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Planting a Riparian Buffer

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What Is a Riparian Buffer?

Streams are dynamic and complex systems that include the active channel as well as its floodplain or riparian zone. Riparian zones—which are characterized by high levels of interactions between vegetation, soil and water—link terrestrial and aquatic environments. These areas have high biotic, structural, and functional diversity.

Urban development and agricultural activities can negatively impact stream ecosystems. Streams draining urban lands often suffer from "urban stream syndrome," which is characterized by flashy hydrology, elevated concentrations of nutrients and contaminants, altered morphology, decreased amounts of organic matter, and poor biotic richness. Streams draining agricultural lands can also be negatively impacted. Livestock grazing and crop production can compact soils, remove riparian vegetation, alter stream morphology, and increase pollutant loads to streams. One way to reduce the impacts of urbanization and agriculture on stream ecosystems is through the use of riparian buffers.

Riparian buffers are vegetation zones located between water bodies such as streams and upland areas such as pastures. These buffers can be composed of one vegetative community but typically consist of three zones planted with native species (Figure 1). A zone of fast- and slow-growing water-tolerant trees (Zone 1) is located adjacent to the water; a zone of shrubs (Zone 2) is located next to the trees, and a zone of grasses and forbs (Zone 3) next to the shrubs. Ideally, the zones are left undisturbed; however Zone 3 can be mowed or grazed once fully established. Buffers can consist entirely of grass (grass filter strips), but fewer benefits are provided by that approach. The USDA-NRCS states that riparian buffers should be 25 ft (7.6 m) wide, at a minimum; however, a buffer width of 200 ft (61 m) is recommended.

What Are the Benefits of Riparian Buffers?

Riparian buffers offer a number of ecosystems benefits related to water quality, streambank stabilization, and habitat. Riparian buffers slow and capture runoff, which can improve water quality by trapping and filtering pollutants such as sediment, nutrients, pesticides, herbicides, road salts, and heavy metals. The root systems of riparian vegetation help to stabilize streambanks by holding the soil in place. Leaves and

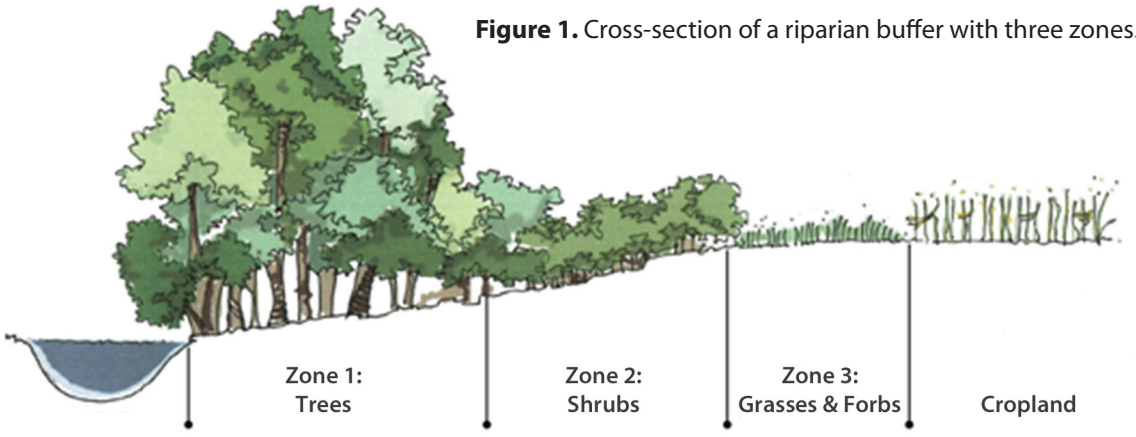

Figure 1. Cross-section of a riparian buffer with three zones.

Source: Corey Wilson, Landscape Architecture.

twigs serve as a food source for aquatic bugs called benthics that live in the water and are an important part of the food web. Riparian vegetation can also provide birds and animals with fruits and nuts as well as cover. The shade provided by the canopy of riparian vegetation helps regulate the water's temperature by keeping it cooler during the summer months. Maintaining a cooler water temperature helps increase the dissolved oxygen level in the water, thus creating a healthier habitat.

How Do I Create a Riparian Buffer?

Riparian buffers can be created passively (naturally) or actively. Passively creating a riparian buffer is as simple as establishing a no-mow zone. Over time, plants will become established on the site as seeds are introduced from birds and animals, water from the stream, and the wind. This method is an easy and cheap way to create a riparian buffer. However, this passive approach often results in less than optimum conditions, and it can produce a riparian habitat that is harmful. Dispersal of unwanted plants can be problematic (Table 1) and can create a riparian area covered with non-native invasive species. The species that establish, even if native, can be less effective at holding together unstable streambanks or providing valuable wildlife habitats than riparian buffers that are actively created.

Actively creating a riparian buffer typically consists of six steps: site assessment, planting plan development, site preparation, species selection, planting, and protection and maintenance. Figure 2 shows a planted riparian buffer at the Kentucky Horse Park.

Table 1. Common invasive species in Kentucky.

Bush honeysuckle *(Lonicera maackii)*	**Multiflora rose** *(Rose multiflora)*
Japanese honeysuckle *(Lonicera japonica)*	**Kudzu** *(Pueraria lobata)*
Winter creeper *(Euonymus fortunei)*	**Garlic mustard** *(Alliaria petiolata)*
Tree-of-heaven *(Ailanthus altissima)*	**English ivy** *(Hedera helix)*
Chinese privet *(Ligustrum sinense)*	**Common reed** *(Phragmites australis)*
Japanese knotweed *(Fallopia Japonica)*	**Japanese stiltgrass** *(Microstegium vimineum)*
Purple loosestrife *(Lythrum salicaria)*	**Reed cannarygrass** *(Phalaris arundinacea)*

Figure 2. Newly planted riparian buffer at the Kentucky Horse Park.

Site Assessment

When evaluating the location for a riparian buffer, information such as land ownership, permits, site characteristics (climate, soils and geology), utilities, and planned future land use should be gathered. If stream banks are steep and eroding, re-grading may be necessary prior to planting. Check on permitting requirements for your selected site prior to performing any earthwork. Federal, state, and local agencies issue permits for a number of activities in and along streams. The width of the buffer will depend largely on land availability, but other site characteristics such as slope, infiltration capacity of the soil, soil quality, and site needs (e.g. what the site will be used for) will factor into the buffer design. For example, if the goal is to filter sediment, a buffer width of 25 ft (7.6 m) may be sufficient for slopes less than 15 percent. However, if the goal is to reduce soluble nutrient (e.g. nitrates) and pesticide concentrations in runoff, buffer widths of 100 ft (30 m) may be needed. Buffers targeting wildlife habitat or temperature control for fisheries will require wide buffers as well. Also, buffers located on steeper slopes as well as those with poor-draining soils will likely require greater widths to remove contaminants from runoff. Soil samples should be collected to determine pH, moisture content, and nutrient content (e.g. macronutrients such as nitrogen, phosphorus). Prior to planting and especially before beginning any digging, underground utility lines should be located and clearly marked. Call 811 to locate underground utility lines.

Planting Plan Development

When developing a planting plan, one of the first things to do is identify the boundaries and constraints of the site. Clearly note property boundaries, utilities, permit conditions, land use considerations, and budget. Identify any unique land features such as springs, wet areas, or pedestrian and biking paths. Determine how many plants are needed. To achieve streambank stabilization and water quality protection, vegetation should be planted densely and in a tiered fashion (Figure 1). Streambanks should be planted with trees able to quickly colonize this environment, such as willows, in order to provide protection from the erosive forces of stream flows. Trees should be planted at a rate of 800 trees per acre using 8- by 7- foot spacing. Shrubs should be placed 3 to 5 ft (0.9 to 1.5 m) apart and transplants or plugs of grasses and forbs 1 to 3 ft (0.3 to 0.9 m) apart. Consider the time of year when planting will occur. Ideal times to plant trees are late autumn through early winter and late winter through early spring when the ground is thawed. In Kentucky, this is generally November to December and March to April. For grasses, consider whether you want cool-season varieties, which should be planted in late autumn to early winter, or warm-season ones that are best planted in late spring, summer or early autumn. When developing a budget, be sure to include costs associated with land acquisition, permits, streambank stabilization, soil amendments, plants, vegetation protection, labor, and maintenance.

Site Preparation

Before the site can be planted, it must be prepared. If the streambanks are unstable, meaning they are steep and eroding, they should be addressed first. Re-grading the banks so that they are less steep may be needed. Seek advice from an experienced professional and check on permitting requirements if streambank re-grading is needed. Invasive species should be removed. Removal can typically be done mechanically or using herbicides approved for use in aquatic areas. If necessary, the appropriate soil amendments should be added. Soil tests are used to determine what amendments are needed, such as lime and fertilizers, and in what amounts. Prior to any earthwork activity such as digging or mechanically removing vegetation, erosion control measures should be properly installed to prevent sediment-laden runoff from entering waterways. Examples of erosion control devices include silt fences, straw bales, and mulching. Also, providing the proper noncompetitive ground cover can assist greatly in establishing tree and shrub species while reducing maintenance and possible invasion from non-native invasive species. Consult tree planting guidelines for noncompetitive ground covers and other site preparation recommendations for establishing hardwood tree plantings (see UK cooperative extension publication *Professional Hardwood Notes: Site Preparation and Competition Control Guidelines for Hardwood Tree Plantings* [FOR-107] at http://www.ca.uky.edu/agc/pubs/for/for107/for107.pdf). Be sure to check for signs of erosion after each rain event. If erosion is occurring, adjust current erosion control measures and/or install additional ones.

Species Selection

When selecting plants, consider factors such as water tolerance, project goals, natural succession, plant availability, and aesthetics. As riparian areas often experience wetting from floods, selected plants must be tolerant of such conditions. Different vegetation types also have different benefits (Table 2). For example, grasses are highly effective at filtering sediment from runoff while trees are best at improving aquatic habitat through water temperature regulation and introduction of debris such as leaves, twigs, and small logs. In all cases, select native species as these plants will be best adapted to the local climate. Table 3 contains a listing of some native species that are appropriate for planting in Kentucky riparian buffers. Consider the anticipated changes in the plant community over time or natural succession. After preparation, the site may have bare soils and lots of light. Plant fast-growing

Table 2. Vegetation effectiveness for select buffer benefits.

	Vegetation Type		
Benefit	**Trees**	**Shrubs**	**Grasses**
Streambank stabilization	High	High	Low
Filtering sediment	Low	Low	High
Filtering nutrients, pesticides, pathogens	Moderate	Low	Moderate
Improving aquatic habitat	High	Moderate	Low
Improving forest habitat	High	Moderate	Low
Improving field (pasture) habitat	Low	Moderate	High
Flood protection	High	Moderate	Low
Visual diversity	High	Moderate	Low

pioneer species that are adapted to these conditions as well as slower-growing longer-lived species adapted to more shaded and crowded conditions. When selecting plants, be sure to find out what plants will be available for purchase during the projected planting period. Also give consideration to aesthetics by noting plant characteristics such as flowering and seasonal foliage color.

Planting

A wide variety of methods may be used for planting different types of vegetation. For trees, one-year-old bare-root seedlings are often used as they are cost-effective and generally available at local nurseries. Transplanting larger trees is an option but will cost more. Shrubs such as dogwoods and willows are commonly established from live stakes due to cost,

Table 3. Commonly used native species in Kentucky riparian buffers.

Trees	Shrubs and Small Trees	Grasses	Perenial Wildflowers
American sycamore *(Plantanus occidentalis)*	**Spice bush** *(Lindera benzoin)*	**Switchgrass** *(Panicum virgatum)*	**Great blue lobelia** *(Lobelia siphilitica)*
Pin oak *(Quercus palustris)*	**Arrowwood viburnum** *(Viburnum dentatum)*	**Eastern gamma grass** *(Tripsacum dactyloides)*	**Purple coneflower** *(Echinacea purpurea)*
Swamp white oak *(Quercus bicolor)*	**Eastern redbud** *(Cercis Canadensis)*	**Big bluestem** *(Andropogon gerardii)*	**Cardinal flower** *(Lobelia cardinalis)*
Yellow Buckeye *(Aesculus flava)*	**Buttonbush** *(Cephalanthus occidentalis)*	**River bank wild rye** *(Elymus riparius)*	**New England aster** *(Aster novae-angliae)*
White oak *(Quercus alba)*	**Silky dogwood** *(Cornus amomum)*	**River oats** *(Uniola latifolia)*	**Swamp milkweed** *(Asclepias incarnate)*
River birch *(Betula nigra)*	**Rough-leaf dogwood** *(Cornus racemosa)*	**Deer tongue grass** *(Panicum clandestinum)*	**Grey goldenrod** *(Solidago nemoralis)*
Bur oak *(Quercus macrocarpa)*			**Greyheaded coneflower** *(Ratibida pinnata)*
Swamp chestnut *(Quercus michauxii)*			**Joe Pye weed** *(Eupatorium fistulosum)*
Red maple *(Acer rubrum)*			
Yellow-poplar *(Liriodendron tulipfera)*			
Eastern Cottonwood *(Populus deltoids)*			
Black walnut *(Juglans nigra)*			
Bald cypresss *(Taxodium distichum)*			
Black willow *(Salix nigra)*			
Tupelo gum *(Nyssa sylvatica)*			
Green ash *(Fraxinus pennsylvanica var. subintegerrima)*			

but containerized plants can be used. Live stakes are dormant, unrooted plant cuttings, generally less than 2 inches (5 cm) in diameter and 3 ft (0.9 m) in length, that produce roots when planted. Grasses are generally sowed by hand or with the use of a hand-held broadcaster, but they can be mechanically planted with a seed drill or no-till planter. Only the most common methods for planting trees, shrubs and grasses will be discussed.

Tree Seedlings

When planting small trees such as seedlings (typically one-year-old bare-root seedlings from a nursery), precautions should be taken regarding timing, transportation, and handling to minimize stress to improve chances of survival. The ideal time to plant a tree seedling is when temperatures are below 50°F (10°C) and the ground is thawed. During transport, seedlings must be kept cool (33-40° F or 0.5-4.5° C) and moist. This can be done by wrapping the roots of the seedlings in moist paper towels and storing them in a refrigerator, then transporting them to the project site in coolers. Seedlings can be planted by hand for rough terrain or small areas using either the slit method (for dibble bars, KBC bars, or sharpshooter spades) or the wedge method (for use with hoedads or sand shovels). Refer to Davis et al. (2010) for specifics regarding the slit and wedge methods. For large areas, mechanical planters are an option.

Live Stakes/Cuttings

Like tree seedlings, live stakes, also known as cuttings, should be planted during the dormant season when the ground is thawed. Only certain species such as willow or cottonwood can be propagated in this manner. Fresh cuttings can typically be obtained from nearby existing riparian areas. Cuttings should be at least 0.5 in. (1.3 cm) in diameter and 18 in. (46 cm) in length. The top of the cutting should be square and the bottom should be angled to ease planting. Immediately soak live stakes in water to preserve moisture. Do not harvest live stakes more than 48 hours prior to planting. Plant the stakes with the angled (bottom) end going into the ground. For softer soils, a rubber mallet can be used. For firm soils, create a pilot hole using an iron bar. Plant live stakes so that about 80 percent of their length is in the ground. Be careful not to split the stake or damage the bark when planting. Live stakes are typically planted 1 ft (0.3 m) on center for dense planting.

Containerized Plants

If larger trees are desired or if transplantation needs to occur during the growing season, containerized or balled and burlapped (B&B) plants may be used. Containerized plants are grown from seed or cuttings in pots of varying size that are usually filled with a soilless media (bark, sand, peat). The advantage of using containerized stock is that the entire root system is transplanted with the tree which greatly reduces transplant shock. A disadvantage of containerized plants is that the potting material has a tendency to dry. Care must be given to ensure that they are watered frequently. Also, containerized plants can become root-bound in their pots. Efforts to detangle the roots should occur before planting to ensure proper growth. Balled and burlapped plants offer the opportunity to plant much larger trees with soils that can be matched to that of the transplantation site. Unfortunately, use of B&B trees pose some special problems due to their size (heavy, bulky) and may require large equipment (backhoe, tree spade) for successful transplantation.

Planting instructions for containerized and B&B trees are typically provided by the nursery or commercial provider. If instructions are not provided, the following may be used:

- Dig a hole just as deep as the root ball and two to three times as wide. Scarify (roughen) the soil in the bottom and sides of the hole to encourage root penetration into the native soil.
- Remove the moistened root ball from its container. Loosen the roots from the bottom of the ball. If root-bound, slice some of the roots from the matted bottom and sides with a knife or pruner until some hang freely. With B&B trees, remove the string or wire that holds the burlap to the root ball. It is not necessary to completely remove the burlap, but any plastic wraps covering the burlap (or if used in-lieu of burlap) should be completely removed.
- Place the plant in the empty hole. Step back to ensure that the stem is straight, and then check its depth. The top of the root ball should be even with, or slightly above, the surrounding ground.
- Fill the void around the root ball with the soil that was excavated from the hole. Soil amendments or alternative soil materials should be avoided unless site characteristics dictate otherwise (large rocks or solid clay).
- Lightly tamp the soil around the buried root ball to remove any air pockets. Create a watering basin by mounding the soil several inches high just beyond the edge of the planting hole.

The transplanted trees should be watered if dry conditions prevail at the time of planting. With the use of a bucket, watering can be easily performed in riparian zones due to its close proximity to the stream. Mulching trees in riparian zones is generally not recommended due to the potential for frequent flooding, which would wash the material away. Staking of trees may be beneficial. Staking will help support the tree (especially during flooding events) until the roots are established enough to properly anchor it in place. Guying of the tree to the stakes should not be too tight to allow for some movement of the tree. Remove all support wires once the trees are established to prevent girdling and subsequent mortality.

Native Warm-season Grasses

Native warm-season grasses provide dense root systems and wildlife habitat in riparian buffers. These grasses can also serve as forage for livestock. Establishing native warm-season grasses can be challenging, mostly due to competition from already established cool-season grasses. The most important factor to consider when planting native warm-season grasses is controlling competition, which is generally done using herbicides and site preparation. The first step when planting native warm-season grasses is to use herbicide to remove weeds. This step should be done in the year prior to establishment of warm-season grasses before seed formation occurs. Next, prepare the site by removing as much vegetation as possible during the autumn preceding establishment. In the spring, apply an herbicide treatment once six inches of cool-season plant growth has occurred. Seven to ten days before seeding, apply a combination herbicide treatment to kill any remaining cool-season and warm-season plants. Finally, seed warm-season grasses in mid-May to mid-June when the soil temperature is above 55°F. Grasses should be seeded to a depth no greater than ¼ inch; otherwise they may not emerge. Consultation with local Kentucky Department of Fish and Wildlife Resources (KDFWR) and Natural Resources Conservation Service (NRCS) personnel is recommended when establishing native grass stands. These professionals can provide guidance and often loan equipment to landowners establishing native grasses for riparian buffers and wildlife habitat. Some seed companies offer contracting services that include herbicide treatments, site preparation, and seeding of grasses for landowners.

Protection and Maintenance

Once the riparian buffer is planted, it faces threats from livestock and wildlife browsing, insects, humans, and unwanted establishment of invasives. The emerging vegetation should be monitored to ensure that undesired species are identified and quickly removed (Table 1). Fencing can help prevent livestock and wildlife from grazing and prevent emerging vegetation from being damaged or destroyed by mowing. Signage can be used to mark the boundaries of the riparian buffer if fencing is not used. Tree shelters, which are plastic cylinders that are placed around seedlings to create moist microenvironments, have been shown to not only offer protection from mowers and browsing animals but also to increase tree growth (Figure 3). Fabric mats are another option for improving tree growth. Seedlings are placed in the center of a mesh fabric mat (approximately 18 in by 18 in or 46 cm by 46 cm in size), and the ends of the mat are staked into place. These mats prevent competition from herbaceous vegetation, such as ground cover species and grasses, and prevent competition for water and nutrients, but they do not offer protection from browsing animals.

Figure 3. Use of tree shelter and fabric mat to for protection from animal browsing and competition.

Minimal maintenance is required for riparian buffers. The site should be visited yearly during the first three years to check tree survival. If tree survival is low, additional plantings may be required.

Resources

For additional information on riparian buffer planting and maintenance, contact your local University of Kentucky Extension office, Natural Resource Conservation Service (NRCS) office, or Kentucky Department of Fish and Wildlife Resources office. The University of Kentucky Arboretum as well as the Bernheim Arboretum and Research Forest are good sources of information. Funding assistance may be available through programs such as the Environmental Quality Incentive Program (EQIP), Wildlife Habitat Incentive Program (WHIP), or Conservation Reserve Program (CRP); contact your local NRCS office for additional information.

For information about planting materials, sources of these materials, and invasive species control useful contacts include:

Kentucky Division of Forestry
(http://forestry.ky.gov)

Dropseed Nursery
(http://www.dropseednursery.com)

Kentucky Department of Fish and Wildlife Resources
(http://fw.ky.gov)

Roundstone Native Seed Company
(http://www.roundstoneseed.com)

Shooting Star Nursery
(http://shootingstarnursery.com)

Wilson's Nursery
(http://www.wilsonnurseriesky.com)

Kentucky State Nature Preserves Commission (KSNPC)
(http://naturepreserves.ky.gov)

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