quality and filter pollutants. If a berm from tillage or sediment trapping develops along the field edge of the grass zone, a disk may be needed to pull the material back into the crop field from time to time.

If the warm-season grass zone cannot be harvested, some of the grass can be removed by controlled grazing, using fences to keep livestock away from and out of the stream. Remember to consider wildlife habitat and nesting issues in these management decisions.

The use of fast-growing tree species (willow, cottonwood, poplar, silver maple, and green ash) ensures rapid growth and effective uptake and use of nutrients and other excess chemicals that could pollute our waters. To remove nutrients and chemicals stored in their stems, it may be necessary to harvest these fast-growing trees every 8-12 years once the trees are established. Periodic harvest also promotes continued vigorous growth. If harvested in winter, these species will regenerate from stump sprouts after harvest, thereby maintaining root system integrity and result in continued protection. Trees can be harvested in whole rows, blocks (several feet within rows), or small groups (several rows each for several feet). For a continuous annual harvest after the first eight years, remove $1/8$ to $1/12$ of the total tree zone each year and make sure the harvested trees regrow.

If the buffer strip has high-value species, such as black walnut, red or white oak, or white ash, these trees can be managed for sawlog production. Tree selection and thinning promote faster growth and higher quality material than trees allowed to grow without management.

If problems with beaver develop, such as loss of large numbers of trees or unwanted beaver dams, a controlled trapping program may be needed. Increased diveristy attracts many kinds of wildlife to an area including some which may be perceived to be a nuisance. Permission must and can be



obtained from most state natural resource departments to trap nuisance animals.

For more information

Information about riparian zone management systems is being developed by Iowa State University and the Leopold Center for Sustainable Agriculture. Support for this work and the development of these publications is from the USDA Forest Service—Northeast State & Private Forestry, the Leopold Center, and the Iowa Department of Natural Resources through a grant from the U.S. Environmental Protection Agency under The Federal Nonpoint Source Management Program (Section 319 of the Clean Water Act.

To arrange a guided tour of demonstration sites or find out about field days, contact the Department of Forestry at 251 Bessey Hall, Iowa State University, Ames, Iowa, 50011, (515) 294-1458; fax: (515) 294-2995, or e-mail: rschultz@iastate.edu.

For specific information about various riparian management techniques, get other publications in this series at any ISU Extension office. They are:

- *Stewards of Our Streams: Riparian Buffer Systems*, Pm-1626a, and
- *Stewards of Our Streams: Bank Stabilization*, Pm-1626c.

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