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, help recharge underground water supplies, prevent soil erosion, and preserve wildlife habitat. Trees in the buffer strip also 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 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 demonstration 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.

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 closest to the stream is a minimum 30 ft.-wide strip of trees (four to five rows). The middle zone is a minimum 12 ft.-wide zone of shrubs (one or two rows).

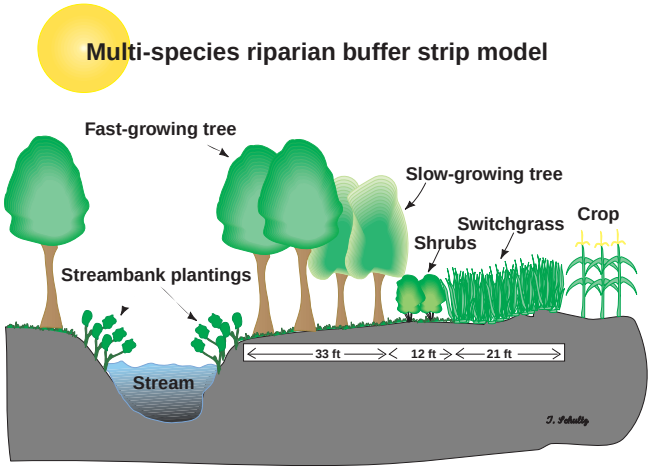

Figure 1. The natural benefits of a riparian (or river) zone can be re-created by planting strips of trees, shrubs, and grasses, and stabilizing streambanks, shown above, as well as constructing small wetlands to capture tile flow from nearby fields. Source: Iowa State University , 1995.

Farthest from the stream, next to cropland, is a minimum 20-24 ft.-wide strip of native warm-season grasses.

This combination of trees, shrubs, and grasses helps protect the stream more than planting a single 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 effective 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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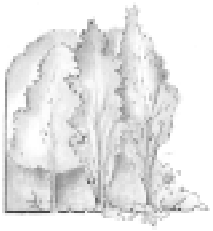
PM 1626b April 1997



Tree zone (next to 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 in this zone (rows one and two and possibly three) 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, four, and five), hardwoods such as black walnut, red and white oak, and white ash can be planted to produce high-value timber. If the water table is at least three feet below ground 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.

Figure 3 shows how diversity in the buffer strip can be increased by alternating groups of 10-50 trees and shrubs of each species within a row. Combinations in adjacent rows can consist of the same species to provide small clumps of one species. For example, 50 Eastern red cedar trees could be planted in the two outside rows (25 in each) to provide winter cover for wildlife. Similar combinations of shrubs and native grass can be used.

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

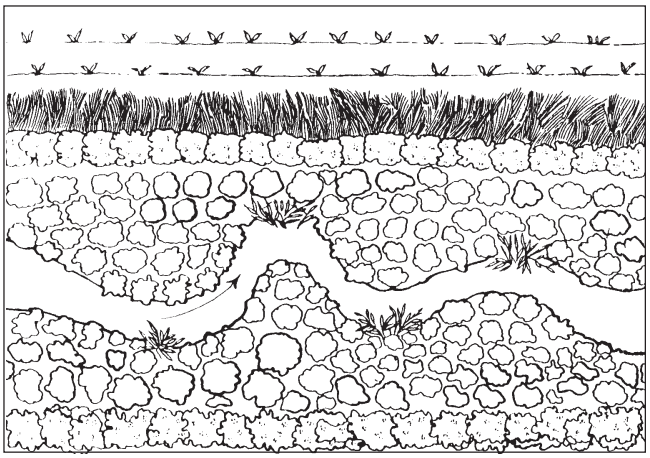
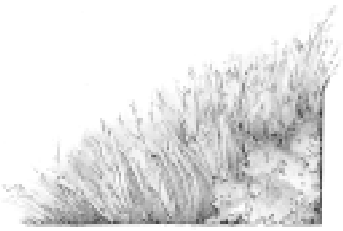


Figure 2. Using buffer strips to straighten tillage boundaries.
Source: Iowa State University

Shrub zone

Shrubs also develop a perennial root system, add diversity and wildlife habitat to the ecosystem, and help slow floodwater when the stream leaves its channel. One or two rows of shrubs are recommended. Shrub species successful on ISU test plots include 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 (shown in Figure 3, next page) either by planting a different kind of shrub in each row or by block planting. A mixture also prevents loss of benefits if one species fails. Shrubs used on ISU test plots are readily available from local nurseries, easy to establish, and have a moderate to fast growth rate.



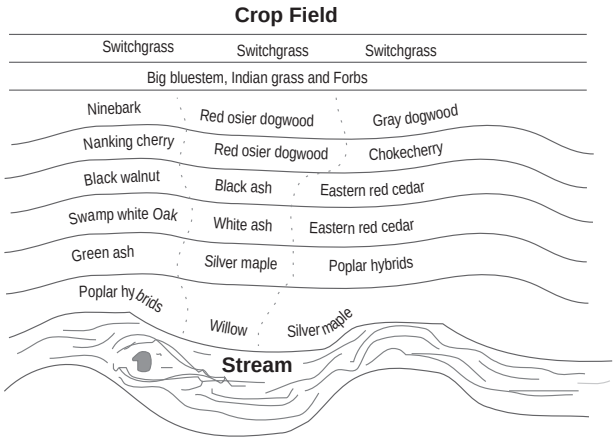


Figure 3. A multi-species buffer strip should be used on both sides of the stream. This plan shows diversity and block planting of species. Source: Iowa State University

Grass zone (next to cropland)

The warm-season grass zone is located on the outside of the buffer strip nearest the field crop. Where surface runoff is a problem, a minimum 20-24 ft. width is recommended. Switchgrass is preferred because its dense, stiff stems slow the overland flow of water, allowing water to infiltrate and sediment carried by water to be deposited in the buffer area. In addition, 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, however; always maintain a 10-ft. switchgrass strip at the edge of a crop field. Black-eyed susan and purple- and gray-headed coneflower also might be planted with grass to intercept surface runoff that might occur. 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 other native grasses. Cool-season grasses, such as brome and fescue, are not appropriate for the grass zone because they do not tend to remain upright under the flow of water. They also produce up to eight times less root mass than native grasses and, therefore, do not improve soil quality as quickly or as much as the same planting of warm-season grasses.

Other species combinations

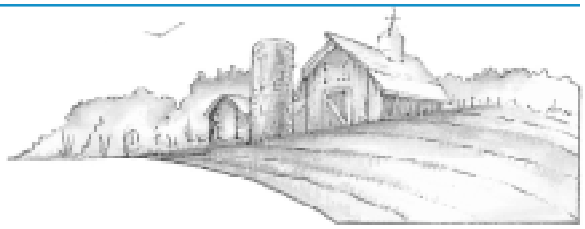
Combinations already described provide the most effective buffer strip, but they are not the only species that will provide water quality, habitat, and timber benefits. Site conditions, surrounding land use, owner objectives, and cost-share program requirements should be considered in determining combinations 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 increase timber or wildlife habitat. In either case, permanent woody roots are maintained, but use a mixture of species.
- Plant the entire buffer area to warm-season prairie grass. The area closest to the stream could include a mixture of grasses and forbs, but always maintain a 24-ft. strip of switchgrass along the edge of a crop field. 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 and is best suited where streambanks are not very high or steep.
- Where grazing is desired and adjacent crop fields are more than several hundred feet from the stream, plant warm-season prairie grass in a 15- to 20-ft. strip along the stream and completely fence that area. Fencing regulates stream crossings; watering sites must be provided 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 and could be harvested.
- Broadcast or randomly plant a mixture of tree and shrub seeds 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

The recommended width of the buffer strip depends on many factors including slope, soil type, farming practices, size of crop fields, and the landowner's objectives. ISU test plots show that for removing agricultural



chemicals and sediment from surface and subsurface runoff, buffer strips should be at least 66 ft. wide on each side of the waterway. A buffer strip less than 66 ft. wide does not hold water in the root zone long enough for chemicals to be removed from the water, although it can trap most sediment moving in surface runoff. To make a buffer strip wider than 66 ft., increase the width of any of the three zones.

Here are guidelines and information developed by researchers in other regions of the country:

- If the only objective is to remove sediment from surface runoff, a 50-ft. buffer strip may be sufficient on slopes less than 5 percent.
- 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 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 forested buffer strip.
- NRCS land capability classes also can be used as a guide in determining buffer strip widths. Land capability classes can be found in NRCS County Soil Surveys and show, in general terms, the suitability of soils for most kinds of field crops. Restrictions for use usually increase with higher numbered classes. Buffer strip widths of 95 ft. are recommended 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

Site preparation should begin the fall prior to planting. If the site has been pastured, prepare it by eliminating competing perennial vegetation in 3-ft.-wide to 4-ft.-wide strips or circles where 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, if needed, in spring. Use care, however, when applying herbicides in the riparian zone because chemicals can go directly into water supplies.

If the 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 in the buffer strip that will be planted to switchgrass. Use 10 lb. switchgrass per acre. Mow two to three times the first year to control broadleaf and grass weeds.

Replace any clay or perforated drainage tiles running through the buffer strip with solid PVC tile because tree roots can plug non-PVC or perforated PVC tiles. If tiles cannot be replaced, 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

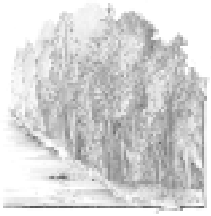
One- to two-year-old seedlings of most tree and shrub species, or rooted or unrooted cuttings of willow or poplar hybrids can be obtained from various forest nurseries. Order plants early to get desired species and type of planting stock. Consider ordering 10 to 15 percent more trees and shrubs than what you think you will need. The additional plants can be planted in a nearby "holding" area and used for replacement plantings. Seeds for broadcast planting can be collected and planted in the fall, or stratified spring planting (contact your state service forester for details).

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 with good root systems. Quality hardwood seedlings should have a minimum of four to five large lateral roots.

Layout

Tree rows should be 6-10 ft. apart. Depending on species and desired results, leave 4-8 ft. between trees within the row. If production of biomass for energy is a goal, use closer spacing between rows and within rows. For timber production, use wider spacing between rows and within rows. Shrub rows should be 4-6 ft. apart and, depending on species, leave 3-6 ft. 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). A tree planter, auger, planting bar, or shovel can be used to plant seedlings and cuttings. Before planting, soak rooted cuttings 2 to 4 hours in water and unrooted cuttings 24 hours. 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 quickly can 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 mark rows. 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 6 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 the first five years until grasses are well established.

Long-term management

Buffer strips must be monitored and managed to maintain their maximum 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. Repairs should be made as soon as possible.

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 soil 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 short, controlled grazing, using fences to keep livestock away from and out of the stream. Remember to consider wildlife habitat and nesting issues in management decisions.

The use of fast-growing tree species (willow, cottonwood, poplar, silver maple, and green ash) ensures rapid growth and effective use of nutrients and other excess chemicals that could pollute water. To remove nutrients and chemicals stored in their stems, it may be necessary to harvest these fast-growing trees every 8-12 years. If longer rotations are desired, wider spacing within rows should be used. Periodic harvest also promotes continued vigorous growth. If harvested in winter, these species will regenerate from stump sprouts, thereby maintaining root system integrity and continued protection of the streambank.

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 l/8 to 1/12 of the total tree zone each year and make sure the

harvested trees regrow or are replanted.

A buffer strip with high-value species, such as black walnut, red or white oak, or white ash, 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 diversity attracts many kinds of wildlife to an area including some which may be perceived to be a nuisance. Beaver can be trapped during regular trapping seasons. Special permission also can be obtained from most state natural resource departments to trap or destroy them outside regular trapping seasons as 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. To arrange a guided tour of demonstration sites or find out about field days, contact the Department of Forestry, 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 other components of this management system, get 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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Support for this work and the development of these publications is from the U.S. Department of Agriculture (USDA) Forest Service—Northeast State & Private Forestry, the Leopold Center for Sustainable Agriculture at ISU, and the Iowa Department of Natural Resources (IDNR). Also supporting this work are grants from the U.S. Environmental Protection Agency (EPA) under the Federal Nonpoint Source Management Program (Section 319 of the Clean Water Act), and a grant that is part of the Agriculture in Concert with the Environment (ACE) program, jointly funded by the USDA, Cooperative State Research, Education and Extension Service, and the EPA under Cooperative Agreement No. 91-COOP-1-6592.

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