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Riparian Forest Buffer #1

AGROFORESTRY NOTES

Riparian Forest Buffers: An Agroforestry Practice

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Introduction

Located along streams, lakes, or wetlands, riparian forest buffers deliver water quality, habitat, recreation, and other benefits in agricultural, woodland, range, suburban, and urban settings. A wide variety of state and federal programs support the installation of riparian forest buffers on public and private lands.

Riparian forest buffers can be used in landscape-scale green infrastructure plans to serve a variety of functions, particularly along the rural-urban interface. Green infrastructure is an approach to conservation that involves creating a network of green areas to benefit people and wildlife.

Definition

A riparian forest buffer is an area adjacent to a stream, lake, or wetland that contains a combination of trees, shrubs, and/or other perennial plants and is managed differently from the surrounding landscape, primarily to provide conservation benefits.

Objectives

Riparian forest buffers can help meet a number of natural resource, economic, and social objectives, including:

- Filtering nutrients, pesticides, and animal waste from agricultural land runoff
- Stabilizing eroding banks
- Filtering sediment from runoff
- Providing shade, shelter, and food for fish and other aquatic organisms
- Providing wildlife habitat and corridors for terrestrial organisms
- Protecting cropland and downstream communities from flood damage
- Producing income from farmland that is frequently flooded or has poor yields
- Diversifying landowner income
- Creating recreational spaces

A number of factors can impact the effectiveness of riparian forest buffers in meeting these objectives. These include site conditions such as adjacent agricultural practices and crop types, stream size, topography, and soils; landscape conditions such as position in the watershed, adjacent land use, and buffer continuity; and other conditions such as markets, processing infrastructure, and public interest.

The application of riparian buffers varies across the U.S. according to geography, land use, and conservation priorities. In the northwest, for example, buffers are employed primarily to restore and protect migratory fish habitat, while in the arid southwest, most buffers are established to improve habitat for at-risk aquatic and terrestrial species. In the east, buffers are often used to reduce nutrients and sediments flowing into streams and estuaries, while in the Midwest, buffers are generally used to stabilize stream banks, reduce pollutant runoff, and restore habitat for fish and wildlife in extensively cultivated landscapes.

Planning Considerations

A buffer plan should identify both the location for buffer placement in the watershed as well as site-specific design elements such as size and shape, plant selection, and management. Each of these details are determined by the objectives of the land manager or owner.

Potential buffer objectives might be to increase habitat, boost water quality, reduce erosion, add economic opportunities, enhance aesthetics, or improve recreational opportunities. If the design is intended to meet a combination of objectives, there may be tradeoffs in performance and/or cost among potential designs. One trade-off considered by many land managers and owners is between maximizing production and maximizing conservation, since, in order to reap buffer conservation benefits, land use in the riparian buffer must change.

Most riparian buffers provide more than one function, even if designed with only one function in mind. Such "multifunctional" buffers are appealing to many producers, especially when providing new production benefits that can help compensate for taking land out of production. For example, buffers can be planted with trees and shrubs that produce fruits, nuts, decorative florals, or other non-timber forest products that can be sold.

Buffer design should take into account intended functions as well as potential unintended impacts – positive and negative. For example, a buffer designed for wildlife habitat could potentially increase habitat for agricultural pests.

Photo Credit: NRCS

Multiple rows of trees and shrubs, as well as a native grass strip, combine in a riparian buffer to protect Bear Creek in Story County, Iowa.

Buffer Planning Tools

Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways: This tool provides information on design considerations to match specific buffer goals and aids in designing multifunctional buffers.

AgBufferBuilder: A Filter Strip Design Tool for GIS: This tool designs variable width buffers for water quality that enhance pollutant trapping efficiency and helps in designing buffers with a targeted level of pollutant trapping efficiency.

Riparian Buffer Design Guidelines for Water Quality and Wildlife Habitat Functions on Agricultural Landscapes in the Intermountain West: This tool provides science-based procedures for determining buffer widths and management techniques to optimize riparian benefits. It is focused on the Intermountain West.

Buffer$: This tool estimates the costs and benefits of buffers compared to traditional cropping systems and provides analysis that can include payments from incentive programs.

Non-Timber Forest Product Calculator: This tool estimates costs and income from harvesting and selling non-timber forest products from a conservation buffer.

Water Erosion Prediction Project: This tool models soil erosion and predicts the effects of conservation practices on soil erosion, but is limited to herbaceous plant material, an important component of buffers.

Riparian Restoration to Promote Climate Change Resilience: This tool identifies areas in the riparian zone that would benefit most from increased shading. It is focused on the northeast and Appalachia.

See "Additional Information" to find out how to access these tools.

The design of riparian forest buffers should always take into consideration broader landscape processes. For example, the design of buffers intended to stabilize streambanks in an urbanizing watershed must account for stream flows that may dramatically increase as impervious cover is added to the landscape. In such cases, buffers should comprise one component of multiple conservation efforts throughout the watershed. In fact, in rural and urbanizing areas, riparian buffers work best as a component of a broader system of conservation practices. In an agricultural context, the greatest conservation benefits are realized when in-field practices such as contour grass strips, grass waterways and residue management are included.

Riparian buffers can be designed to meet a range of objectives, including those of private landowners and public resource managers (e.g. public water supply managers or fish and game managers). A private landowner, for example, might want to improve wildlife habitat, reduce soil erosion, add economic opportunities, protect property from flood waters, or enhance the aesthetics of their property. A public resource manager might be focused on improving water quality, reducing sedimentation of drinking water reservoirs, or providing for healthy fish and wildlife populations. While public benefits may be a motivation for either audience, private landowners are more likely to be interested in the benefits of riparian buffers for improving their operations. Hence, it is critical that buffer design tools account for such needs.

Planning Steps

Once the objectives for a riparian forest buffer are identified, the following steps can be taken:

STEP 1: Identify the types and placement of vegetation that will best meet landowner objectives.
When selecting plants for a buffer, keep in mind that the functions of the buffer will be determined by placement and vegetation characteristics (e.g. woody, herbaceous, tall, short, stiff-stemmed, or fast-growing). Riparian forest buffers should include grasses (including forbs), shrubs, and trees that are arranged in a manner that meets the desired objectives. It will be important to use local knowledge to determine plant species that are available and suited to the situation. To support biodiversity and wildlife habitat goals, many agencies prefer and some even require that only native plant species be planted in riparian buffers when their program dollars are involved.

STEP 2. Determine buffer size and shape
The intended goals of a buffer will determine its configuration. For example, variable width buffers will be most useful in controlling water soluble nutrients; wider buffers are generally required to trap sediments; and buffers intended for wildlife habitat will need to be sized according to the intended wildlife species.

Figure 1

The buffer size that is needed to be effective may also change based on surrounding topography. This figure provides examples of how buffer sizes vary to effectively provide different buffer benefits.

STEP 3: Develop an installation plan
A buffer installation plan will help to ensure desired long term benefits. Some landowners may choose to develop their installation plan with the assistance of a local Natural Resources Conservation Service (NRCS) professional. The NRCS in each state has developed guidelines for the Riparian Forest Buffer Conservation Practice Standard 391, as well as other conservation practices that can be used for buffer establishment. The practice standards for any state can be found online in the Field Office Technical Guide, often referred to as the FOTG.

Riparian areas present some unique installation and management challenges. For example, many practices commonly used for site preparation and weed control may be in conflict

with water quality protection goals. Some herbicides are restricted for use adjacent to streams and lakes. In addition, riparian areas can be prone to periodic or seasonal flooding.

If a site planned for a buffer already has trees, shrubs or grasses, it will be important to determine whether this existing perennial vegetation can be incorporated into the buffer design, since some benefits (such as shade from trees) are greater with more mature vegetation.

STEP 4: Develop a maintenance plan

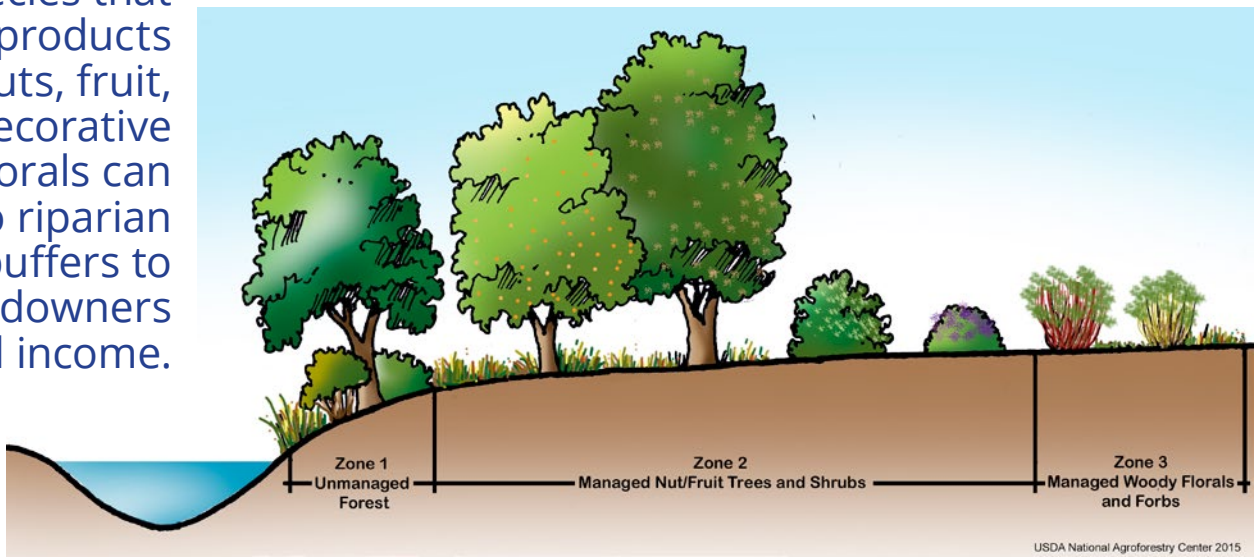
As with all land management practices, riparian forest buffers require maintenance in order to function properly over the long term. Such maintenance will likely include management for aggressive competing vegetation and wildlife damage. Extensive tillage or applications of some herbicides may not be appropriate due to the risk of water contamination from erosion and herbicides. However, a variety of tree protection devices can reduce damage by wildlife, each with pros and cons to be considered. Mechanical control of aggressive vegetation can be successful, though labor intensive.

Over time, the leaves and twigs of well-established trees and shrubs can contribute the same level of nutrients to adjacent water (e.g. streams or ponds) as are taken up through the roots. Periodic harvesting of buffer vegetation may therefore be necessary to remove these captured nutrients and other compounds from the riparian system. Such harvesting can help maintain vigorous plant growth for filtering and nutrient uptake and may provide salable products. If a riparian forest buffer is established with state or federal financial assistance, planned management practices, especially harvesting, should be included and approved as a part of the management plan.

Productive Buffers

While riparian forest buffers are typically implemented for their conservation benefits, they can also be designed for production. Buffers can include species that produce perennial crops of native fruits and nuts, native medicinals, and floral trees and shrubs. Adding these species may make riparian forest buffers more appealing to landowners interested in growing local foods and having additional income opportunities. However, careful design is required to ensure that such buffers also meet intended conservation objectives.

Woody species that provide products such as nuts, fruit, and decorative woody florals can be added to riparian forest buffers to provide landowners additional income.



Species intended for production benefits should be selected with their end-use in mind. For example, some producers may be interested in edible and floral trees or shrubs for home use. Others may intend to sell these crops, in which case markets, value-added opportunities, and local processing infrastructure should be considered.

Protecting trees and shrubs from wildlife is always a management concern, but especially important for those that produce edible crops. Buffer design, including planting pattern and location of roads and paths, should account for accessibility to these edible and floral trees and shrubs to make management and harvesting easier.

Some programs used for buffer establishment may have requirements that affect the use of multifunctional buffers. For example, some programs prohibit producing income from buffers that are established using government funding. Also, tree cutting is often prohibited by programs until the contract term ends or by other regulations. In this case, harvesting fruits and nuts may be more appropriate than harvesting woody florals, which would involve tree cutting.

Conclusion

Riparian forest buffers can be effective at meeting conservation goals and can be used in conjunction with other conservation practices. It is important to remember that one size does not fit all. The most effective location, size, and composition will vary depending on site conditions and natural resource objectives. Riparian forest buffers can be designed to achieve more than one goal or objective. Multi-purpose buffers can be more complicated to design and manage, but have the potential to deliver many additional benefits. Resources like the Conservation Buffers Guide can help in designing multi-purpose buffers.

It takes time for riparian forest buffers to produce most intended functions, especially when large trees are required. Hence, landowners should not expect immediate results. As every site is different, the level of impacts will also differ from site to site and watershed to watershed. A well planned, designed, and managed riparian forest buffer can provide benefits for years and decades into the future.

Additional Information

Tools:

AgBufferBuilder: A Filter Strip Design Tool for GIS: http://nac.unl.edu/tools/AgBufferBuilder.htm

Buffer$: http://nac.unl.edu/tools/buffer$.htm

Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways: http://nac.unl.edu/buffers/index.html

Non-Timber Forest Product Calculator: http://nac.unl.edu/tools/ntfp.htm

Riparian Restoration to Promote Climate Change Resilience: http://applcc.org/plan-design/gis-planning/gis-tools-resources/riparian-restoration-decision-support-tool-1

USDA PLANTS Database: http://plants.usda.gov/java

Water Erosion Prediction Project: https://www.ars.usda.gov/midwest-area/west-lafayette-in/national-soil-erosion-research/docs/wepp/research

Other Resources:

National Agroforestry Center Riparian Forest Buffer Webpage:
http://nac.unl.edu/practices/riparianforestbuffers.htm

Agroforestry Note #3: Riparian Buffers for Agricultural Land:
http://nac.unl.edu/documents/agroforestrynotes/an03rfb02.pdf

Agroforestry Note #4: How to Design a Riparian Buffer for Cropland:
http://nac.unl.edu/documents/agroforestrynotes/an04rfb03.pdf

Agroforestry Note #5: A Riparian Buffer Design for Cropland:
http://nac.unl.edu/documents/agroforestrynotes/an05rfb04.pdf

Agroforestry Note #38: Landscape Planning For Environmental Benefits:
http://nac.unl.edu/documents/agroforestrynotes/an38g10.pdf

Agroforestry Note #39: Conducting Landscape Assessments for Agroforestry:
http://nac.unl.edu/documents/agroforestrynotes/an39g11.pdf

Agroforestry Note #40: Indicators and Guidelines for Landscape Assessment and Planning for Agroforestry: http://nac.unl.edu/documents/agroforestrynotes/an40g12.pdf

Working Trees Information Sheet: Why Add Edible and Floral Plants to Riparian Forest Buffers? http://nac.unl.edu/documents/workingtrees/infosheets/WTInfoSheet-MultiFunctionalBuffer.pdf

US EPA Non-Point Source Pollution:
https://www.epa.gov/polluted-runoff-nonpoint-source-pollution

NRCS Field Office Technical Guide:
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg

R.C. Schultz, T.M. Isenhart, J.P. Colletti, W.W. Simpkins, R.P. Udawatta, and P.L. Schultz. "Chapter 8: Riparian and Upland Buffer Practices." North American Agroforestry: An Integrated Science and Practice. Ed. H.E. Garrett. Madison: American Society of Agronomy, Inc. 2009.

Regional Resources

East

Chesapeake Bay Program Forest Buffers Webpage:
http://www.chesapeakebay.net/issues/issue/forest_buffers

How to Plan and Plant Streamside Conservation Buffers with Native Fruit and Nut Trees and Woody Floral Shrubs: http://pubs.ext.vt.edu/ANR/ANR-69/ANR-69_pdf.pdf

North Carolina Riparian Buffer Protection Program: https://deq.nc.gov/about/divisions/water-resources/water-resources-permits/wastewater-branch/401-wetlands-buffer-permits/401-riparian-buffer-protection-program

Understanding the Science behind Riparian Forest Buffers: An Overview:
http://www.pubs.ext.vt.edu/420/420-150/420-150.html

Central

Iowa State Riparian Buffer Systems: http://www.buffer.forestry.iastate.edu

University of Minnesota Riparian Forest Buffers: http://www.extension.umn.edu/environment/agroforestry/riparian-forest-buffers/riparian-forest-buffers.html

University of Minnesota Riparian Forest Buffers for Trout Habitat Improvement: http://www.extension.umn.edu/environment/agroforestry/buffers.html

West

Riparian Buffer Design Guidelines for Water Quality and Wildlife Habitat Functions on Agricultural Landscapes in the Intermountain West: http://www.fs.fed.us/rm/pubs/rmrs_gtr203.pdf

Riparian Forest Buffers on Agricultural Lands in Western Oregon: http://www.forestry.oregonstate.edu/sites/www.forestry.oregonstate.edu/files/agroforestry/RiparianForestBuffers.pdf

Washington State University Riparian Buffers: https://puyallup.wsu.edu/agbuffers

Contact: USDA National Agroforestry Center, 402.437.5178 ext. 4011, 1945 N. 38th St., Lincoln, Nebraska 68583-0822. http://nac.unl.edu

The USDA National Agroforestry Center (NAC) is a partnership of the Forest Service (Research & Development and State & Private Forestry) and the Natural Resources Conservation Service. NAC's purpose is to accelerate the development and application of agroforestry technologies to attain more economically, environmentally, and socially sustainable land use systems by working with a national network of partners and cooperators to conduct research develop technologies and tools, establish demonstrations, and provide useful information to natural resource professionals.

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