

The “Science” of Riparian Buffers

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Riparian Buffers:

Riparian buffers are streamside tree buffers. They serve many valuable purposes: protect the creatures in the stream with shade, stabilize stream banks against erosion, filter pollution from storm water, and more.

The Board of County Commissioners for Frederick County is looking at requiring the protection of riparian buffers during new development in order to protect streams. They are currently looking at a proposed stream buffer ordinance for part of the Linganore Watershed. The part of the watershed being considered is all of the land that drains to Linganore Creek above the dam. This watershed is impaired by excess phosphorus and sediment and has regulatory limits for these pollutants from the U.S. Environmental Protection Agency (EPA); these limits are called Total Maximum Daily Loads (TMDLs). Other watersheds are being evaluated for TMDLs because they are on the State’s list of impaired water bodies. The proposed TMDLs include nutrients, sediment and bacteria in Double Pipe Creek; sediment in Catoctin Creek; nutrients, sediment and bacteria in the Lower and Upper Monocacy River; and PCBs in the Upper Potomac (including all of Monocacy, Catoctin and Little Pipe Creek). TMDLs present a challenge to the local government to control pollutants that are released by private entities. The County Commissioners have asked Comprehensive Planning staff for recommendations for a countywide riparian buffer ordinance and are looking at other forest requirements related to new development. The Watershed Management Section within the County’s Division of Public Works is helping to provide Planners with the science of riparian buffers so that they can make recommendations that will best benefit the citizens and the environment.

The table below reviews recommendations in the literature for minimum buffer widths depending on the purpose of the buffer.

Riparian Buffer: Recommended widths for various purposes from literature review

Purpose	Width	Cite Source	Note
Nitrogen, Phosphorus, Sediment Removal	62 feet will remove 60.4%-89% N from surface runoff depending on soils. 100 feet will remove approximately 95% NO ₃ from MD cornfield. Proposes 3-zone system with zone 1 native trees (min 15 ft, no harvest undisturbed, control stream area), zone 2 forest (min 60 ft, managed selective harvest), zone 3 grasses (20 ft, to create roughness slow water). Most N uptake in zones 1,2.	Riparian Buffer Effectiveness Literature Review, prepared by Straughan Environmental Services, Inc. Prepared for MDE	Buffers take 15-20 years from planting to function effectively- argument for protecting existing trees. Poplar especially effective at uptake. Poorly drained soils allow for most removal. In piedmont, buffers prevent N in subsurface flow.
	100 feet or more	National Agroforestry Center, USDA NRCS	Width up to 100 feet or more may be necessary on steeper slopes and less-permeable soils to obtain sufficient capacity for infiltration of runoff, and vegetation and microbial uptake of nutrients and pesticides.

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	30-89% Phosphorus removal, 84-94% Sediment removal. 3-zone buffer recommended	Relative Nutrient Requirements of Plants Suitable for Riparian Vegetated Buffer Strips, for VA DEQ, by ICPRB	Useful where nitrogen and phosphorus are limiting nutrients. See document for specific uptake by species
	<120 feet to control sedimentation, buffer widths from 50 ft for slopes less than 1% and 130 ft for slopes under 15% would be adequate for sediment reduction	Quantitative Review of Riparian Buffer Width Guidelines from Canada and the United States, P. Lee.	Can not protect against clearcutting in wider watershed. Relationships between slope, buffer width, and sediment transport are monotonic and relatively continuous (Wong and McCuen, 1982).
	>82 ft for 50-90% sediment removal short term. Wider buffer may be needed long term.	A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation, University of GA	For total suspended solids, buffer widths need to increase by a factor of 3.0 for a 10% increase in removal efficiency, and 60 m (197 ft) wide buffers provide the greatest efficiency. Grass buffers effective at stopping TSS in Piedmont. Dillaha et al (1988, 1989) found that as buffer slope increased from 11% to 16%, sediment removal efficiency declined by 7-38%.
Remove Organic Matter and Biological Contaminants	34-74% fecal coliform removal in 20 ft grass strip. A 197 ft long grass filter strip reduced fecal coliform by 87%, total coliform by 84% and BOD by 62%.	A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation, University of GA	Includes pathogenic microorganisms including fecal coliform, Biological Oxygen Demand (BOD)
Remove Pesticides and Metals	Variable. Mechanisms not well understood. 30-50 ft or greater recommended.	A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation, University of GA	Buffers are very important in displacing pesticide application away from streams, preventing direct contamination and reducing the danger of drift. Many pesticides are broken down within buffer soils, while metals may bind to soil particles. Greater buffer width increases the retention time for chemicals (allowing more opportunities for contaminants to decompose) and provides more sites for binding metals.
Stabilize Banks	Adjacent to stream	National Agroforestry Center, USDA NRCS	May require more for severe erosion
	Dependent on stream type, extent of existing erosion-should be wide enough to permit channel migration. Width of 100 year floodplain at minimum.	A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation, University of GA	To allow for all possible migration would require a buffer the width of the active (100-year) floodplain
Filter sediment	25-30 ft	National Agroforestry Center, USDA NRCS	Greater width may be required for shrub and tree vegetation, on steeper slopes, or where sediment loads are particularly high.

Purpose	Width	Cite Source	Note
Provide shade, shelter, and food for aquatic organisms	Adjacent to stream	National Agroforestry Center, USDA NRCS	Width up to 100 feet in trees may be needed for adequate shade and water temperature control for cold water fisheries in warmer climates.
	50->100 feet for prevention of rising instream temperature, >100 ft to protect invertebrate (fish food) populations instream	Quantitative Review of Riparian Buffer Width Guidelines from Canada and the United States, P. Lee.	Partial harvest in riparian buffer causes problems for temperature. Especially important for trout: Wesche et al. (1987) found that overhead bank cover provided by riparian vegetation explained the greatest amount of variation in trout population size in Wyoming streams. Trees also provide organic material, roughness for food and habitat at >100 feet. The relationship between buffer width and presence of fish is not straightforward.
	Provide shade, shelter, and food for coldwater trout including native brook trout (Use 3 and 4) 100+ feet	National Agroforestry Center, USDA NRCS	Width up to 100 feet in trees may be needed for adequate shade and water temperature control for cold water fisheries in warmer climates. [Other factors also determine trout survival including road densities, % human land use in watershed, % impervious, groundwater withdrawals- see CAMBI doc]
	>50 ft to protect woody debris inputs, > 100 feet in logging areas, >30 feet to protect instream temperatures	A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation, University of GA	No tree harvesting should occur within 25 ft (12 m) of the stream (50 ft/15 m is preferable), and harvesting in the remainder of the buffer should leave some mature and senescent trees.
Wildlife Habitat	Width required is highly dependent upon desired species	National Agroforestry Center, USDA NRCS	NRCS Standards call for a minimum of 45 ft of grass to promote upland game birds
	100-175 feet for 90-95% preservation of riparian birds if used as forage and travel with adjacent hubs.	Quantitative Review of Riparian Buffer Width Guidelines from Canada and the United States, P. Lee.	Interior forest species require wider buffers for habitat but less acceptable for forage and travel if hubs contiguous. Regulations should mention "explicit statements about the protection of aquatic and terrestrial habitats and biota" to justify wider buffers. Most notably core habitat for medium and large mammals and birds were wider than most current guidelines.
	>300 ft	A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation, University of GA	required to protect diverse terrestrial riparian wildlife communities (300 feet- pers. Comm. with Ken Yetman, DNR)
Economic products	Minimum width requirement is highly dependent upon the desired crop and its management. Tax incentives and cost-share program requirements must also be considered in determining buffer width from an economic standpoint.	National Agroforestry Center, USDA NRCS	

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Protect low topo areas with subsurface flow initiation	greater width buffers (GWBs) >200 ft	M. Herrmann, Defending 300 Foot Buffers	* Extend residence time for surface and subsurface flows * Optimize opportunity for buffer/groundwater interaction in low topographic areas near initiation of subsurface flow paths. * Increase surface roughness to runoff on erodible, steeply sloped soils.
Protect streams with steep slopes	greater width buffers (GWBs) >200 ft	M. Herrmann, Defending 300 Foot Buffers	Maryland State Law recognizes the importance wider buffers to protect waterways from erosion off steep slopes. Laws addressing forest harvest operations and the Critical Area require that buffers expand 4 feet for every additional percent of slope. Further, it is recommended that all steep slopes greater than 25% be included in the forest buffer (Wenger 1999; Schueler, 1995).
Protect Headwater Areas	>100 ft	A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation, University of GA	Riparian buffers are especially important along the smaller headwater streams that make up the majority of stream miles in any basin. Even ephemeral streams should be protected, since these waterways can carry appreciable flow and sediment during storms.

Recommendations:

The variable width buffer proposed by Comprehensive Planning addresses many of the minimum buffer widths in the literature. The minimum buffer of 50ft from any perennial or intermittent stream will provide measurable benefits. A minimum of 100 feet or more appears to be a value that addresses most goals of riparian protection, including nutrient removal and the protection of aquatic organisms. The protection of greater than 50 feet in areas with steep slopes is addressed by the proposed ordinance. Protection of the floodplain, at minimum, is also key and is included in the proposed ordinance.

Several local conditions are not addressed by the proposed buffer: Coldwater fisheries, often in headwater areas, require a minimum buffer distance of at least 100 feet. These fisheries have state-Designated Uses 3 and 4. The County could consider more stringent buffer requirements in these areas. The County could also consider additional protections in these areas, as riparian buffers alone are not adequate to protect the survival of coldwater fisheries. Some other factors could include: reduced road densities and road crossings, maximum % human land use in watershed, maximum % impervious, and limits to groundwater withdrawals. A more thorough treatment of human practices as they relate to native brook trout survival is available in a draft Strategy for the Catocin, Antietam and Monocacy Brookie Initiative (CAMBI). Groundwater recharge areas are not addressed and these areas may warrant additional protections to insure protection of groundwater supplies.

Riparian buffers should be considered in a larger context of water resource management that includes protection of drinking water quality, ambient water quality, and habitat. This larger planning initiative may be included in the preparation of HB1141 compliance; such an effort provides the opportunity to create overlays of important resources to protect, along with practices to encourage, require, discourage, and prohibit within each overlay.

The protection of aquatic and terrestrial habitats and biota can require a larger buffer of 300 feet or more, as many species require interior forest. If this is impractical, a reasonable alternative could be to protect a minimum buffer width to provide forage, cover, and travel for species; these corridors would connect to green infrastructure hubs. These hubs generally contain forest interior and/or the protection of specific environmental resources. The Department of Natural Resources has prepared a Green Infrastructure study for the region that includes proposed hubs. The Watershed Management Section within DPW has conducted studies to determine important resources for water quality and habitat in the region as part of its watershed assessments.

A zone of forest closest to the stream of about 15-25 feet should be protected from selective logging, due to impacts from the loss of trees and from the equipment in the stream area. Areas outside of this minimum buffer could permit selective logging, when applicable. Grass buffers should not be considered a substitute for forested buffers and should not be included in an ordinance within the minimum buffer width. However, grass buffers do provide significant sediment trapping and some nutrient removal, and they maintain sheet flow

and prevent rill erosion. Grass buffers are an appropriate outer zone in a riparian buffer but should not figure into minimum buffer width.