United States Department of Agriculture

Practice Guide for Riparian Forest Buffers

(Pennsylvania NRCS)

Overview

Riparian forest buffers are areas of trees and shrubs located adjacent to surface waters like streams, lakes, ponds and wetlands. Riparian forest buffers perform a variety of highly valuable functions in the landscape—they intercept sediments, nutrients, and other water-borne materials being carried by runoff and prevent those materials from polluting the neighboring water body; they reduce or absorb dissolved nutrients and pollutants in shallow subsurface water flow and prevent those pollutants from penetrating ground water; they shade the adjacent water body, lowering the water temperature and maintaining water chemistry; they minimize erosion, since their vegetation anchors the edges of the water body and slow and disperse flood waters; they provide leaf litter and other dead vegetation which acts as the base of the aquatic food web, supporting the in-stream adsorption of dissolved nutrients; and lastly, they provide valuable wildlife habitat, both as distinct, unique habitats and as corridors that provide connections across the landscape.

Site conditions

Assess the soils and soil condition of the planned riparian forest buffer. Relative wetness and drainage of the soils each have a dramatic effect on the plant species and plant materials used within the buffer. Soils conditions may vary greatly on a seasonal basis, as a result of percolation, saturation, or flooding related to the adjacent water body. Minimize erosion by maintaining all overland flow through the riparian forest buffer as sheet flow, rather than concentrated flow. Level-lipped spreaders, streambank stabilization, and other stabilizing practices may be needed to support or complement a riparian forest buffer.

Grazing and cropping activities within the planned buffer area should stop prior to installation of the riparian forest buffer. If necessary, plan and install livestock-related practices like fences, stream crossings, animal trails and walkways, pipelines, and watering facilities to sustain grazing activities outside the new buffer acreage. If previous cropping activities left bare ground or very little residue in the planned buffer area, establish a permanent ground cover of grasses or forbs prior to planting trees and shrubs, to provide protection again erosion until the riparian forest buffer is established.

Existing vegetation that will hinder planting or provide excessive competition to the tree or shrub seedlings should be controlled or removed prior to planting, using any combination of the following methods:
--Mechanical control of vegetation by mowing or mechanical removal (for erosion and weed control, any disturbed areas should have grass seeded and established *prior to* planting trees and shrubs).
--Chemical control of vegetation with appropriate herbicide(s). In Pennsylvania, herbicide applications prior to October 15th should be fine; after October 15th, confirm that the target plants are actively growing and have not gone dormant yet. Follow all label instructions for safety precautions, rates and timing of herbicide application. Consult the current Penn State Agronomy Guide for herbicide recommendations.

Existing trees/shrubs may remain in place if the site is to be interplanted and the existing trees/shrubs are acceptable species which help fulfill the purpose of the new planting. For example, if wildlife habitat is a purpose of the planting, retain native trees that provide den sites or food sources while the new planting becomes established. Undesirable trees that will restrict planting or provide excessive shade should be removed or killed and left standing as "snags".

Plant Materials

Select combinations of tree and shrub species that will best achieve the purpose(s) of the riparian forest buffer given the site-specific conditions of the area to be buffered. Plant selection often depends most heavily on two main considerations: the intended purpose of the riparian forest buffer and the soils in which the buffer the will be established. For example, a buffer established on relatively dry soils and meant to shade a narrow stream will contain trees and shrubs that differ greatly from a buffer established on wet soils and meant to improve water quality and pollinator habitat. Consult the support document *Tree and Shrub Information for PA NRCS*. It

provides a comprehensive and helpful list of trees and shrubs, and describes their characteristics related to use in a riparian forest buffer (i.e., soil drainage, plant hardiness zone, flood tolerance, deer resistance, etc.).

Ball-and-burlap nursery stock, container-grown plants, bare-root seedlings, live stakes, direct seeding with seeds/nuts, and natural regeneration are all acceptable options for establishing trees and shrubs in riparian forest buffers. Bare-root seedlings and live stakes must be dormant at installation; their buds should be firm, but show no evidence of new growth.

Choose, and combine as necessary, plant materials to maximize tree and shrub survival and establishment. Match the plant materials to the site conditions, keeping in mind that some plant materials are better suited to certain conditions *(see Table 1, below)*. For example, live stakes may be the most successful plant material for extremely wet portions of a planting site, while bare root seedlings, container plants, or balled-and-burlap plants may be successful plant materials for drier portions of the same site.

Table 1. Plant material suitability based on predominant site conditions.

	A suitable plant material would be…					
If the site is…	**Balled-and-burlap**	**Container plant**	**Bare root**	**Live stake / cutting**	**Direct seeding**	**Natural regeneration**
dry or well-drained	•	•	•		•	•
very wet or very poorly drained	o	o	o	•	•	•
prone to flooding	o	o	•	•	•	•
streambank				•		
prone to "frost heave"	•	•				•

- • Acceptable plant material for given site condition
- o Acceptable, but may require specific or seasonal site conditions for this type of plant material (i.e., using this material may present challenges during wet periods)

Storing Plant Materials

Store plant materials in cool, but not freezing, conditions (air temperatures of 35° F to 50° F). Avoid damage to roots of all plant types during storage. The roots of bare root plants and live stakes should be kept moist, but not wet. If bare root seedlings must be stored for more than one week and cold storage is not available, the seedlings should be "heeled-in" in a moist, shady location. This is done by digging a trench, placing the seedlings' roots in the trench and covering the roots with moist soil. Do not allow the roots of any plant materials to dry out.

Site Layout

The planting layout should allow access for long-term maintenance of shelters, weed control, and fence maintenance (if applicable). Usually, the 15' or 20' foot rows that result from the most common spacing patterns serve this purpose without additional adjustments; however, if fencing is involved, carefully consider gate locations during site layout to allow adequate access for later maintenance activities.

The maximum spacing for trees is 20' x 20', resulting in a minimum plant density of approximately 100 seedlings per acre. However, at this low density, only 2- or 3-year-old containerized plants in 3" – 4" pots (or larger), or balled-and-burlap plants are acceptable. Another spacing pattern of 15' x 15', or roughly 150 seedlings per acre, is frequently used, and is acceptable for all seedling types. In contrast, the use of live stakes or direct seeding may require high numbers of plants installed at relatively short spacing. Plant 2' live stakes on roughly 5' x 5' spacing (approximately 1,750 live stakes per acre); plant larger nuts/seeds on a 4' x 4' spacing

(approximately 2,700 seeds/nuts per acre); plant or broadcast—into properly prepared seed beds—smaller seed at ~100,000 seeds per acre. The high numbers of live stakes or seeds involved with these high-density plantings are generally balanced by their low cost per stake or seed, ease of installation, and good growth and survival on sites where the use of other plant material types may be limited.

Regardless of plant materials used, consider planting on a "grid" or "staggered row" layout, for easier maintenance of the planted area (*see sample layouts on PA NRCS's Forested Riparian Buffer Job Sheet*). While random placement of seedlings is acceptable and more natural in appearance, it is also much harder to maintain with mechanized equipment, and should only be considered for sites where weed control, herbicide applications, and other maintenance efforts will be done by hand.

If evergreen trees are included in the planting for general purposes, they can be installed on the same spacing as the deciduous trees. However, if the evergreens' purpose is to provide winter cover for wildlife —often referred to as "thermal cover"—additional layout guidelines must be considered. Long, linear, single-row plantings of evergreens may slightly redirect or slow winds, but generally **will not** provide adequate shelter since winter winds can easily penetrate the single row. Evergreens for winter cover should be 6' – 10' apart, and planted in blocks at least 50' x 50' in size. Clumps of this density and size will develop a central or core area which will be protected from wind penetration.

Plant at least six plant species in the buffer, usually four deciduous tree species and two shrub species, from the list provided in or with the site-specific Conservation Plan. For forested riparian buffers, no more than 20% of the plants may be evergreens. If improving water quality is a purpose of the riparian buffer, do not plant evergreens in the two rows nearest the streambank; this applies to both sides of the stream, if both are buffered.

To improve plant diversity and pest resistance, mix plant species within the buffer. If possible, avoid putting plants of any one species next to other plants of the same species, with the exceptions of Persimmon and Holly trees, which must be planted in groups of male and female plants to allow pollination and fruit production.

Avoid planting trees in utility line right-of-ways; they may be cut or sprayed without notice during maintenance of the right-of-ways. Right-of-ways should be seeded to grasses or forbs. As an extra precaution against maintenance-related damage, the rows of woody plants at the edge of the right-of-way should be low-growing shrubs like raspberries, red-stemmed dogwoods, or silky dogwoods. These plants will never get large enough to interfere with the adjacent utility line (even overhead lines), and will probably re-grow if they suffer maintenance-related damage. If possible, install signs identifying the areas as a conservation planting and requesting no mowing or spraying.

Planting

If needed, root-prune seedlings that have extremely long main roots or roots longer than the effective depth of planting tools or machines (which is usually about 8 inches). However, no more than one-quarter of the root system should be removed.

Ball-and-burlap, container-grown, bare-root plants, live stakes/cuttings and direct seedings may be installed in late winter or spring, as long as the ground is thawed. Container-grown plants, bare-root seedlings, live stakes, and direct seedings must be planted while dormant. For planting methods and tips, refer to *A Guide to Conservation Plantings on Critical Areas for the Northeast* (Salon and Miller, 2012)

Protecting or sheltering the new trees and shrubs is highly recommended, and can be a major factor in plant survival and growth. Various types of protection exist, ranging from plastic tree tubes and shelters to exclosures made from fencing materials. The use of 5-foot tree shelters to protect deciduous tree seedlings and single-stemmed shrub seedlings is highly recommended, especially in areas with deer pressure. **Do not** use plastic tree shelters or tubes on evergreens or multi-stemmed shrub species, as they will severely stunt or kill those plants; if sheltering is needed for those plants, consider a fence-based option: one "fence ring" per plant, or

a larger deer exclosure to protect many plants at once. Drive all plastic tree shelters/tubes 1-2 inches into the ground, or pile soil around the shelter base to a similar depth. This prevents entry by rodents, limits the flow of hot air through the shelter in summer months, and promotes a greenhouse effect that increases moisture levels within the shelter. Anchor tree shelters/tubes with at least one stake, to which the shelter should be firmly and tightly attached in at least two places. Anchor single-plant fence rings with at least two stakes, and firmly attach the fence to the stakes in at least two places. Stakes should be at least 4' long, and should be driven a minimum of 8 inches into the ground on the upstream or upwind side of the shelter. Install larger deer exclosures as regular fencing projects with appropriate fence posts and anchoring methods. (Refer to NRCS' standards for Fence and/or Access Control.)

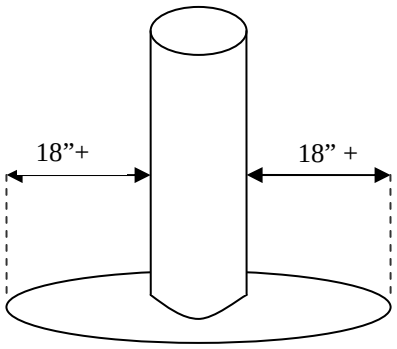


Diagram 1. Herbicide ring around tree shelter.

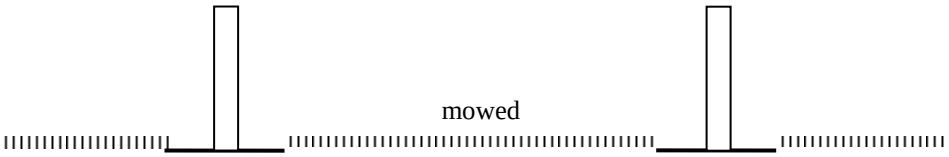
Establishment Activities

Weed Control: Competing vegetation may be controlled as needed after planting. Weed control is often the most important factor in tree and shrub survival, especially for deciduous species. Weed control may be accomplished through mulching, mowing, or herbicide. For all methods, the vegetation should be controlled in either an 18"-wide band down each side of the seedling row, or in a 18" radius circle around each seedling (*Diagram 1*). Spray competing vegetation near the trees in May and September to ensure that 1) there won't be too many other roots competing with the trees, and 2) rodents will have no cover or food immediately around the tree and tree shelter. Apply herbicides for at least the first three years that the trees are in the ground—additional spraying would be optional, depending on how well the plants are established.

Mowing is also very beneficial during establishment, since it reduces the amount of competing vegetation around the new plants. While it is possible to mow the area as often as desired during establishment, there are three key times to mow: spring (May), mid-summer (early July), and fall (late September). Spring mowing will reduce the amount of cover available to rodents, and hopefully force them to look elsewhere for places to make nests to have young. Summer mowing will prevent weeds from producing seed, and could be replaced with an appropriate herbicide treatment. Fall mowing is the most important, since it greatly reduces the winter habitat available for rodents. Discouraging rodents from living in the buffer area over winter months decreases the chances of rodents chewing on the plants over winter (*see Diagram 2*). Mow at a height of 6" or more—mowing lower won't discourage rodents any more, but may increase erosion.

Diagram 2. Mowing options.

If the entire buffer won't be mowed, focus mowing efforts ***near*** the plants—such as one mower width on each side of plant rows—rather than mowing down the middle of the row and leaving uncut vegetation near the plants.



Fall mowing should include the entire field, to reduce winter cover for rodents. Leave at least 6" of cover. If possible, direct the grass clippings away from the tree shelters, to reduce the amount of nesting material available to rodents near the new plants.

Mowing doesn't provide total weed control, since roots still remain to compete with the tree and shrub seedlings for nutrients and water. Herbicides provide weed control, both above- and below-ground, but does not remove or shorten nearby vegetation enough to limit rodents. Therefore, a combination of mowing the entire planted area and applying herbicide treatments around individual plants yields the best establishment of trees and shrubs. Please be aware that mowing and herbicide treatments may also kill any naturally-growing trees and shrubs in the planted area, and precautions should be taken if natural tree/shrub growth is desired within the buffer.

Other weed control options include weed mats and mulching, both of which limit competing vegetation by creating physical barriers around the base of the new plants. Place mats or mulch at the time of planting, and maintain them as needed to continue their proper function. Mats may need to be re-anchored over time to maintain tight contact with the soil; this is a particular concern because any gaps or crawl spaces under mats often become rodent burrows. In contrast, many mulches (particularly stone or large wood chips) discourage burrowing by rodents, but require re-application or "topping off" to replace materials lost to flooding or decomposition.

Shelter Maintenance: Another major component of successful tree establishment is the year-round maintenance of tree shelters. Shelter maintenance isn't difficult, and will greatly improve the growth and survival of the buffer plants. Tree shelters *must* be checked regularly, to ensure the following: 1) shelters should be upright and solidly attached to their stakes; 2) plastic shelters/tubes should be seated 1-2 inches into the soil, or soil should be piled around the base of the shelters; and 3) plastic shelters/tubes with holes or sizeable cracks in them should be replaced. Shelters that are leaning, sitting loose on the surface of the ground, or cracked/chewed open will actually do more harm than good for the trees inside. All three of the conditions described above generally result in dead plants, because they give rodents easy access to the trees inside the shelters or cause other problems like bent or broken trees, hot air flowing through shelters in summer months, and so on. If tree shelters are capped with bird netting, remove the netting whenever the tree grows within a few inches of the top of the shelter. Seedlings **will not** grow through the netting, and their growth will be severely restricted or distorted if the netting remains in place. Remove tree shelters only after the seedlings have been visible out of the top of the shelters for at least two years.

In summary, the best way to improve tree growth and survival is to have shelters on your trees and maintain herbicide rings around the shelters for at least two years. Mowing the tree planting areas once or twice a year will be an additional step to further reduce the chance of rodents killing trees over the winter months (*see Diagram 2 for possible mowing options*).

Pest Management: Plant injury or death should be minimized through preventative measures. Exclude domestic animals and wildlife that could damage or browse the plants. To limit damage from wildlife, consider reducing nearby vegetation (which may hide rodents or rabbits), increasing hunting and predation, or the use of pest repellants. Monitor new plantings for potential insect and disease problems. Contact NRCS, the DCNR Bureau of Forestry, or Penn State Extension Services for prevention and control recommendations.

Replanting: Over time some of the buffer plants will die, from a variety of possible causes. A survival rate of 70% is considered acceptable; lower survival rates require replanting or acceptable levels of natural regrowth/regeneration in the buffer area. If replanting is necessary, follow the same guidance given above for the original planting (*see* **Planting** *section above*); consider adjusting tree and shrub selection to favor those species from the original planting which survived the best.

Operation and Maintenance Activities

Maintain trees and shrubs for the life span of the conservation practice (15 years), or if applicable, the USDA contract associated with the establishment of the buffer (like CREP, CSP, EQIP, or WRP), whichever is longer. Noxious weeds *(see list below)* must be controlled at all times. Control of invasive plants, while not required, is highly recommended to prevent excessive competition with the desired buffer plants. Spot treatments with

appropriate herbicides may be done at any time, following label directions for rate and timing of herbicide application. After trees and shrubs are established (roughly 3 to 4 years after planting), stop or greatly reduce the amount of mowing in the buffer area, to encourage additional tree and shrub recruitment via natural regeneration.

NOXIOUS WEEDS: Canada Thistle, Johnsongrass, Marijuana, Jimsonweed, Giant Hogweed, Multiflora Rose, Shattercane, Mile-a-minute, Goatsrue, Bull or Spear Thistle, Musk or Nodding Thistle, Kudzu-vine and Purple Loosestrife. (This list is subject to periodic updates).

INVASIVE PLANTS (partial list*): Norway Maple, Tree-of-Heaven / Ailanthus, Princess tree / Paulownia, Callery Pear, Barberry, Burning Bush, Lespedeza, Privet, Tartarian honeysuckle, Wineberry, Japanese stiltgrass, Phragmites, etc.
*A full list of invasive plants is available at http://www.dcnr.state.pa.us/conservationscience/invasivespecies/index.htm

References

Tree and Shrub Information for PA NRCS. PA NRCS. 2014.
http://efotg.sc.egov.usda.gov/references/public/PA/PA_391_treeshrubinfo.pdf

Forested Riparian Buffer – Job Sheet. PA NRCS. 2014.
http://efotg.sc.egov.usda.gov/references/public/PA/PA_391_JS.pdf

Salon, P.R. and C.F. Miller. 2012. A Guide to: Conservation Plantings on Critical Areas for the Northeast. USDA, NRCS, Big Flats Plant Materials Center, Corning, NY.
http://plant-materials.nrcs.usda.gov/nypmc/

Conservation Practice Standard – Fence. PA NRCS. 2014.
http://efotg.sc.egov.usda.gov/references/public/PA/382fencestandardfinal.pdf

Conservation Practice Standard – Access Control. PA NRCS. 2014.
http://efotg.sc.egov.usda.gov/references/public/PA/Std472Dec09.pdf