Water Quality Series

Riparian Forest Buffers

OSU Extension Facts

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Riparian forests, found throughout Oklahoma, play an important role in maintaining water quality.

Introduction

Riparian areas are the lands directly adjacent to water as shown in Figure 1. Riparian areas include the trees and other plants growing next to a stream, river, pond, or lake. These areas may be a few feet near streams or a mile or more in floodplains. Both perennial and intermittent streams support riparian vegetation. Because riparian areas represent the interface between aquatic and upland ecosystems, the vegetation in the riparian area commonly has characteristics of both aquatic and upland habitats. Many of the plants in the riparian area require plenty of water and are adapted to shallow water table conditions.

Due to water availability and rich alluvial soils, riparian areas are very productive. Tree growth rate is high and the vegetation under the trees is usually lush and includes a wide variety of shrubs, grasses, and wildflowers. In Oklahoma, bottomland hardwood forests are good examples of riparian areas.

Riparian areas have many functions. Most notably, riparian areas can 1) store water and help reduce floods; 2) stabilize stream banks and improve water quality by trapping sediment and nutrients; 3) shade streams and help maintain temperature for fish habitat; 4) provide shelter and food for birds and other animals; 5) support productive forests which can be periodically harvested; 6) can be used as recreational sites; and 7) provide productive pasture lands for livestock.

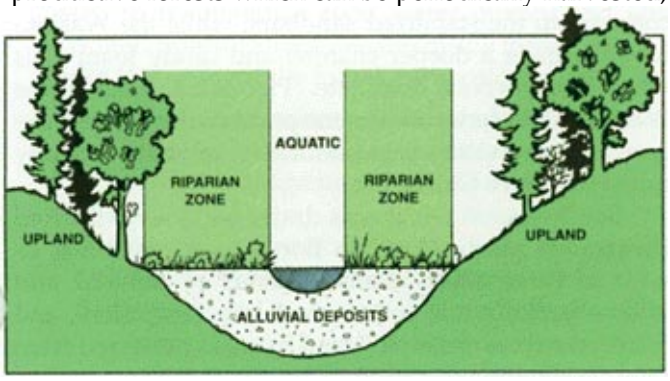

Figure 1. Diagram of a riparian area.

Streamside forests are critical to the protection and enhancement of water resources. It is important that a streamside forest's capacity to provide the products and habitat is not reduced. Many of these areas are best managed as forests, rather than converted to other uses.

This fact sheet is intended to identify the benefits of riparian areas, describe the various riparian systems in Oklahoma, and suggest appropriate management practices to help maintain them.

Riparian Areas in Oklahoma

A diversity of stream system types support riparian vegetation throughout Oklahoma. These include areas around perennial and intermittent streams and bottomland hardwood forests.

Bottomland hardwood forests of eastern Oklahoma can be classified into two general plant association types. The elm-ash-cottonwood association is typical of floodplains in the better drained soils more prevalent in northeast and central Oklahoma, and the oak-gum-cypress association is found on wetter sites with finer textured soils in southeast Oklahoma. A profile of an idealized bottomland hardwood forest in southeast Okla-

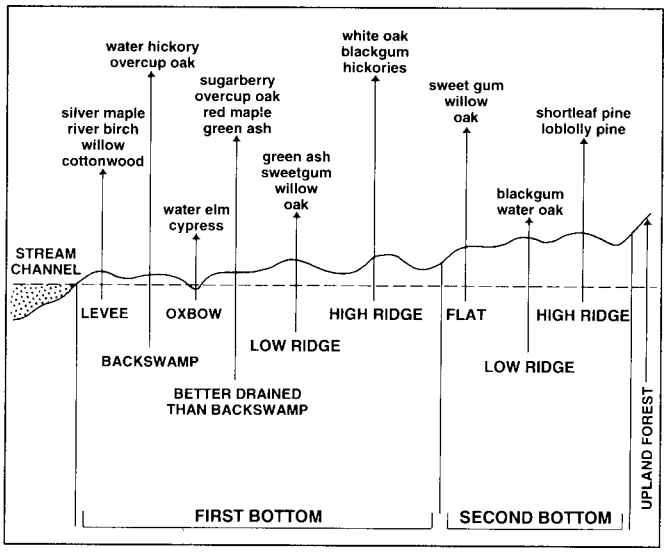

Figure 2. Profile of a bottomland hardwood forest in southeast Oklahoma.

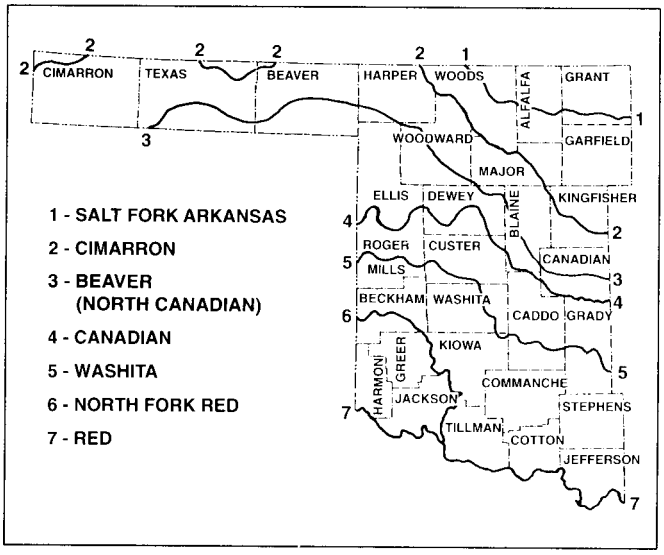

Figure 3. River systems in western Oklahoma which support bottomland hardwood types.

homa, showing the progression from wetland to upland species, is presented in Figure 2. On the most disturbed areas, such as newly formed point bars or levees, black willow, river birch, and silver maple, are common species, in addition to cottonwood.

Bottomland hardwoods in eastern Oklahoma represent about 10 percent of the 4.3 million acres of commercial forest land in Oklahoma. This is only about 15 percent of the bottomland hardwood type that originally existed in Oklahoma. Common overstory trees in bottomland hardwood areas in northeast and southeast Oklahoma are presented in Table 1.

Riparian areas of central and western Oklahoma are associated with waterways which traverse a variety of landforms and upland vegetation types (Figure 3). The relationship of riparian lands to downstream transport of water and nutrients is most obvious in this part of the state where streamside corridors offer a break to the landscape and an oasis for wildlife. Where rainfall reaches 20 inches per year or more, the riparian areas are dominated by willow, cottonwood, American elm, and hackberry. Significant numbers of black walnut, green ash persimmon, western soapberry, eastern red cedar, and tamarisk (salt cedar) may also be found.

In the plateau region of the extreme western Panhandle, stream conditions are generally ephemeral or intermittent. Streamside areas are limited and vegetation on portions of larger floodplains may be similar to surrounding uplands. Moving east, the major rivers of the high plains region include the Cimarron, Salt Fork, Arkansas, and Beaver (North Canadian) Rivers which have floodplains as wide as one or two miles. Riparian vegetation commonly includes tamarisk and willow, while stands of cottonwood occur higher on the terraces.

The major drainage basins in west-central Oklahoma include the Canadian and Washita Rivers. The Canadian River has broad and sandy floodplains with tamarisk common to the stabilized sandbars, while the Washita River exhibits a deeper channel and sandy loam soils where cottonwoods dominate. Floodplain lands of the Washita River have undergone perhaps the greatest degree of conversion to agricultural development of any river in western Oklahoma.

Southwestern Oklahoma drainages flow to the Red River, with sandy alluvium floodplains sometimes as wide as three miles. Dense thickets of tamarisk and willow occur, while cottonwood, elm, soapberry, and hackberry trees are established in areas protected from scouring floods and shifting deposits of sand.

Table 1. General importance of overstory trees in bottomland hardwoods of eastern Oklahoma.

Northeast Area		Southeast Area	
Species:	**Importance*:**	**Species:**	**Importance:**
American elm	18.7	Overcup oak	12.3
Sugarberry	14.8	Green ash	10.8
Green ash	10.1	American elm	9.5
Pecan	8.5	Willow oak	9.4
Pin oak	5.9	Sugarberry	7.5
Shumard oak	5.6	Winged elm	5.4
Boxelder	4.5	Water oak	4.6
Pignut hickory	4.0	Osage Orange	3.3
Red mulberry	3.4	Pignut hickory	2.9
Silver maple	3.0	Blue beech	2.7

* Importance is the relative frequency that a tree species occurs with an adjustment for tree size (Brabander et al. 1985).

All major drainages in western Oklahoma are fed by smaller perennial streams and ultimately from intermittent streams, all of which support riparian vegetation. Although different in many respects to riparian areas in eastern Oklahoma, many of the benefits they provide are similar in nature.

Benefits of Riparian Areas

Riparian areas provide different values to society. All riparian areas do not develop the same way and can have different sizes and shapes. Some are very productive and others are not. The following is a brief discussion of some basic values that riparian areas provide.

Flood Control

Riparian areas associated with river and stream floodplains act as water storage areas that can significantly reduce the height of floods downstream. In addition, the abundant vegetation found in riparian areas can help reduce flood velocities. This is why maintaining these areas as forest lessens flood damage.

Healthy riparian areas act like a sponge. When flood waters are slowed, these areas allow some of the excess water to enter underground water storage areas. Slow release of stored water from riparian zones helps maintain streamflow between storms. Establishing proper drainage, filling river and stream floodplains, and modifying water courses decreases flood storage, thereby increasing both the number and intensity of floods that cause severe erosion and property damage. Many of the same attributes that enable riparian areas to reduce flooding also reduce stream bank erosion. Vegetation slows wave action and roots of trees help bind and stabilize the soil.

Water Quality

Riparian areas are important to the control of non-point sources of pollution from land management practices.

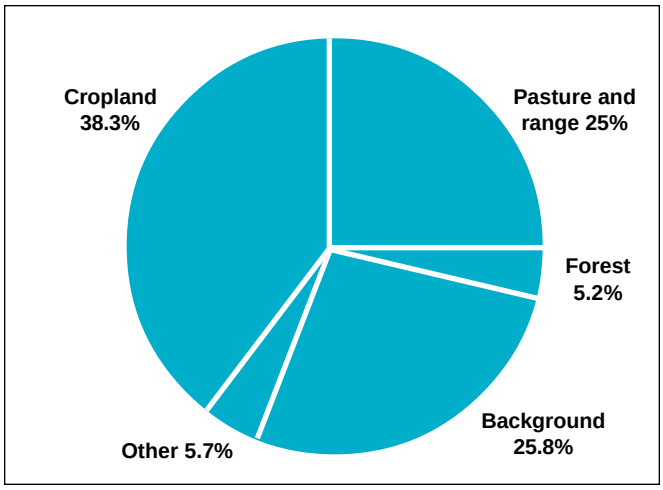

Figure 4. Non-point sources of sediment, 1980.

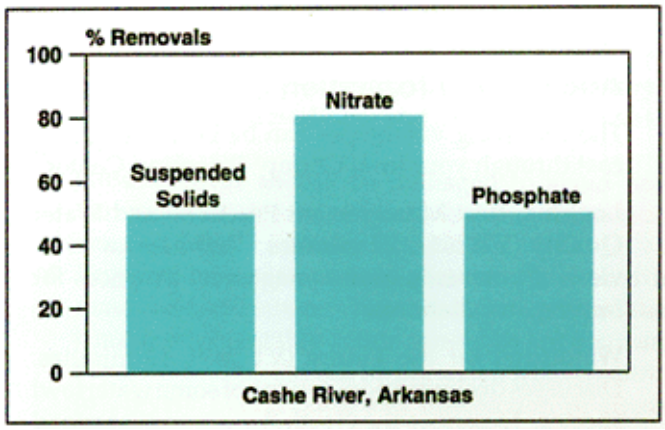

Figure 5. Removal of pollutants from upstream sources by a riparian forest.

Non-point source pollutants include sediment, nutrients, pesticides, animal wastes, and other substances which enter our water supply as part of runoff and ground water flow. The streamside forest acts as a buffer by allowing sediment to settle out from flood waters or surface runoff.

Sediment is the most common and most easily recognized of the non-point source pollutants. Erosion from cropland accounts for about 38 percent of the sediment that reaches our nations waters each year (Welsch 1991). Pasture and range erosion accounts for another 26 percent (Figure 4).

Forests only contribute about 5.2 percent of the sediment that reaches our nation's waterways. Forest harvesting operations, especially when best management practices are utilized, can be performed with minimal hazard of soil erosion. In Oklahoma, studies have shown that soil erosion after a clear-cut, probably the most extreme forest regeneration method, will average about 250 pounds per acre the first year (Miller et al. 1988). By the third to fifth year following harvest, erosion returns to background levels of two to 240 pounds per acre per year. This is a small amount of soil loss compared to lands in agricultural production where soil loss commonly exceeds 10,000 pounds or five tons per acre per year.

Sediment suspended in the water blocks sunlight, limiting the growth and reproduction of aquatic plants. Sediment on the stream bottom interferes with the feeding and reproduction of bottom-dwelling fish and aquatic insects, weakening the food chain. Large deposits of sediment can clog stream channels and floodplains, greatly increasing the potential of flooding.

Riparian vegetation slows runoff from upland sites, allowing water borne sediments, nutrients, and toxicants to settle out. Plants use some of the nutrients for new growth. Phosphorus is reduced by the buffer action of streamside forests because about 85 percent of available phosphorus is bonded to small soil particles in the sediment. Some nitrogen is also associated with soil particles which settle out in the riparian buffer.

The streamside forest also stabilizes nutrients and chemicals when they are deposited into the riparian buffer. For example, in soils with good aeration, bacteria and fungi in the forest floor convert nitrogen in runoff and decaying organic debris into mineral nitrate forms. This form of nitrogen is quickly scavenged by plant roots making the forest a "sink" for nitrogen. When soil moisture is so high that there is no oxygen in the litter and surface soil layers, other bacteria can convert dissolved nitrogen into various nitrogen gasses which return to the atmosphere. Studies have shown that the amount of nitrogen in runoff and shallow ground water can be reduced as much as 80 percent after passing through a streamside forest (Welsch 1991). In an Arkansas study, floodplain deposition reduced sediment by 50 percent, nitrates 80 percent, and phosphates 50 percent (Figure 5). This can be an important asset, especially on agricultural lands producing crops with high fertilizer needs.

By providing shade to streams and rivers, riparian forests also affect nutrient availability in the water. Streams with no shade can show an increase in temperature of 10°F to 15°F. Slight increases over 60°F can cause significant increases of phosphorus release from sediments (Karr and Schlosser 1977). Maintaining streamside vegetation is an easy way to control nutrient problems in waterways.

Wildlife Habitat

Due to their proximity to water and open areas, forest buffers are extremely important habitat for numerous wildlife species. They also serve as travel corridors between different habitat types. Trees shade and cool the waterways underneath them. As a result, they improve aquatic habitat by lowering water temperatures and increasing dissolved oxygen levels. Overhanging branches and roots provide cover for wildlife. Leaves, twigs, flowers, animals, and insects from the streamside forest provide the fundamental food source in the aquatic food chain.

These organic inputs are most dominant in small streams flowing through forests and act as food that supports many invertebrate animals, which in turn are the principal food source for fish. Aquatic invertebrates shred large organic debris to smaller pieces which move downstream to be used by larger animals who feed by filtering or gathering. By providing large stable debris to the streambed, streamside forests allow organic material to be held long enough to be processed by the invertebrate community.

Bottomland hardwood forests are important as habitat for both resident and migratory species. Many small and large mammals, birds, reptiles, and amphibians depend on bottomland hardwood forests for at least a portion of their life needs. These forests serve as wintering, feeding, and breeding grounds for migrant species. Pair bonding, which is very important to reproduction in several waterfowl species, takes place in bottomland forests. Food in the form of hard mast (i.e., oak acorns, black walnut, pecan, and hickory nuts) found in bottomlands are used by many animals, especially game species, such as turkey, deer, and squirrel. Insects produced in the bottomland hardwood forest are an important food source for many bats. Snags, den trees, fallen logs, and other nesting sites provide essential cover and help reproductive success.

Bottomland hardwood forests in Oklahoma support at least 20 species of mammals, 160 species of fish, 38 species of amphibians, 54 species of reptiles, and 150 species of birds. Some of these are considered threatened and endangered. Table 2 lists some of the threatened or endangered animals found in or that are dependent upon riparian areas in eastern and central Oklahoma.

Riparian areas in central and western Oklahoma support at least 49 species of mammals, 28 species of fish, 13 species of amphibians, 43 species of reptiles, and 134 species of birds. In western Oklahoma, the endangered bald eagle relies heavily on trees, such as cottonwoods, for perch and roost sites. The endangered whooping crane, piping plover, and interior least tern utilize the broad sandbars of major western Oklahoma rivers or salt flats for nesting, feeding, or roosting. For additional information regarding threatened and endangered species in Oklahoma, the Threatened and Endangered Species manual is available from most Cooperative Extension Centers or the U.S. Fish and Wildlife Service in Tulsa (phone: 918-581-7458).

Table 2. Riparian species in eastern Oklahoma considered threatened and endangered.

Fish	
	Arkansas River shiner (state threatened)
	Longnose darter (state endangered)
	Blackside darter (state threatened)
	Leopard darter (federal threatened)
	Neosho madtom (federal threatened)
Mussels	
	Neosho mucket (state endangered)
	Ouachita rock pocketbook (federal endangered)
Reptiles	
	American alligator (federal threatened)
Birds	
	Bald eagle (federal endangered)
	Whooping crane (federal endangered)
	Piping plover (federal endangered)
	Interior least tern (federal endangered)
Mammals	
	Gray bat (federal endangered)
	Indiana bat (federal endangered)

Establishing a Riparian Forest Buffer

Depending on site conditions, a riparian forest buffer as little as fifty feet wide (measured from the streambank away from the stream) may filter the majority of non-point source pollutants from agricultural and urban runoff. The width of an effective forest buffer depends on the slope of the land adjacent to the waterway and the purpose of the buffer. For instance, buffers for agricultural land may need to be wider than buffers for forest harvesting.

Forest buffers, also known as streamside management zones, should be wider if wildlife habitat is a major purpose. For example, one study showed that a wide variety of reptiles and amphibians were much more abundant in medium to wide streamside buffers (99 to 313 feet) as compared to buffers 0 to 82 feet wide (Rudolph and Dickson 1990). The wider zones were characterized by closed canopy overstory, well developed midstory, and sparse vegetation on the forest floor. Small mammals, however, were found to be more abundant in narrower streamside areas with well developed herbaceous vegetation, compared to wider zones with sparse vegetation (Dickson and Williamson 1988).

Dickson and Huntley (1987) found abundant signs of squirrel feeding and squirrel leaf nests in buffers wider than 165 feet, but virtually none in zones narrower than 99 feet. Another study found that wild turkey populations thrive in areas with substantial pine plantations, if the plantations are properly managed to accommodate wild turkeys and if streamside zones or other suitable mature forest habitat is available. The study showed that turkey sign was significantly less when streamside management zones were less than 150 feet than when the width was greater than 270 feet (Burk et al. 1990).

Such varying results certainly confuse the question about how wide to make a streamside buffer. If wildlife is a consideration, then the important point to remember is that habitat needs for wildlife depend on the species of interest. The results reported above may suggest some general guidelines to use, but much more research needs to be done before concrete recommendations can be made.

Establishment of a riparian forest buffer is only one step to maintaining good water quality and wildlife habitat. Specifications for streamside forests should also take into account the following considerations:

1. Streamside forests should be used in conjunction with sound land management systems that include nutrient management and sediment/erosion control.
2. Streamside forests should be wide enough to trap most of the sediment from surface runoff.
3. Trees should be removed periodically to maintain vigorous growth and remove nutrients that have been stored in woody biomass. Harvesting should be followed by prompt regeneration.
4. Periodic minor ground shaping may be necessary to encourage dispersed flow and prevent concentrated flow.
5. Ground cover should be managed to avoid wide variations in stream temperature and to maintain temperature for instream aquatic life.
6. Unstable tree tops and smaller debris should be removed from stream channels to prevent problem jams, but large stable debris should be left instream.
7. Riparian buffers should be protected from livestock to prevent overgrazing and destruction of stream banks from livestock. A rotational grazing system can allow vegetation regrowth during the summer and fall.
8. Utilize best management practices when harvesting trees. When operating in a streamside forest buffer, a) keep skidders away from stream banks, b) under wet conditions keep heavy equipment out, and c) do not skid across streams.

Voluntary best management practice (BMP) guidelines have been in use in Oklahoma since 1982. It is important for landowners to consider BMPs during all forest operations. For example, when selling timber, a written contract that describes best management practices can avoid many problems. The best way to ensure that BMPs are used properly is through careful administration of the contract. Forestry consultants can assist with timber sale, layout, and administration. For more information on best management practices in Oklahoma and a list of forestry consultants, contact your local State Department of Agriculture-Forestry Services office, County Extension Center, or Conservation District office.

Forest Stewardship Program

Farmers, ranchers, and landowners across Oklahoma who have streamside forests or would like to establish a riparian forest buffer may be interested in the Forest Stewardship Program. This program is administered by the State Department of Agriculture-Forestry Services and is designed to help landowners receive more benefits from their forest land through good forest management. The program provides technical assistance and recognizes good forest stewards. Once a management plan is approved, a landowner can apply for financial assistance under the Stewardship Incentive Program (SIP). This program can assist with planting trees, establishing wildlife habitat, and installing fences to protect streamside forests.

Additional Information

The following videotapes can be borrowed at no cost through your local County Extension Center.

Logging, Best Management Practices, and Water Quality (VT 264), 22 minutes. Provides an overview of voluntary best management practices for forestry in Oklahoma.

Waterfowl for the Future (VT 242), 16 minutes. Discusses declining populations of some waterfowl species. Describes the North American Waterfowl Management Plan.

Forest Stewardship: Conserving Our Forests (TC 125), 1 hour 30 minutes. Provides an overview of the Forest Stewardship Program and the Stewardship Incentive Program. Showcases several stewardship forests from around the nation.

American Tree Farm Showcase (VT 175), 58 minutes. Features 12 interviews with tree farmers from the Great American Woodlot Series about woodlot management and stewardship.

Agriculture and Wildlife (VT 359), 2 hours and 30 minutes. A set of 11 programs which discuss the relationship of agriculture and wildlife. Segments include winter food plots, grazing management, streamside woodlands, field borders, wetland restoration, and CRP.

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