

The Importance of Surface Water Buffers

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The vegetated corridors adjacent to lakes, streams and rivers, also called “riparian buffers” are effective and relatively inexpensive tools for protecting water quality and stream health both in rural and urban environments. By filtering sediments and transforming nutrients so they are less damaging to the water bodies, buffers act as safeguards from the impacts of land use practices. Trapped sediments and nutrients in the forest floor and soil also nourish plants and trees and are why buffers are unique in their productivity and biological diversity. Riparian buffers also provide water storage and floodplain protection and streambank stabilization. A few of these riparian functions are discussed in greater detail below.

Sediment retention

Sediment in streams, rivers, and lakes is the most ubiquitous pollutant in the United States. Over 17% of the water bodies that do not meet federal water quality standards are listed for sediment problems.¹ Sediment in water has many sources including historic sedimentation from farming cotton and other row crops, gravel dredging and mining, livestock and row crop agriculture, forestry practices, and residential and commercial development. Sedimentation destroys aquatic habitat and increases the mortality of some fish, mussels, and aquatic insects by elevating the level of total suspended solids (“TSS”) in the water. Vegetated areas along water bodies trap sediments in the leaf litter and in the soil and reduce the amount of sediment that flows into water bodies. Studies have shown that the removal of TSS by buffers increases with

¹ Radcliffe, D.E., *A Protocol for Establishing Sediment TMDLs in Georgia*, UGA’s River Basin Center and The Georgia Conservancy’s Sediment TMDL Technical Advisory Group, at 4 (2002).

buffer width and decreases with slope percentage.² Research suggests that in the very short-term, a minimum buffer of 15 feet is effective at removing sediments.³ However, 82-foot buffers are needed to trap sediments over a longer period of time, and 197-foot buffers are recommended for removing TSS altogether.⁴

Filtration

In addition to filtering out sediment, buffers also filter nutrients and contaminants, including heavy metals, pesticides, biological pathogens, and oil and grease found in stormwater runoff. Second to sediment, nutrients in runoff from agricultural practices in rural areas and from fertilization of lawns in urban areas are the largest sources of nutrients in stormwater runoff. Runoff volume increases in proportion to the percentage of impervious, or non-infiltrating, surface area.

Phosphorus has been the most problematic nutrient pollutant for lakes and ponds and is the cause of over enrichment, or eutrophication, of water bodies that are characteristically low in dissolved oxygen. This results in less oxygen being available for fish and other aquatic wildlife. Because studies have shown that buffers can eventually become saturated with phosphorus and thus allow soluble phosphorus to enter water bodies, efforts need to also focus on reducing phosphorus loadings from major sources. Sources of phosphorus include fertilizers from agriculture and lawns, field applied animal wastes from concentrated animal feeding operations (CAFOs), septic drain fields, and leaking sewer pipes. Generally, the same buffer width

² Wenger, S., *A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation*, Univ. of Ga. Office of Public Service and Outreach, Institute of Ecology, at 12 (1999).

³ Wenger, S. and L. Fowler, *Guidebook for Developing Local Riparian Buffer Ordinances*, Univ. of Ga. Institute of Ecology, at 4 (1999).

⁴ See Wenger, *supra* note 2, at 12. The overall recommendation of these researchers is that 100-foot buffers are recommended under most circumstances to effectively trap sediments. *Id* at 18.

recommended for retaining sediments (100 feet) is accepted for filtering phosphorus, because phosphorus typically arrives to a water body attached to sediment or organic matter. With an adequate buffer width, streamside forests can filter approximately 80% of phosphorus.⁵

Nitrogen, similar to phosphorus, is also a contributor to eutrophication of water bodies and comes from the same sources as phosphorus. Both the nitrate and ammonium forms of nitrogen are toxic to aquatic organisms and humans. Buffers remove nitrogen by direct uptake by vegetation and by the denitrification process by microorganisms that convert nitrate into nitrogen gas. Studies have found that the effectiveness of total nitrogen removal increases with buffer width. In most cases, it is estimated that a 50-foot width is minimum and a 100-foot width provides good control for nitrogen removal.⁶ Efficiency of removal depends upon buffer type, landuse, region, nitrogen form, and entry by surface runoff or groundwater, but a 164-foot buffer significantly reduces all forms of nitrogen in surface runoff (79% of nitrate, 78% of ammonium, and 86% of particulate).

Pathogens, or pathogenic microorganisms, contribute to water degradation and enter the water bodies through leaking sewer pipes, septic systems, animal waste from fertilized fields and waste lagoons. Fecal coliform is used as an indicator of pathogens and is the primary category of pollutant causing Georgia's stream, river, and lake segments to fail to meet their water quality standards. To date, the Regional Development Centers and the Georgia Environmental Protection Division have developed, or are in the process of developing, a total of 894 TMDLs for fecal coliform in 12 of Georgia's 14 river basins.⁷ Buffers trap pathogens the same way they

⁵ Welsch, D.J., *Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources*, USDA Forest Service: NA-PR-07-91, Radnor, PA, at 7 (1991).

⁶ See Wenger, *supra* note 3, at 4.

⁷ Conversation with Vickie Yarbrough, Watershed Protection Branch, Georgia Environmental Protection Division (February 16, 2005).

trap sediment and filter other nutrients. The effectiveness of the buffer varies depending upon buffer type and width, but one study found an 87% reduction of total fecal coliform with a 197-foot buffer⁸

Pesticides are toxic chemicals that can cause direct mortality to aquatic organisms. The main sources of pesticides are row crop agriculture, forestry, and urban lawns. Buffers help to break down the chemicals, and wider buffers increase the retention time of the chemical and the decomposition of the contaminants.

Like other pollutants, metals are carried to surface waters through stormwater runoff. Buffers have been shown to be effective at removing or retaining hydrocarbons and metals with approximately 40% of lead and 60% of copper, zinc, and iron being removed.⁹

Water storage and streambank stabilization

In addition to filtering pollutants, buffers help mitigate the impact of storms on water bodies. Under storm conditions, the leaves of plants and trees buffer the impact of falling raindrops, allowing more rain to seep into the soil. This infiltration reduces the volume of runoff and the amount of soil and nutrients entering the water. Reducing both the volume and the velocity of stormwater runoff means the water has less power to erode banks and channels. Vegetated buffers also help protect streams and rivers against high, fast flow, because the roots of trees and plants hold soil in place and stabilize the banks.

⁸ See Wenger, *supra* note 2, at 30.

⁹ See *id.* at 31.

Habitat

Riparian buffers are also a critical component of aquatic ecosystem habitats, because they provide food (leaves, debris, insects), temperature control through shade, and habitat (deposited large woody debris and leaf litter) for a variety of wildlife. A study of 16 North American streams shows that wide forest reaches had more macroinvertebrates, total ecosystem processing of organic matter, and nitrogen uptake than narrow deforested reaches.¹⁰ Shade and stream temperatures are particularly important in North Georgia, because naturalized rainbow and brown trout populations cannot survive once stream temperatures exceed 72°F. A University of Georgia study found that by cutting a 100-foot buffer in half, approximately 90% of their 373 study sites would have temperatures greater than 72°F.¹¹ Such a shift would dramatically change the diversity of species in that stream reach.

Trees in the buffer zone also provide habitat by the leaves, twigs, and branches that fall into the water body. This woody debris provides valuable fish habitat, allows for high levels of invertebrate productivity, and provides refugia for endangered and threatened mussels. In southeastern Coastal Plain streams, woody substrate habitats had a higher diversity and production of macroinvertebrate species than any other habitat.¹² For habitat protection, buffers from 35-100 feet wide are estimated to be sufficient, depending upon slope and other factors.¹³

¹⁰ Sweeney, B.W., T.L. Bott, J.K. Jackson, L.A. Kaplan, J.D. Newbold, L.J. Standley, W.C. Hession, and R.J. Horwitz, *Riparian Deforestation, Stream Narrowing, and Lost of Stream Ecosystems Services*, PNAS, V101, N39, at 1 (2004).

¹¹ Kundell, J.E., Judy L. Meyer, Elizabeth A. Kramer, C. Rhett Jackson, Geoffrey C. Poole, Krista L. Jones, B. Lane Rivenbark, Laura E. England, Mark C. Scott, and William Bumback, *Progress Report. Trout Stream Buffer Study*, UGA River Basin Science and Policy Center, at 10 (2001).

¹² Wallace, J.B. and A.C. Benke, *Quantification of Wood Habitat in Subtropical Coastal Plain Streams*, *Can. J. Fish. Aquat. Sci.* 41: 164 (1984).

¹³ See Wenger, *supra* note 2, at 10.

Economic and recreational

In addition to their important ecological benefits, buffers also provide important economic benefits. Trout fishing is an excellent example of both the economic and recreational benefits that come from maintaining riparian buffers. Buffers help maintain cool water temperatures and clean water that trout need to survive. Georgia has approximately 4,320 miles of trout streams, and the Georgia Wildlife Resources Fisheries Division issued a total of 107,755 trout licenses in 2004, generating \$547,778 in state revenue. Taking into account all freshwater fishing in 1996, 160,000 anglers spent over \$1 billion on travel-related expenditures and equipment in Georgia.¹⁴ Another economic indicator is that property values along streams and rivers tend to be higher due to the aesthetic value associated with the property. Finally, the value of clean water is probably the most important function of buffers. By calculating how much it would cost to provide a similar service, for example the cost of drinking water treatment, we can help measure the economic value of buffers.

Economic costs of ineffective buffers or loss of buffers

Water storage and trapping sediments and contaminants in riparian vegetation and soils and keeping them out of waterways are valuable ecosystems services. The loss or lack of buffers on our surface waters can have significant societal costs including higher costs to treat drinking water, costs of engineered stormwater management solutions, and the high costs of dredging sediments out of waterways for continued recreational and commercial use. Studies have specifically noted the increased costs of drinking water treatment due to the need to filter

¹⁴ U.S. Fish & Wildlife Service, *Economic Effects of Trout Production by National Fish Hatcheries in the Southeast, Southeast Region, Atlanta, Georgia*, at 15 (2001).

sediments¹⁵ and to remove nitrate and ammonium, metals, and pathogens.¹⁶ With regard to dredging, Maryland spends an estimated \$10 to \$11.5 million annually to dredge the sediment deposited into the Baltimore Harbor by the Patapsco River.¹⁷

Conclusion

Two comprehensive studies of buffers by University of Georgia researchers found that the extent, vegetation, and width of buffers were the most critical factors in protecting all the services buffers provide. The studies recommend that, at a minimum, all perennial, intermittent, and ephemeral streams be protected by buffers.¹⁸ Although grass adequately functions to trap sediments and contaminants, native forested buffers are needed to provide water storage and streambank stabilization, habitat, and the full range of economic and recreational services.¹⁹

The studies' most protective recommendation is that buffer widths need to be 50-100 feet, however wider buffers will provide a greater margin of safety to protect all functions and services.²⁰ Variable widths can be considered if slope, the presence of wetlands, width of the floodplain, and the presence of impervious surfaces are taken into account.²¹ The University of Georgia researchers recommend a base width buffer of 100 feet, plus 2-foot increments per 1% of slope in order to ensure high water quality and support good habitat for native aquatic

¹⁵ See Wenger, *supra* note 2, at 23.

¹⁶ See Welsch, *supra* note 6, at 5-6.

¹⁷ Meyer, J.L., L.A. Kaplan, D. Newbold, D.L. Stayer, C.J. Woltemade, J.B. Zedler, R. Beilfuss, Q. Carpenter, R. Semlitsch, M.C. Watzin, P.h.Zedler, *Where Rivers are Born: the scientific imperative for defending small streams and wetlands*, American Rivers and Sierra Club, at 12 (2003).

¹⁸ See Wenger, *supra* note 2, at 39. A perennial stream is a one that flows throughout the year except perhaps during extreme drought. Intermittent streams flow at least six months out of the year but will not flow during part or all of the summer. An ephemeral stream flows less than six months in a year, and may have flow only during or after a rainstorm event.

¹⁹ See *id.* at 45.

²⁰ *Id.*

²¹ See Wenger, *supra* note 3, at 6.

organisms.²² In addition, the studies recommend that the buffer should extend to the edge of floodplain, the buffer should extend by the width of wetlands that lie within or partly within the buffer; existing impervious surfaces in the water body zone should not count toward buffer width, and slopes over 25% should not count toward width.²³

Although the services and functions of surface water buffers are relatively well known and widely accepted, buffers are increasingly becoming more fragmented by urban encroachment. From 1974 to 1998, the forested cover area and the average length of continuous forest within 196 feet of rivers and streams decreased for all of Georgia's 52 watersheds.²⁴ This same study found on average, a 170 foot reduction in the length of intact riparian buffers for all watersheds in Georgia.

These significant reductions, coupled with what we can see in our rivers, streams, and lakes after every rainfall raises the serious question of whether our current buffer rules are serving the purpose for which they were intended. Even Environmental Protection Division Director Dr. Carol Couch has stated that our system of buffer regulation is troubled.²⁵ She has suggested the need to take a broader look at the buffer program to ensure the services provided by buffers are better protected.²⁶ Knowing that the battle over buffers are far from over, perhaps a new approach that focuses on buffer services rather than the one-size fits all formula approach we now have will be the basis of a more productive dialogue that will better protect our water.

²² *Id.*

²³ See Wenger, *supra* note 2, at 41.

²⁴ Kramer, E. and B. Bumback, *A Statewide Analysis of Riparian Vegetation Change, From 1974-1998*, Proceedings of the 2005 Georgia Water Resources Conference (April 25-27), The University of Georgia, at 3 (2005).

²⁵ Speech before the Board of Natural Resources concerning the rules proposed pursuant to SB 460 (December 7, 2004).

²⁶ *Id.*