Riparian Buffer

Definition

A riparian buffer is a zone of permanent vegetation immediately adjacent to a stream or other water body. The buffer can consist of existing or planted vegetation, or both. Buffer vegetation can be grasses, shrubs, trees, or other types, in any combination. Buffers are meant to be relatively undisturbed; activities within buffers should be limited to maintenance, or other approved activities that do not impede buffer functionality. This best management practice (BMP) includes descriptions of multi-zone buffers, and the filter strip as a specialized buffer type.

Description & Purpose

Pollutants Controlled

- Sediment
- Nutrients
- Pesticides
- Temperature
- Erosion

Treatment Mechanisms

The riparian buffer is designed to intercept runoff as sheet flow before it enters the adjacent water body. The mechanisms include slowing down runoff, allowing any infiltration to occur, allowing uptake of water and nutrients by vegetation, allowing any sediment to settle out, and be physically intercepted by buffer vegetation. Tall woody vegetation (trees and shrubs) provides shade, which can lower stream temperatures and provide fish cover.

Pollutant Removal Efficiency

Several researchers have measured reductions in sediment and nitrate concentrations of greater than 90 percent. Riparian buffers do a reasonably good job of removing phosphorus attached to sediment, but are less effective at removing dissolved phosphorus (Gilliam, 1994). Riparian buffers also slow runoff, allowing more rainwater to infiltrate and be absorbed by plants. A number of sources provide summaries of riparian buffer pollutant removal efficiencies (USEPA, 2005; Southeastern Wisconsin Regional Planning Commission, 2010).

Companion & Alternate Practices

A level spreader (North Carolina Cooperative Extension, 2010) or similar practice may be necessary to ensure that any concentrated flow is spread out into sheet flow before it enters a riparian buffer. This will protect the buffer from erosion, and from any short-circuiting of runoff through the buffer without receiving sufficient treatment. In pastureland, livestock exclusion fencing (USDA NRCS, 2011a) is often used to protect riparian vegetation from being grazed or trampled. Stabilized, gated, fenced-off stream crossings (USDA NRCS, 2012) are also used in areas where livestock need to cross a stream to reach an adjacent pasture.

Advantages & Disadvantages

An advantage of riparian buffers of sufficient width and suitable vegetation types is the provision of habitat, which is described in more detail below.

Although riparian buffers provide numerous benefits to agriculture, primarily erosion control and the resulting soil conservation, some farmers may be reluctant to install riparian buffers due to the relative reduction in the amount of land that can be cultivated or used as pasture. Solutions to this problem include cost-share and rental payment programs, which reimburse farmers for the installation of riparian buffers (among other practices); examples of these include the Conservation Reserve Program, and Conservation Reserve Enhancement Program.

In more developed, urban or suburban areas, establishing riparian buffers can be complicated by the presence of existing development located immediately adjacent to or near water bodies, limiting the area available.

Location

Riparian buffers are located adjacent to streams or other water bodies. They are suitable for all land uses. They are especially important on steep slopes, for mitigating any potential erosion due to otherwise excessive runoff velocity. Minimize water body crossings or incursions into riparian buffers. Crossings at right angles to water bodies minimize the amount of riparian buffer disturbed, compared to crossings at oblique angles.

Design

Filter Strip

The filter strip is often used in the creation of riparian buffers, either as a stand-alone practice, or as part of a multi-zone system (described below). The United States Department of Agriculture Natural Resource Conservation Service (USDA NRCS) recommends a minimum filter strip width of 20 feet for controlling suspended sediment and associated runoff, or 30 feet for controlling dissolved contaminants in runoff (USDA NRCS, 2011b). They further recommend widening the filter strip, depending on land slope, soil type, and flow length (USDA NRCS, 2011c), up to a maximum of 216 feet. The United States Department of Agriculture (USDA) Revised Universal Soil Loss Equation version 2 (RUSLE2) can be used to help determine the minimum filter strip width based on contributing land conditions.

In multi-zone riparian buffers, the filter strip is the zone furthest from the water body. A filter strip may be necessary when a riparian buffer is adjacent to an area from which any storm water runoff requires additional pre-treatment, such as farm fields or impervious surfaces. A filter strip is not usually necessary as part of a multi-zone system where the adjacent land cover is grassland, forest, or other types that do not produce significant sediment, nutrients, pesticides, or other pollutants.

One source of guidance on selecting filter strip vegetation is the USDA NRCS *Filter Strip* practice standard (USDA NRCS, 2011b), which lists approximately 20 species, to be used individually, or in combination. While this guidance includes seven native species (Big Bluestem, Eastern Gammagrass, Indiangrass, Intermediate Wheatgrass, Little Bluestem, Switchgrass, and Tall Wheatgrass), it also includes Reed Canarygrass.

Though Reed Canarygrass species is neither restricted nor prohibited, and is still used in the state, it has been identified in a Michigan Department of Natural Resources (MDNR) invasive species document (MDNR, 2009) as sometimes problematic in certain areas. So, where feasible, when installing filter strips, consider suitable alternatives to Reed Canarygrass. Note that the MDEQ Nonpoint Source (NPS) Program will not fund the planting of Reed Canarygrass.

One useful resource for selecting potential filter strip vegetation is the Minnesota Pollution Control Agency's *Plants for Stormwater Design* (Shaw & Schmidt, 2003), which identifies both desired native species, and those to avoid (including Reed Canarygrass).

In considering particular plant species to be used as filter strip vegetation, check with the MDNR's prohibited and restricted invasive species list, to make sure the species of interest are not on this list.

Multi-Zone Riparian Buffer

A number of sources describe and recommend multi-zone riparian buffers. The USDA NRCS (2000) has a practice standard for riparian forest buffers, to be established primarily in open or agricultural land. Schueler (1995) describes a system more suited to developed, urban or suburban areas.

Described below is a synthesis of the various multi-zone systems, which ties together the various recommended minimum widths, vegetation types, land use restrictions, and allowances:

Zone 1. This is the innermost zone, closest to the adjacent receiving water body. It is also referred to as the 'streamside zone'. It is typically wooded, with trees or shrubs; mature trees are preferred. Neither livestock access nor timber harvesting are recommended.

In more developed areas, the recommended minimum width is 25 feet, and recommended land uses should be limited to footpaths or watercourse crossings.

Zone 2. This zone is also referred to as the 'middle zone'. Like Zone 1, it is typically wooded, ideally with mature trees. In some cases Zone 2 can be a managed forest, in which selected, minimal timber harvesting is allowed, primarily for maintaining the health of the stand, and as an economic incentive. No livestock access is recommended.

In more developed areas, recommended land uses should be limited to bike paths, storm water BMPs, or other low-impact recreational uses. The recommended minimum width in developed areas is 50 feet, increasing to include the 100-year floodplain, steep slopes, adjacent wetlands, or higher-order streams.

Zone 3. This zone, furthest from the stream, is also referred to as the 'outer zone'. In agricultural areas, this zone typically consists of a filter strip (described above). In agricultural areas where there are no streamside trees, filter strips are still often established adjacent to water bodies, in which case this practice comprises the entire riparian buffer. Conversely, in areas with existing riparian forest buffers (i.e., Zones 1 and 2), if the adjacent up-slope land is grassland, forest, or other area that does not produce sediment, nutrients, pesticides, or other pollutants, then a filter strip may not be necessary. As described above, the recommended minimum filter strip width ranges from 20 to 216 feet, depending on a number of factors.

In more developed areas, the minimum recommended width is 25 feet. In residential areas, the vegetation in this zone often consists of turf grass (such as a back yard). Property owners should be encouraged to plant other dense herbaceous species to provide increased filtering capacity.

Figure 1 contains a schematic cross-sectional view of a hypothetical multi-zone riparian buffer, including recommended vegetation types, minimum widths, and land uses.

Other Riparian Buffer Width Criteria

While primary design criteria for filter strip and multi-zone riparian buffers are discussed above, other riparian buffer width criteria, some regulatory, others simply recommended, are as follows.

The 16 designated Natural Rivers in Michigan have riparian buffer requirements, in some cases exceeding the recommendations given above. Refer to Table 1 for the minimum required vegetated riparian buffer widths on private land along the main stems of the listed rivers. A given width is measured outward horizontally starting at the ordinary high water mark, on both sides of the river. Note that buffers along tributaries, on state land, or in other cases can have different requirements. For specific guidance, refer to the individual plans for each designated Natural River, or consult the MDNR Natural Rivers Program.

Table 2 summarizes the results of a literature search for minimum recommended buffer widths for the protection of the listed terrestrial animal species. These studies made conclusions by correlating the relative amount of habitat provided by buffers of various widths with the number of animals encountered.

Schueler (1995) recommends a minimum overall urban riparian buffer width of 100 feet.

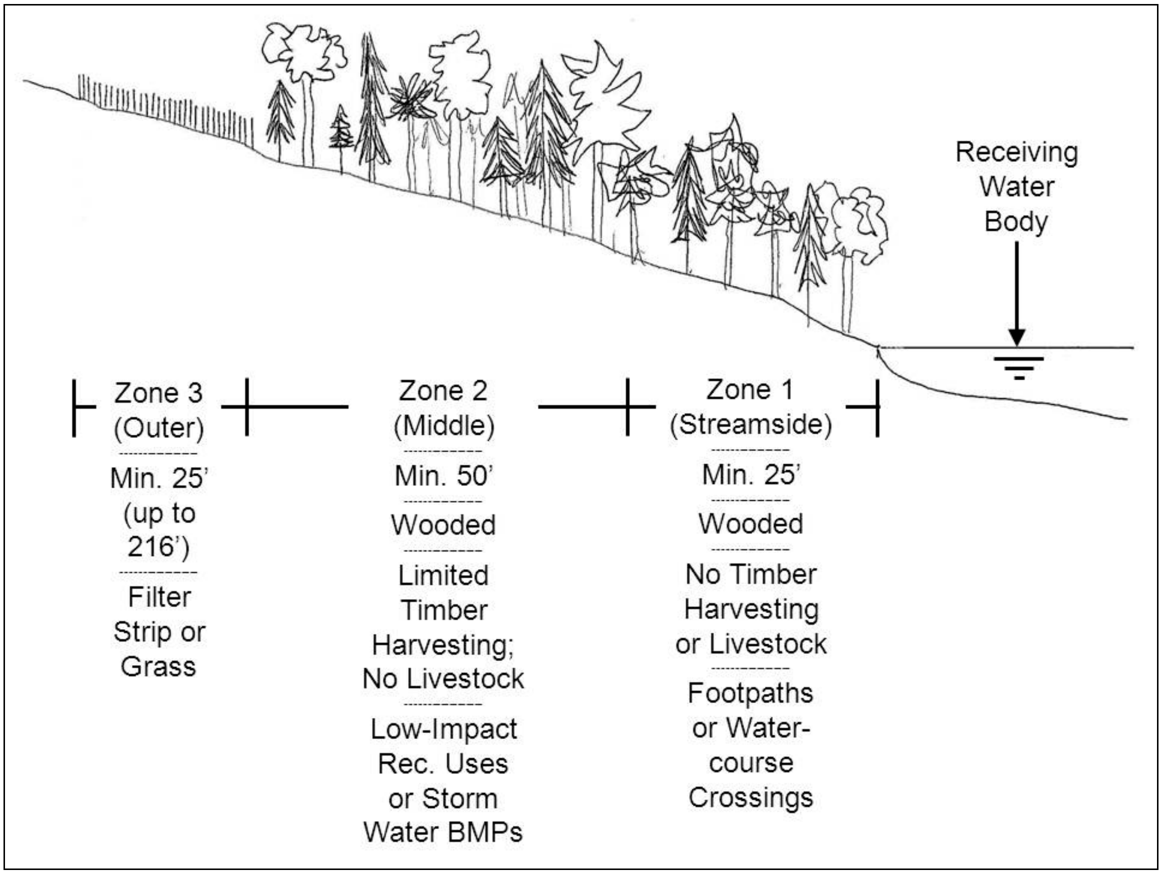

Figure 1. Multi-Zone Riparian Buffer

Table 1. Michigan Natural River Buffer Requirements

Min. Vegetated Buffer (feet)	River
100	Fox, Two Hearted, Jordan, Pigeon, Pine
75	Au Sable, Pere Marquette, Rifle, Upper Manistee
50	Betsie, Boardman, Huron, Lower Kalamazoo, Rogue, White
25	Flat

Source: MDNR, 2004.

Table 3 summarizes the results of a literature search of riparian buffer studies that considered various water quality parameters and aquatic animal species.

Performance Enhancers

Native plant species are preferred over introduced species for a number of reasons. First, they are often more acclimated to the local climate, making them hardier and more drought-tolerant. Second, many native plant species have deeper root structures, which can facilitate increased infiltration, and the take-up of more runoff.

Table 2. Recommended Riparian Buffer Width to Support Listed Animal or Taxon

Animal or Taxon	Riparian Buffer Width, feet	Source
Amphibians & Reptiles	>99	Rudolph & Dickson, 1990.
Birds, breeding	>50	Premo, 1995
Mammals	Narrow buffer w/ well-developed herbaceous vegetation better than wider buffer w/ sparse vegetation	Dickson & Williamson, 1988
	>400 for coniferous buffers	
Squirrels	>99 minimum	Dickson & Huntley, 1987
	>165 for abundance	
Turkeys	>150	Burk et al, 1990

Table 3. Water Quality-Related Riparian Buffer Literature Search Summary

Parameter(s) Studied	Study Location	Conclusions/ Recommendations	Source
Gully Erosion	LA	Buffers did not stop gully erosion that started up-slope of buffers. All 1,584 sites studied had developed gullies.	Farrish et al, 1993
Macro-invertebrates	CA	Streams with riparian buffer widths less than 30 meters (98.4 feet) showed same response as streams logged without buffers. Changes caused by decreased canopy density, and increased: primary production, stream flow, temperature, and sediment.	Erman et al, 1977
	New Zealand		Graynoth, 1979
Nutrients, Turbidity	WV	In streams with riparian buffers of widths 10 to 20 meters (32.8 to 65.6 feet), both turbidity and nutrients increased during and after logging.	Aubertin & Patrick, 1974
Temperature	OR	For the streams studied, max. shading ability was reached within 80 feet, and 90% of max. was reached within 55 feet. Angular canopy density also needs to be factored into buffer width determination.	Brazier & Brown, 1973
Turbidity, Sedimentation	PA	Recommends buffer widths of 23 to 30 meters (75 to 98 feet).	Corbett et al, 1978
		Recommends buffer widths of 30 meters (98 feet).	Lynch & Corbett 1981
		Recommends buffer widths of 100 feet, or 1.5 times average tree height.	Lynch & Corbett, 1990
Water Yield	MN	Clear-cutting aspen and pine forests increased annual water yield 9 to 20 cm, a 30% to 80% increase, taking 12 to 15 years to return to pre-harvest levels.	Verry, 1986

For the transitions between vegetation types in multi-zone riparian buffers, the more variation in vegetation types, the greater the habitat variability, and greater potential for biodiversity.

Construction

Install any necessary temporary or permanent upland BMPs.

Prepare the site. If grading is necessary, consider the **Land Clearing** and **Grading Practices** BMPs. Never grade to the edge of a water body without proper soil erosion and sedimentation controls in place. Consult the **Soil Management** BMP for any necessary soil amendments, such as fertilizer.

For vegetation establishment, refer to the **Seeding**, **Sodding**, **Mulching**, and **Trees, Shrubs, and Ground Covers** BMPs. Consider using mulch between and around any trees or shrubs, to keep soil on site, retain moisture, and promote infiltration.

Maintenance

General

Maintain any temporary upland BMPs until riparian buffer vegetation is sufficiently established (i.e., a minimum of 90 percent coverage). Filter strip grass or other vegetation should be at least four inches tall.

Leave riparian buffers undisturbed except for the land uses listed previously. Do not use heavy equipment or run vehicles on riparian buffers.

Vegetation

If a buffer is designed for nutrient removal, harvest and remove vegetation, and dispose of outside the buffer. Riparian buffer vegetation can also be managed with prescribed burns. Ensure that riparian buffer performance is maintained after any vegetation removal. For example, if harvesting vegetation, cut only the tops of plants, versus mowing down to the ground. Or, if conducting a prescribed burn, do so only on one part of the buffer at a time.

If grass fails to grow in a newly-established filter strip or 'Zone 3'/'outer zone' (of a multi-zone riparian buffer), determine the reasons for failure before reseeding. The **Lawn Maintenance** BMP includes information on unhealthy turf. Spot seed only when small areas are affected.

If insects or invasive species are damaging the filter strip, consider integrated pest management techniques presented in the **Pest Management** BMP to minimize the effects on any wildlife using the filter strip. Resort to chemical controls only after all other methods have been ruled out.

Collected Sediment

Remove any excess sediment that has accumulated in or adjacent to the buffer. Re-grade if necessary, to ensure runoff enters and passes through the buffer as sheet flow. Look in particular for sediment accumulated along the leading edge of the buffer, which can potentially concentrate flow, leading to gully erosion. Re-vegetate any areas that need it.

If sediment enters a buffer in amounts which cannot be removed by hand, or in amounts which cause damage, additional upland BMPs likely need to be installed or implemented.

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