CHESAPEAKE BAY
PROGRAM

NORTHEASTERN AREA
State and Private Forestry

Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers

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Section VI

Determining Buffer Width

Determining Buffer Width

Determining the Width of Riparian Buffers

There is substantial agreement in the scientific community about the value of using vegetation to buffer valuable aquatic resources from the potential impacts of adjacent human use of the land. There is also general agreement that the greatest range of buffer benefits is provided when natural vegetation, like forests, are the target vegetation. However, there is often little agreement and much continuing research and debate over how to best achieve the level of protection needed and how to best delineate and manage a buffer. Of all questions related to practical use of riparian buffers, determining the appropriate minimum width of a buffer is certainly the most frequently discussed.

One of the important factors which determines the effectiveness of a buffer is its size or effective width. Buffers that are too narrow may still place water quality or aquatic resources at risk. They may also present problems with sustainability over the long term. Although wider is nearly always better, buffers that are wider than needed may unnecessarily restrict use of a portion of the land. Therefore, the need to determine "minimum" widths has been a primary focus of resource agencies and local governments for many years. Complicating the picture further, buffer size requirements are typically established by political acceptability and compromise rather than on scientific merit. It is likely that these debates will continue.

Buffer Width Criteria

Various approaches and formulas have been devised to determine and evaluate the needed width of a riparian buffer. Establishing criteria that are scientifically based should be the goal of resource and conservation agencies. Four criteria are generally discussed for determining the adequate width of riparian buffers for protection of streams. They are the:

1. existing or potential value of the resource to be protected,
2. site, watershed, and buffer characteristics,
3. intensity of adjacent land use, and
4. specific water quality and/or habitat functions desired.

If necessary, these scientific criteria can then be modified by the management objectives or constraints of a given landowner or land management agency. In this way, scientific criteria guide width decisions, but are modified by socioeconomic variables where the risk and benefits of the decisions can be identified and discussed.

For example, when a 75-foot-wide buffer is determined appropriate, but is reduced to 25 foot by constraints imposed by land use, the risk of reduced water quality functions and potential sustainability should be identified. Likewise, when a decision is made to choose warmseason grasses over forest as the target buffer vegetation, reductions in stream stability, flood mitigation, groundwater nutrient removal, and aquatic/terrestrial habitat should be identified. In simple terms, narrower buffers may be adequate when the riparian area is in good condition, the resource values may be low, site conditions are ideal, the adjacent land use has a low potential for impact, and/or the desired buffer functions are few. Conversely, wider buffers are necessary when the buffer quality is poor and high-value water resources exist adjacent to intense land uses where a high level of multiple buffer functions is desired.

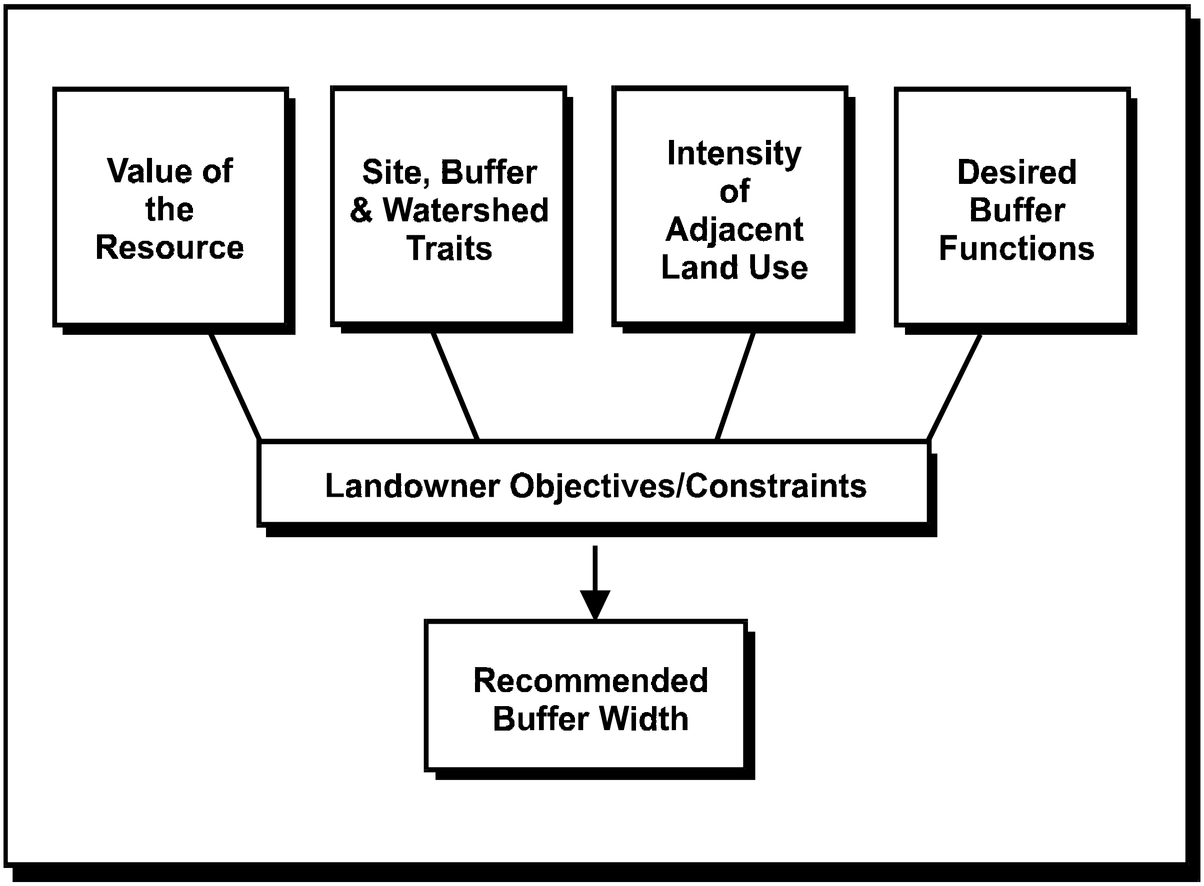

Figure 6 - 1. Criteria for determining width of riparian buffers and their relationship to landowner objectives.

Science-Based Criteria

Decisions about buffer width can be made using professional judgment in choosing among the following criteria. Four criteria (Figure 6-1) are discussed for which data may be available to support an informed decision. These criteria can form a “checklist” for buffer width determination.

Existing or Potential Resource Value

In general terms, narrower buffers are adequate when the stream, wetland, shorezone, or lake is of relatively low functional value. Although the determination of “value” can involve subjective judgment, scientific information can be applied to assist in this assessment. For example, states routinely rate the value of fish habitat based on potential natural condition or the target species being managed. The Chesapeake Bay Program has identified priorities for stream blockage removal based on value to migratory fish. Streams in watersheds providing municipal water supply or recreational use would likewise be considered of high functional value. Aquatic systems with a high disturbance regime or ones that are dominated by non-native species may be considered of lower functional value.

Conversely, degraded watershed, water quality, or habitat conditions may also be used as criteria for increasing buffer width if desire for improvement of conditions related to riparian areas has been specified. The designated uses of water or specific fish or wildlife species needs should be considered when buffers are established as a component of watershed restoration rather than protection strategies.

Site, Buffer, and Watershed Characteristics

Site factors are most important when evaluating performance in pollutant removal (Table 6-1). This is because reliable generalizations about the role of riparian buffers as nutrient and sediment filters can be based on the condition of the soil in the buffer area (including plant, animal, and microbial communities present) and the route and rate of surface and groundwater movement through the buffer. These characteristics are complex, interrelated, and not always apparent to the field observer. For example, judgments about water quality performance of a buffer in the Coastal Plain may be made on observations of surface storm runoff, not recognizing that 50-80 percent of nitrogen loads are carried by subsurface water flow. Site factors are also discussed later in desired buffer functions, but some general comments can also be made.

Site Criteria Affecting Buffer Width

- **watershed condition**
- **slope**
- **stream order**
- **soil depth and erodibility**
- **hydrology**
- **flood plains**
- **wetlands**
- **streambanks**
- **vegetation type**
- **stormwater system**

Table 6 - 1
Site Factors that Enhance or Limit Pollutant Removal Effectiveness of Buffers
(adapted from Schueler, 1995)

Factors that enhance effectiveness	Factors that reduce effectiveness
Slopes < 5 percent	Slopes greater than 5 percent
Contributing flow length <150 feet	Overland flow paths over 300 feet
Seeps, high water table—subsurface flow	Flow path to deep or regional groundwater
Permeable, but not highly sandy soils	Compacted soils
Level spreaders or flow dispersal	Concentrated storm flow
Organic matter, humus, or mulch layer	Snowmelt, ice conditions, low organic soil
Entry runoff velocity less than 1.5 feet/second	Entry runoff velocity more than 5 feet/second
Routine maintenance	Sediment buildup at entrance
Poorly-drained soils, deep roots	Shallow root systems
Forest and dense grass cover (6 inches)	Tall bunch grass; Sparse vegetative cover

Slope - Slope has the greatest influence over sediment removal and is a determinant in the rate and nature of water flow. In general terms, steep slopes increase runoff velocity and the volume of surface runoff. Buffers are often expanded to include steep slopes on small streams or buffer widths are increased on steeper slopes to provide a lower risk of impact from adjacent land use. For forestry practices in Maryland for example, a minimum 50 foot buffer width is modified for slope by adding 4 feet for each percent of side slope.

Stream Order – In order to design an effective stream buffer system, it is important to understand spatial connections between the stream and its watershed. Stream order is a useful tool to classify elements of the stream network. Headwater streams, defined as first or second order, are generally short in length, but comprise 75 percent or more of the total stream and river miles. In general terms, buffers have the greatest potential for control over water quality when adjacent to low-order streams. Lower order streams are small in size and have less contributing area per unit volume of water. Smaller buffers may be adequate to maintain the desired level of protection for first order streams.

As stream order increases, the contributing area and volume of water available to the buffer area also increases, potentially diminishing the relative capability of the buffer to filter and remove pollutants as a percent of total loading. This does not mean that the buffer's effectiveness in treating pollutants immediately upslope may be compromised, only that the magnitude of control exerted over the water in the stream diminishes. An example of this type of relationship is portrayed in Figure 6-2. Likewise, as stream order increases so does stream size, thus decreasing the ability of streamside trees to provide control of water temperature. The importance of the buffer zone in flood mitigation, on the other hand, may increase with stream order, whereas, critical fish habitat may be maximized by streamside trees in low to mid order streams.

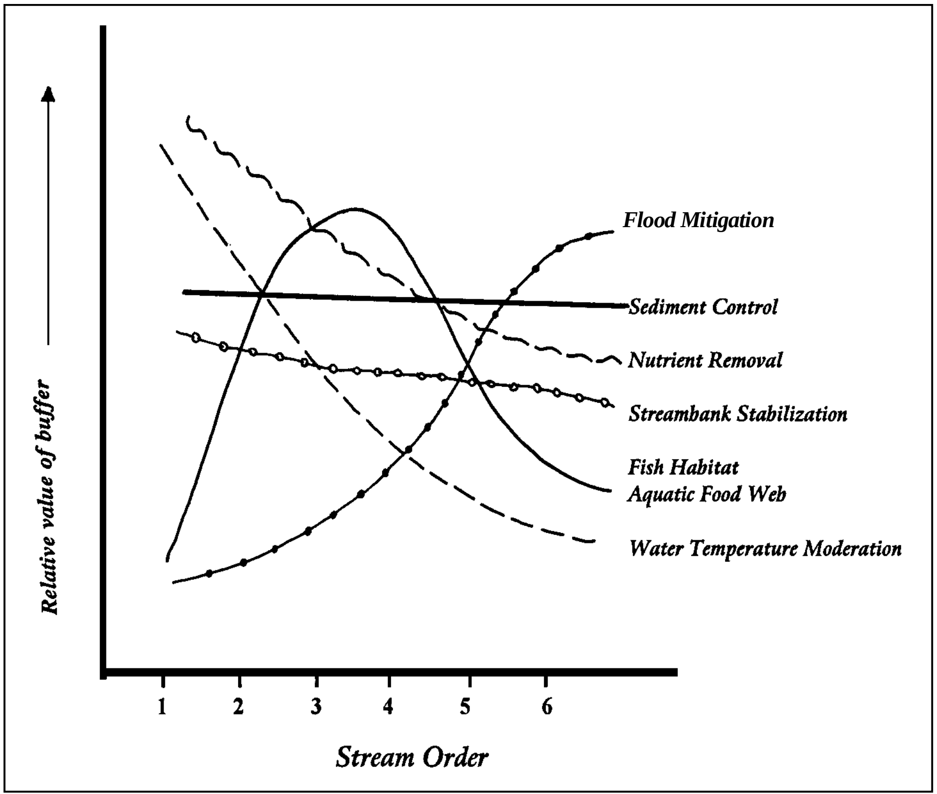

Figure 6 - 2. Generalized effect of stream order on variations in buffer function.

Target Vegetation and Condition **-** In simple terms, adequate buffers may be smaller if properly designed and maintained in good condition. Most riparian buffers use adapted or enhanced natural vegetative systems. Therefore, buffers in better condition (e.g. dense native vegetation, undisturbed soils, healthy microbial community) are likely to provide a variety of functions more effectively. Common sense shows that by looking to the natural ecosystem, the natural resource manager will find guidance in maintaining and restoring riparian functions. Although a number of vegetation types can be used to meet these specific buffer functions and provide multiple benefits, in the Chesapeake Bay region, as in much of the eastern United States, these benefits are amplified by or require a streamside area that is forested. Forests provide the greatest range and number of potential environmental benefits, and therefore, should be promoted as the target vegetation whenever possible in a hierarchy of vegetation types. These benefits are summarized in Table 6-2.

Table 6 - 2
Benefits of Riparian Buffers That Include Woody Vegetation

Benefit	***Greatly enhanced by or requiring Forest***
Protection from streambank erosion	✓
Increased removal of nitrogen	✓
Removal of phosphorus and sediment	
Reduced downstream flooding	✓
Thermal protection	✓
Food and habitat for wildlife	✓
Food and habitat for fish and amphibians	✓
Foundation for present or future greenways	✓
Increased urban/suburban property values	✓
Provision of corridors for habitat conservation	✓
Preservation of “right-of-way” for lateral movement	
Enhanced potential for stream restoration	✓
Reduced watershed imperviousness	✓
Reduced small drainage complaints	
Protection of associated wetlands	✓

Incorporation of flood plains and wetlands **-** Buffer width is often expanded to incorporate sensitive landscape features such as flood plains and wetlands. Including the entire flood plain width is desirable, but often difficult. Additional areas such as stormwater ponds and buffer infiltration areas (biofiltration swales) will often be incorporated in buffer layout in urban areas.

Continuity **-** Achieving contiguous buffers on the landscape along a stream system may be given a higher priority than increased width in areas where aquatic and terrestrial habitat goals are important.

Soils **-** Along with hydrology, soil characteristics are important in determining potential for removal of nitrogen and pollutants carried by sediment such as phosphorus and some pesticides. Primary considerations are soil texture, depth to water table, and organic matter content of soils. Moderate- to well-drained soils have the greatest permeability and intercept large amounts of water that may enter the buffer as surface flow, thus promoting deposition of sediment and related pollutants. Conversely, moderate- to fine-textured soils have superior potential to create conditions favorable for extensive denitrification.

Since denitrification is carried out by anaerobic microbes, soil conditions must be wet enough to allow oxygen depletion to occur. The large amount of decaying organic material on the ground and in upper soil layers in forested buffers helps to deplete oxygen supply and "fuel" the denitrification process. Although denitrification rates and duration vary depending on site conditions, even drier forest soils commonly have pockets that support these bacteria. In more poorly drained, higher organic matter soil, denitrification may proceed at relatively high rates in the top foot of soil. At better-drained sites, denitrification depends on the cycling of plant biomass back to the surface in litter fall. Here denitrification will not be uniform, but still active in surface soil. A combination of soil properties which provides a gradation of coarse- to finer-grained materials closer to the waterbody seems ideal. Sites with a depth to water table of 3 to 15 feet will allow maximum root penetration by woody plants and sustain uptake of nutrients and chemicals in solution below the surface. The water table need only be present for a portion of the year.

Hydrologic Soil Groups are often used as criteria for determining buffer width and are commonly available in county soil survey reports (Section IV).

Intensity of Adjacent Land Use

Generally, when the density, intensity, magnitude, or potential impact of the activity increases, the width of the buffer necessary to contain the negative effects increases proportionally. The differences between developed or disturbed lands and the aquatic environment are significant; the more intensely developed or disturbed, the more significant. Likewise, the size or importance of the buffer increases as the potential yield of nutrients, chemicals, sediment, and runoff from adjacent land use increases. Table 6-3 illustrates how these loadings can vary by land use. However, it is clearly recognized that a number of desired buffer functions, such as nutrient removal, are reduced in urban areas as impervious surface increases. Impervious surfaces increase watershed runoff efficiency reducing base flow to the stream and limiting the total volume of water passing through the buffer.

Buffer widths prescribed in urbanized areas are often increased to account for the risk of future encroachments and to anticipate future changes in stream morphology due to increases in stormwater runoff. This stream "right-of-way" approach is useful in development site planning. Maintaining larger wooded corridors along streams and rivers in urban planning helps preserve open space and offset general forest loss in a watershed. It is often most economical to consider this approach at the onset of land use change.

Table 6 - 3
Nutrient Loading Delivered to Edge of Stream as Used in the Chesapeake Bay Watershed Model

(does not include manure application areas)

Land Use	Total N (lbs./acre/year)	Total P (lbs./acre/year)
Forest	3.00	0.05
Pasture	9.34	0.61
Urban	11.44	0.67
Cropland	21.13	1.84

Studies in the coastal plain of Georgia described a relationship of buffer area to contributing area treated of 1:3 in agricultural areas with high nutrient loads. This ratio may be higher where potential impacts are less. Likewise, smaller buffers may be adequate where the magnitude of impact from land use is also low, e.g. parklands, haylands, or low-density development. A buffer width that is one-third the distance from the streambank to the top of the pollutant source area is sometimes recommended. The intent is to create a buffer between field and stream which occupies approximately one-third of the source area. This is reduced to one-fifth of the drainage area for lakes and ponds.

Desired Buffer Functions

One of the most important scientific criteria for determining buffer size requirements is an evaluation of the specific functions that a buffer needs to provide under site-specific conditions. A search of the literature clearly suggests that buffer sizes necessary for adequate performance of specific buffer functions vary widely. Accordingly, some judgment and setting of priorities is nearly always necessary to attain a desired minimum buffer width for a desired set of functions. Figure 6-3 illustrates a generalized range of minimum widths based on specific objectives for the buffer. The following is an overview of some important buffer functions and discussion of their relationship to width. Scientific references for these discussions are extensive.

Sustainability - Inevitably, when discussing riparian buffer establishment, the concept that “anything is better than nothing” will be raised. This is probably an accurate assessment when it comes to maintaining the functions of stable streambanks and making some improvements in stream or shoreline habitat. However, it is important to recognize that for a riparian area to serve the water quality functions of buffering impacts from adjacent land use, a “critical mass” or sustainable width is often essential. Buffers of less than 50 feet have proven increasingly difficult to maintain as effective filters in the field, except on small, low order drainages.

Sustainability should be a key consideration of buffer layout and design, prior to making substantial investments or assumptions about expected buffer performance. Sustainability like other functions will be determined by site characteristics and adjacent land use. For example, very narrow buffer strips of 15 to 25 feet are generally inadequate for sediment or nutrient reductions, except on small, low order streams. Narrow forest strips may provide shade and bank stability, but may not sustain a forest ecosystem capable of accumulating organic matter

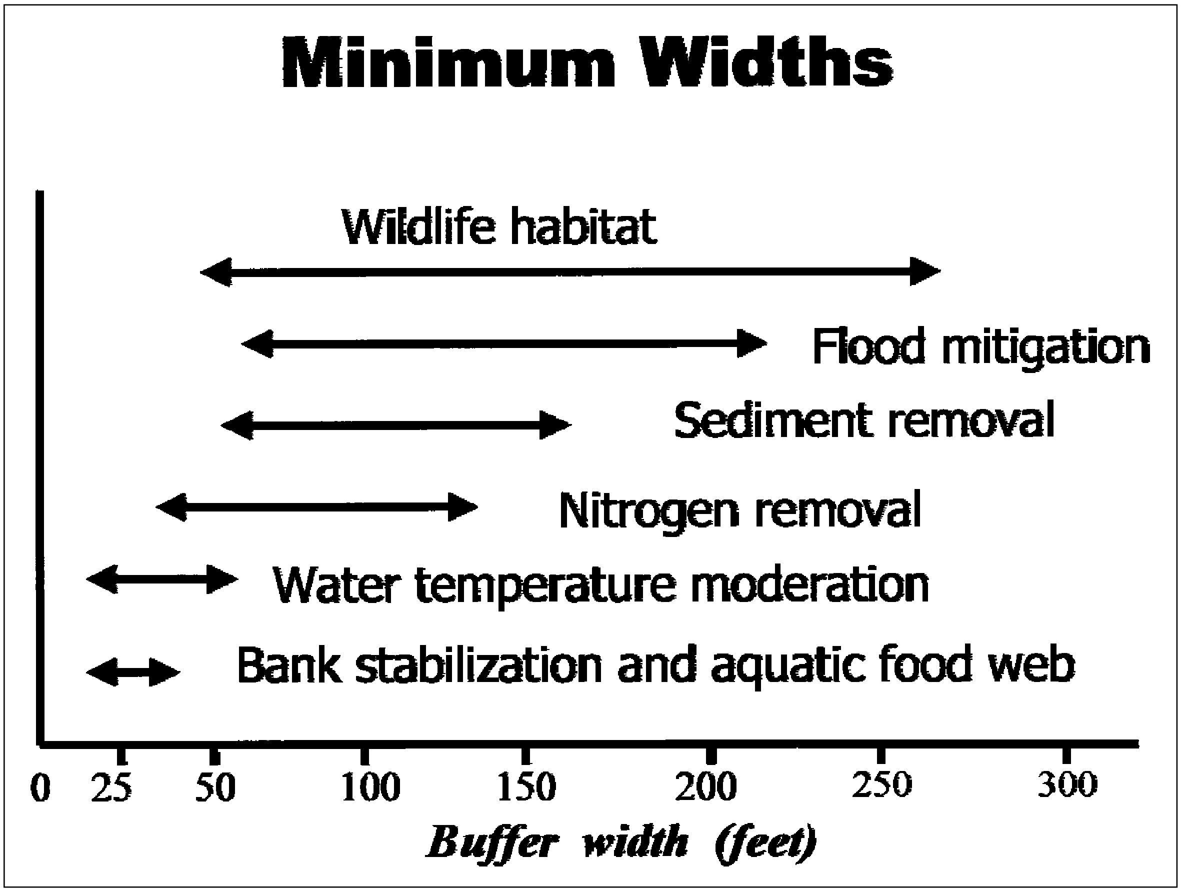

Figure 6 - 3. Range of minimum widths for meeting specific buffer objectives.

and providing the water storage necessary for desired levels of nitrogen removal. These narrow strips are also far more susceptible to damage from floods and blowdowns. Grass filterstrips may be effective initially at reducing sediment loads, but be quickly overwhelmed if sediment loads remain high.

Excess nitrogen removal - Determining the ability to provide nitrogen removal should consider: 1) the pathway by which nitrogen enters the buffer zone (e.g. surface runoff, deep or shallow groundwater, atmospheric deposition), and 2) the potential for transformation of nitrogen within the buffer strip due to site conditions. By filtering and absorbing runoff and reaching groundwater within the rooting zone, nutrients such as nitrogen (and dissolved phosphorus) are processed in plant uptake or transformed by denitrification. The denitrification process converts excess nitrogen compounds into nitrogen gas that is released into the atmosphere. Microbes use organic compounds as food, degrading them into simpler compounds or synthesizing them into microbial biomass. Riparian forests in particular, support a variety of microbial degradation mechanisms, though the specific conditions that promote them are not yet well understood.

Although the focus of many studies is often placed on surface flow, it is important to recognize interactions with water traveling as shallow or deeper groundwater. Groundwater carrying nitrogen passes through or surfaces within the riparian area where it can be acted upon by biological processes in the buffer. The natural resource manager must pay close attention to both localized and regional flow paths in determining this function.

Processes of denitrification occur under a wide range of conditions, but will be most intense in the wetter streamside area, whereas, the uptake of nitrogen by vegetation will begin at the up-slope edge of the vegetation. Woody plants enhance buffer functions through aggressive uptake of nitrogen in plant biomass, accumulation of organic matter, root-fungal interactions, and moisture retention. In this way, some reductions in overall buffer width may be possible when forests occupy a substantial portion of the buffer system. Efficiency will depend on residence time (affected by width) and nutrient load. In nearly all documented studies, most nitrogen removal occurred in the first 35 to 90 feet of forest. Nitrogen reductions of 25 to over 90 percent of total loadings have been shown in field studies. Where conditions for water storage, vegetative uptake, and denitrification are ideal, widths as small as 35 feet may provide substantial removal of the nitrogen passing through the buffer.

There are a variety of hydro-physiographic regions in the Chesapeake Bay Watershed and each one has an effect on nitrogen processing. See Section II for additional descriptions of these areas.

Reduction of sediment and phosphorus - Vegetated buffers improve water quality by trapping sediment and debris, by stabilizing streambanks, and by promoting infiltration of runoff. Vegetation forms a physical barrier to movement and mechanically traps associated sediment. Roots maintain soil structure and prevent erosion of soil. Reducing flow rates and disrupting channelized flow by providing resistance is the role of vegetation, thus allowing more time for infiltration and settling of sediment. Because nearly 90 percent of phosphorus is carried to streams attached to soil particles or organic matter, reducing sediment transport helps to reduce phosphorus loads. The ability of vegetation to colonize the sediment and rapidly use available phosphorus is a related function. Reductions in soil sediment by 40 to 70 percent from lands using riparian buffers are typical.

Prevention of channelized flow is the primary concern for sediment removal and is significantly affected by slope. Most studies show buffer widths of 50 to 100 feet for adequate removal. While small buffers remove small amounts of sediments, the relationship between buffer width and sediment removal is not linear. Beyond efficiencies of 80 percent removal, disproportionately large buffer widths are required for incrementally greater sediment removal. Except under conditions of excessive channelized flow and steep slopes, buffer widths in excess of 150 feet did not show additional returns. Maintaining vegetation cover sufficient to reduce flow is key. In agricultural areas, researchers found that of the 35 or more grass filter strips inspected after three to five years of use, less than 10 percent continued to be effective because of channelized flow and sediment build-up at the field edge of the filter strip. The combination of grass filter strips with a forested buffer are especially efficient in performing this function.

Reduction of pesticides **-** Generally speaking, buffer strips of 45 feet or more have proven effective in reducing some pesticide contamination of streamflow. Factors that affect pesticide transport in buffers are similar to those affecting nutrients. Most pesticides in common use are adsorbed to soil particles or carried in runoff and subsurface flow. Organic pesticides are subject to microbial breakdown processes common in organically rich riparian forest environments. For example, buffers are an effective tool prescribed for protection of water supplies from atrazine.

Moderation of water temperature **-** Forested riparian buffers provide shade cover, thereby helping to lower water temperatures during summer and lessen temperature decreases in winter. Lack of shade has a direct effect on water quality and aquatic life. Elevated temperatures are a catalyst for water quality problems by accelerating or increasing the impacts of nonpoint source pollution and robbing oxygen from the system. Small streams flowing through exposed reaches can increase as much as 1.5 degrees F for every 100 feet of exposure to summer sun. Maximum temperature fluctuations for daily peaks can be as much as 12 to15 degrees F higher, and ambient temperatures of 6 to 8 F degrees higher are not uncommon. The evapotranspiration process of forests also contributes to lower water temperatures. The removal of streamside trees is one of the most significant causes of degradation for streams in the United States.

The ability of a buffer to provide shade is directly proportional to height of the vegetation and bankfull width of the stream. Even 15- to 25-foot buffers can provide adequate shade for small streams. Fifty- to 75-foot forest buffers are sufficient to ensure favorable conditions for trout, and buffer widths along slopes can decrease with increasing tree height with no loss of shading. Aspect is also an important consideration. Grass filter strips along streams are generally unable to provide cover sufficient to moderate water temperature.

Preservation of stream channel integrity and bank stability - Vegetation in the riparian area exerts a strong control over the condition and stability of the stream and its banks. In the eastern United States, trees often define the physical characteristics of stream channels. Trees anchor streambank soils through dense root masses, and large roots provide physical resistance to flow energy. Woody debris anchors channel substrate and determines bar formation, stores large amounts of streambed sediment and gravel, helps control sinuosity, and provides channel structure through pool/riffle or step formation. Until recently, the value of large woody debris was misunderstood and much was removed throughout the country. It is likely that the direct effect of buffer width on this function is limited. Only vegetation within 25 feet of the stream channel will provide a powerful role in stabilization. However, increasing buffer width will continue to indirectly enhance stream stability by providing additional protection and stability during extreme flood events, allowing stability during channel migration, and as a physical barrier to human impact.

Moderation of storm flows and runoff - Stream corridors and natural forest vegetation help to reduce the downstream effects of floods by dissipating stream energy, temporarily storing flood waters, and helping to remove sediment loads through incorporation in the flood plain. On a given site, a vegetated buffer that resists channelization is effective in decreasing the rate of flow, and in turn, increasing infiltration. Forests provide as much as 40 times the water storage of a cropped field and 15 times that of grass turf. These increases in storage are largely due to the forest’s ability to capture rainfall on the vast surface area of the leaves, stems, and branches; the porosity and water holding capacity of organic material stored on the forest floor and in the soil; and the greater transpiration rates common to the community of forest vegetation. Forests are being evaluated more frequently for their role in reduction of water volume for stormwater management.

Increasing width to incorporate the flood plain also increases the potential efficiency of water storage from upstream flow during storm events. Providing flood storage buffers where possible along smaller streams in a watershed may provide a valuable approach to downstream flood reduction. However, once the entire flood plain is included within the buffer area, the effect of buffer width on flood peak reductions is negligible.

Provision for aquatic habitat and food - Leaf litter is the base food source in most stream ecosystems and streamside trees are critical in establishing this aquatic food web. Small fish, some amphibians, and most aquatic insects rely primarily on leaf detritus (dead leaf material) from trees as food. Studies have shown that when streamside trees are removed, many aquatic insects decline or even disappear, and with them, native fish, birds, and other species that may depend on them. Some insects are adapted to specific tree species and are unable to reproduce or even survive when fed the leaves of grasses that are non-native or exotic species.

Large woody debris also creates cover and habitat structure for fish and other aquatic species in shallow water estuarine habitat. Here it may serve as a nursery area or refuge for fish, crabs, and other organisms. This function is noteworthy in the Chesapeake Bay since the decline of submerged aquatic vegetation. Although the portion of the buffer nearest the waterbody exerts the greatest influence over this function, increasing buffer width provides support and sustainability. This is especially true when considering the need to provide long-term woody debris recruitment, diversity of vegetation for leaf detritus, and refuge for species during high water. The presence of trees is directly related to greater biodiversity in the stream ecosystem.

Provision for terrestrial habitat corridors - Riparian areas have the potential to provide rich habitats for a wide diversity of wildlife species. Species such as turtles, pheasant, turkey, wood ducks, great blue herons, woodpeckers, raptors, tree frogs, salamanders, songbirds, and many mammals require trees for breeding, nesting, feeding, and escape habitats. Even narrow forest strips will provide essential habitats for some of these species. However, the width and character of buffers will vary to meet the needs of particular species. A mixture of grasses and forbs, especially tall species, will provide suitable habitat for some game birds. In all cases, maintaining forests as a component of the buffer system greatly enhances diversity and abundance of birds and other wildlife.

Buffers also provide transition zones between upland and aquatic environments. Although buffers alone will not provide needed migratory songbird habitat, studies have shown that even narrow 100-foot corridors increased neotropical bird abundance when they connected small patches of remaining forest. To provide corridors for movement of many larger mammals such as deer and bear, or to provide reliable breeding habitat for migratory songbirds, larger buffer widths (100 to 300 feet) are needed.

Landowner-Based Criteria

Riparian buffers can also be designed to provide additional human benefits such as recreation and aesthetic enjoyment, as well as sites for hunting, fishing, or observing nature. Buffers can provide the foundation for future greenways. In addition, buffer width may be expanded to provide an economically-viable unit for future timber harvest or to provide sufficient land base to sustain other secondary products derived from compatible activity within the buffer.

Landowner concerns most often serve to constrain the width of a buffer. These decisions may be due to economic considerations, livestock watering and pasture management, operation of adjacent farm fields, competing uses, or existing developments. As decisions are made, landowners should be aware of the potential changes in desired buffer functions that occur and the potential compromise of long-term values. This is especially important when buffers are being used within the context of overall nutrient management plans. In most cases, a buffer width can be determined which will meet landowner needs while also providing an adequate array of buffer functions.

Application

Given the practical need for simplicity, the operable question is how these multiple criteria can be incorporated in field applications. The problems related to using multiple criteria are not effectively addressed in the scientific literature. Most often, states or local agencies use an approach where multiple buffer criteria are simply stated as separate requirements and their interpretation is left to field staff. This approach has considerable merit, but results in inconsistency. There are several other methods with potential where multiple criteria are combined into a single requirement. One example is the cartographic modeling approach used in conjunction with a GIS. Here, multiple criteria are expressed in spatial terms, and mapping of buffer widths capable of meeting the criteria are displayed. For example, if temperature moderation is desired, a level of shading needed for the stream can be determined. Extension of this approach to multiple resource values and desired functions would be possible if additional criteria can be determined and expressed in spatial terms.

Another approach, maximum protection, evaluates each of several criteria and then adopts the greatest width to accommodate all desired functions. A variation on this approach commonly used is to utilize average widths in the same manner. A regional method might also be used to set a recommended buffer width. For example, buffer widths could be determined based on a set of criteria and desired function for selected stream reaches within a region. Then, by evaluating the statistical probability of occurrence for various stream types within a watershed, a regional buffer width could be selected to meet the criterion a prescribed percent of the time. Approaches of this kind are also useful in prioritizing or targeting areas for protection or restoration.

Many agencies rely predominantly on stream rating systems to establish minimum buffer sizes. Most minimum widths are determined by functional resource value alone or a specific intended use or group of uses rather than by site-specific factors. By looking at one function alone or one site criteria, application is simplified, but most of the scientific information available may be ignored.

The last and perhaps simplest approach may be to determine a minimum width that will meet a majority of the multiple desired functions with the target vegetation. This could provide a limited number of additional site criteria that would allow for modification and flexibility based on site conditions.

Fixed Minimum Versus Variable Width Buffers

There are two principal ways by which most buffer widths are defined: 1) the width may be set as a fixed distance, usually measured from the streambank on each side of the stream, or 2) the width may be variable depending on specific natural or man-made features adjacent to the waterway. Minimum width buffer strips are usually promoted primarily because they are simple to implement and administer. Because minimum widths are most often developed by compromise or by considering an average of desired functions, it is likely that minimum width buffers may provide more than adequate protection in some areas, and inadequate protection in others. Where political compromise has resulted in very narrow buffer widths, people may be given a false perception that a stream is protected when serious risk may still exist. Fixed buffer widths in common use across the country range from 25 to 300 feet or more.

Variable width approaches to buffers usually attempt to integrate buffer functions with site-specific conditions. In this way, the width of the buffer depends not only on the minimum width needed for a specific function or set of functions, but also on the sensitivity and characteristics of the stream and watershed in which it is located. Adjacent slope, soil type, presence of wetlands and flood plains, mature forests or special habitats, scenic or cultural features, recreation use, and other local aspects of significance may be considered in determining buffer width. Buffer expansion and contraction, as a characteristic of design width, are promoted, especially in urban settings. A range of adequate widths may also be provided. Although, variable width approaches are likely to be more science-based, they inevitably require more extensive site investigation and evaluation and are ultimately more difficult to monitor and administer. Often a combination of these approaches is used. For example, a minimum width is determined and specific criteria for expansion and contraction are specified.

The 3-zone buffer concept, discussed in Section I, presents another way in which desired buffer functions/values can be evaluated, resulting in a design that meets the landowner’s or resource manager’s needs. Specific zones are managed

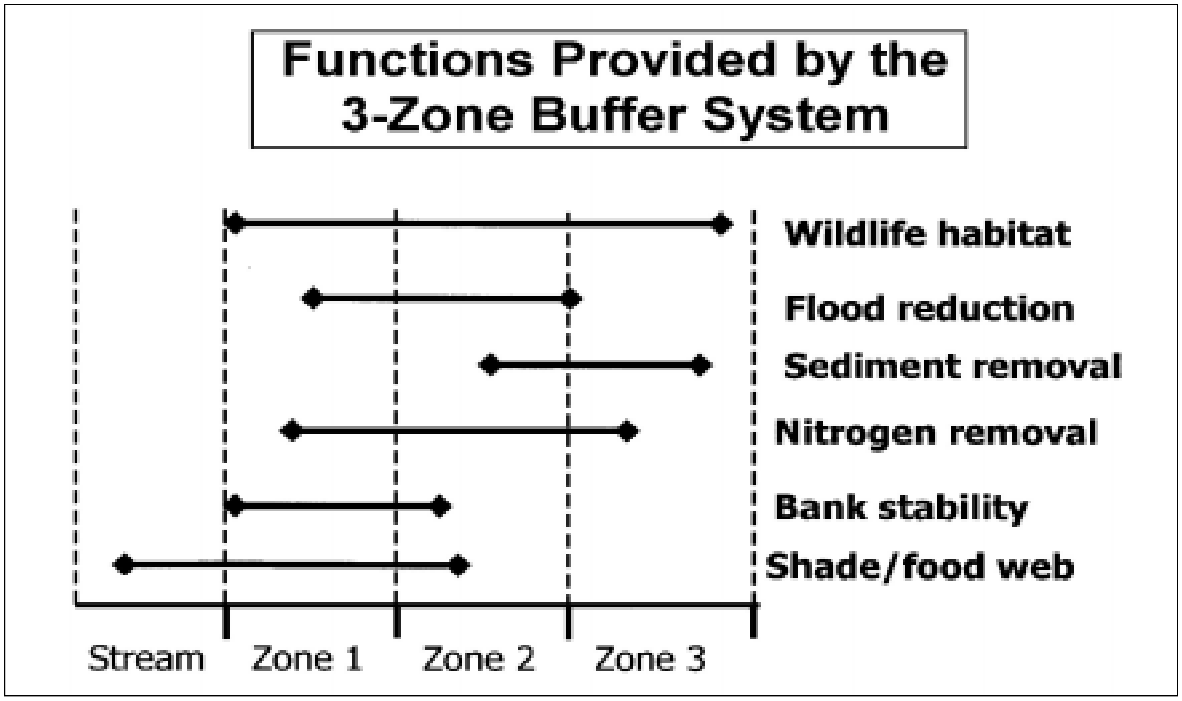

Figure 6 - 4. Each zone of the riparian forest buffer provides various functions and values to the landowner.

alone or in combination to accomplish various objectives. Figure 6-4 illustrates how some common buffer functions apply to the 3-zone concept of buffer design.

Conclusion

The scientific literature clearly supports that there is no "ideal" buffer width for all applications in all areas. A number of criteria are appropriate for consideration in determining adequate buffer widths in an ecosystem context. Evaluating a combination of these factors such as site and watershed characteristics, functional resource value, intensity of land use, and desired buffer functions all provide considerations from a scientific viewpoint. Because most buffers are established on private lands or public lands managed for a variety of uses, landowner/manager and public constraints and objectives are also considered.

The most commonly prescribed minimum buffer widths for use in water quality and habitat maintenance are approximately 75 to 100 feet. The scientific literature appears to support that buffers of less than 35 feet cannot sustain long-term protection of aquatic resources. To provide an array of functions then, buffers should be a minimum of 35 to 100 feet in width under most circumstances. Buffer widths toward the lower end of the range appear to provide some physical and biological components of the stream ecosystem, especially on small streams. Buffer widths at the upper end of the range are likely to provide protection of physical, chemical, and biological characteristics of the aquatic resource.

The establishment of riparian forest buffers in agricultural or urban/suburban areas may require significant care and investment. Likewise, protecting riparian forests as buffers also requires an investment of land in lieu of other uses. Regardless of how buffer width is determined, resource professionals should ensure that three basic elements are considered. First, the minimum width should be of significant size to perform desired functions for water quality and habitat. If buffer width is significantly reduced or constrained by landowner or other criteria, then the risk that certain desired buffer functions may not be realized over time should also be recognized. It is safe to say that an increase in buffer width reduces the risk of failure. Third, a determination of minimum width should consider sustaining stream protection and buffer functions over the long term and the potential future threats to buffer integrity that the site, stream, or watershed may experience.

Three main considerations for determining minimum width:

- ✓ **FUNCTION**
- ✓ **RISK**
- ✓ **SUSTAINABILITY**

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