Targeting Areas For Riparian Forest Buffer Effectiveness
In the Chesapeake Bay Watershed

Judith A. Okay, PhD, Riparian Specialist Chesapeake Bay Program
2008

The Chesapeake Bay Executive Council (EC) comprised of the governors of Maryland, Pennsylvania, and Virginia, the mayor of the District of Columbia, the Director of the Environmental Protection Agency, and the Chair of the Chesapeake Bay Commission signed the historical Directive NO.94-1. In this document there was the recognition that riparian forests used as buffers between terrestrial land use and waterways provide a means to achieve nutrient reduction for the water quality goals of the 1987 Chesapeake Bay Agreement.
Since the Directive was signed, millions of dollars have been spent to increase the miles of riparian forest buffers in the Chesapeake Bay watershed. With the 10,000 mile goal endpoint quickly approaching in 2010, placing forest buffers in the most effective positions in the landscape is critical to the expected outcomes for the health of the Chesapeake Bay.

The Signatory states of the Chesapeake Bay have collectively recorded 5720 miles of riparian forest buffer restoration in the Bay watershed since 1996. These buffer miles are not necessarily placed in the landscape where they will be most effective for nutrient removal goals. The buffer locations are the result of landowner requests rather than programmatic prioritization for nutrient reduction achievements. Scientists with the US Geological Survey have studied buffer effectiveness and demonstrated that all buffers do not have the same efficiency for nutrient reduction. The nutrient removal effectiveness is dependent on the access of buffer to surface and ground water (Speiran, Hamilton, and Woodside 1998). The biological functions of riparian forest buffers require an interface between the aquatic component of the ecosystem and the terrestrial component of the ecosystem. The interception of sheet flow from landscape hot spots of heavy nutrient loading by a forest buffer is the basic premise for the use of riparian forest buffers as best management practices. The rate at which the trees in the buffer take up nutrients is influenced by many variables. The variables involved need to be captured as attributes of a targeting matrix to determine forest buffer location for effectiveness.

One approach to riparian forest buffer targeting by Ferraro (2001) correlates cost effectiveness and biophysical characteristics for water quality benefits. It was developed to support riparian forest buffer conservation in source water areas. Width, length, position in landscape, and species composition influence ecosystem services. The Chesapeake Bay Program Forestry Workgroup Technical Team developed a riparian forest buffer watershed targeting exercise in 2004. Some of the primary site attributes included in that exercise were similar to those in Ferraro's targeting protocol. This particular targeting exercise was not implemented formally, but was introduced as a means to target riparian forest buffer placement in the Chesapeake Bay watershed. Both of the cited targeting ideas have merits, but they do not address all pertinent issues. At this time, there is political and programmatic pressure to increase riparian forest buffer effectiveness in the Chesapeake Bay watershed. A primary way to accomplish this objective is to come up with a scientifically based scheme that can be used to identify areas in the Bay watershed for better riparian forest buffer placement with an expectation of full performance. Table 1. shows the attributes of the Ferraro, Forestry Workgroup, and the current proposed targeting matrices.

Table 1. Riparian Forest Buffer Targeting Matrices

Riparian Forest Buffer Targeting Matrix►	Ferraro (2001) targeting matrix	FWG Tech. Team (2004)targeting matrix	Proposed (2008) targeting matrix	Potential Map
Attributes of schemes				
	Steep slope	Slope	Slope	SSURGO and/or SPARRPOW
	Hydric soil	Soil	Soil	SSURGO
		Hydro geomorphic regions	Hydrology (depth to water table)	SSURGO
	Distance to intake pipe	Hydrologic units	Hydrologic units watersheds (11 digit HUC)	NHD
	Land use intensity	Land use	Land use	RLA/RESAC land cover
		Water Quality Risk	Source Nutrient Loading	SPARROW
	Distance to intake pipe	Watershed imperviousness	Watershed imperviousness	RLA/ uban as surrogate/RESAC land cover
	Development potential	Vulnerability to development	Vulnerability to development	RLA
	Biophysical attributes (ecological services) that contribute to the conservation goal for water quality		Impaired Waterways	State impaired stream maps
			Land ownership (public/private)	RLA and local tax maps
			Location in watershed	NHD

The following glossary explains why the use of the attribute filters in the Proposed 2006 Targeting Matrix will result in the successful placement of riparian forest buffers in areas of the Chesapeake Bay watershed where they will be most beneficial for nutrient reduction.

Slope – The topography of the land affects the flow of surface water through a forest buffer. If the slope is steep the residence time of the water in the buffer zone is reduced. Longer residence time increases tree root and water contact time and thus improves the nutrient removal capabilities of the buffer.

Soil – There are many characteristics of soil that affect riparian forest buffer nutrient removal effectiveness. Soils that are saturated or supersaturated have fewer pore spaces for surface water infiltration and oxygen storage. Soil texture is a controlling factor in soil saturation. The depth and composition of the soil profile in a specific location will also have an impact on infiltration. The depth of the organic layer (O horizon) of the soil profile influences infiltration rates and also biological de-nitrification rates.

Hydrology – The hydrologic features of a site include all water distribution within the site, and the location of water at various soil depths (water table, ground water, and surface water). Where the water is located determines its accessibility to the riparian forest buffer. Nutrient laden ground water that is not in contact with tree roots will not be directly influenced by the buffer.

Hydrologic units – Watershed or drainage location and size determine need for forest buffers.

Land use – Various land use types have a diversity of nutrient load production. Land use adjacent to riparian forest buffers have an impact on buffer effectiveness. Agricultural nutrient loads are much different than urban nutrient loads in content and concentration. The way the nutrient load reaches the forest buffer in these situations is also very different. In an urban situation the buffer may be bypassed by the use of a stormwater facility that will discharge water through a pipe versus sheet flow from an agricultural crop field.

Imperviousness of watershed – Land use with an urban classification can sometimes be a surrogate for imperviousness. It should be noted that the Center For Watershed Protection has demonstrated that when imperviousness reaches a level of greater than 10%, water quality is negatively impacted by increased temperature and nutrient levels.
Generally when imperviousness increases in a watershed, forest cover within a watershed decreases.

Vulnerability to development – The Chesapeake Bay watershed Resource Lands Assessment reflects the 1990-2000 vulnerability of forest land to land use change primarily commercial or residential development. The loss of riparian forest buffers is higher in areas vulnerable to development.

Impaired streams - Streams that have been designated impaired according to the pollutants they convey and contribute to the Chesapeake Bay. The application of forest buffers in these areas will lead to reduction of the pollutant loads.

Land ownership – The ability to implement riparian forest buffer projects in a particular area is dependent on landowner objectives and approval. Whether a site is public or private land makes a considerable difference. Federal and state agencies have been directed to put riparian forest buffers on their lands where it is feasible.

The application of the suggested GIS map layers (Table 1) of the matrix attributes is the most obvious way to pin point where riparian forest buffers will be most effective in a landscape. The 2004 Forestry Workgroup targeting matrix uses mapping to display the areas in the Chesapeake Bay watershed where riparian forest buffers are most needed. This new proposed targeting scheme uses many of the same attributes in the Forestry Workgroup matrix, but a primary difference is that this proposal is based on attributes that modify effectiveness of function. Most of the attribute information is already available in a GIS map format. The compatibility of the maps and the scale at which they are available may limit current map usefulness for this targeting exercise. Solving this issue and moving forward with mapping where riparian forest buffers will be most effective is the implementation step of this proposed targeting matrix.