LS-1-05

THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

School of Environment and Natural Resources, 2021 Coffey Road, Columbus, Ohio 43210

Livestock and Streams

Understanding the Benefits of Healthy Riparian Areas

James J. Hoorman
Extension Educator,
Water Quality/Grants
OSU Extension Center at Lima

Jeff McCutcheon
Extension Educator,
Agriculture and Natural Resources
Knox County

Surface water, streams, rivers, ponds, and lakes are some of our most precious natural resources. They provide clean water for a variety of human uses, as well as habitat for wildlife and aquatic life. Today, emphasis on water quality and protecting surface water has shifted to nonpoint source pollution. Management of riparian areas on farms has been a major focus of nonpoint pollution control efforts. Livestock grazing riparian areas can cause problems with nonpoint source pollution.

This series of fact sheets looks at the issues of livestock and streams and what livestock producers can do to protect this precious resource. To decrease nonpoint source pollution in streams and along riparian areas, it is helpful to review the benefits riparian areas provide in any discussions about managing livestock grazing.

Photo courtesy of USDA Natural Resources Conservation Service. A healthy riparian zone protects this stream.

Riparian areas are the green vegetated areas adjacent to a creek, stream, or river. Riparian areas include streams, streambanks, and wetlands adjacent to streams.

The riparian zone creates well-defined habitats within the drier surrounding landscape. While they make up a small portion of the overall area, riparian zones are generally more productive in plant and animal biomass than the surrounding areas and are high in diversity.

What Are Healthy Riparian Areas?

According to Bellows (2003), healthy riparian areas have many different characteristics depending upon location, geology, landscape, and climate. However, all healthy riparian areas have similarities that include:

- A thick growth of vegetation with diverse species of grasses, forbs (weeds), shrubs, and trees that cover the streambanks and provide shade.
- Land surrounding streambanks generally remains wet throughout most of the year except where streams cut through rocky terrain.
- Streambanks are more vertical and steep than flat and rounded.
- Stream flow levels vary only moderately throughout the year.
- Streamwater is relatively clear but contains debris from streambanks (leaves, twigs, or logs) that create pools and other habitat for fish and aquatic insects.
- A diversity of wildlife including fish, aquatic life, mammals, and birds.

Photo courtesy of USDA Natural Resources Conservation Service. Image of a healthy riparian zone along a stream.

How Does Vegetation Benefit Riparian Areas?

Riparian areas protect water quality by capturing, storing, and treating water through their soils before it gets to streams. A thick growth of diverse vegetation, plant residues covering the soil surface, and non-compacted soils facilitate water capture. High streambanks with high water tables provide water storage capacity. Healthy growing plants take up nutrients transported into the riparian areas. Soil organic matter captures or facilitates degradation of contaminants. Healthy riparian vegetation captures water and filters the water through the soil. Riparian areas with a diversity of plant species are most effective in slowing the flow of water and storing it for future use (Bellows, 2003).

The diversity of plants works together to hold streambank soils in place and protect them from erosion and undercutting by floodwaters, transported woody debris, or ice jams. The deep, penetrating roots of sedges, rushes, willow, grasses, and other herbaceous plants provide structural support for streambanks, while the thicker, harder roots of woody plants protect streambanks against bank scouring by floods and ice jams (Winward, 2000).

What Types of Vegetation?

Riparian vegetation species are not arranged in a random manner. They are organized in parallel bands, each consisting of species adapted to survive in the specific moisture and climate of that area.

Starting at the edge of the water we find the first band of vegetation is made of water-loving plants (rushes and sedges). These plants have deep, strong roots that stabilize streambanks against erosion and are critical for promoting water recharge and water table height (Clark, 1998; Martin and Chambers, 2001). The first band is the most ecologically important and requires the greatest protection from degradation. This zone serves as an indicator of riparian health since it is the most sensitive.

Away from the water's edge the second band of vegetation starts in the wet ground, usually near the edge of the bank. This band consists of shrubs, trees, moisture-loving grass, and water-tolerant broad-leaved plants (Huel, 1998).

The third band of vegetation is a mixture of riparian and upland plant species. It is found in the drier soil where the riparian zone merges with the uplands (Huel, 1998).

Plants in the second and third band also play a critical role. They catch water and facilitate its absorption. They also take up nutrients and provide habitat for wildlife.

Does Vegetative Species Matter?

Native plants do not have to dominate these bands to provide environmental benefits. To provide functions similar to native species, water-loving plants must be present. Exotic species that are water-tolerant tend to grow aggressively and are less palatable to grazing animals. Under this competition, native species suffer and tend to die out. In this way, exotic species decrease the ability of riparian areas to maintain high water table levels, retain stream stability, provide forage for livestock, and support wildlife habitat (Huel, 1998).

Photo courtesy of USDA Natural Resources Conservation Service. The first band of vegetation in a riparian zone consists of water-loving plants like rushes and sedges.

Photo courtesy of USDA Natural Resources Conservation Service. The second band of vegetation in a riparian zone consists of shrubs, trees, and water-tolerant broadleaves.

The natural vegetation does differ depending on the location of the riparian area. Grass vegetation dominates streambanks developed from sediments, while trees and shrubs dominate steep, rocky banks of more rapidly moving and narrower headwater streams (Sovell et al., 2000).

It has been observed that when riparian areas restore themselves naturally, woody species are often the first plants to become established. This provides stabilization for stream channels against the forces of erosion while protecting the growth of water-loving grasses, sedges, rushes, and forbs (Elmore and Beschta, 2000). The herbaceous plants then stabilize streambanks with their thick, deep roots, while their stems trap sediment carried by runoff water and stream-scouring floodwaters.

Water-tolerant or water-loving plants with deeper and stronger roots are more effective for holding streambanks in place than are plants from upland areas (Winward, 2000). Trees that are not water tolerant also do not have extensive root systems and are likely to be undercut and fall into streams. Upland plants in the first band of vegetation often serve as indicators of disturbed or degraded riparian areas.

What Are Unhealthy or Degraded Riparian Areas?

There are very few pristine riparian areas left in the United States. Almost all riparian areas exhibit some signs of degradation. According to Bellows (2003) degraded unhealthy riparian areas have some of the following characteristics:

- Patchy or scrubby plant growth with bare ground showing in many places.
- Vegetation dominated by upland plants and noxious weeds.
- Soil that is compacted, eroded, and had bare trails and pathways along the streambank.
- Streambanks that are eroding, severely undercut, or sloughing off.
- Streams that flood regularly in the spring and become dry in the summer.
- Streamwater that is muddy or murky.
- Limited biodiversity of fish, aquatic life, mammals, or birds.

These characteristics of degraded riparian areas reflect their inability to protect water quality and provide critical habitat for wildlife.

Why Is Riparian Water Storage Important?

One benefit of riparian areas is they store a lot of water. This large water storage capacity of riparian areas buffers the movement of water from uplands areas into streams. Instead of allowing water to flow directly into a stream after a rainstorm or snowmelt, a healthy riparian area holds and stores water, providing a slow release and water recharge to the stream.

Healthy riparian areas with good vegetation have highly permeable soils and high streambanks. Their water table extends underground and outward from the streambanks. This provides a large amount of groundwater storage (Pritchard, 1998). Degraded riparian areas have a low water table, sloping banks, and wide, shallow streams, with limited storage capacity.

Degraded riparian zones typically are subject to stream flashing. Stream flashing occurs when runoff is heavy, such as following an intense storm or a rapid snowmelt, and stream levels rise rapidly, often to flood stage. The rise in water levels is often very short term, lasting only hours or even a day or two, after which water levels decrease dramatically. The rapid rise and fall of water levels caused by runoff is called stream flashing.

Vast quantities of water are stored in healthy riparian areas, decreasing the potential for flooding. Vegetation

Photo courtesy of USDA Natural Resources Conservation Service. Image of an unhealthy degraded riparian area showing severe streambank erosion and lack of vegetation.

Photo courtesy of USDA Natural Resources Conservation Service. A stream experiencing flash flooding or stream flashing.

Photos courtesy of USDA Natural Resources Conservation Service. Healthy riparian areas have water storage capacity to slowly release water to flowing streams.

growing in the flood zone daily take-up and transpire thousands of gallons of water per acre (Elmore and Beschta, 2000). That is one reason riparian buffer zones are critical to maintaining healthy riparian zones.

How Is Water Storage Increased in Riparian Areas?

A riparian zone with diverse vegetation can trap 80% to 90% of sediments transported from fields (Naiman and Decamps, 1997). The trapped sediment, along with the new lush growth helps water infiltration and increases water storage. New roots and leaves shade the soil and conserve water and increase storage. More organic matter is produced and soils become more porous. Organic matter acts like a sponge to hold water and is involved in the formation of soil aggregates that enhance soil porosity.

Sediments trapped by riparian vegetation increase the height of the streambank (Platts, 1990; Ohmart, 1996). The water table rises as the streambanks build up, water absorption is increased, and water loss due to evaporation decreases. Under healthy riparian conditions, the water table rises until it reaches the height of the plants' root zone on the former flood plains (Elmore and Beschta, 2000). These riparian soils remain wet throughout most of the year.

How Are Nutrients Removed in a Riparian Area?

Riparian areas contain a combination of wet and dry soils that facilitate a variety of biological and chemical reactions. These reactions reduce the availability of some nutrients and decrease the toxicity of some contaminants (Edwards, 2000).

Nutrients are transferred into streams regardless of the presence of grazing livestock. Levels of nutrient loss from a native prairie in west-central Minnesota was studied to compare the effects of different grazing levels on nutrient loads in runoff. Two interesting findings were that depending on the nutrient of interest, 63% to 88% of the average annual nutrient loads were transported in snowmelt. Also, concentrations for all nutrients were higher for runoff following rainfall (Timmons and Holt, 1977).

Dissolved nutrients are transported into streams primarily in the groundwater (Gregory, et al., 1991). Because of the riparian zone position within the watershed, it intercepts the soil solution as it passes through the rooting zone prior to entering the stream. Riparian zones also contribute seasonal pulses of dissolved components derived from plant litter into streams. Thus, the riparian zone functions to remove nutrients and modify inputs to the stream.

Riparian forests were responsible for removal of more than three-quarters of the dissolved nitrate transported from croplands into a Maryland river (Peterjohn and Correll, 1984). Natural riparian forests can denitrify and release 25 to 35 pounds of nitrogen per acre per year (Cole, 1981). Because of their unique position at the interface between land and aquatic ecosystems, riparian zones play a critical role in controlling the flow of nutrients from watersheds.

The presence of slowly decomposing plant residues in wet soils further facilitates water purification. Some organic matter particles have a high ability to capture and hold many potential contaminants, while others serve as sources of food and energy for soil organisms involved in contaminant detoxification. Peat is a highly reactive material that has the ability to capture and hold many chemicals including nutrients, pesticides, heavy metals, and other contaminants that flow through riparian areas (Cohen, 1997).

How Does a Healthy Riparian Zone Provide Habitat?

Riparian areas provide food and habitat for soil, aquatic, and land organisms. A multistoried plant community of annual and perennial grasses, forbs (broadleaf plants), shrubs, and trees provides a varied habitat for birds and wildlife and a below ground habitat for burrowing animals

and soil organisms. Streambanks provide breeding areas for many aquatic species, as well as habitat for algae and macroinvertebrates (aquatic insects) that are used as food by fish and other aquatic life (Bellows, 2003).

Riparian vegetation provides up to 90% of the organic matter (food) necessary to support headwater stream communities (Cummins and Spengler, 1978) and 99% of stream energy input (food) may be imported from bordering riparian vegetation and only 1% derived from instream photosynthesis (Cummins, 1978).

Woody debris derived from riparian tree and shrub communities is important in slowing the stream, reducing energy, and controlling erosion. It also provides diversity of habitats in small streams, helping create pools, catching sediment, providing substrate for aquatic organisms, and cover for fish (Thomson, 1984). Riparian vegetation provides shading for the stream, consequently lowering stream temperatures and providing cover for fish.

The ability of riparian areas to stabilize stream flow levels throughout the year is critical to the survival of many fish and other aquatic species. Fish need enough water in streams to navigate and find food. High water levels caused by stream flashing can rapidly increase water temperatures, which can be fatal to some fish and other aquatic organisms. Stable water levels provide moderate water temperatures required for the growth of fish and the aquatic organisms that they use for food (Cohen, 1997; Wenger, 1999).

Summary of Understanding the Benefits of Healthy Riparian Areas

Riparian areas are the vegetated areas adjacent to a flowing body of water. Healthy riparian areas have many characteristics including: diverse plant species that provide cover and shade, water storage capacity and constant stream flow, vertical streambanks, and habitat for diverse wildlife species. Riparian zones provide a variety of functions including capturing, storing, and treating water. A riparian zone with a diversity of vegetation is able to trap 80% to 90% of sediments transported in water. The large water holding capacity of riparian zones buffers water movement.

Degraded unhealthy riparian areas tend to have: patchy or scrubby plant growth, rounded streambanks, eroding banks that are undercut or sloughing, flood regularly, muddy water, and limited biodiversity for wildlife. Degraded unhealthy riparian zones typically are subject to flash flooding or stream flashing, which is characterized by a rapid rise and fall of water levels due to runoff. The riparian zone provides food and habitat for a wide diversity of wildlife. Unmanaged livestock grazing can damage riparian areas.

For more information on the effects of livestock grazing riparian areas see the following fact sheets in the Livestock and Streams series:

- Negative Effects of Livestock Grazing Riparian Areas, LS-2-05
- The Effects of Grazing Management on Riparian Areas, LS-3-05
- Best Management Practices to Control the Effects of Livestock Grazing Riparian Areas, LS-4-05
- Pathogenic Effects from Livestock Grazing Riparian Areas, LS-5-05

References

Bellows, B. C. March 2003. Protecting riparian areas: Farmland management strategies. Soil systems guide, appropriate technology transfer for rural areas. At www.attra.ncat.org.

Clark, E. A. 1998. Landscape variables affecting livestock impacts on water quality in the humid temperate zone. Canadian J. of Plant Sci., Vol. 78. p. 181-190.

Cohen, R. 1997. Fact sheets: Functions and values of riparian areas. Massachusetts Department of Fisheries, Wildlife and Environmental Law Enforcement Accessed at: http://www.crjc.org.

Cole, D. W. 1981. Nitrogen uptake and translocation by forest ecosystems. In: F. E. Clark and T. Rosswal (eds.) Terrestrial nitrogen cycles. Ecological Bulletin. Vol. 33. p. 219-232.

Cummins, K. W. and G. L. Spengler. 1978. Stream ecosystems. Water Spectrum. 10:1-9.

Edwards, R. 2000. The hidden river in riparian areas. p. 103-104. In: Summit 2000: Washington Private Forest Forum. University of Washington, College of Forest Resources. Seattle, WA. Accessed at: http://www.cfr.washington.edu/outreach/summit/proceedings.html.

Elmore, W. and R. L. Beschta. 2000. Riparian areas: Perceptions in management. Aurora Project. A production of the Bureau of Land Management and the U.S. Department of Interior. Accessed at http://www.mtnvisions.com/Aurora/percepmn.html.

Gregory, S. V., F. J. Swanson, W. A. McKee, and K. W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience 41(8): 540-550.

Huel, D. 1998. Streambank stewardship: A Saskatchewan riparian project. Saskatchewan Wetland Conservation Corp. Regina, Saskatchewan. Accessed at: http://www.wetland.sk.ca/pdfs/landowner/streamstew_FULL.pdf.

Martin, D. W., and J. C. Chambers. 2001. Restoring degraded riparian meadows biomass and species responses. J. of Range Management. Vol. 54, No. 3. p. 284-291.

Naiman, R. J., and H. Decamps. 1997. The ecology of interfaces: Riparian zones. Annual Review of Ecology and Systematics. V. 28. p. 621-658.

Ohmart, R. D. 1996. Historical and present impacts of livestock grazing on fish and wildlife resources in western riparian habitats. In P. R. Krauseman (ed.) Rangeland wildlife. The Society for Range Management, Denver, CO. p. 245-279.

Peterjohn, W. T. and Correll, D. L. 1984. Nutrient dynamics in an agricultural watershed: Observations on the role of a riparian forest. Ecology, vol. 65 (5), p. 1466-1475.

Platts, W. S. 1990. Fish, wildlife and livestock: Protection of riparian areas. In: Western Wildlands. Summer. p. 16-19.

Pritchard, D. 1998. Riparian area management: A user guide to assessing proper functioning condition and the supporting science for lotic areas. Technical Reference 1737-15. U.S. Department of the Interior, Bureau of Land Management, National Applied Resource Sciences Center, Denver, CO. p. 126.

Sovell, L. A., B. Vondracek, J. A. Frost, and K. G. Mumford. 2000. Impacts of rotational grazing and riparian buffers on physiochemical and biological characteristics of southeastern Minnesota, USA, streams. Envir. Management Vol. 26, No. 6. p. 629-641.

Thomson, C. S. 1984. Stream relocation in surface mine areas: Effects on fish and invertebrates. In: D. H. Graves (ed.) Proceedings of the 1984 Symposium on Surface Mining, Hydrology, Sedimentology, and Reclamation. University of Kentucky OES Publications. Lexington, KY. p. 345-355.

Timmons, D. R. and Holt, H. F. 1977. Nutrient losses in surface runoff from a native prairie. J. Env. Qual. 4(6): 369-373.

Wenger, S. 1999. A review of scientific literature on riparian buffer width, extent and vegetation. Office of Public Service and Outreach, Institute of Ecology, University of Georgia. Athens, GA. Accessed at: http//outreach.ecology.uga.edu/tools/buffers/lit_review.pdf.

Winward, A. H. 2000. Monitoring the vegetation resources in riparian areas. General Technical Report RMRS-GTR-47. U.S. Department of Agriculture-Forest Service. Rocky Mountain Research Station. Ogden, UT. p. 49.

Acknowledgments

The following persons reviewed the original material: Dr. Lloyd Owens, Soil Scientist, USDA-ARS; Dr. Steve Loerch, Professor of Animal Sciences, The Ohio State University; and Robert Hendershott, Grassland Specialist, USDA-NRCS. The authors would also like to thank Jerry Iles, Extension Educator, Watershed Management, OSU Center at Piketon for comments and suggestions. The authors thank Kim Wintringham (Technical Editor, Section of Communications and Technology) for editorial and graphic production.