
Chapter 5: Upland & Riparian Forest Buffers

In this Chapter:

- **Defining Upland and Riparian Forest Buffers**
- **Planning and Design**
- **Management and Maintenance**
- **Marketing Value-Added Products from Buffers**
- **Financial Considerations**
- **Success Stories**
- **Additional Resources**
- **Exercises**



Properly applied on a landscape, riparian and upland forest buffers can enhance and diversify farm income opportunities, improve the environment and create wildlife habitat. By developing an understanding of the interactions between a riparian buffer (trees, shrubs and grasses), the stream, and the adjacent upland area, its layout can effectively meet the goals for which it has been established. A similar understanding of the interactions of upland buffers with landscape position and annual crops is necessary to meet the design goals of these buffers. By understanding the requirements of each of the components of the buffer, it can be managed to maintain effectiveness over time, and also sustain its contributions to the farm as an integrated agroforestry practice.

What is a Riparian Forest Buffer?

Riparian forest buffers are designed combinations of trees, shrubs, grasses, forbs and bioengineered structures adjacent to, or within, a stream channel designed to mitigate the impact of land use on the stream. The term riparian applies to what is commonly called the flood-plain, and designed buffers often occupy only a portion of that landscape. At the landscape level, riparian forest buffers link land and aquatic ecosystems, and perform vital ecosystem services. By establishing, or managing, trees, shrubs and grasses in the zone adjacent to streams, water quality and aquatic ecosystem health can be sustained or enhanced. However, to be effective, buffer design and management strategies must include plants that are adapted to specific riparian environments (channel conditions, flood regimes, soils, water table depths, and upland topography), as well as provide management guidelines landowners are willing to follow to keep buffers healthy and effective.

What is an Upland Forest Buffer?

Upland forest buffers are areas of trees, shrubs, grasses and forbs planted on the contours of the upland areas of watersheds, within agricultural fields. They provide many of the same benefits as riparian forest buffers, but differ in location and are often narrower in width. They are not to be confused with the woody portion of an alley cropping system (see Chapter 3) or windbreaks (see Chapter 6) as they are primarily planted to reduce non-point source pollution and erosion, and prevent gully formation. However, depending on the site and land-owner objectives, upland forest buffers could provide some of the same benefits as these other two agroforestry practices.

Advantages of a Riparian Forest Buffer

- Reduce sediment, organic material, nutrients and pesticides in surface runoff and reduce nutrients and other chemicals in shallow groundwater flow
- Create wildlife habitat and provide wildlife corridors
- Create shade and lower water temperatures to improve habitat for aquatic organisms
- Provide a source of detritus and large woody debris for aquatic and terrestrial organisms
- Provide a harvestable crop of timber, fiber, forage, fruit or other crops consistent with other intended purposes
- Stabilize eroding stream banks and reduce scour erosion in the floodplain
- Increase carbon storage in plant biomass and soils

Disadvantages of a Riparian Forest Buffer

- Possible intensive management required, depending on design and harvestable products
- Loss of crop ground or pasture
- Flooding may damage harvestable products
- Challenges with artificial subsurface drainage (tile)

Advantages of an Upland Forest Buffer

- Stabilize crop field soils by providing a frictional perennial plant surface that slows surface runoff and traps sediment and associated nutrients
- Provides a zone of improved soil quality that allows high infiltration rates of water into the soil, allowing runoff to be filtered by the buffer before it reaches the shallow groundwater
- Provides a refuge for beneficial insects that may help control crop pests
- Provides wildlife habitat
- Slows wind that can increase evaporation from drying crop plants

Disadvantages of an Upland Forest Buffer

- Loss of crop ground or pasture
- May reduce available soil moisture for crops adjacent to the buffer

- Provides shade which may reduce growth of crops adjacent to the buffer
- Provides habitat for wildlife that may feed on adjacent crops

Riparian Forest Buffer Zones and Benefits

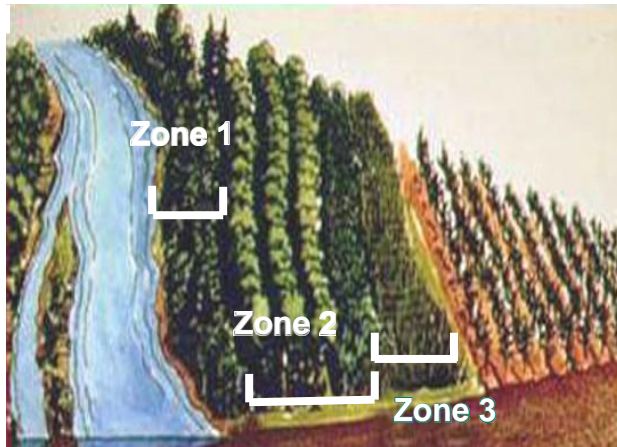
A riparian forest buffer is typically composed of three management zones, planted parallel to the stream:

Zone 1 – A zone closest to the stream bank that can include a mixture of fast growing native bottomland trees, shrubs, grasses and forbs that are designed to grow rapidly to stabilize stream banks. This vegetation should be able to tolerate periodic flooding and is not harvested to provide natural interactions with the stream channel, including shading of the stream and providing large woody debris to the channel following natural mortality or loss resulting from undercut stream banks.

Zone 2 – A much wider managed zone adjacent to Zone 1 consisting of trees, shrubs and grasses and forbs that can tolerate periodic flooding and high water tables. Upland trees and shrubs can be planted in riparian areas adjacent to deeply incised channels that have lowered water tables. Their primary water quality purpose is nutrient uptake and storage and flood mitigation. Woody stems, especially of multi-stemmed shrubs, slow floodwater and trap floating debris within the buffer keeping it out of the adjacent crop field or pasture. This zone can be managed for specific wildlife and additional income from nuts, berries, woody florals, or biomass products.

Zone 3 – An area adjacent to crop fields or pastures that provides high infiltration, sediment trapping, nutrient uptake and can help disperse concentrated runoff. Native grasses and forbs are normally preferred for their multiple benefits and adaptability, but dense, stiff-stemmed introduced grasses may also be effective. Grass and forb seeds can be harvested and sold for

other projects, or grasses may be harvested for hay or use as biomass.



The three distinct zones of a riparian buffer require individual management decisions to optimize their benefits. For example, in Zone 1, seek plants that help stabilize the bank and provide long-term support for aquatic habitat. For Zone 2, decorative woody florals, fruit-bearing shrubs and fast-growing trees are an excellent choice for additional income and to diversify wildlife habitat options. Zone 3 is well suited for native grasses and forbs.

Riparian Forest Buffers and Market Opportunities

Infiltration of nutrients, trapping sediment in surface runoff and debris from floodwaters, and stabilizing stream banks are the important water quality process functions of riparian forest buffers, but they can also provide a landowner with value-added market opportunities and enhanced wildlife habitat.

Edible berries and decorative woody florals, such as red osier dogwood and curly willow, may be planted in Zone 2 of the riparian buffer. These are valuable components of the floral and decorating industries. Nut- or fruit-bearing trees or fast-growing biomass trees planted in Zone 2 also contribute to income opportunities from buffers. Wildlife habitat for game and non-game species is significantly enhanced with the implementation of a diverse species riparian forest buffer, and lease hunting may be another economic opportunity gained through a riparian buffer system.

Planning and Design for Upland and Riparian Forest Buffers

Establishing a buffer for specific goals

When considering riparian or upland forest buffer design and implementation, it is important to understand landowner objectives and concerns; major functions of the buffer; present land-use of the proposed buffer site; soils and relief; stratigraphy and water table location; establishment methods to be used; short and long-term management methods; government programs; and market opportunities for potential products of the buffers.

The challenge to designing and maintaining a buffer system is to achieve your desired goals while also retaining the buffer's critical environmental benefits. For example, riparian buffers established for reducing stream bank erosion require designs which incorporate plant materials both on and adjacent to the eroding bank that have deep and fibrous roots that better stabilize soil. Buffers created for filtering sediment and associated chemicals and nutrients from agricultural runoff work best by slowing surface runoff, and improving soil quality that supports rapid infiltration, so water can move through plant root zones before it enters the adjacent water body. This can best be accomplished by establishing stiff stemmed grasses and forbs. Once in the soil, plant roots and soil organisms capture, transform and store non-point source pollutants that would otherwise end up in aquatic systems.

Considering your desired outcomes for a buffer is a necessary first step in creating a functional design. Landowners are strongly encouraged to work with a natural resource professional to make a sketch of the buffer on an aerial photo and identify major problem areas, such as severe bank erosion, grass waterways and gullies that exit into the existing perennial riparian plant community, drainage tiles, etc. Trees, shrubs, grasses and forbs should then be planted in their appropriate

zones to accommodate any unique problem areas. For example, trees, shrubs and deep-rooted native grasses and forbs should not be planted directly above field drainage tile lines. Shallower-rooted, native or non-native grasses are more appropriate for these sites. It is important to also be realistic about the time you have available for managing plants in buffer systems. In the case of many large scale row crop and/or livestock farms, the time required for buffer maintenance and harvesting of plants may not be available because these occur at the same time as intensive farming activities. In these cases, selecting lower-maintenance plants, or hiring a natural resource management professional to oversee the maintenance aspects of the buffer may be appropriate.

A list of the different plant species, their planting location and spacing are a critical part of the design sketch. The most effective riparian buffer, which can be as wide as 180 ft. (55 m) has three zones of vegetation, each planted parallel to the stream, as indicated in the section “Riparian Forest Buffer Zones and Benefits.” Upland buffers do not have specific zones as they are usually only 6-16 ft. (2-5 m) wide.

Many streams are deeply incised and are no longer in contact with their floodplain. Along these kinds of channels, upland as well as riparian tree and shrub species can be planted, depending on both functional and market objectives of the landowner.

A totally functional riparian buffer often requires additional riparian management practices. Examples of these kinds of practices include: 1) stream bank stabilizing bio-engineering techniques, 2) small wetlands or bio-filters to intercept field drainage tiles, 3) saturated buffers where tile lines are intercepted by lateral tiles that run parallel to the buffer causing their flow to move through the riparian soil profile to the stream, 4) stream channel stabilizing boulder weirs, and 5) controlled flash grazing practices.

Dick Schultz, professor, Department of Natural Resource Ecology and Management, Iowa State University, offers suggestions for preparing to establish a buffer:

“Before you select the kind of buffer to install along your stream, think of what you would like the stream and riparian zone to look like, and what you would like the site to accomplish. Once you have identified your objectives, walk the site with natural resource professionals and explain your objectives and desires. They may use the Natural Resources Conservation Service ‘Stream Visual Assessment Protocol’ or a similar tool to help you identify functional problems within the riparian zone. Once the site problems and objectives have been identified, select the buffer type that addresses your specific site’s needs.

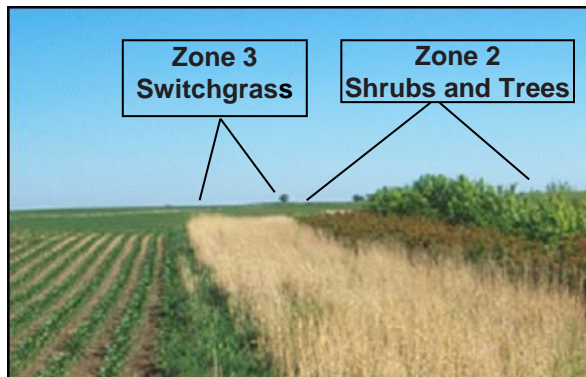
Keep in mind that riparian forest buffers and grass filter strips may not solve all of the identified problems along your stream corridor. They are primarily designed to reduce surface runoff of sediment and agricultural chemicals, bank erosion, subsurface movement of agricultural chemicals in the shallow groundwater, and degradation of aquatic or upland habitat. They are not designed to stop bank erosion along deep channels with vertical banks or stabilize the channel bed. They have no impact on groundwater moving directly through drainage tile networks, and they are not usually designed to accommodate livestock grazing. However, riparian buffers are but one tool among a number of riparian management practices.”

Key areas for consideration

Stream Channel – This involves an assessment of the shape and form of the stream channel, the material found in the stream bed and the shape and vegetative cover

of the stream banks. Channel lengths that have been straightened create problems both up- and downstream of the channelized section.

Straightening the channel increases the slope of the channel which increases the velocity and erosive potential of water moving through the channel. This can lead to increased down-cutting of the channel both up- and downstream of the channelized section. Once down-cutting has reached a resistant bed material and/or the strength of the bank soil reaches an unstable height, the banks will begin to collapse, widening the channel and encroaching on the riparian zone. Channels can be stabilized with practices such as boulder weirs and bioengineering techniques.



Adjacent to the Stream (Zones 1 and 2) – Plants growing on land in direct contact with the upper edge of the stream bank can both stabilize bank erosion and serve as a living filter. This area also functions to slow flood waters, filter flood debris, and provide both upland and aquatic wildlife habitat. Selection of the species to provide these functions will depend on their ability to withstand the frequency, magnitude and length of the flooding regime of the site and the depth to the water table during the growing season.

In Zone 1, deep rooted plant species can serve to provide bank stability along deeply incised channels. Longer lived woody roots can provide reinforcement of the bank soils and shade and organic matter inputs to the stream

channel. If the channel is incised, fast growing bottomland trees (such as silver maple, willow, cottonwood, green ash, and box elder) should occupy the first two rows adjacent to the channel to allow rapid stabilization of stream banks. These two rows of trees should be allowed to mature and die without removal to provide continuous shade and organic matter for the aquatic ecosystem, unless they are along streams with tile or other drainage roles. If drainage tile outlets are present, these rows of trees should be allowed to reach maturity but should be harvested to reduce the chance of contributing large woody debris to the channel thereby restricting drainage.

Where woody plant inputs to the channel are not desired, shrubs or deep-rooted grasses and forbs can be planted, although they do not provide the same strength to vertical banks because of their more rapid turnover. Where banks have a slope of 3 to 1 or less, these grasses and forbs can provide very effective stability.

The next two or three rows of trees or shrubs (Zone 2) can consist of bottomland or upland species along deeply incised channels where the water table during the growing season is an average of 4 or more feet (1.2 m) below the surface.

Where flooding is frequent and flood waters carry significant debris, several rows of multi-stemmed shrubs should be planted at the outer edge of the woody zone (Zone 2) to trap the debris and keep it from being deposited on the grass/forb outer zone or the adjacent crop field or pasture.

Select species adapted to the soil conditions on the site. Depending on landowner objectives, trees and shrubs that provide potential marketable timber or specialty crops can be used. Use a mix of tree and shrub species either by planting a different kind in each row or by block planting. A mixture prevents loss of benefits if one species fails and provides a more diverse wildlife habitat.

Understanding the Buffer Zone: Function and Management

Comprised of two or three zones, these zones become areas where specific plants and management are combined to create a forested riparian buffer that is highly effective at improving and maintaining water quality and aquatic habitat.

ZONE (Location, species choice)	FUNCTION	MANAGEMENT
Zone 1 (Beginning near the edge of the stream) (fast growing trees/shrub species)	<ul style="list-style-type: none"> • Shade the stream and moderate water temperature • Provide bank stabilization • Enhance aquatic habitat with organic matter • Final filter of material moving through the buffer • Reduce velocity of over-the-bank flood waters 	<ul style="list-style-type: none"> • Unmanaged zone, trees allowed to mature & fall into stream contributing important large woody debris • Large woody debris not allowed in streams with tile drainage or other specific drainage functions. • Use selective harvest, with replacement from planting or coppice resprouting • Logging equipment excluded • Grazing is excluded
Zone 2 (Beginning at the edge of Zone 1) (fast and slower growing trees and shrub species)	<ul style="list-style-type: none"> • Provide maximum infiltration • Uptake of Non-Point Source (NPS) nutrients and chemicals • Storage of NPS pollutants • Breakdown NPS pollutants • Provide forest-grown products • Enhanced wildlife habitat • Reduce velocity of over-the-bank flood waters • Trap debris moving in flood waters to keep it out of crop fields 	<ul style="list-style-type: none"> • Active management encouraged • Marketable products encouraged from trees and shrubs were feasible • Harvest should stimulate new growth • Avoid soil compacting activities • Grazing excluded • Wildlife activities such as bird watching or lease hunting
Zone 3 (Beginning at the edge of Zone 2) (grass and forb species)	<ul style="list-style-type: none"> • Slow surface runoff converting concentrated flow to sheet flow • Slowed runoff drops most sediment/debris at outside edge of zone • Remaining sediment is filtered from sheet flow • High infiltration of water delivering NPS nutrients & chemicals to soil filter • Uptake of nutrients and chemicals 	<ul style="list-style-type: none"> • Maintain vigorous vegetative growth • Remove biomass – mow and bail so as not to smother remaining plants. • Remove biomass – flash grazing possible with fencing of woody zones • Remove biomass – burn on 3-5 year cycle • Work accumulated sediments away from the buffer edge, back into the field

On non-recreational or non-incised streams, Zones 1 and 2 are often combined, and management becomes more closely aligned to that of Zone 2 alone. In each of the zones, it is important to recognize the role that buffer health plays in maintaining function. Healthy and actively growing vegetation provides the best capture and utilization of problem NPS nutrients and chemicals prior to their entering waterways.

In areas with frequent flooding, trees and shrubs should also be less densely planted so a ground cover of grasses and forbs can be established. Where the trees and/or shrubs completely shade the soil, surface erosion from

flood waters can be extensive and counter productive to the function of the buffer system. It is therefore important to maintain a woody plant spacing that allows enough sunlight to reach the soil to support a grass/forb cover.

This spacing depends on species and is usually wider than that recommended for planting timber trees but narrower than widths suggested for major nut growing plantations.

Outer Edge (Zone 3) – This zone provides the initial treatment of direct runoff from adjacent land uses. This runoff is usually in the form of concentrated flow associated with ephemeral gullies. Sheet flow or broad shallow flows are rare in cultivated field settings. As a result the intercepting plant community must present a dense and stiff barrier that can slow the concentrated flow, causing it to spread and drop its sediment load before entering the grass/forb zone and then move into the zone where high infiltration rates will allow the water to enter the soil filter.

Mixtures of grasses and forbs can be used effectively if the zone is wide enough. Width will depend on the length and slope of the adjacent crop field. If the grass zone has been established on previously cultivated riparian soil it will take at least 5-10 years to redevelop the maximum infiltration potential of the undisturbed soil. Where Zone 3 intercepts a grass waterway, a wider, triangular-shaped area should be developed to provide an apron for the water to spread over before entering Zone 3. Native warm- and cool-season grasses with associated forbs are best suited for this zone, as they remain upright under the flow of water and have deeper root systems than introduced cool-season grasses. These deep root systems, much of which are replaced annually, provide large amounts of organic matter to the soil. Organic matter improves soil quality by increasing amounts of large soil aggregates that create large macropores, which in turn favor high water infiltration rates and increased microbial activity for non-point source pollution processing.

Introduced cool-season grasses can be used but often require a zone that is twice as wide as that made up of native grasses, and may have less of an impact on improving soil quality.

The introduced grasses are easier to establish and can provide more fodder for livestock, but native grasses and forbs provide a more diverse habitat for upland game birds, such as pheasant and quail, and non-game species. As with the other zones, make sure to select those species that are adapted to the soil moisture and flooding regime of the site. It is important that the grass zone be well managed to maintain vigorous growth of the grasses and forbs (see section on Management and Maintenance of Forest Buffers). For native grass/forb filters burning or baling of the biomass on a 3-5 year rotation is required. For introduced grass strips mowing and baling or flash grazing can be used. If grazing is used, the woody zones (Zones 1 and 2) should be fenced.

It is imperative that the woody plant zone also have a grass/forb filter zone on the outside edge of the buffer. Most surface runoff from adjacent crop fields is in the form of concentrated flow. When that flow is intercepted by a woody zone that has minimal ground cover, gullies can easily form through the buffer. This is also true for grass waterways that are intercepted by woody zones without a grass/forb filter. Gullies that form in the riparian forest convey sediment to the stream and gullies can develop and move up into the crop field or the grass waterway. This is commonly the case for “remnant” forest buffers that landowners often believe act as effective buffers. If no grass filter is possible, then wider spacing of the trees and shrubs to allow a dense grass covered soil is necessary.

Additional Considerations

Width: Widths of Zones 1, 2, and 3 can vary depending on the physical characteristics of the site and the functional requirements needed to improve water quality and aquatic habitat. USDA Conservation Reserve Program (CRP) requirements will also dictate allowable widths of each of the zone. If CRP is not used to establish a forest buffer, then zone widths can be adjusted to meet management and functional objectives.

When determining the width of your buffer, it is a good rule of thumb that “wider is better.” If surface runoff is the only problem, a grass/forb filter 30-60 feet wide may be sufficient depending on the slope and width of the adjacent crop field. Concentrated flow in the form of ephemeral gullies or grass waterways may require a wider apron at the intersection of the two features. If bank stability is an issue, especially if the channel is deeply incised with vertical banks, a woody tree and/or shrub zone should be included. Buffer width may vary to address runoff hotspots as mentioned above or to adjust to field widths, especially along meandering channels. Widths of the various zones can be adjusted depending on the “needs” of the site. For example, if the crop field is relatively flat and the channel is deeply incised with vertical banks, the grass filter width could be reduced; if the crop field had significant slope and numerous areas of concentrated flow, the grass filter would remain at its designed width and the woody zones would be adjusted.

should be conducted to determine the fate of any concentrated flow entering the zone including that moving down a grass waterway.

If gullies exist from the edge of the field through the native plant community, a grass/forb filter zone should be added or widened. While buffers along the channel of an individual property can significantly reduce the sediment and nutrient load from the adjacent crop field, buffering only a small percentage of the entire length of a channel may not result in measurable improvements in water quality or aquatic habitat in the larger stream ecosystem.

Ideally streams should be buffered starting at their source and moving downstream. But any buffer along any portion of the channel is a positive contribution either directly in terms of improving water quality and aquatic habitat or by providing a role model that often stimulates other landowners along the stream to follow suit.

Impacts on wildlife habitat: Buffers can be designed to meet water quality functions, provide market options for the landowner and improve wildlife habitat. If upland birds like pheasants and/or quail are desired, a wide zone of native grass/forb filter with or without woody zones can be developed. If a diversity of non-game birds in addition to upland game birds is desired combinations of diverse woody and native grass/forb zones will provide the largest diversity. Continuous buffers along a channel will provide a connective corridor for wildlife movement.

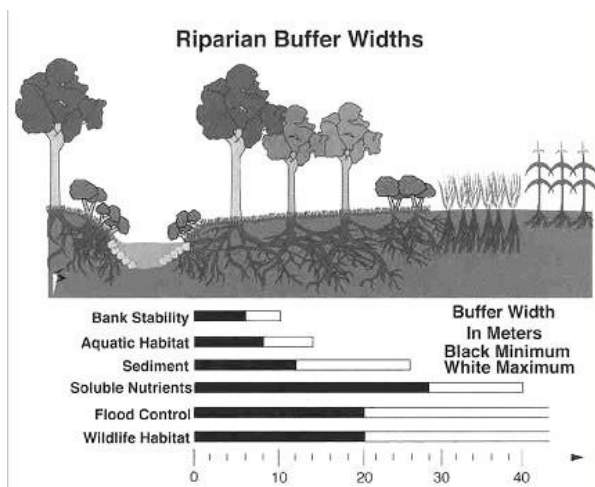


Figure 1. Riparian forest buffer widths by various sections. Source: Schultz et al. 2009.

Length: A zone of perennial vegetation should be included along the entire length of any stream channel. If a zone of woody or herbaceous species already exists, a survey

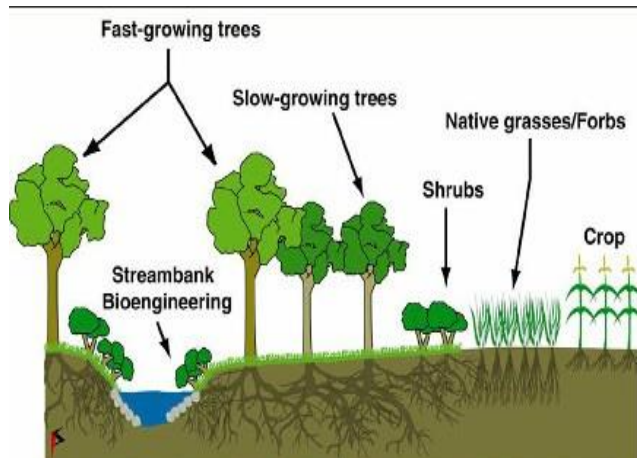


Figure 2. Selecting the appropriate species for a riparian buffer will help ensure its success and longevity. (Source: Schultz et al. 2009.)

Planting Tips and Species Selection

The selection of appropriate tree, shrub, grass and forb species is essential for the success of the buffer. When possible, select species of plants adapted to the site conditions. Often this is best accomplished by using native plants. Native plants - with proper management - will spread through underground rhizomes, bulbs or other vegetative means and are an excellent choice for the zones of a riparian forest buffer.

Compared with the roots of most non-native cool-season grasses, warm-season grasses and forbs have deep, extensive root systems that help improve soil quality and processing of non-point source pollutants. These native plants can withstand long periods of dry weather, and do not require watering unless the buffer is established in an urban setting and is less than one year old. The main considerations are: 1) selecting species that grow on potentially moist sites; 2) choosing species based on the severity of surface runoff from adjacent crop fields or grazed lands; and 3) making certain that seed of desired natives is both available and affordable. Most nursery information includes a description of sites suited for different species.

These seeds can be expensive. Most native seed nurseries have several mixtures that can be appropriate at varying levels of cost. Specific mixtures are also provided to meet specific CRP conservation practice standards.

Many forest nurseries carry one to two-year old seedlings of most tree and shrub species for planting in Zones 1 and 2 of the buffer. Use high quality stock with good root systems. Quality hardwood seedlings should have a minimum of four to five large lateral roots. Trees and shrubs should be planted in early spring, soak seedling root systems in water for up to 12 hours before planting and make sure the planting holes are completely closed so the roots do not dry out.

Consider as wide a variety of species as possible to develop diverse wildlife habitat and reduce potential diseases and insect infestations with associated loss of plants. If you plan to sell products from your buffer, identify markets prior to purchasing seeds or plants. Non-natives may also have good market value, but take care to avoid establishing invasive exotics.

To determine the most suitable species for your design, ask the following:

1. What are the functional needs of the site?
2. What are my objectives?
3. What are the problems?
4. Which species will do well on my site?
5. Which species are available from local nursery sources?
6. Will harvesting of products from these species occur at the same time as other land management activities (field cultivation, planting, harvesting, etc.)?

Species Combinations: *Here are species combination possibilities that could provide important riparian buffer functions.*

- Replace shrub rows with trees, or tree rows with shrubs, to increase timber product or floral and/or fruit product options or provide more diverse wildlife habitat. In either case, permanent woody roots are maintained with a mixture of species. Numerous different combinations of trees and shrubs and grasses and forbs can be used to more closely mimic the kind of riparian habitat that might have been native to an area. For example, where a shrub thicket of willow and shrubs might have been typical and the channel is not deeply incised, the trees can be completely removed from Zones 1 and 2 and a combined shrub zone created.
- Plant the entire buffer area to warm-season prairie grass. Some bank-stabilization may be needed (i.e., willow or red osier dogwood planted on the stream bank) to provide long-term stability. This system is best suited to riparian areas that are still in contact with the channel where banks are not high and are gently sloped.
- Where riparian grazing is desired and adjacent crop fields are more than several hundred feet from the stream, plant a native grass/forb mixture in a 15- to 20-ft (4.6-6 m) strip along the stream and completely fence that area. Fencing keeps livestock off the banks and can direct livestock to armored crossings and access to water for drinking. Ideally these would be minimal with watering sites provided away from the stream.
- Use direct seeding and broadcast or randomly plant a mixture of tree and shrub seeds or seedlings in both tree and shrub zones to naturalize the planting and avoid rows. (Source: Iowa State University Extension, "Stewards of our Streams" series,

Resource professionals at your local NRCS, state department of conservation or natural resources, or university extension office can assist you with species selection.

Planting an Upland or Riparian Forest Buffer

Woody species planting is best done with seedlings. Direct seeding can be done in some situations but the density of the ensuing stand of trees often is too dense to allow a complete herbaceous ground cover to develop. Preparing a site for tree planting depends on the existing cover of the site. If the buffer is to be planted into an existing crop field, seed the area to a mixture of perennial ryegrass and timothy. Seedlings can be planted directly into this minimally competitive grass mixture. After planting, spray a 4 foot wide strip centered over the trees with a grass killing herbicide.

Mow the grass strips between the tree rows for the first three to four years. Late season mowing will reduce winter habitat for rodents that can girdle seedlings. Distance between tree rows should be wide enough to support the mowing equipment that is available and to allow grass cover to remain throughout the life of the buffer. If the woody species are going to be planted into an existing grass or mixed grass- and forb-covered riparian zone, four foot wide strips should be sprayed with glyphosate prior to planting. Once seedlings are planted, keep this strip grass- and forb-free for the first 3-4 years and mow the strips between the rows of trees. Spacing of trees should range from feet (3-4.6 m) between rows and 8-10 feet (2.4-3 m) within the rows.

Site preparation for planting Zone 3 grasses and forbs in a filter strip can take numerous forms. If the site was previously in pasture, burning down the existing pasture vegetation with glyphosate in the fall and again in the spring, and then using a prairie seed drill can result in a good stand of plants. If the site was previously in row crops, light tilling of the surface to kill early weed species, followed by surface packing with a cultipacker and then using a seed drill will provide a good stand. Annual rye or oats can be mixed in with the native grasses and forbs if rapid cover is desired, especially in areas that are prone to flooding.

For woody plant establishment, site preparation

should begin in the fall, followed by spring planting.

Brad Riphagen is a Field Coordinator for *Trees Forever*, a non-profit organization founded in 1989 dedicated to planting and caring for trees and forests. He offers suggestions for planting trees, shrubs and grasses.

“When seeding grass and forbs, a firm seedbed is needed to ensure that the small seeds are in contact with the soil yet remain close to the surface. You can drill directly into soybean stubble and into sod that has been killed with glyphosate. When planting trees and shrubs into a crop field, it is a good idea to drill grasses, like timothy or perennial rye, which won’t out compete the trees and help to prevent erosion.

Order trees and shrubs early, up to four months before scheduled planting time to assure receiving the desired species. For direct seeding of most trees or shrubs, collect or purchase seed and plant in the fall. Direct seeding in the spring is possible if you can purchase seed from a dealer. Plant tree and shrub seedlings as early in the spring as site conditions allow. Grasses and forbs should also be planted in the spring.”

Management and Maintenance of Upland and Riparian Forest Buffers

Managing an Existing Streamside Forest for a Riparian Buffer System. Buffer function should be a primary consideration in management. Therefore, management of existing buffers should focus on either maintaining or enhancing buffer function. Although plant materials may be alive and growing, they may not be growing vigorously and be in the best of health. Plants with vigorous growth will have enhanced uptake and use of nutrients. This also equals greater storage of materials that would otherwise

travel into the water system. Management strategies need to look toward creating stronger plants, resulting in plants that are more likely to survive environmental stress, such as seasonal flood events. Natural life spans of plants should also be considered. Under proper management woody plants will grow vigorously until they have matured at which point their physiological processes will reach a plateau and begin to decline. When woody plants have reached this point they no longer add major stores of agricultural nutrients and chemicals and should be harvested and replaced with young seedlings or coppice stems from stumps or roots.

Densities of woody plants in existing stream side forests are often too great to support good perennial plant cover on the soil surface. Therefore one of the most important management tasks for maintaining buffer function is to thin the forest to allow light to reach the forest floor. If this is not done, gullies will form in the forest at points where concentrated flow, either from ephemeral gullies or from grass water- ways entering the existing forest. These gullies are sources of sediment in the stream and will ultimately work their way out of the forest buffer and into the adjacent crop field or pasture.

Management and Maintenance of Planted Forest Buffers. Function is maintained when the buffer zones are maximizing their potential for plant growth. For grasses and forbs, this may mean mowing or selectively applying flash or rotational grazing at appropriate times of the year (such as dry and not wet periods). This can assist in minimizing the accumulation of dead grass material and enhance overall grass and forb growth and vigor. However, it is crucial that access to adjacent woody zones or the stream or creek be limited. One method of limiting access is to only have fenced access available in small, planned areas (Figure 3). Additionally, grass zones adjacent to crop fields may occasionally need to have accumulated soils pulled back into the field. This can be accomplished by directionally disking such that soil is moved away from the grass edge.

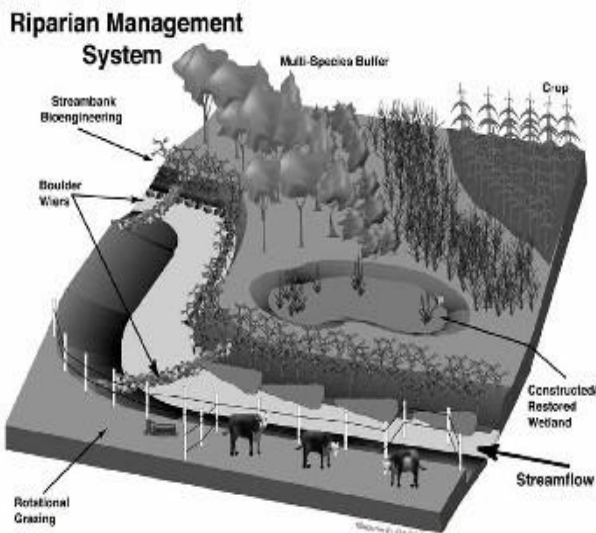


Figure 3. Riparian management system with livestock access restricted by fencing. Source: Schultz et al. 2009.

In the shrub zones, management may include such practices as cutting the shrubs back and control of invading grasses and weeds. In the timbered zone, thinning and selective harvest may be used to keep the remaining trees and herbaceous ground cover in a state of health and vigorous growth. Also, your management plan in the timbered zone should take into account the need for regeneration and the establishment of new seedlings. This can either be natural or artificial, such as when planting new seedlings. It is important to remember that as trees age, slower growth rates and death are natural. One management tool then, is to harvest mature trees prior to their death, degradation, or breakdown, when they may otherwise become debris in the waterway that inhibits proper flow or release stored nutrients back to the ecosystem.

Enhancement. From time to time, in spite of any maintenance that may be completed, it may also be necessary to enhance or enrich the buffer to maintain the desired functionality. This may be as simple as planting additions (over-seeding grass zones or planting trees or shrubs in openings created by harvest or loss

from flood damage). Remember, the goal is to have a healthy and vigorously growing buffer, and one without gaps that would allow water to channel through.

Maintenance begins at the time of buffer establishment and may include mulching, mowing, and herbicide application for weed control until trees and shrubs are large enough to compete on their own. A native grass and forb zone planting requires about 3 years to become well established. During the first 2-3 years it is important to mow the grass and forb zone as high as possible to reduce annual weeds, but without removing the young grasses and forbs.

You can increase the filtering capacity and potential economic returns by trimming, cutting back, mowing, or harvesting the shrub, grass and forb species. By keeping the plants in a state of vigorous growth, they will actively filter more soluble nutrients from the water.

Finally, inspect the buffer annually and after significant storm events to determine the need to remove excess sediment at the cropland edge of the buffer that can prevent shallow runoff from flowing evenly through the buffer, or to repair concentrated flow cuts through the buffer.

Replanting and reseeding. Replanting and reseeding are important maintenance practices during the first few years following establishment of a riparian buffer and can be done in the spring or fall. Replace significant losses of tree and shrub seedlings during the first three years to ensure the desired plant density of the mature buffer. If more than three or four consecutive seedlings have died they should be replaced. Spot planting can be done quickly with just a bucket full of water, seedlings and a shovel. Protecting young trees and shrubs from deer, rabbits and beaver can be expensive, but may be necessary in some cases.



Applying a chemical barrier helps seedlings get off to a good start.

Replanting in the native grass/forb zone may be a bit more involved, depending on the density and quality of the grasses and forbs. If there is poor establishment, a herbicide like glyphosate can be used, followed by re-drilling. If there is some establishment, but not as dense as desired, the site can be directly reseeded. If the areas needing reseeding are large a prairie seed drill can be used, if they are small, hand-spreading the seed and raking it into the ground is acceptable.

During the life of a forest buffer, trees will begin to compete with each other as they do in a natural forest, and without pruning and thinning they will not maintain an optimal growth rate. They will also provide such a dense shade that no living ground cover that completely covers the soil to reduce erosion from out-of-bank events will be able to exist. Depending on spacing, fast-growing trees such as cottonwoods and poplars will be competing with each other within 10 years of planting. After 8 to 9 years, every second or third tree may have to be harvested to increase water availability and growth space for remaining trees.

Prescribed burning. Fire is a good maintenance tool for native grass and forb plantings associated with upland and riparian forest buffers. To reduce weed competition and invigorate the grasses and forbs during the year, prescribed burns are usually performed early in the spring. During this time, many of the competing introduced cool-season grasses, weeds and woody plants begin growing while

the warm-season native prairie plants are still dormant. Always develop a prescribed burn plan prior to burning. Assistance for developing a prescribed burn plan may be available through your state department of natural resources or conservation.

While different burning frequencies may be used, an annual spring burn for the first three or four years is recommended. Following establishment of a good stand of desired grasses and forbs, a burning cycle of once every three to four years can be used. The burning cycle is usually defined by the accumulation of dead plant material on the ground, weed species invasion and general vigor of the plant community. Fall burns also can be used to stimulate forb growth more than the grass growth. However, they may be problematic if adjacent crops are not harvested, and will reduce winter habitat for wildlife.

Burning the native grass and forb component of an upland or riparian buffer can be tricky due to the close proximity of shrubs and trees. Such a burn requires numerous people, careful planning, attention to fuel sources and amounts, and attention to wind. Using a small, slow backfire (a fire that burns into the wind) helps to keep the fire more controlled while it is close to neighboring shrubs and trees. A fire break is often mowed or raked between the shrubs and/or trees and the native prairie component. The fire break can be wetted if the fuel is dry.

A good strategy is to burn when steady wind (10-15 mph) (16-24 kph) is blowing away from the woody zones. This way, a backfire can be started with a drip torch along a firebreak and allowed to burn into the prairie grass filter. The fire moves slowly because it is burning into a prevailing wind. Once the backfire has burned a strip of 10 - 15 feet ((3-4.6 m) in width, a head fire (burning with the wind) can be lit and allowed to burn rapidly with the wind. If there is heavy corn stover left along the crop edge, care must be taken to keep the fire out of the field. This can be done by raking or wetting

the stover or running a disk along the edge of the grass/forb zone just before the fire is lit. The crew, equipped with fire rakes, fire swatters, and backpack sprayers, should patrol the burn to keep it contained. Fires should be kept small and well controlled (start small to test the wind, moisture conditions, and to train your crew). A water tank in a pickup truck fitted with a small pump and garden hose can be very useful for wetting the fire break and corn stover. If you have not performed a controlled burn before, you should ask for assistance from a local natural resource professional who has experience dealing with controlled burns. Consideration should be given to the influence of burning on nesting birds and small mammals.

Ideally, you should burn in sections; burn only one side of the creek or break the grass/forb zone into three or four sections and burn one each year. Fall burns eliminate winter cover and late spring burns can destroy nests. However, fire helps to maintain native plant health. Most native prairie plants will grow more vigorously, produce more flowers and produce more seed after a fire. The active growing points of most prairie plants are below or just at the soil surface, and are therefore unaffected as the fire rapidly passes over. After the fire, these plants are stimulated by warmth of the blackened ground and the nutrients that were released from burned plant material. (End: Iowa State University Extension contribution)

Other Riparian Practices that May be Required

Specific Considerations for Stability: Stream Bank Structures

In some cases, erosion caused by runoff and/or sloughing of stream banks is too excessive to be stabilized by a Forested Riparian Buffer alone. Therefore, to quickly stop erosion, it may be necessary to use stream bank bioengineering. This is an expensive and intensive practice and is only appropriate for specific trouble spots.

Stream bank bioengineering can:

- Be used to change the steep angle on actively eroding banks to a more gradual slope on which plants may then become established,
- Slow water movement and reduce erosion by adding frictional material to stream banks,
- Reduce undercutting,
- Reduce stream sediment loads,
- Improve water quality,
- Improve aquatic habitat and wildlife habitat.

The following bioengineering practices and structures can be used singly, or in combination, to create a more stable stream channel and bank.

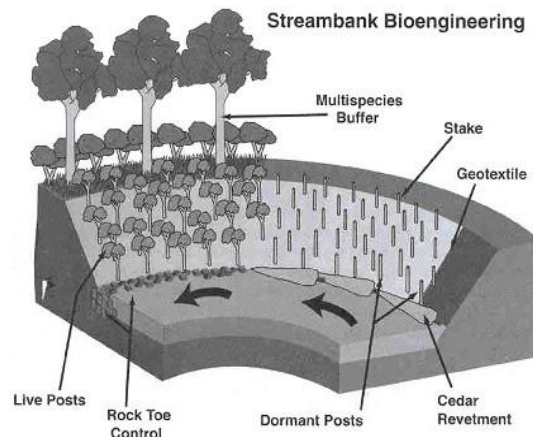


Figure 4. A combination of live and dead materials used in the stream bank bioengineering practice. Source: Schultz et al. 2009.

Rock rip-rap. Rocks anchored to the toe of the stream bank. This type of stabilization is useful in areas of severe undercutting. Size of the rock is directly related to stream size, and the volume and velocity of water flow. Larger streams with increased water volume and velocity will require larger rock. A mixture of rock sizes is often appropriate to provide a surface with minimal openings that allow water to move through turbulently. In no case should

large chunks of concrete be used for this purpose as they often allow large gaps that water is forced through at higher velocities and turbulence that can erode the soil behind the concrete slabs. In order to avoid undercutting of the anchored rock, the rip-rap should extend to stable material in the channel bottom. In some cases, it may be necessary to reshape the streambank prior to rock placement.

Tree revetments. In smaller streams, (1st-3rd order) cut trees can be anchored along the toe of the bank in place of rock rip-rap, with the butt of the tree facing upstream. Eastern red cedar is ideal for this purpose, as it can hold its leaves for more than a year following cutting; however, bundles of branches from other tree species can also be used. The dense branches provide significant friction that slows water and drops sediment, creating a stable bank toe on which other plants can become established. Logs and branches can also be hiding places for aquatic organisms. Planting willow cuttings and/or red osier dogwood seedlings above the cut trees or branch bundles can increase the stabilizing potential of this practice.

Geotextile fabrics. Fabrics of jute, coconut, or other fibers may be used in conjunction with any of the living structures. These fiber mats will hold soil in place while the live plant material becomes established. The fabric can be held in place with stakes and/or placed in the trench with fascines and covered with a shallow layer of soil.

Live post and stakes. By using dormant plant material, stream banks can be quickly stabilized. Dormant material (cuttings) of a few selected tree and shrub species (particularly willows) will quickly develop root structures below ground and produce live shoots above. Stakes of one-half inch diameter and larger are driven into an eroding bank. The longer the stake, the better stability that is provided because the more roots will sprout along the stem. Lengths may range from 2 to 3 feet for stakes, and up to 10

feet for posts. Installation should begin with the larger stakes being placed at the base, along the water line, and the smaller stakes planted into the upper stream bank.

Live fascines. Also known as wattles, these are bundles of live, dormant branches (whips) primarily of willow species. The material used is often the smaller diameter tops associated with the stakes that were installed as described above. Individual whips should be at least 4 feet (1.2 m) in length. These branches are then overlapped, with all butts and buds pointed in the same direction, to form bundles of up to 8 inches (20 cm) diameter and 10 to 20 feet (3 – 6 m) in length. As with live stakes, it is desirable to use species which will quickly root. Place the fascines in shallow trenches, leaving the upper live buds exposed. Soil should be tamped into place around the bundles and a dead stake used to anchor them in place. By placing fascines along the contour, small branch dams are formed against soil movement. This will create a terraced effect on stream banks. Bundles should be spaced from 3 to 6 feet (0.9 - 1.8 m) apart with narrower spacings used on steeper banks.

In-stream structures. Where channel incision is still actively occurring and stream banks are unstable, or where there is a lack of in-stream habitat, rock structures, such as boulder weirs can be constructed. These structures are constructed of properly sized rock and are no more than 1.5 to 2 ft. (0.5 – 0.6 m) high at their center. They are usually constructed with a slight V in the center to direct flow down the center of the channel. They have an upstream rock apron with a 4:1 slope and a down-stream apron with a 20:1 slope. These aprons reduce the turbulence of the water, while allowing enough to improve oxygenation of the water. These structures are usually used in series, allowing the pool of the downstream weir to back up to the apron of the upstream weir. This placement reduces channel bed erosion. Providing pools that are 1.5 to 2 ft. (0.5 – 0.6 m) deep reduces the critical bank height at low flow, thus reducing bank erosion. (See Figure 3, page 8).

Field Tile Structures. Artificial subsurface drainage (field tiles) passes directly through riparian forest buffers with no treatment of the water flowing in them. For any treatment of contaminants in the tile water to occur, the water in the tile must exit the tile and move through the living soil filter of the buffer. Two promising new techniques can achieve significant treatment of tile flow: biofilters and saturated riparian buffers.

Biofilters consist of passing the tile flow through a large volume of woodchips that have been buried in pits in the soil. The woodchips provide a habitat for microorganisms that can reduce nitrate and other contaminants. These pits can be developed as part of the grass/forb filter or can be placed directly upslope of Zone 3. Pits are usually about 4 feet (1.2 m) deep with an average size of 15 ft. by 100 ft. (4.6 – 30 m). A soil layer is placed over the buried chips and planted to grass. Equipment can travel over the pits although planting row crops directly over them is not recommended. The woodchips will need to be replaced periodically, perhaps every 10-20 years.

Saturated buffers consist of intercepting a field tile before it flows below the riparian buffer and splitting the flow into lateral tiles that run parallel to the buffer. The water in these lateral tiles then flows through the living soil filter of the riparian buffer. In an early test of this system at least 60% of the flow from the primary tile was diverted into the laterals and water moving through the buffer soil showed over 90% reduction of nitrate-nitrogen.

Considerations for Wildlife

One of the most notable benefits of using native plant species in a buffer is the creation of effective wildlife habitat. Native grasses and forbs provide different heights, densities, shapes of stems and leaves, different flowering times, and different flowers and fruits to attract different species of wildlife. The key is to plant as wide a mix of species as possible to achieve the maximum wildlife benefit.

Planting pure native warm-season grass strips with one or two species is more effective than just one species of introduced low-growing cool-season grass, but planting 5 or 6 species of native grass and 25 forbs provides much more habitat potential. Similarly, planting mixtures of trees and shrubs will provide more diverse structural habitat, but if a landowner is mainly concerned with upland bird habitat, trees provide perches for predator raptors that may prey on the prairie birds. In a recent study of bird use of riparian forest buffers over 40 species of birds were found in a three-zone riparian buffer where only 12 species were found in an area similar to the pre-buffer condition of the site.



Lease hunting is an opportunity for income from the wildlife habitat created by your riparian buffer. (MDC photo) Improved wildlife habitat for species such as ducks, pheasant and quail, are another benefit of riparian buffers.

Jim Wooley is the Field Operations Coordinator for Quail Forever, a non-profit organization dedicated to the protection and enhancement of pheasant and other upland wildlife populations through habitat improvement.

“Quail Forever and Pheasants Forever are interested in riparian buffers and other buffer systems because of the habitat that these types of practices provide for pheasants and other wildlife, including non-game wildlife. Beyond that, establishing a buffer offers an exceptionally good economic benefit for a landowner. He’s taking ground that in a lot of cases is productive, but may have some problems associated with it. In some cases, we’re looking at cash rentals and incentives that approach two hundred dollars per acre. That’s an excellent return on the ground, and the buffer is providing many benefits, not only to the landowners, but to society in general.”



Improved wildlife habitat, such as ducks and quail, are another benefit of riparian buffers.

Market Opportunities with Upland and Riparian Forest Buffers

Many products grown in the buffer have monetary value in addition to their functional conservation benefits. A trip to a local florist or craft store will give you an idea of the diverse

uses of plants and plant stems that could be harvested from an upland or riparian buffer with the proper species. It may also be helpful to ask if local stores are interested in purchasing locally and sustainably grown materials. At that time, inquire how they would like to receive the material (condition and packaging).



Willow and dogwood branches are bundled for sale to retail and wholesale florists, bringing as much as 50-75 cents per branch in some markets.



Markets for nut crops like black walnut (background) and pecan (inset) include farmers’ markets and retail/specialty grocers.

Decorative woody florals and craft products.

Decorative woody florals can be planted in Zone 2 of a riparian forest buffer for additional income. This category includes any woody plant species that has a colorful or unusually shaped stem, bud, flower, fruit or leaf. Common examples include pussy and curly willows and red- and yellow-stemmed dogwoods. These plants, and many others, are regularly used in the floral industry to add height and breadth, enhance line and form, and add a splash of

color. They retain their bright colors for a long time, extending an arrangement's usable life. Woody florals accent cut-floral arrangements and enhance consumer perceptions of size and value, and can make a statement even when used alone in a vase design. They can be sold to retail or wholesale florists by the stem or the bundle at competitive prices.

Learn more about decorative woody florals through research conducted by the University of Nebraska Extension Forestry Program.

Market Opportunities	
Examples of 'marketable' products	Timeframe to reach market potential
Floral and craft products	Beginning approximately 2 years after establishment, and if done correctly (i.e. plants re-sprout), continuing for many years
Berries and nuts	From 2 to 15 years, depending on the crop
Biomass	3 to 20 year rotation, market dependent
Timber trees	In most cases, 40+ years

Berries and nursery stock. Various species of edible berries, including elderberries, blackberries and raspberries, can be grown in the shrub zone of a riparian buffer for additional income. Markets for fresh berries can be found by contacting local farmers' markets, grocers and specialty health food stores.

Harvesting nut crops. Planting nut-bearing species including pecan, hazelnut, and black walnut in Zone 2 can provide income from nut

harvests. Nut crops are readily sold at farmers' markets, roadside stands or to retail and wholesale grocers. The University of Missouri Center for Agroforestry is conducting extensive research to identify outstanding cultivars of chestnut, pecan and black walnut. Informational guides and research updates are available at www.centerforagroforestry.org/profit.

Timber trees. Planting trees in Zone 2 of your riparian buffer for a future timber harvest requires a management plan and patience, but can be very profitable over the long-term. In Missouri, when the market is right, Silver Maple brings almost as much as oak species (price per board feet).

Integrating riparian buffers into your current land use practices can maintain the integrity of stream channels, reduce the impact of upland sources of pollution, generate income and optimize performance for environmental protection and economic production. With thoughtful consideration to site characteristics, landowner goals, species selection and environmental and wildlife benefits, riparian buffers provide an additional source of sustainable production with multiple conservation benefits.

Financial Resources

There are many agencies offering programs that can be used to establish and maintain agroforestry practices on private land. One of the most significant of these agencies is the USDA Farm Service Agency (FSA), through the various elements of the Conservation Reserve Program. Each of the programs are designed to take environmentally sensitive and highly erodible land out of production by offering a soil rental payment, a cost-share for the establishment of various conservation practices and other financial incentives to landowners who offer to set aside their land.

Riparian buffers have become a priority for most USDA agencies. Under the requirements of the FSA riparian forest buffer practice (CP22) or the NRCS 391 practice landowners must establish at least a two-zone buffer. The total width of the riparian forest buffer will vary depending on the size of the stream and landowner objectives. For first and second order streams, the buffer must be at least 50 feet (15 m) wide and cannot exceed 180 feet (55 m). Buffers along third order streams must be at least 100 feet (30.5 m) wide. Riparian forest buffers along the Missouri and Mississippi Rivers may be increased to 300 feet (91 m). Buffers may be extended beyond 180 feet or 300 feet (55-91 m) for the purpose of improving water quality benefits.

For more information, contact your local USDA FSA or NRCS office.

Additional USDA programs to establish and maintain riparian forest buffers are offered through the Forest Service (FS) and the Sustainable Agriculture Research and Education (SARE) program. The United States Fish and Wildlife Service (USFWS) also offers assistance; see chart below for a listing of incentives offered by these federal agencies or consult the UMCA publication "Funding Incentives for Agroforestry in Missouri."

Riparian Forest Buffer (CP22)	
♦	10- to 15-year contracts
♦	Conservation Reserve Program continuous sign-up
♦	Eligible for the following CRP financial incentives
-	120 percent Soil Rental Rate (SRR)
-	50 percent regular cost share
-	Student Intern Program (SIP)
-	Performance Improvement Plant (PIP)
-	\$7-\$10 maintenance
♦	Width requirements - (1st and 2nd order streams)
<i>Grass zone:</i>	<i>25 feet maximum</i>
<i>Minimum buffer width:</i>	<i>50 feet</i>
<i>Maximum buffer width:</i>	<i>180 feet</i>
♦	Width requirements (3rd order streams)
<i>Grass zone:</i>	<i>25 feet maximum</i>
<i>Minimum buffer width:</i>	<i>100 feet Maximum</i>

Summary

When incorporated on the farm landscape, forested upland and riparian buffers can effectively improve water quality and limit soil loss. A buffer can be established and become productive in a relatively short time period.

One of the keys to the successful buffer is the choice of materials and plant species that are suitable for the selected site. The next step is to understand the dynamics of the watershed and stream with respect to adjacent land-use issues so that the buffer design will adequately address the problem. Finally, be clear on the management needed in order to maintain the effective functioning of the buffer over time.

Success Stories

Lon Strum

Story County, Iowa



Lon Strum rotates corn and soybeans on his 1,000-acre operation in Story County, Iowa. Before installing a riparian buffer, his tractor would occasionally get stuck on the banks of Bear Creek. While he no longer produces corn or soybeans from the buffered land, he no longer loses his crops during wet years, doesn't have to worry about getting his tractor stuck, and enjoys the benefits of a healthy stream with a significant amount of habitat.

"When I was on the edges, I was constantly getting stuck as I was working close to the creek. It was just more hassle than what I wanted. Since putting in the riparian buffer, I don't notice any difference in the yields, but now I just go in straight rows."

"The buffer has also added to our wildlife habitat. This is the hunting paradise of Story County right here, especially for pheasant hunting. People have come from Alaska, Michigan, and all over Iowa. The demand is very large."

Ron Risdal

Story County, Iowa

Ron Risdal has experienced similar success with the riparian buffer he installed back in 1990. Risdal rotates corn, soybeans, and alfalfa on his farm.

"There's always something new. We can go fishing, or we can go out here and kick up a deer or pheasant or partridge."



"I don't think we've lost hardly any stream bank since 1993, but before we were moving fences almost every year. Yesterday morning when it was flooding, it stopped at the buffer strip instead of washing all over the bank. We don't have to haul rocks in the gullies like we used to do years ago."

Additional Resources

In Print

Schultz, R.C., T.M. Isenhart, J.P. Colletti, W.W. Simpkins, R.P. Udawatta, and P.L. Schultz. 2009. Riparian and Upland Buffer Practices. Chapter 8 In: H.E. Garrett, (Ed.) North American Agroforestry: An integrated Science and Practice, 2nd Ed. American Society of Agronomy, Madison, WI.

University Resources

Establishing and Managing Riparian Forest Buffers. UMCA. Agroforestry in Action Guide AF1009. <http://extension.missouri.edu/explorepdf/agguides/agroforestry/af1009.pdf>

Managing Iowa Habitat Series. Iowa State University Wildlife Extension and Outreach <https://www.nrem.iastate.edu/wildlife/extension-publications>

Stewards of our Streams: Maintenance of Riparian Buffers. Iowa State Extension and Partners. <https://store.extension.iastate.edu/product/Riparian-Buffer-Systems-Stewards-of-Our-Streams>

Research involving upland native grass buffers at Iowa State University.

Science-based Trials of Row crops Integrated with Prairies (STRIPS).

<https://www.nrem.iastate.edu/research/STRIPS/>

The University of Nebraska Forestry Extension (Resources about decorative woody florals and other specialty forest products) <http://ncdc.unl.edu/woodyfloral.shtml>

State-Based Resources

Missouri Department of Natural Resources (Perform a search for “buffers” to see current bulletins and information.) www.dnr.mo.gov/

Missouri Department of Conservation (Find the Resource Forester for your county through this online listing.) mdc.mo.gov/regions

Grow Native! (A native plant marketing and education program of the Missouri Prairie Foundation, established to increase the demand, use of native plants in the Lower Midwest) www.grownative.org

Federal Resources

USDA Agricultural Research Service (ARS) (Search for “buffers” to find research projects and publications) www.ars.usda.gov

Natural Resources Conservation Service (Use subject search to view nationwide guides and publications on riparian buffers.) www.nrcs.usda.gov/

The USDA National Agroforestry Center --

<https://www.fs.usda.gov/nac/practices/riparianforestbuffers.shtml>

ATTRA (NCAT) Riparian Buffer management guide attra.ncat.org/attra-pub/download.php?id=115

AFTA Riparian Buffers: <https://www.aftaweb.org/about/what-is-agroforestry/riparian-buffers.html>

Non-Profit Organizations

Trees Forever (An organization dedicated to natural resources stewardship and addressing the challenges facing communities and the environment, including water quality.)

www.treesforever.org/

STROUD Water Research Center. Watershed Restoration: <https://stroudcenter.org/restoration/>

Five Practices of Agroforestry DVD: Produced by the University of Missouri Center for Agroforestry

Includes the basics of establishing a riparian buffer practice.

<https://www.youtube.com/watch?v=8HDnyV1ViHw>

EXERCISE: REVIEW OF RIPARIAN FOREST BUFFERS

- 1. Why are warm season grasses viewed as an essential component of a well-designed riparian forest buffer?*
- 2. Due to the effectiveness of warm season grasses at slowing the movement of water headed towards streams and waterways, sediments accumulate at the up slope side of the buffer. Is this a problem in the long run and can it be managed?*
- 3. If I manage my grass/shrub/tree buffer for the first 3 to 5 years and it has become well established, can it be left alone to take care of itself from that point?*
- 4. As their name implies, warm season grasses do not begin active growth until late spring. However, fertilizers and other soil amendments are applied early in the spring. Also, while crops are being planted and getting established, the soil is relatively unprotected from rainfall and prone to serious erosion. Given this situation, how effective are warm season grasses as buffers?*
- 5. How wide should my buffer be?*
- 6. What cost share programs are available to help offset the costs of RFB establishment?*

EXERCISE KEY

1. Why are warm season grasses viewed as an essential component of a well-designed riparian forest buffer? Warm season grasses are typically stiff-stemmed clump grasses. Once established, warm season grasses roots penetrate deeply into the root zone. These two attributes contribute two essential functions to the buffer. First, the stiff stems hold up against water movement and forces water to slow down as it moves through the grasses. Second, coupled with the well-developed deep root profile and well aerated soil, flowing water will have adequate residence time to percolate into the soil. Sediments and phosphate fall out of solution, soluble nutrients enter the root zone, while atrazine can be detoxified by plant roots and microorganisms.

2. Due to the effectiveness of warm season grasses at slowing the movement of water headed towards streams and waterways, sediments accumulate at the up slope side of the buffer. Is this a problem in the long run and can it be managed? Yes, this can become a problem if the warm season grass buffer is not managed. Riparian forest buffers are living filters, and like all filters, they need to be “cleaned” periodically to function properly. In the case of a RFB, cleaning refers to periodic maintenance.

3. If I manage my grass/shrub/tree buffer for the first 3 to 5 years and it has become well established, can it be left alone to take care of itself from that point? RFBs must be managed continuously to maximize their buffer function. To maintain active growth and out-compete fescue and other invasive woody species, warm season grasses and forbs must be burned periodically. Trees must be thinned periodically to maintain active growth rates and not stagnate. Similarly, many shrubs selected for RFBs must be coppiced (cut back close to the ground) to maintain vigorous root and shoot growth.

4. As their name implies, warm season grasses do not begin active growth until late spring. However, fertilizers and other soil amendments are applied early in the spring. Also, while crops are being planted and getting established, the soil is relatively unprotected from rain-fall and prone to serious erosion. Given this situation, how effective are warm season grasses as buffers? For a buffer to be truly effective, warm season grasses are an essential component. The above stated problem is their biggest weakness. Therefore, warm season grasses need to be used in combination with both cool season grasses and woody perennials for a RFB to be effective on a year-round basis. Cool season grasses begin growth early in the spring, and even though they are relatively shallow rooted and lack stiff stems (so that water will knock them down and flow right over the top) they are active and a first line of defense against water, soil and nutrient movement early in the growing season. Combined with shrubs and trees, some of which also become active early in the growing season (e.g., willow species), RFBs are fully functional.

EXERCISE KEY, con't

5. How wide should my buffer be? The general rule of thumb is that wider is better. However, that is a very broad generalization. Buffer width depends on many factors including the purpose(s) for the buffer, the associated cropping pattern and related conservation practices being employed upslope, the specific soil and slope conditions, and whether or not government cost share programs are involved which require certain minimum widths. Buffers may be designed for bank stability, aquatic habitat protection and improvement, sediment control, removal of soluble nutrients from adjacent crop fields, flood control or wildlife habitat. To stabilize streambanks and protect aquatic habitat, effective buffers can vary from 30 to 90 feet wide. For sediment and flood control or to improve wildlife habitat, buffers must be wider, ranging from 60 feet to well beyond 150 ft.

6. What cost share programs are available to help offset the costs of RFB establishment?

USDA FSA offers a variety of cost share programs including the Conservation Reserve Program (CRP), and the Conservation Reserve Enhancement Program (CREP). Each of these programs contains approved practices that support RFB establishment. Further details on cost share programs are found in the UMCA Publication “Funding Incentives for Agroforestry in Missouri” (changes to these programs may occur frequently so check with your local FSA or NRCS office).

Notes