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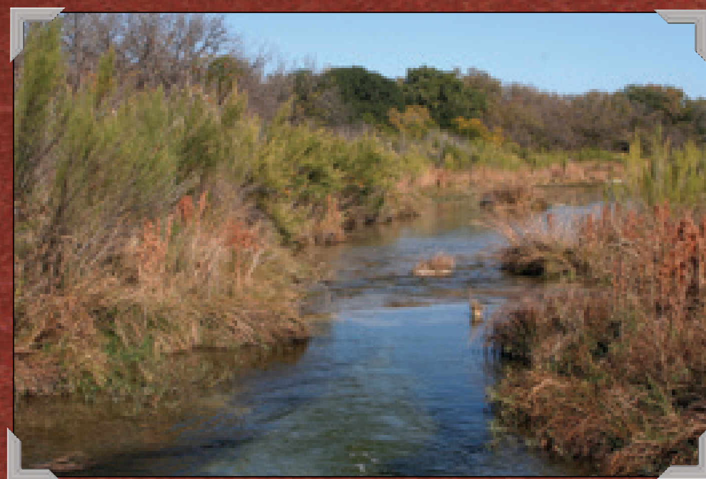

Managing Riparian Areas

A guide to caring for special places that need preferential treatment

by Steve Nelle

A publication of the Nueces River Authority

Dear readers and fellow lovers of riparian places,

It is our great pleasure to publish this riparian management booklet written by Steve Nelle, our mentor, colleague, and friend. Though Steve developed this educational content as part of another project, he generously gave Nueces River Authority permission to produce it as a companion piece to the Remarkable Riparian Field Guide.

As Texas' most acclaimed riparian educator, Steve Nelle has created here a thorough, well-organized, and wise guide for riparian stewards everywhere. He has a great deal of knowledge to impart and has done it wonderfully within these pages—almost as good as a walk along the bank of a special stream with Steve as our personal guide.

We give big thanks to the Dixon Water Foundation and the Shield-Ayers Foundation for providing funds to develop and reproduce this valuable educational tool.

I am honored to have learned under Steve's tutelage and to put forth this booklet for others to use.

Thank you.

Sky Jones-Lewey
Resource Protection and Education Director
Nueces River Authority

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The Special Character of Riparian Management

Introduction

Riparian areas are most simply defined as the transition or interface between comparatively drier upland areas and wetter areas. Riparian areas can exist along the margins of creeks, rivers, ponds, lakes, wetlands and bays. This booklet will focus on the management of riparian areas that exist along creeks and rivers.

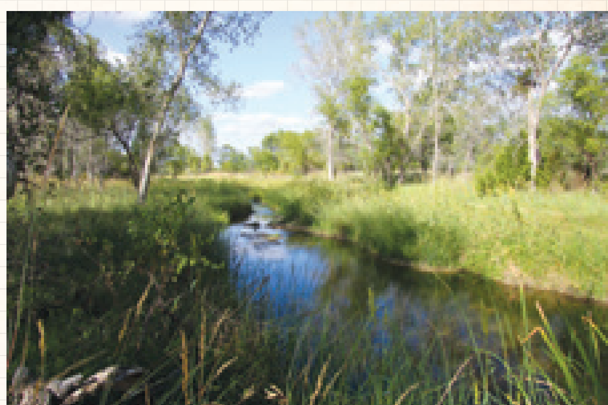
Streams and their riparian areas can be classified according to the duration of flow. Perennial creeks and rivers flow continuously on the surface except during the most severe drought. Seasonal creeks, also called intermittent creeks, flow for only a portion of the year, and yet maintain a connection to the associated alluvial water table. Ephemeral creeks flow only in direct response to rainfall and runoff and have no connection to a water table. Perennial and seasonal streams usually have well developed riparian areas. Ephemeral creeks and draws usually have poorly developed riparian areas due to a lack of a contributing water table and are not addressed in this booklet.

There is tremendous variability in riparian areas across Texas, and for this reason, the appropriate management will also vary from place to place and should be site specific. The information presented here is general in nature and not intended to prescribe specific management for a specific riparian area. Onsite technical assistance by experienced riparian professionals is available to help determine specific management that may be needed.

Small yet Special

The value of riparian areas in the landscape far exceeds their relatively small size. In most settings, the actual riparian area makes up only one to five percent of the total land area, but the ecological, hydrological, economic and human values of these areas is comparatively much greater. Riparian areas have been referred to as "ribbons of gold" to help communicate their great worth. Those who own or manage land adjacent to creeks or rivers should understand their responsibility for the conservation and sustainable management of these special resources.

Although riparian areas comprise only a small part of the landscape, their contributions and value far exceed their small size. Riparian areas are special places.

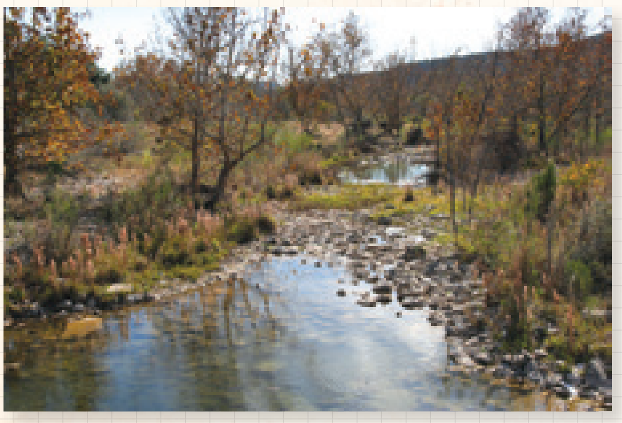


Riparian areas need preferential management. This healthy riparian area in the Panhandle is receiving preferential management in the form of specialized grazing management.

When considering the management of riparian areas, there is one guiding principle that needs to be remembered: Riparian areas are special places; they need *preferential treatment.* The same kinds of management that work well on upland areas do not necessarily work well in riparian areas. The management needed in the riparian area is different and distinct and should be specially prescribed and carried out. Understanding this truth will help riparian managers take better care of these special places.

Sensitive yet Resilient

Riparian areas are more sensitive, yet also more resilient than other parts of the landscape. Riparian areas are sensitive and potentially vulnerable to the high energy of turbulent floodwaters that apply tremendous stress to banks and channels. The stress is compounded by the transport of gravel, cobble, logs, trees and other objects during flood events. Riparian areas are also sensitive due to the disproportional amount of human activity that often takes place in and near creeks and rivers. These activities can potentially increase physical, biological or chemical stress to the stream and associated riparian area.



Riparian areas are especially sensitive to disturbance, but they are also resilient. Natural resiliency is the basis for most successful riparian management.

Yet, riparian areas are also extremely resilient to stress and disturbance, especially if the proper kinds and amounts of riparian vegetation are present. The resiliency is a function of extra water, fresh inputs of nutrient-rich sediment and inputs of seed and plant materials from upstream. The inherent resiliency of riparian areas and their tendency to naturally restore themselves after disturbance is the basis of most riparian management.

Think Water Catchment (not Watershed)

Even though the focus of this publication is on the larger river systems, major tributaries, and the importance of maintaining flow regimes, it is important to note the essential connection of larger creeks and rivers to the entire landscape (Kershner 1997). The waters that make up the flow of larger streams originate on the uplands via precipitation and runoff, which then pass through a series of small drainages and ephemeral creeks until they progressively merge into larger and larger creeks, and finally into the major river systems of Texas. Likewise, the water that percolates into aquifers and subsequently discharges into creeks and rivers via springs also originates on the uplands.

The importance of watershed management has gained a great deal of attention in recent years (Adler 1995). Yet, the term "watershed" can convey an unintentionally wrong message. Literally understood, an area of land that repels, or "sheds," water is not the goal of a healthy landscape. Instead, some people have adopted the term "water catchment" to more aptly communicate how healthy landscapes should function. Consider the contrast between these two terms. A water catching landscape retains and stores water for a slow and prolonged release. A water shedding landscape moves water quickly down slope, off site and downstream for a rapid and short lived release.

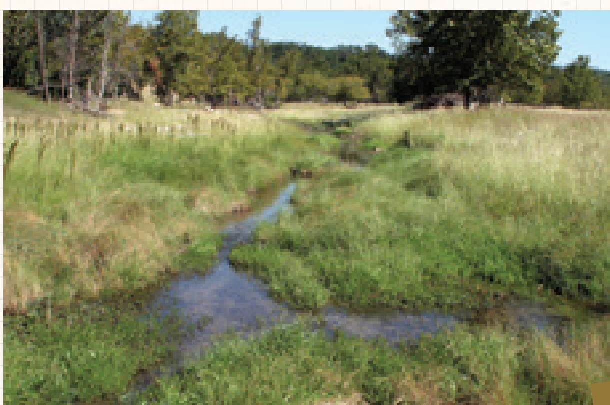
The management of riparian areas should generally strive to create or enhance water-catching conditions rather than water shedding conditions. Desirable riparian vegetation is the key component that determines the water catching, water slowing, and water holding capacity of riparian areas. In both upland and riparian areas, the goal of management, in most cases, is to slow down the movement of water, thus keeping water on the land longer.

The Greek philosopher Plato clearly recognized the connection of land, water and people, and understood the concept of the land as a water catchment in about 400 B. C.:

> *"In the primitive state of the country, the mountains and hills were covered with soil and there was an abundance of timber. The plains were full of rich earth, bearing an abundance of food for cattle. Moreover, the land reaped the benefit of the annual rainfall, having an abundant supply of water in all places; receiving the rainfall into herself and storing it up in the soil. The land let off the water into the hollows, which it absorbed from the heights, providing everywhere abundant fountains and rivers. Such was the state of the country, which was cultivated by true husbandmen, who made husbandry their business, and had a soil the best in the world and abundance of water."*

Properly managed, well-vegetated upland areas can be referred to as "water catchments". A water catching landscape with good soil health will absorb and store rainfall, allowing for slow and prolonged release. Management of upland areas to reduce runoff volume and slow runoff rates will help maintain riparian areas.

Poorly managed upland areas repel water and increase runoff rates. Water shedding landscapes inhibit the natural water cycle and exacerbate riparian problems.



Good management of small headwater tributaries is an important aspect of good overall land and water management.

The roles of upland catchment areas, infiltration, surface runoff and subsurface flow are all critical components of the water cycle that also influence the character of creeks, rivers and riparian areas. Successful riparian management strategies include an emphasis on the entire catchment area as well as the myriad smaller tributaries that support the flow of larger creeks and rivers (USDA 1998).

Former President Lyndon B. Johnson, raised on a Texas ranch and active in early water management issues, also understood this interconnectivity: *"Saving the soil and the water must start where the first raindrop falls."*

Upland areas in good hydrologic condition can do a great deal to maintain the integrity of associated riparian areas. Good management on upland water catchments helps to process and protect the waters of Texas in the following ways:

- Vegetation or plant litter intercepts raindrops, thus reducing the erosive energy of rainfall
- Rainwater seeps gently into the soil surface
- Soil maintains good structure, good porosity, high organic matter content, and microbial life
- These soil qualities promote rapid infiltration and high water storage capacity
- Runoff begins more gradually at a slower and more prolonged rate
- Water quality of runoff is improved

What happens on each acre of land has an impact on the waters of Texas. Astute landowners will incorporate this kind of holistic perspective as they manage the uplands as well as creek and river areas. Everything is connected.

However, it must also be noted that good conditions and good management of the uplands do not necessarily mean that the associated riparian areas will also be in good condition. It is possible for upland areas to be in healthy functional condition while adjacent riparian areas are in poor functional condition (Platts and Nelson 1985). This disparity can be caused by disturbances far upstream or downstream which disrupt riparian function many miles away.

"Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land."

Luna Leopold, former Chief Hydrologist with the U.S. Geological Survey

Riparian Management – Past, Present and Future

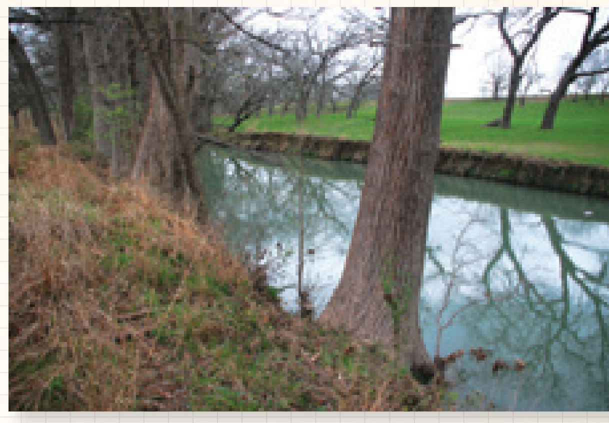
The current condition of riparian areas is largely the product of past management and activity. Humans have been attracted to settle and live near riparian areas for centuries and millennia. As European settlement progressed in the mid-1800s, Texans naturally settled in large numbers in close proximity to creeks and rivers. Cutting of timber, grazing, farming, milling, development of transportation corridors, and other essential activities often took place near the creek, and riparian areas were negatively impacted. In many rural locations in recent years, this intense human activity near creeks and rivers has diminished and many riparian areas are recovering. In other rural locations, land is being subdivided into smaller tracts, which often result in more activity and greater impacts in riparian areas.

In many cases, there has been little or no specific management targeted at riparian areas other than what has happened accidentally and unintentionally. The principle of "benign neglect" has served dual yet opposing roles in riparian management. In some cases, neglect has maintained intact functional riparian areas. Sometimes doing nothing is the best form of riparian management. However, other forms of neglect have caused or accelerated riparian problems.

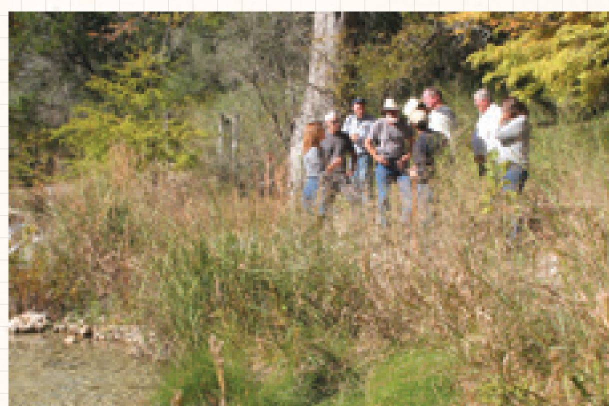
In some cases, riparian management has been intentional but not always with a good outcome. This intentional management is usually done with good motives, but too often is based on myths, misinformation, and traditions. In too many cases, management of riparian areas is applied without a good understanding of riparian dynamics. Riparian problems have often been caused simply by the side effects and spillover of management of the adjacent uplands. Remember – *riparian areas are special places; they need preferential treatment.*

Creeks and rivers, and their associated bottomlands have long been appreciated for the water, fish, wildlife, forage, timber, rich soils and other associated values they provide, but the basic functional attributes of riparian areas have not been widely considered. Likewise, until fairly recently in Texas, there has been little emphasis on proper riparian management. University programs in natural resource management and agriculture seldom address the critical role of riparian management. Most natural resource agencies and professionals do not yet have a good practical understanding of riparian dynamics. Consequently, few landowners are aware of the principles that govern riparian areas. However, landowners do pay attention to what happens in their creek and river bottom areas. Equipped with a basic and practical level of understanding, many landowners will make responsible choices regarding activities and management in riparian areas.

Decades of poorly managed grazing, beginning in the late 1800s have caused extensive damage to creeks and riparian areas. Overcoming the effects of past mismanagement is one of the challenges of modern riparian management.



Teaching people what healthy riparian areas look like is an important part of riparian education. Many people still prefer a manicured appearance and do not yet fully understand the value of a natural functional riparian area.



Outreach and education will be a key element in training and motivating people about the importance of good creek, river and riparian management.

The future of riparian management in Texas will depend largely on long-term education and outreach. Landowners are clearly a primary target audience for such outreach. However, government agencies, conservation organizations, agricultural organizations, real estate agents, land improvement contractors, students, and the public all need to become educated about basic creek-river-riparian dynamics and management and the contributions these areas make to our quality of life (Orr 1990).

The future success of riparian management also hinges on people wanting to do the right thing. Voluntary conservation and management of private land riparian areas is much preferred and generally more successful than the regulatory approach. Appropriate incentives and financial and technical assistance are available to help increase the adoption of good riparian management.

Cooperative Riparian Management

Because the waters of Texas are a shared resource and because water knows no landownership boundaries, the proper management of water is a shared responsibility (NRC 2002). This is especially true for creeks, rivers and riparian areas that run through dozens if not hundreds of different properties on their course downstream. Management of the upland water catchments as well as riparian areas affects everything downstream. Therefore, successful landscape conservation must emphasize cooperative riparian management. In a state like Texas, where landowner independence and private property rights are strong core values, cooperative management can be a challenge. The time tested, proven model is voluntary cooperation of neighboring landowners to achieve common, mutually beneficial natural resources goals.

The most successful model of cooperative natural resource management in Texas is found among the many independent wildlife management associations. These formal or informal associations are sometimes referred to as "wildlife coops" and their purpose is to promote the proper management of shared wildlife resources that live on multiple properties. The key to the success of these associations is twofold. First, the individual landowners declare some level of voluntary commitment to the goals of the association; and secondly, the group meets on a regular basis for educational purposes and to monitor the success of their management.

Many of these existing wildlife management associations are formed on watershed boundaries or along creeks. The landowners already know each other and have worked together for years. It makes perfect sense to incorporate the riparian management message into these existing associations. In areas where these associations do not currently exist, the formation of new natural resource associations with emphasis on cooperative riparian management will be a worthwhile endeavor. Some of these organizations already exist, including South Llano Watershed Alliance, Trinity Waters, and Wimberley Valley Watershed Association.

Successful large scale riparian and watershed management will depend on many adjacent landowners working cooperatively toward mutual goals. Landowner associations such as the South Llano Watershed Alliance are a good way to encourage widespread adoption of good land and water conservation.

Riparian authority Wayne Elmore speaks from more than 40 years of direct riparian experience as he summarizes the importance of a cooperative grassroots approach in dealing with riparian issues:

> *"Riparian restoration will not happen by regulation, changes in the law, more money, or any of the normal bureaucratic approaches. It will only occur through the integration of ecological, economic, and social factors, and the active involvement of affected people. "*

This truth does not negate the value of appropriate regulations, financial resources or governmental assistance; it merely points out that people who are actively and cooperatively engaged in riparian issues are the most valuable asset. When people share a common understanding and appreciation for riparian resources – this is a first critical step toward good riparian management.

Stewardship Ethics – A Prerequisite for Successful Riparian Management

Those who are fortunate enough to own or manage land adjacent to creeks and rivers have an ethical obligation to be conscientious custodians and caretakers of the riparian area. Those who do not own land, but who benefit from healthy functional creeks, rivers and riparian areas, at the very least owe a great debt of gratitude to those who practice such stewardship.

The ownership of riparian land (as well as all other land) should come with the deep inner sense of responsibility to take good care of the land and carry out proper management (Orr 1990b). Land ethics is the moral philosophy dealing with man's relationship to land. The proper attitude of the land steward is that even though they own title to a tract of land and pay taxes on the land, and make costly improvement to the land, they consider themselves merely tenants or trustees of the land. The tenant has the responsibility to take care of land entrusted to him and to ensure that it is maintained and managed during his tenure for future sustainability.

Many landowners will readily apply management that provides short-term personal benefits, and most will implement management practices that will benefit their children and grandchildren. But genuine land stewardship goes beyond these primary motivations and considers the benefits to society. There is a great deal of altruistic benevolence involved in true land stewardship. For the genuine land steward, self-imposed responsibilities become of equal if not greater importance than landowner rights. One of the more desirable benefits of a long-term land stewardship ethic is that it is often an economically profitable way to manage the land. Genuine land stewardship is truly a winning combination for the land, the landowner and society as a whole.

Land stewardship ethics provide the motivation that compels, inspires and energizes the owner or manager to be a deeply principled caretaker of the land. Without an active land stewardship ethic, it is doubtful that creek and river landowners will see the need to provide the special management required in riparian areas. On the other hand, landowners and managers who possess a genuine land ethic are likely to embrace stewardship of the creek and riparian area and to become riparian advocates to their neighbors and examples to their community. These communities, at some point in the future, may want to consider some system of remuneration for the landowners who provide critical natural resource benefits to the public..

Landowners with a strong land stewardship ethic are motivated and compelled to take good care of the land under their management. Where land ethics are weak, land management is often poorly understood and poorly practiced.

Genuine land stewards are those who understand the inner workings of the land and who take responsibility for maintaining or restoring the health of the land.

The Basis for Riparian Management

Intensity of Riparian Management

Riparian management comes in many different forms with no two situations alike. Differences between riparian areas, differences in landowner goals, and differences in the resources available for management all combine to create infinite variability in riparian management. While the same general principles apply across most situations, the specific ways in which management is carried out will differ a great deal from place to place.

Riparian management can be divided into three broad categories, each requiring a different intensity of management (Balch). Some projects call for a combination of approaches:

- Maintain existing riparian condition
- Improve or enhance riparian condition
- Restore degraded and nonfunctional riparian condition

The various intensities of management required for riparian areas also suggest a logical prioritization of management. Maintaining an intact riparian area is much easier and more economical than attempting to restore a nonfunctional, deteriorated area. Furthermore, the likelihood of success is much greater and the risk of failure is much lower (NRC 1992). If resources are limited, funds invested in maintaining or enhancing riparian condition will go much further than intensive and expensive restoration projects. As with many other aspects of natural resource management, it is always better to prevent riparian problems than try to repair them. However, this should not discourage intensive restoration projects if resources are available.

Riparian Function – The Cornerstone of Riparian Management

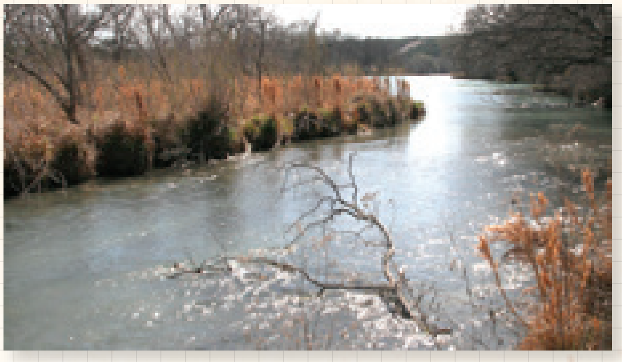
Riparian function has been described in many different ways. Most descriptions and definitions of the term mix various biological and human values with the underlying physical processes. For the purpose of this chapter, it is important to be able to differentiate between the values provided by riparian areas and the basic physical-mechanical processes that support those values. It is vital to understand that the physical processes are what generate and sustain the values that we desire.

If riparian managers understand the importance of maintaining the physical functional processes, they will discover that, in most cases, the values they desire will follow. Riparian management that is focused primarily on these human-biological-economic values without understanding the physical processes is likely to experience frustration and limited success and have false expectations of what is possible.

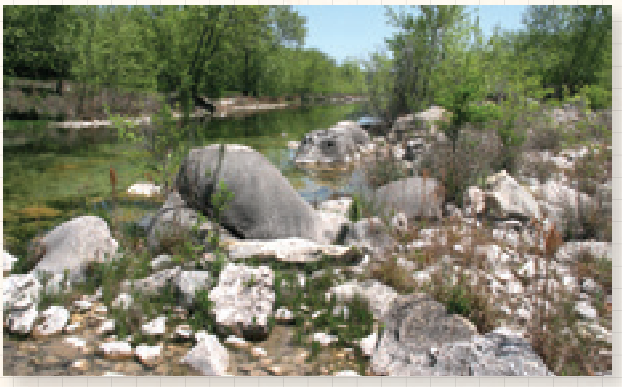
For the purpose of this booklet, the following definition of riparian function is used. A functional riparian area is one that has adequate vegetation, landform, or large woody material to accomplish the following physical processes: dissipate the energy of high flow events; protect banks from excessive erosion; stabilize channels; trap sediment; build floodplains; store water; provide recharge of shallow aquifers; and sustain base flow (Prichard 1998).

Each of these components of riparian function involves physical processes, which are governed by the universal natural laws of physics and energy. When these basic functional attributes are working together, they in turn produce or enhance many of the important creek, river, and riparian values listed in Table 1.

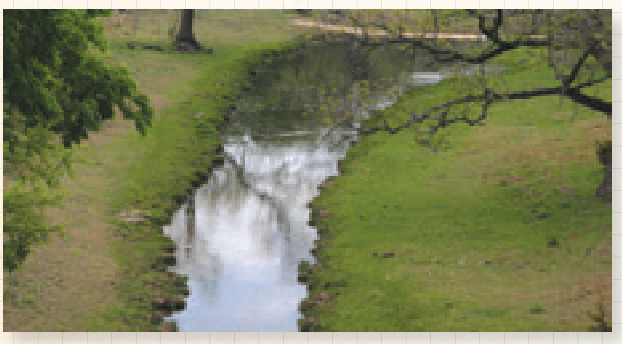
It should be emphasized that the physical functional processes take place in the context of adequate riparian vegetation, landscape formation (boulders, sinuosity, and channel roughness), and large woody material. The most successful riparian managers will have a good understanding of how these factors affect riparian function.



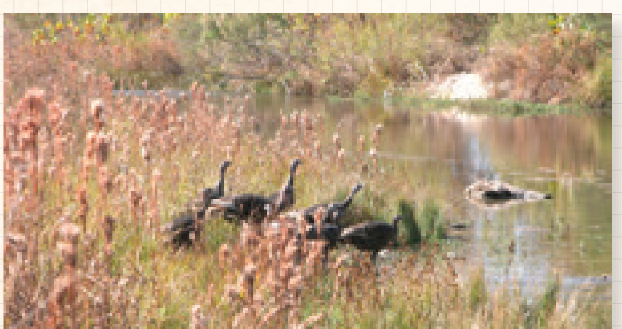
A riparian area in properly functioning condition is more stable and resilient, better able to hold up to moderately high flow events. Management that insures the right kinds and amounts of vegetation is the key to maintaining good functional condition.



When riparian managers understand the physical processes that drive the riparian area, they are better able to implement management that works. A working knowledge of riparian dynamics is crucial for proper management.



A non-functional riparian area lacks adequate vegetation to dissipate energy, protect banks, trap sediment, and slow down the water.



A properly managed and properly functioning riparian area is the foundation and basis for many of the associated values we desire, including wildlife, fish, water quality, forage, and recreational potential.

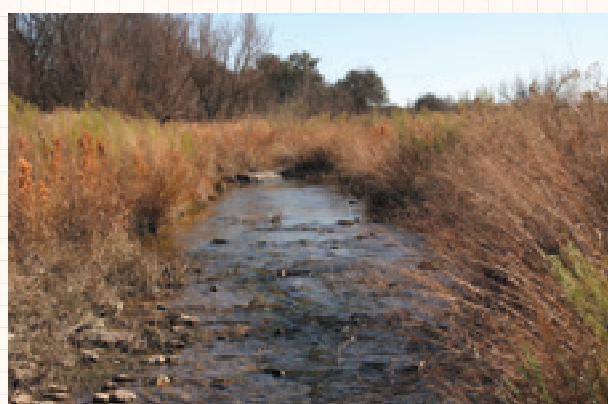
TABLE 1.
SOME VALUES PROVIDED BY FUNCTIONAL RIPARIAN AREAS

- Improved water quality
- Fish and aquatic habitat
- Terrestrial wildlife habitat
- Livestock forage
- Aesthetic values
- Real estate and economic value
- Recreational potential
- Sustained flows
- Reduction of downstream flood damage

Maintaining Equilibrium

In a natural setting and in the absence of significant artificial disturbances, most riparian areas will maintain themselves in a relatively stable condition known as "dynamic equilibrium." According to this concept, creeks, rivers and riparian areas react to normal disturbances in a manner that compensates and helps correct for the disturbance. In this way, creeks and rivers utilize these disturbances for their own benefit, and are always at work to "fix themselves."

This concept of equilibrium should not be misunderstood. It does not mean a perfectly stable balance, nor does it mean the absence of disturbance. Riparian areas are naturally prone to significant and even extreme disturbances. These natural disturbances include both erosion and the deposition of eroded material both spatially and temporally. The intensity, duration and frequency of flooding and/or drought are the most common disturbances that temporarily upset the equilibrium. Other natural disturbances that may

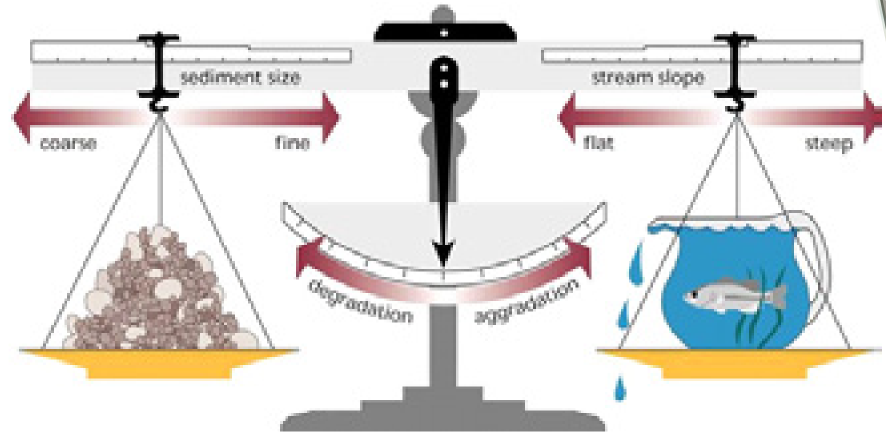


Riparian areas under good management are able to sustain a relative balance between the forces of erosion and sediment deposition.

temporarily upset equilibrium include the washing out of beaver dams, insect or disease problems that disrupt key riparian vegetation, wildfire, and natural grazing and browsing by wildlife. These natural disturbances often cause lateral migration of banks, formation of new gravel and sand bars, and the subsequent changes in sinuosity and channel gradient (Leopold et al. 1964). These changes are countered by the eventual stabilization of the new surfaces by riparian vegetation.

FIGURE 1.

DIAGRAMMATIC MODEL OF THE LANE-BORLAND STABLE CHANNEL BALANCE



When various abnormal activities cause severe and prolonged disturbances, the creek or river attempts to accommodate the disruption with an equally severe reaction, thus upsetting the normal equilibrium. Most of the chronic riparian problems seen in Texas are the result of these excessive or abnormal disturbances that repeatedly disrupt the equilibrium and keep the creek or river out of balance. Extreme and recurring bank erosion, channel down cutting, excessive deposition of sediment, and aggradation of channel are common indicators that creek and river systems may be out of balance and attempting to re-establish a new equilibrium.

A basic understanding of these dynamics will greatly enhance a manager's ability to recognize what is happening in the riparian area. Often, a perceived problem is merely the creek making necessary adjustments to rebalance equilibrium. Managers who do not understand the natural seesaw process of imbalance and rebalance are often tempted to fix something that does not need to be fixed. The unnecessary fixing of some problems actually impedes the normal and natural process of restoring equilibrium and can be very expensive.

The basic principles of dynamic equilibrium are best illustrated by the diagram in Figure 1. Emory Lane was a hydrologist with the Bureau of Reclamation who first described the four basic variables of equilibrium – discharge of water, sediment load, slope of channel, and size of sediment. The qualitative equation he published in 1955 is commonly known as Lane's Relationship (Lane 1955). A co-worker of Lane, Whitney Borland, drew the diagram depicting the four interrelated variables as a beam balance. The Lane-Borland Stable Channel Balance is now widely used to help teach these principles (Rosgen 1996). A few common examples of how this balance works are described below.

Example 1. If vegetation is reduced on the contributing watershed, increased runoff rates will deliver more water to the creek channel. This might be caused by heavy grazing, wildfire, land clearing, or urbanization. This increase in water will tip the right side of the balance beam downward, which will cause erosion (degradation of channel bottom or lateral erosion) in the channel. To correct for this imbalance, the creek channel may increase its meandering or sinuosity, which in turn will decrease the slope of the channel. This decrease in channel slope will correct for the increase in discharge and bring the channel back into balance.

Example 2. If some disturbance in the watershed or floodplain is occurring (such as gravel mining or construction activity), an increased amount of sediment will be delivered to the channel. This will tip the left side of the balance beam downward, which will lead to aggradation or deposition of sediment in the channel. This imbalance can be corrected by an increase in channel slope, which occurs when channel meandering and sinuosity decreases. As the amount of meandering decreases, and the slope of the channel increases, there is greater energy to move the sediment, thus reestablishing equilibrium.

Example 3. If dams are constructed on perennial creeks or rivers, sediment is trapped behind the dam. This is true for small low head dams or large reservoirs. The water that goes over the dam or is released from the dam has a decreased sediment load. This decrease in sediment will tip the left side of the balance beam upward, which will cause erosion or degradation of the channel. The channel correction that often begins to take place downstream is an increase in meandering, which eventually decreases the slope of the channel. As this occurs, the balance can be gradually reestablished.

Riparian managers do not need to become expert hydrologists or fluvial geomorphologists. However, if managers understand how the balance works in theory, they can learn to predict responses to disturbances and will be able to see how creeks and rivers make adjustments to restore the balance.

Disturbance with heavy equipment along the banks for floodplain will often result in large additions of sediment to the channel, which disrupts the balance. Photo courtesy of Sky Lewey, Nueces River Authority

This riparian area in South Texas is in the process of rebalancing after years of disturbance. Sediment is being trapped by vegetation and assimilated into the floodplain, as the channel redevelops a more natural and narrow dimension. Good management is allowing these natural processes to take place.

Removing Hindrances – the Key to Riparian Management

Riparian workers have discovered a fundamental truth that helps to deal with most out-of-balance riparian conditions. If one or more activities or issues can be identified that are hindering the normal equilibrium dynamics, and if those disrupting activities can be corrected, then in most cases the riparian area will begin to mend itself (Kauffman et al. 1997). Stated more simply – stop doing those things that hamper the natural rebuilding process and the riparian area will tend to restore itself. It is not so much a matter of knowing precisely how to fix a degraded riparian area, but rather allowing natural processes to work unimpeded.

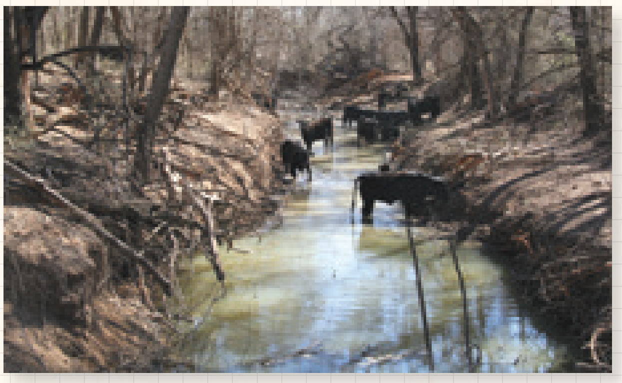
In most cases where there are chronic or acute riparian problems, one or more activities or issues are obstructing the proper function and balance of the riparian area. In many cases, these activities hamper the growth of necessary riparian vegetation. Listed below are some of the common hindrances that can disrupt the equilibrium and keep a creek-river-riparian area out of balance:

- Farming, mowing, or spraying weeds or brush too close to the bank
- Logging and related timber harvest activities adjacent to the creek
- Manicured or altered residential or park landscapes next to the creek
- Prolonged grazing concentrations in creek areas
- Excessive populations of deer, exotic hoofstock, or feral hogs in creek areas
- Burning in riparian area
- Removal of large dead wood and downed trees
- Artificial manipulation of banks, channels or sediment
- Physical alteration of floodplain
- Excessive vehicle traffic in creek area
- Excessive recreational activity or foot traffic in creek area
- Excessive alluvial pumping or other withdrawals
- Low water dams
- Large reservoirs
- Poorly designed road crossings / bridges

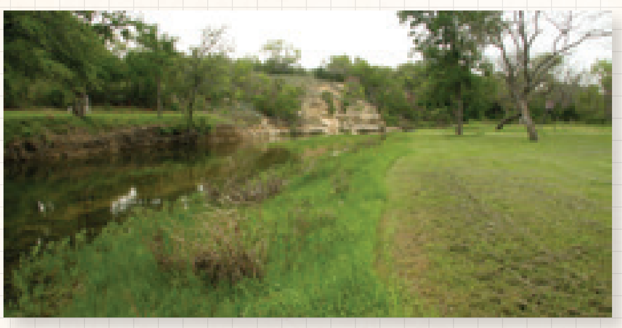
The relative ease or difficulty of addressing each of these hindrances varies considerably. For example, it is relatively simple for a landowner to stop mowing vegetation close to the creek bank. It is a matter of recognizing the impacts and potential damage and making an intentional decision to stop the practice, or modify the practice to reduce the impacts. Likewise, it is straightforward for a livestock rancher to alter grazing management to reduce or eliminate chronic livestock concentrations in creek areas. However, first, he or she must become convinced that livestock concentrations in riparian areas are detrimental. Although straightforward, it still may require considerable effort and expense to implement needed changes in riparian grazing management.

Other practices are a much greater challenge to overcome. For example, excessive populations of free-ranging exotic wild ungulates such as axis deer are a severe problem on hundreds if not thousands of miles of riparian area in the Edwards Plateau. While many landowners and natural resource professionals acknowledge the problem, long-term solutions are exceedingly difficult to apply.

Any practice that hinders the natural processes will prevent or retard restoration of the riparian area. When such practices are altered or eliminated, riparian areas will tend to gradually fix themselves. In this example, recreational driving in the riparian area has removed a large area of vegetation in the floodplain. Restricting vehicle driving will allow the area to heal. Photo courtesy of Sky Lewey, Nueces River Authority.

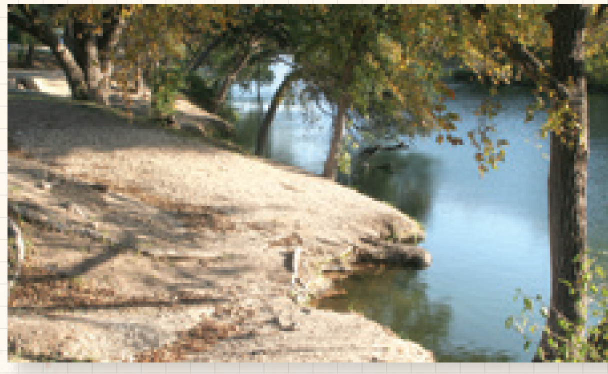


An extreme example of chronic livestock concentration hindering riparian recovery. A change in grazing management will be required to allow natural processes to restore vegetation. Photo courtesy of Ricky Linex, NRCS.



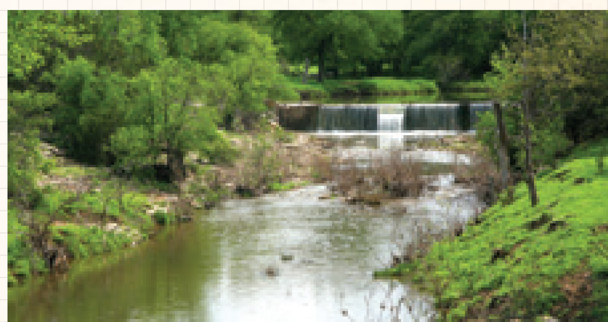
Excessive mowing near the creek will hinder the development of necessary vegetation and prevent or retard natural recovery. Changing mowing practice will allow the growth of needed vegetation and help restore proper function. Photo courtesy of Ricky Linex, NRCS.

There are still other hindering practices so difficult to overcome that they are not yet being seriously discussed. Examples include the thousands of low head concrete dams that have been constructed in creeks, mostly on private land, as well as thousands of poorly designed crossings, culvert installations and bridges. Many of these are under the jurisdiction of county or municipal road and bridge departments or Texas Department of Transportation.



Excessive and extreme recreational impacts frequently hinder proper riparian function in parks and heavy use areas. By altering and managing access, riparian managers can help promote a degree of restoration while still allowing recreational enjoyment.

Creekside landowners sometimes manicure the landscape, creating a park-like appearance. Riparian outreach and education can help teach landowners the value of maintaining dense riparian vegetation. Photo courtesy of Sky Lewey, Nueces River Authority.



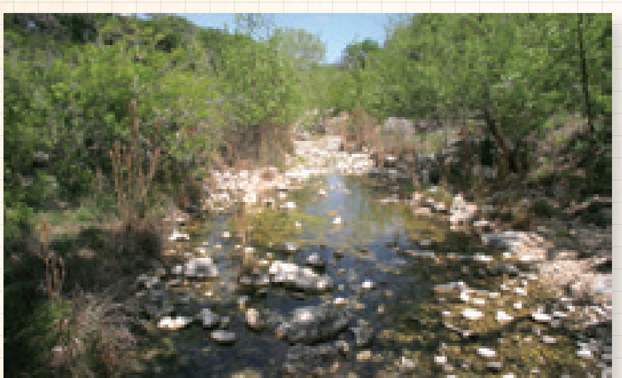
Thousands of low head concrete dams have been built on Texas creeks. These dams disrupt the natural movement of sediment that is needed downstream to build point bars and sinuosity. Erosion is often accelerated below the dams, creating additional problems. Some landowners are now considering the removal of these dams. Photo courtesy of Ricky Linex, NRCS.

Other hindering practices may require legislation and regulation to overcome. An example of this is the tremendous riparian damage caused by unrestricted motor vehicle driving in public riverbeds. In 2003, Senate Bill 155 was passed by the Texas Legislature, which restricted and regulated such driving. In the years since this legislation, many miles of riparian land are restoring themselves naturally in the absence of vehicle traffic. Restrictions and control of pumping of shallow alluvial aquifers may be another instance where legislative and regulatory solutions are warranted. Exploitation of alluvial aquifers for agricultural irrigation or other purposes is severely depleting the base flow of some rivers and creeks in Texas.

The Beauty of Natural Regeneration

In most cases, if the factors that are hindering riparian recovery are dealt with, the riparian area will begin to restore itself naturally. The natural regeneration of appropriate riparian vegetation is often the mechanism that allows this recovery to take place (NRC 2002). Within nearly all medium-sized or larger creek systems, there is an adequate source of desirable native riparian vegetation upstream. These intact or partially intact upstream plant communities provide a source of seed and plant material for downstream establishment.

During runoff events that exceed bankfull discharge, where floodwaters spread out across the floodplain, these seed and plant parts are carried downstream and deposited on wet ground. Seeds that are dispersed in floodwater include cypress, button bush, sycamore, maple, elm, pecan, oaks, sedges, rushes, cutgrass, knotgrass, eastern gammagrass, water primrose and many others. Other plant parts that detach and float downstream and root in a new location are called plant propagules. This can be a large clump of sedge or grass that gets washed out in a flood, with the clump being broken up into many individual plants and floating to new locations. Or it can be detached stems or stolons (runners) of riparian plants such as water willow, watercress or knotgrass, which will root from stem segments. Once established in a new location, these plants will make additional seed and root stock to increase new plant establishment.



This small creek has started to recover on its own after a long period of continuous grazing. The riparian vegetation will continue to improve with time.

Other plants have different modes of dispersal. The seeds of certain riparian plants are dispersed by the wind. Examples of wind-dispersed plants are bushy bluestem, baccharis, willow, cottonwood, cattail, goldenrod and brickelbush. Other riparian plants are commonly spread by wild animals or livestock into new locations. Regardless of the specific method of plant dispersal, it is important to understand that the natural regeneration of riparian plants is an effective method of re-vegetation and is usually the primary means of establishing appropriate vegetation.

Seedlings of bushy bluestem establish naturally in bare areas and fresh sediment deposits. The seed of this riparian grass is dispersed by the wind.

The beauty of natural regeneration of riparian vegetation is that it takes place naturally and effectively, without the high cost and intensity of artificial re-establishment. Normally, this natural process will establish an appropriate and desirable diversity of native riparian species including both early stage "colonizer" species, as well as stronger "stabilizer" species. After a single high flow event, where fresh new seed is deposited, it is not uncommon to observe seedling densities of 50 to 100 plants per square foot. Furthermore, natural regeneration takes place progressively and repeatedly over time, with new seed and new species added. Natural regeneration usually takes place within a reasonable period, but is closely tied to the timing and frequency of overbank flow events, rainfall and other climatic factors.

Unfortunately, in some locations, regeneration of native plant species is hampered by the rapid establishment of exotic and sometimes invasive plant species. This is discussed in a separate section later in this booklet.

As with any natural process, there are times when desired vegetation does not establish according to our expected timeline. Patience is a critical virtue for the riparian manager. There is little that can be done to speed up the process without high inputs and costs and no guarantee of success.

Artificial Re-vegetation

In some special cases, it may be important to establish new vegetation as quickly as possible and not wait for natural regeneration to occur (NRC 2002). Other times, the on-site and upstream source of native plant materials may be so impaired that natural regeneration will occur too slowly or ineffectively. These circumstances may warrant the planting of riparian grasses, sedges, shrubs and trees.

The re-planting of riparian vegetation on degraded or heavily disturbed sites should generally attempt to mimic the natural plant communities to the extent possible (if soil conditions permit). Project managers should search for nearby stream reaches that support intact, functioning native plant communities. These may serve as helpful benchmarks to guide in the selection of plant materials. In the future, Ecological Site Descriptions (ESD) for riparian areas will help managers determine appropriate plant species to use. ESD's have been developed for many upland soils in Texas and are compiled and published by the Natural Resources Conservation Service. However, ESD's for riparian areas have not yet been developed in Texas.

Various artificial re-vegetation techniques are used to jump-start the development of riparian vegetation. Re-seeding and transplanting have been successfully used in riparian restoration projects.

Sawgrass, native to much of the Edwards Plateau, is a good candidate for transplanting. Large clumps can be dug and divided into smaller units. Sawgrass is somewhat resistant to heavy grazing by livestock and deer. Once established, it provides exceptional bank stability and energy dissipation.

At the present time, there are commercially available seed sources for only a few important riparian species. This shortage creates a challenge for establishing appropriate plant diversity. Commercially available seed for riparian species includes switchgrass, eastern gamma grass, bushy bluestem, western wheatgrass, Canada wildrye and Virginia wildrye. In addition to establishment by seed, some growers now offer rootstock of riparian plants for sale. If growers are contacted one to two years ahead of time, some are willing to custom grow riparian plants on a contract basis.

Perhaps the most effective means of artificially re-establishing riparian plant communities is to locate nearby intact riparian areas and seek permission to dig and transplant fresh rootstock. Although the process is labor intensive, results have been very promising. Riparian species that have been successfully transplanted includes Emory sedge, sawgrass, switchgrass, eastern gamma grass, knotgrass, spikerush, goldenrod and scouring rush. Many other species have not yet been tried, but hold much promise. Plants are ideally dug in winter or early spring and immediately transplanted in a similar location, paying special attention to moisture requirements and the depth to the water table.

For the establishment of riparian woody plants, nurseries offer bare root or containerized plants of bald cypress, sycamore, rough leaf dogwood, bur oak, chinquapin oak, pecan, cedar elm, and many other native riparian trees. The fastest way to get large numbers of woody plants established is to use stem cuttings and pole plantings of species that are known to root from dormant stems. All species of willow and cottonwood will readily root from dormant branches, twigs or poles planted in late winter. The butt of the stem must be planted deep enough to stay in contact with moist soil during the first year or two. Other woody plants that are known to root from dormant stems include buttonbush, sycamore, American elder and some species of baccharis.

For new plantings, protection from livestock and wildlife grazing or browsing is important and will often be the primary factor in success or failure. Damage by beaver or nutria can also be significant. Proper use of irrigation and weed control may also materially improve the success of re-vegetation projects, but will increase costs.

It is beyond the scope of this booklet to discuss artificial re-vegetation techniques in any detail. The use of mulches, hayseed, hydromulch, erosion control blankets, bioengineering, and other specialized techniques are often employed in large restoration projects (USDA 1996, Hoag and Fripp 2002). The use of experienced consultants, engineers and contractors will help maximize success and reduce the risk of failure in these projects.

General Riparian Management Guidelines

Riparian management practices and techniques are determined in large part by the surrounding land use. Land that is in agricultural production usually has different riparian issues than urban land or recreational land. Likewise, land that is used for timber production has different issues than land that is used for row crops or livestock grazing. Basic riparian management issues and guidelines are summarized below for major land uses in Texas.

Cropland

Approximately 27 million acres of Texas land is used for crop production. A large portion of the cropland in Texas is located in the High Plains where creeks and riparian areas are few and far between. However, cropland is scattered across all parts of Texas and much of it is located in proximity to creeks and rivers. The potential impacts of farming on adjacent riparian areas are numerous. Plowing and planting too close to creek and river banks is a serious problem that can cause significant riparian damage. The removal of deep-rooted perennial vegetation and the conversion to cropland will greatly accelerate the risk of severe erosion and bank failure. A common sense solution for this problem is the establishment of non-cropped permanent buffers composed of appropriate native deep-rooted vegetation between the edge of cropland fields and the banks.

The proper width of non-cropped buffers will vary from place to place. Larger creeks will need wider buffers than smaller creeks. The safest buffer would include the entire 100-year floodplain, which would ensure that very little cropland would be subject to flooding and erosion even in very large events. Another consideration is to leave a significant buffer along the edge of the high bank. These high banks are often unstable, especially on outside bends. Leaving a buffer of natural vegetation equal to three to five times the height of the vertical bank will help accommodate the development of vegetation as the bank erodes.

Another good practice is to plant a dense herbaceous buffer between the edge of the cropland field and the beginning of the slope that leads to the riparian areas. The purpose of this grass strip is not only to stabilize the soil, but also to help trap sediment coming off the cropland field and to reduce concentrated flow into the riparian area (Dillaha et al. 1989). The most commonly used grasses for this include switchgrass, Indiangrass and eastern gammagrass, although species will vary by region. Farmers should resist their inherent urge to manicure, mow or spray weeds in this buffer area after establishment.

A filter strip of dense perennial grass is needed at the edge of this cropland field to slow down runoff, trap sediment and reduce erosion. Switchgrass and Indiangrass are good choices for native grass filter strips in many locations. Photo courtesy of Ricky Linex, NRCS.

A riparian buffer established between cropland fields and the riparian area will reduce the movement of sediment, nutrients and pesticides into the creek. In this example, farming is taking place too close to the creek. Incentives are available to farmers to plan and establish buffers and filter strips. Photo courtesy of Ricky Linex, NRCS.

In addition to traditional commodity crops, cropland areas are also commonly used for grazing. Where crops or crop residue is grazed by livestock, there are other riparian considerations that must be addressed. Refer to the section on grazing management in this booklet.

Farming methods on upland fields can also have an impact on adjacent riparian areas. Farming practices that slow down the movement of water and reduce sediment and nutrient-laden runoff into the creek will help maintain the integrity of riparian areas (Dillaha et al. 1989). These practices include terraces, contour farming, cover crops, crop rotations using high residue crops, conservation tillage, residue management, contour buffer strips and filter strips. In addition, the proper application of pesticides and fertilizer will help reduce or eliminate the movement of potential contaminants into the creek.

Assistance in developing a system of conservation farming techniques suited to the individual needs and goals of the landowner can be obtained through local field offices of the Natural Resources Conservation Service.

Pastureland

Approximately 11 million acres of Texas land is classified as pastureland. Pastureland is defined as perennial grasses under intensive management grown for grazing and/or hay production. Pastureland almost always involves a monoculture of exotic grasses, but occasionally native grasses are utilized. Pastureland is not to be confused with rangeland (see next section), even though both are used for grazing. Common pastureland grasses in Texas include coastal bermudagrass and other hybrids, bahiagrass, various exotic bluestems, buffelgrass, kleingrass, and wilman lovegrass. Management of pastureland usually involves the regular application of fertilizer and the control of weeds and woody plants.

Pastureland is often established in the best and deepest soil on a farm or ranch and therefore is commonly located near creek, riparian and bottomland settings. The potential risk of having pastureland immediately adjacent to riparian areas is the danger of erosion and bank failure. Most pastureland grasses do not have the same stabilizing ability as native riparian plant communities. Riparian management in and near pastureland should include the use of native vegetation buffers adjacent to the creek. Routine weed and brush control should not be carried out in or immediately adjacent to the riparian area.

Another potential risk associated with pastureland is the presence of livestock concentrations in the creek area. In

Fencing of creek areas is often a practical way of managing livestock grazing in the riparian area. However, fences should normally be placed well away from the edge of the creek to create a wide buffer and give the creek room to meander. Photo courtesy of Ricky Linex, NRCS.

many cases, livestock will drink water from the adjacent creeks and seek shade in the riparian area. If livestock concentrations persist without adequate rest and recovery periods, the damage to riparian plant communities will be substantial and long term. In this case, management should include the development of alternate water supplies away from the riparian area. Water can be pumped with solar energy from the creek to troughs. Where livestock continue to loaf in the riparian area, fencing may have to be established to exclude or manage grazing animals. Pastureland used for hay production rather than grazed forage will eliminate potential grazing problems in nearby riparian areas. For additional information, refer to the section on grazing management in this booklet.

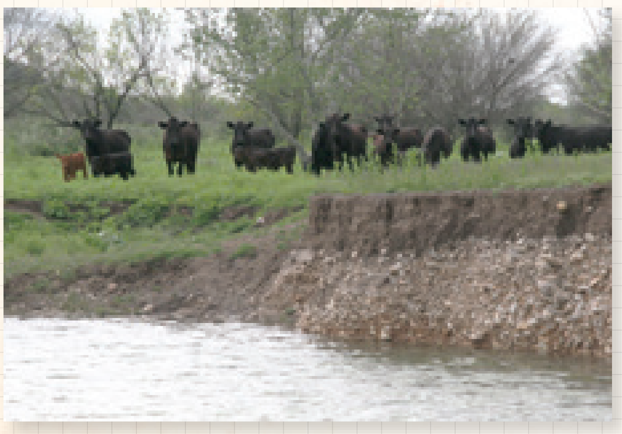
Rangeland

Approximately 97 million acres of Texas land is classified as rangeland. Rangeland is by far the most predominant type of land in Texas, comprising nearly 60% of the land area of Texas. Rangeland is defined as land that supports predominantly native vegetation and is normally managed extensively rather than intensively. Rangeland includes many types of land including grasslands, shrublands, deserts, savannas, woodlands, and some wetlands. Rangeland is commonly used for the production of grazing animals, but not all rangeland is grazed. Rangelands are also commonly used for the production of deer and exotic wild hoofstock.

The majority of creeks and rivers in Texas originate and run through rangelands. The importance of rangeland management on Texas riparian areas cannot be overemphasized.

Historically, since the late 1800s, rangeland has been the basis of the vast Texas livestock industry. In the early days, creeks and rivers provided the only watering locations for livestock and many riparian areas were very heavily grazed for decades. Even after the development of countless earthen ponds and the drilling of water wells to provide livestock water, creeks and rivers have continued to provide important sources of water on many ranches. In addition to water, riparian areas also provide large amounts of forage and shade for summertime temperature regulation.

Because of the presence of water, shade and forage, riparian areas are often subjected to unintentional concentrated and disproportional livestock grazing and loafing (Bryant 1982). Without intentional management, this tendency for livestock to congregate in riparian areas can have severe and detrimental effects on riparian vegetation (Clary 1987). In addition to impacts on the vegetation, livestock concentrations can cause accelerated bank failure and trails can create secondary erosion problems.



The majority of riparian areas in Texas run through rangeland, used for livestock production. When proper management is applied, ranchers can not only benefit from riparian forage but also maintain good riparian condition. Without good management, livestock will tend to concentrate in riparian areas, causing damage to riparian vegetation.

Livestock grazing affects many different kinds of riparian vegetation including grasses, sedges, forbs and woody plants. Many desirable riparian plants are also very good livestock forage plants. Careful management and preferential treatment of riparian areas is essential to maintain or restore functional riparian conditions on rangeland that is used for livestock grazing. Refer to the section on grazing management in this chapter for more information.

Forestland

Approximately 7.5 million acres of Texas is commercial forestland that lies exclusively in East Texas. Forestland is dominated by a dense canopy of trees including pine and/or various hardwood species. The distinction between wooded rangeland and forestland is not always easy to make. Some areas traditionally regarded as rangeland have a dense canopy of trees. This is especially true in the Cross Timbers and the Post Oak Savanna and is also true in many heavily wooded riparian corridors in the central part of the state. For the purpose of this booklet, forestland is restricted to the East Texas Timberlands and Pineywoods ecological regions.

Management of riparian area in forestland primarily involves timber harvest practices. The size of the equipment used in timber harvest and the intensity of disturbance involved in transporting logs can lead to extreme disruption of the soil surface and associated vegetation. Furthermore, the subsequent preparation of seedbeds to plant the next crop of trees adds even more disturbance. For these reasons, it has become standard practice for timber harvesting activities to include Streamside Management Zones or SMZ's. These SMZ's are similar in purpose to riparian buffers. The intent is to maintain undisturbed or lightly disturbed areas of native trees and shrubs adjacent to creeks and rivers (Palik 2000). Streamside Management Zones are often planned at least 50 feet away from the top of the bank but width should vary according to the size of the creek and the length of side slopes (Fallon 1998). When private landowners sell timber, it is recommended to have a written contract with stipulations to protect riparian areas, and to utilize the services of forestry professionals.

General guidelines for management within the SMZ often include:

- Minimize stream crossings
- Build no roads in the SMZ other than necessary crossings
- Use temporary bridgements to skid logs where possible
- Avoid traffic in wet weather to minimize rutting
- Keep skidders away from banks; do not skid logs across the creek channel
- Use cable and chokers to skid logs
- Limit harvest to individual high value trees

In addition to timber harvest considerations, cattle grazing also affects riparian areas in forestland. In this part of Texas, cattle often graze upland pastureland fields during the growing season and are allowed to graze the woods in winter. Refer to the section on grazing management in this booklet for more information.

Urban land

Land within urban settings or developing areas presents one of the greatest challenges to riparian management for several reasons. The land area that drains into urban creeks is often highly altered with a large proportion of impervious surface – a high runoff, water shedding landscape. These impervious surfaces create rapid and high volume runoff even with small rainfall events. The greater volume of runoff entering tributaries and creeks can wreak havoc on channels, causing abnormal and severe erosion, bank failure, down cutting and other problems.

Most creeks in urban areas have been altered in one way or another. Removal or alteration of natural riparian vegetation is common. The increased runoff in urban areas combined with riparian alteration creates a greater risk of erosion during high flow events. Retaining or restoring a buffer of natural vegetation will help maintain a degree of riparian function. Photo courtesy of Ricky Linex, NRCS.

In addition to the "flashy" nature of urban creeks, urban development often encroaches into the floodplain, restricting the ability of the creek to naturally meander. Encroachment of development into the floodplain results in the alteration of floodplain topography and vegetation (NRC 2002). The net result of these alterations is a reduced capacity for the floodplain to function as it should.

During the construction phase of development, abnormal amounts of sediment as well as runoff may enter creeks. The use of temporary sediment fences may reduce the delivery of sediment to the creek, but fail to control sediment adequately during large runoff events.

After construction is complete and pavement is installed, sediment load is often decreased while runoff is greatly increased. This combination leads to severe erosion of banks and/or the bottom of the channel, since the "hungry water" free of sediment has greater energy with which to cause erosion.

In an effort to deal with erosion and increased discharge, cities often resort to alterations of the stream channel and floodplain. Where erosion is severe, hard or soft engineering solutions are often implemented. Vegetation and large wood is often removed to allow floodwaters to move through the channel faster in an effort to reduce the magnitude of flooding. However, by removing the roughness from the stream or riparian area, the energy of floodwater is increased, causing an increase in bank and channel erosion. Furthermore, when floodwater is moved more rapidly through urban areas, it exacerbates flooding problems farther downstream.

Extreme disruptions of channels, banks, sediments and vegetation make the creek and riparian area vulnerable to severe damage during high flow events. Photo courtesy of Ricky Linex, NRCS.

Municipalities or subdivisions that desire to minimize damage to creeks and help maintain semi-functional riparian conditions can plan developments to retard runoff and retain wide, well vegetated riparian areas. The reduction of impervious surfaces, rainwater harvesting, detention storage for storm water, rain gardens, greenbelts and other practices can help maintain some natural riparian function. City engineering departments should be taught about the basic processes of riparian function and especially the role of vegetation and large wood in creeks and riparian areas.

Recreational Land

Land that is intensively used for recreational purposes is also vulnerable to riparian degradation (Weaver and Dale 1978). Creek and river areas subject to heavy recreational use can be some of the most abused and degraded riparian areas in the state. Continual long-term human foot traffic often reduces dense riparian vegetation and creates compacted bare ground (Manning 1979).

Public and private parks and recreation areas used for hiking, biking, swimming, camping, fishing, birding, and horseback riding can be degraded by sustained use, but those impacts can be minimized by management (Cole 2000).

The following management practices can be used in recreation areas to reduce negative impacts:

- Eliminate or restrict vehicle traffic in riparian areas
- Trails should not be aggressively de-vegetated
- Trails should not be immediately adjacent or parallel to creeks
- Meander trails back and forth across floodplain
- Main trails should be on higher ground with periodic access trails down to the stream
- Periodic access trails should be located on inside bends with less stream energy
- Separate heavy use areas with buffers of thick natural vegetation
- Choose less vulnerable areas for heavy use such as inside bends
- Rotate heavy use areas to allow for periods of recovery
- Limit mowing and increase the interval between mowing to encourage vegetation
- Rotate mowed areas to help manage human activity
- Rotate heavy use access points to allow adequate time for vegetation to recover
- Do not remove large logs and dead fallen trees in creek or along banks or in floodplain
- Provide educational material to describe the reasons why these practices are carried out

Restricting access to small mowed areas will help maintain good vegetation in heavily used recreational areas. Pictured here is Devils River State Natural Area, managed by Texas Parks and Wildlife Department.

Unrestricted access by too many recreational users will keep a riparian area in poor condition. Managing access spatially or seasonally will allow rested areas to develop improved vegetation. In this example, heavy recreational use (fishing) is combined with unrestricted grazing.

Riparian Management Issues

Fragmentation in Riparian Areas

Larger, ecologically intact properties under sustainable management for multiple generations act as keystones for sustaining intact watersheds and functional riparian areas. The recent trend toward dividing large tracts of rural land into smaller and smaller tracts is a significant conservation issue in Texas and is especially critical for riparian areas. The progressive selling and subdividing of large tracts into small units often places increased human, livestock and infrastructure pressure on natural resources. As land and riparian areas become more divided, it creates much greater challenges for sustainable management and for maintaining ecological function.

Reducing the rate of land and riparian fragmentation through conservation easements is an effective way of addressing this problem. Conservation easements, developed with the assistance of private land trust organizations, provide incentives and guarantees to keep larger land units intact. Conservation easements are customized to meet the needs and desires of individual landowners, but they all have provisions to restrict future subdivision and development of the property. Conservation easements are not a transfer of ownership, nor a grant of public access. When a landowner chooses to establish a conservation easement with a land trust, he maintains ownership and the ability to continue using the property as he has in the past including farming, ranching, hunting and recreational activity. A conservation easement simply restricts future development regardless of who owns the land in the years ahead. Conservation easements include land management plans outlining land and riparian management practices mutually agreed upon by the landowner and the land trust.

Grazing Management in Riparian Areas

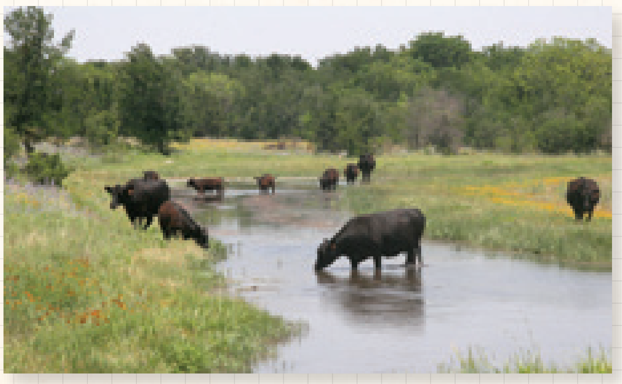
Livestock grazing has been the most widespread and predominant use of land in Texas since the 1880s and has affected almost all creeks and rivers in the state. During the early years of the Texas livestock industry, stockmen had little understanding of or interest in sustainable grazing management. In recent years, many ranchers have taken a much deeper interest in proper grazing management, including riparian management. More riparian areas can be positively (or negatively) affected by grazing management than by any other single land-use practice.

The impact of grazing on riparian vegetation can be understood by this simple fact – one full-grown cow will consume approximately 10,000 pounds of vegetation each year on a dry weight basis. Even a few cows can have a significant effect on vegetation if they stay in comparatively small riparian areas for a long time. The key to sustainable grazing in riparian areas is the timing, duration and frequency of grazing and the length of recovery between grazing periods (Mosley et al. 1997).

Grazing can affect the following functional attributes of riparian areas: energy dissipation, root mass and root stability, bank and channel stability, sediment trapping, colonization of new sediments, plant diversity, plant recruitment and plant vigor. Proper riparian grazing management will favor these elements and improper management will inhibit them (Elmore 1992).

Because of the natural attraction of cattle to creeks, these areas require extra care and attention to ensure they are grazed properly and receive periods of rest after being grazed. One of the most common and successful forms of riparian grazing management is to establish separate riparian pastures. This often requires substantial fencing to separate the creek areas from the rest of the pasture. Ranchers who choose this option are usually careful to create creek pastures that are large enough to be manageable, not simply a long skinny pasture. Often the rancher will set the fence 100 or 200 yards from the edge of the creek. When this is done, the riparian area becomes much easier to manage. The rancher determines when, how many, and for how long the creek pasture should be grazed and uses the pasture as part of a flexible grazing rotation (Clary and Webster 1990).

It is better to graze riparian pastures with a larger number of cattle for a shorter period of time, rather than a small number of cattle for a long period of time. This approach is sometimes called flash grazing. But this does not mean the riparian areas are grazed short. By managing the number of days of grazing, the manager can ensure the desired level of grazing is achieved. Good residual cover should remain even at the end of the graze period. By controlling the length of the rest period, the rancher can be assured that adequate time is given for re-growth. One or two short grazing periods per year with a long rest in between will generally allow for good development of riparian vegetation and a strong, deep root system. Financial incentives are available to landowners who wish to construct riparian pastures to help defray the cost of fencing.



Cattle will naturally congregate in riparian areas in search of forage, water and thermal regulation. Grazing managers have found ways to overcome this disproportional grazing. Short term seasonal grazing followed by a long recovery period is one way to ensure that riparian vegetation stays in good condition.

One of the most potentially damaging times to graze a creek area is when the banks are saturated. Saturated banks are weaker and more prone to sloughing and trampling damage by livestock. The least damaging time to graze creek areas is during the dormant season as long as good stubble remains intact. Grazing during early or mid-spring must be carefully managed since key riparian grasses, sedges and woody plants are making a flush of new tender growth and are more vulnerable.

For those managers unable to establish separate riparian pastures, there are other ways to help overcome disproportional grazing in the creek area (Skovlin 1984). Providing alternate water locations away from the creek often helps lure cattle out of the creek. Studies have shown that cattle generally prefer to drink from troughs on level ground compared to walking down steep banks. Cattle will often choose to drink out of troughs even when they have access to creek water. This may or may not be enough of an enticement to eliminate concentrated grazing of the creek area, but it will usually help.

Another way to reduce the time that cattle spend near the creek is to move all mineral, salt, hay, tubs and supplemental feeding one-half mile away from the creek, or to the far side of the pasture. When feeding areas and water locations are moved away from the creek, cattle will spend less time grazing and loafing in the riparian area and the vegetation and banks will stay in better condition (Leonard 1997).

For creeks that have been severely damaged by decades of unmanaged grazing, a good solution may be to temporarily suspend grazing for several years to jump-start the recovery of desirable vegetation (Elmore and Kauffman 1994). This method of riparian management is being used on many Texas ranches with excellent results. Landowners and managers seem gratified with the speed and degree of recovery and improvement. The goal is not permanent removal of livestock; as the vegetation recovers and the condition of the riparian area improves, livestock grazing is often resumed using the principles described above.

In some cases, ranchers have preferred to permanently remove livestock from riparian areas. This is especially true where the creek or river forms the boundary of the property and there is no practical way to keep livestock from wandering away or to keep neighboring cattle out.

Excessive grazing in the riparian areas has removed the cover of riparian vegetation needed to dissipate energy, protect banks and trap sediment. A change in grazing management can, with time, restore good vegetation.

Some livestock ranchers have chosen to temporarily suspend grazing in riparian areas to allow the vegetation time to fully develop.

Management of Native and Exotic Wildlife

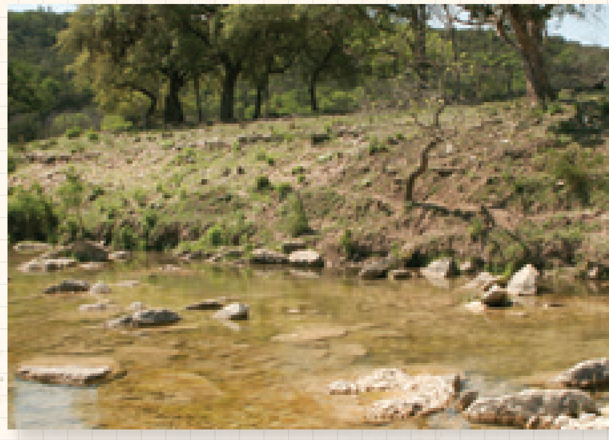
Parts of Texas support large numbers of native deer and/or large numbers of exotic hoofstock. Where deer and exotic numbers are not properly managed, they can cause significant damage to riparian vegetation. When their numbers are kept in balance, riparian condition can be maintained.

White-tailed deer, which are abundant in many parts of Texas, consume primarily browse and forbs. Their primary effect on riparian areas is the browsing of riparian shrubs and trees, especially seedlings and small plants. Excessive populations of deer can essentially eliminate the reproduction and recruitment of key riparian shrubs. Deer also graze several species of important riparian forbs, including water willow, goldenrod, watercress, water hyssop, and water primrose. Fortunately, white-tailed deer do not readily consume grasses or sedges and therefore have little effect on this important class of riparian vegetation. Deer densities in riparian areas are often five to ten times higher than adjacent upland areas. During drought, the disparity is much greater as deer populations shift toward the riparian areas in search of forage and water. Monitoring of browsing on woody plants is an important aspect of riparian management. Managers can learn to recognize the visual signs of hedging and the development of browse lines, using this information to help guide deer herd management.

Axis deer are the most common and most troublesome species of exotic deer because they naturally congregate in riparian areas. It is common to see groups of 20 to 50 or more axis deer traveling up and down riparian areas in central Texas. Axis deer consume all classes of riparian vegetation including grasses, sedges, forbs and woody plants. For this reason, they can cause extreme overgrazing and overbrowsing of riparian areas. The damage caused by excessive numbers of axis deer is severe on many miles of Edwards Plateau creeks and rivers. Options for the management of exotic deer include aggressive hunting and trapping or the construction of high fences to exclude them from riparian areas. Axis deer and other exotics are not regulated game species and may be legally hunted any time of the year.

Other common species of exotic deer include fallow deer, sika deer, red deer and elk. Several less common species of deer can also be found. Many species of exotic antelope and sheep are also found in Texas but they have not generally caused widespread damage to riparian areas.

Feral hogs are widespread in Texas and their numbers and range are increasing. The primary riparian damage caused by feral hogs is physical damage by their destructive rooting habits. Hog wallows can cause extensive damage to banks, seeps, springs, and wet areas. Sediments disturbed by hog rooting and wallowing are easily eroded away, often causing further erosion. The best time for riparian managers to begin hog control efforts is when the first hog is observed. Relentless and perpetual trapping, shooting, and other control methods will be needed to reduce hog numbers in some areas and reduce riparian damage.

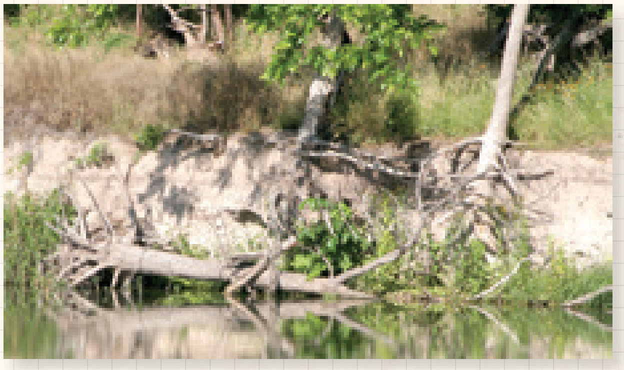


In this example, a combination of poorly managed grazing and excessive populations of axis deer has degraded the riparian area. Management of grazing and control of exotic deer must be done simultaneously in order for the area to recover.

Extreme browsing of important riparian shrubs by exotic and native deer harms plant vigor and eliminates successful reproduction of shrubs. Keeping deer numbers in balance is a key issue for riparian health in some locations.

Retaining Large Wood

In recent decades, one of the most relevant riparian discoveries is the importance of large wood for the proper function of many creek and river systems (Magilligan et al. 2008; NRC 2002). Large wood refers to logs and dead trees that fall or wash into the channel, banks or floodplain. Some washed out trees may float long distances before they are caught on point bars or other channel obstructions. Other trees become trapped near where they fall, especially if there are living trees or shrubs to help hold them in place. The attached root wad often helps anchor large wood in place initially until it can become incorporated into the sediment. When these large trees become lodged and locked into place, they begin to provide many important and diverse functional benefits to the riparian area.



Trees falling into creeks and rivers is a natural and beneficial process. The wood helps dissipate energy and trap sediment. Eventually much of the wood becomes buried in the sediment where it becomes a structural component of the channel.

Large wood provides effective energy dissipation during high flow events and begins to trap sediment, much like a retaining wall. Eventually, many logs become partially or completely buried in sediment, where they become structural components of the channel (Sedell and Luchessa 1982). The presence of large wood buried in the channel is likened to rebar that strengthens and reinforces concrete. Research across the United States and in other countries has shown that buried wood remains intact for hundreds and even thousands of years.

Large sunken wood has been routinely removed from many creeks and rivers across North America for the past 200 years for economic and navigation purposes. Many riparian systems have been damaged by the removal of wood and the natural restoration of suitable amounts of wood will be a very long and slow process.

Large fallen trees and logs that become lodged on the floodplain provide energy dissipation, which promotes the trapping of sediment. In most cases, wood should be left in place in channels, banks and floodplain. Photo courtesy of Ricky Linex, NRCS.

Many Texas landowners and some riparian managers still remove logs and fallen dead trees in the misguided belief that creeks needs to be cleaned out. This is usually done with good intentions but without understanding the inevitable side effects. By removing or burning the wood, they are also speeding up the flow of floodwater, which increases erosion, damages banks and undermines channel stability. By leaving large wood in place, landowners and managers help dissipate energy, slow down the water, reduce erosion, trap sediment and build bank stability.

There are some cases where large wood should be managed when it presents a safety hazard to bridges or other infrastructure. However, in the vast majority of cases, large wood should be left in place, recognizing the necessary benefits it provides. Riparian landowners can learn to appreciate the natural value of wood even though some consider it unsightly.

Management of Exotic Riparian Plants

Exotic plant species often find their way into riparian areas. This is especially true in urban riparian areas and downstream from urban development. Many of the exotic species now commonly found in riparian areas originate in residential landscapes. Not all exotic species found in the riparian zone are problematic. Problems can develop when plants aggressively reproduce, monopolizing at the expense of native species. Some of the common exotic plant species that are causing problems along Texas rivers and creeks are listed in Table 2.

Control or management of aggressive exotic plants may be warranted where the species is known to rapidly reproduce and displace native riparian vegetation (NRC 2002). The challenge is to find control methods that are selective and specific to the target species without harming nearby native plants. This kind of work is tedious, laborious, expensive and slow. Often, the most feasible approach is the individual treatment of plants with bark-applied or foliar applied herbicides that are labeled for that purpose. You will often have to treat an area several times to achieve adequate levels of control. Localized control efforts by individual landowners can be very frustrating when upstream control efforts are lacking. When upstream seed sources are not addressed, recurring problems can be anticipated. This reinforces the importance of cooperative riparian management by many adjoining landowners.

Where isolated and scattered patches of exotic plants are found and when future problems are anticipated, it is

TABLE 2.

SOME COMMON EXOTIC PLANTS FOUND IN RIPARIAN AREAS THAT HAVE INVASIVE CHARACTERISTICS

- Wax leaf ligustrum
- Chinese privet
- Chinese tallow tree
- Salt cedar
- Russian olive
- Chinaberry
- Giant cane
- Japanese honeysuckle
- Elephant ear
- Lilac chaste tree
- Water hyacinth

Giant cane *Arundo donax* is one of the common exotic invasive plant species causing problems in riparian areas. It spreads aggressively by enlargement of clumps and can completely dominate banks and floodplains. Control efforts should ideally begin when plants are scattered and small.

strongly advised to begin control efforts early rather than wait for populations to expand and increase in density. Regular scouting of riparian areas for early detection of problematic plants is an important aspect of riparian management. Riparian managers should be able to identify the exotic plant species that are found in their region and seek assistance on effective control methods.

Extensive control of dense stands of exotics can backfire with unintended consequences if not carefully planned and executed. In some cases, exotic plants may be the only vegetation holding banks together. If removed all at once, the banks and floodplain become extremely vulnerable to damage. One of the first cardinal rules in riparian management is "first, do no harm." A bank protected by unwanted exotic species is better than a n unstable, eroding bank. For example, some riparian areas in west Texas are totally dominated by salt cedar, which is doing a good job of stabilizing banks and channel. If the salt cedar is killed all at once, the bank becomes vulnerable to severe erosion during high flow events. Similar examples have been observed with wax leaf ligustrum and giant cane *(Arundo donax).*

Where dense monocultures of exotic plants exist, managers are urged to take a progressive, incremental approach rather than an aggressive or extensive approach. Control can begin in small pockets, not large areas. Control pockets will be surrounded by intact exotic vegetation. Monitoring the natural regeneration of native plants into these pockets is an important part of exotic plant control projects. If desirable native plants begin to establish in the pockets, continue control efforts with additional pockets. As native plants begin to grow and provide needed stability, the size of control pockets can be enlarged. This approach helps retain root stability and energy dissipation and reduces the vulnerability of the control project to severe erosion. The gradual increase in the size and number of control areas can occur until the exotics are removed and replaced by natives. Several years of follow-up control and maintenance will be needed in most cases to kill new seedlings, root sprouts or plants previously missed. If natural regeneration of desirable native riparian plants does not take place, managers will need to plan for the artificial re-planting of desired vegetation.

Some non-native plants can add functional value to the riparian area and should not automatically be viewed as detrimental; see Table 3. Some exotic plant species fill a similar niche as native plant species without dominating the riparian area or displacing native species. Although native riparian plants are almost always preferred, it is neither realistic nor economically feasible to attempt to control all infestations of exotic plants.

TABLE 3.

SOME COMMON EXOTIC PLANTS FOUND IN RIPARIAN AREAS THAT CONTRIBUTE FUNCTIONAL BENEFITS AND ARE NOT GENERALLY CONSIDERED INVASIVE

- Watercress
- Wild mint
- Bermudagrass
- St. Augustine grass
- Vasey grass
- Dallis grass
- Tall fescue
- Rabbits foot grass

Riparian Management Downstream of Large Reservoirs

Riparian areas that are located downstream from major reservoirs often present special challenges for management. Due to the nature of reservoir management and releases from the floodgates, problems often occur which are out of the control of downstream landowners (NRC 2002). The common situation across the western half of Texas is little or no release below dams for months or even years at a time. All normal inflow is detained in the reservoir and natural bank full or out of bank flow rarely occurs. As a result, the alluvial water tables may no longer be recharged. As the water table is lost or greatly reduced, riparian wetland vegetation cannot survive and vegetation may slowly change to non-riparian species. The effect of the dam may be a major long-term shift from riparian to upland conditions, even in close proximity to the channel. If and when abnormally large rainfall is received and reservoirs fill, large releases are made, but without intact riparian vegetation, the large sudden releases typically result in severe downstream erosion.

For the wetter part of Texas, where constant releases usually take place below dams, the problems are very different. In these situations, an artificial base flow exists most of the time. Larger flows may take place periodically to keep reservoir levels at the desired stage. When large rain events occur above the reservoir and lake levels rise, reservoir managers dump huge volumes of water out of the floodgates or spillways. It is common for these large releases to persist for days or weeks. In some ways, these flows mimic large natural flood events, but usually last much longer than natural flood flows. When lake levels have been reduced to the desired stage, reservoir managers close the gates and water levels drop immediately. Saturated banks, which have been underwater for extended periods then are suddenly exposed, can show severe bank sloughing.

Riparian areas downstream from reservoirs are sometimes heavily impacted due to the way that water is released. As reservoir managers seek to mimic how natural flood flows rise and decline, these impacts can be minimized. Photo courtesy of Ricky Linex, NRCS.

Another important problem exists for releases below reservoirs. Reservoirs trap upstream sediment and water released from reservoirs lacks sediment. This lack of sediment creates what is known as "hungry water," which is more erosive than water with a normal sediment load.

Downstream landowners can do everything right with their riparian management and still have severe problems. The retention of dense natural riparian vegetation and large wood will help minimize the damage that is often caused by sudden and prolonged releases followed by rapid drawdown. A desirable solution would be to work with reservoir managers to manage these releases to more closely approximate the frequency, intensity and recession of natural flows.

Engineered Solutions

In some deteriorated creek and river areas, the damage has been so severe that intensive engineering solutions are sought to help restore desired conditions. These fixes are extremely expensive. In most cases, the only ones that can afford such costly solutions are government entities. Very few private landowners are able to justify the expense. These intensive restoration projects require specially trained engineers who have expertise and experience in hydrology, fluvial geomorphology, stream processes, vegetation, permitting and working with large equipment operators. There are relatively few engineers in Texas who currently have this kind of experience. Civil engineers who do not have the necessary specialized training are more likely to recommend hard engineering practices, such as concrete, riprap, gabions, grade control structures and other traditional solutions (Keown 1983).

Experienced riparian and stream restoration engineers learn to work with the natural dynamics of the creek rather than force rigid structures into a dynamic system (Elmore and Beschta 1989). They try to re-establish normal channel dimensions, sinuosity, slope, velocity, and sediment transport, paying special attention to the critical role of the floodplain and stabilizing vegetation. The use of cross-vanes, J-hook vanes or other similar structures composed of large boulders and/or logs helps direct high flow energies to the center of the channel rather than the banks. These kinds of structures, although artificial, augment the natural process of restoring stream equilibrium and help banks to establish appropriate vegetation. With time and the development of vegetation, many of these structures blend in and are hardly noticeable.

Riparian Assessment and Monitoring

The effectiveness of riparian management can be evaluated by conducting formal or informal assessments and periodic monitoring (Myers 1989). Assessments provide a snapshot of riparian conditions at a point in time. Monitoring involves periodic tracking to determine what changes if any are taking place over time and if those changes are in line with desired goals and objectives. By keeping track of riparian conditions and trends, the manager will be more aware of what kinds of management may be needed (Collins 1992, Platts 1987).

Cursory Riparian Assessment

Formal riparian assessments are desirable but are not always feasible or necessary. Cursory assessment of riparian areas can be useful and will vary in detail according to the level of experience of the manager.

Cursory assessment of riparian areas is an alternative to formal assessment methods. In a cursory assessment, managers may make written notes of plant coverage, plant diversity, plant vigor, and reproduction of key species, or other riparian attributes.

A cursory assessment of a specific creek or river segment can include observations and notes on any combination of the functional attributes listed below. As with any kind of riparian assessment, photographs keyed to a date and location and with explanatory notes are of great value.

- Apparent stability of banks and channel
- Extent of active erosion
- Floodplain adequacy and functionality
- Presence of riparian-wetland plants expected for the site
- Reproduction and vigor of riparian plants
- Adequacy of riparian vegetation to dissipate energy
- Presence of large wood and other energy dissipating features
- Presence of excessive sediment deposits

Formal Riparian Assessment

Formal riparian assessment methods are useful if managers have the right training or have access to those with proper experience or expertise. These formal methods have not been widely used in Texas due to the relatively recent interest in riparian issues.

A popular riparian assessment method widely used in New Mexico, Arizona and many other western states is known as Proper Functioning Condition, or the PFC method (Prichard 1998). This method uses a qualitative Yes or No checklist with 17 visual indicators of hydrology, vegetation, and erosion-deposition. This method requires an interdisciplinary team with experience in the region. Several Texas riparian professionals have received considerable training and experience with this technique and have found it to be useful for assessing Texas riparian areas. The PFC method focuses on functional attributes and the physical processes of energy dissipation, channel stability, sediment trapping, floodplain development, and water storage. With this method, the reach being evaluated is placed in one of three categories based on the preponderance of visual evidence. These categories are: Proper Functioning Condition, Functional At-Risk, or Non-functional.

A variation of the PFC method was developed for use in central and southwest Texas riparian areas. It is called the Riparian Function Worksheet and is found in *Your Remarkable Riparian*, a field guide to riparian plants within the Nueces River Basin of Texas, published by the Nueces River Authority.

Another assessment method that has been used to a limited extent in Texas is the Stream Visual Assessment Protocol, or SVAP, developed by the Natural Resources Conservation Service (NRCS 1998). This method combines the evaluation of aquatic habitat features with some functional attributes of riparian areas. The SVAP method utilizes a numerical score for each evaluation element and combines the scores for a final numerical rating of condition. This nationwide method is designed to be modified for use in different regions and states. This method does not require the same level of training as PFC, nor does it require an interdisciplinary team.

Another riparian assessment technique that can be used on rangeland is found in *A Texas Field Guide to Evaluating Rangeland Stream and Riparian Health,* developed by Texas A&M AgriLife Extension Service. This technique combines functional attributes with aquatic habitat attributes in a matrix format and is adapted from the SVAP and other methods. Some County Extension Agents have been trained in this method.

There are numerous other formal riparian assessment and evaluation techniques that have been developed in other states and regions (Stacy 2006). Most share some similarity to PFC and/or SVAP. With any evaluation technique, the most important information gained is not the numerical score or the final rating, but rather the notes written by the observers. No evaluation method is complete or useful unless the observers have taken the time to carefully write notes to describe what is seen and to provide the basis for rating each evaluation element. Photographs would add even greater value to any evaluation effort.

Photo Point Monitoring

Monitoring of riparian areas is best carried out systematically and regularly to help keep the manager or landowner apprised of changes and trends. Monitoring can be quantitative, descriptive or visual. One of the most effective means of keeping track of riparian change is by annual fixed-point photos. A series of photos of the same location taken from the same place over a period of several years is one of the best ways to document what is happening in riparian areas. If only one monitoring tool

12/2/2007. Photo point monitoring was began on this private ranch on the Nueces River in 2007. Floodplain is clearly lacking adequate vegetation.

7/14/2009. Two years later (during drought conditions) sycamore and baccharis have established naturally, starting the recovery process.

9/10/2011. In the worst one-year drought on record, the Nueces River is dry, but the water table sustains the growth of riparian vegetation.

7/10/2013. In the sixth year of photo point monitoring, the rapid rate of recovery is apparent with dense vegetation providing energy dissipation, sediment trapping, narrowing of channel and improved sediment transport.

is used, photo points are often the most useful, as well as inexpensive and easy. It is important to have a point of reference in each photo such as a large boulder, a peak in the background, or other feature that can be used to frame the photo each time. Riparian areas in heavily wooded locations do not usually lend themselves as well to photo points.

Formal Riparian Monitoring

Most private landowners do not have the resources or the need to implement formal riparian monitoring. Formal monitoring methods are sometimes required on public land or as a part of long-term research projects. Formal monitoring involves measurements and the collection of data, and may include monitoring of riparian vegetation, flow, channel characteristics, or floodplain features (Winward 2000, Rosgen 1996). It is beyond the scope and purpose of this booklet to describe formal riparian monitoring methods, but the information is readily available to those who are interested.

Informal Riparian Monitoring

Informal monitoring may involve the keeping of dated notes in a riparian journal with periodic regular visits to describe observations and changes. The use of random photos or photo points enhances the value of informal monitoring. Examples of this kind of monitoring are found in Table 4.

Informal riparian monitoring involves repeat observations or measurements over time to determine changes and trends. Making notes of plant density, especially new seedlings, with written accounts or photographs is one example of informal monitoring.

TABLE 4.
EXAMPLE OF INFORMAL MONITORING OBSERVATIONS AND NOTES

June 2005	Large number of new bushy bluestem plants noted on low bank side
	Young willow plants heavily browsed
	Spikerush and water hyssop beginning to grow on new sediment
Sept 2005	Cattle grazed in lower creek area for past 45 days; heavy use on Emory sedge
	Light grazing noted on switchgrass and bushy bluestem
July 2006	Noticed 3 chinaberry trees at upper end and many seedlings
May 2007	Big rains; out of bank flows for two days
	New sediment deposited below second bend; 1–3 inches deep
	1-2 feet of bank lost on first outside bend
	Large elm tree washed out and lodged in creek
	2nd crossing washed out
Aug 2007	Several small walnut seedlings and many young baccharis noted on large gravel bar
	Knotgrass expanding rapidly by runners in fresh sediment
March 2008	Feral hogs observed; large new wallow near spring
Sept 2009	Walnut and baccharis noted in Aug 2007 now 3–5 ft tall and healthy
April 2010	Large pecan struck by lightning; split in half; top fell in creek
June 2011	8 mo. into drought; no flow above ground
	Large willow losing leaves
	Deer concentrating in creek bottom; eating water willow very short
Oct 2011	Several large willow dead; drought persists
May 2012	Good spring rains; creek began to flow again

High Flows are Essential

It seems almost intuitive that creeks and rivers should be allowed to flow and this truth is an important component of riparian management. Maintaining base flow is obviously important for the integrity of perennial creeks and rivers. When natural base flow is robbed by excessive withdrawals, creeks and rivers become little more than drainage ditches. In addition to normal base flow, creeks and rivers must also experience periodic high flow events of varying size and duration. These flows range from smaller pulse flows to channel filling flows to larger out-of-bank flows that spill on to the floodplain. Flooding is not something bad that happens to a river — it is an essential process of the river. The functional and ecological integrity of creeks and rivers can only be sustained when these flows are maintained (NRC 2002, Poff et al. 1997).

Some may argue that these necessary flows are not something that can be managed by people; that they are entirely dependent upon rainfall and weather patterns. But as the population of Texas has grown and as our demands for surface water have increased, most rivers and many creeks are now heavily impacted by dams and other withdrawals that interrupt these flows. In too many cases, flows are greatly diminished if not essentially eliminated for significant reaches of creeks and rivers. One primary key of riparian management in Texas is that creeks and rivers be specifically managed to allow them to flow, and that these flows mimic natural flow regimes to the extent possible. Without these managed flows, many other aspects of riparian management are irrelevant.

Large frequent pulse flows and bank filling flows are essential to maintain the integrity and proper function of creeks and rivers. As withdrawals and altered flows become more frequent, the intentional provision of high flows will become an important part of riparian management.

Larger out-of-bank flows that spill into the floodplain are critical for trapping sediment, storing water and providing ground water recharge. Without larger flows, even on over-allocated rivers, their functions and values will be impaired and diminished.

Conclusion and Summary

Riparian areas are special places. They are special for many reasons. They are special because they provide the 190,000 miles of connections through which the waters of Texas flow. They are special because they connect people, they connect nature and they connect people with nature. They are special because they help cleanse the waters, sustain the flows and recharge the aquifers. Creeks, rivers, and the surrounding bottomlands are special to our soul and spirit just as they are special to our mind and body. We depend on creeks, rivers and riparian areas—for sustenance, for renewal, for reflection. Each bend, each pool, each riffle, each sunken log, each sandbar, each backwater slough, each cut-bank, each boulder, each tree, each clump of grass, are parts of the whole, just like the parts of the body. They work together. The more we understand these inner workings, the better we can apply the specific management needed to sustain them.

Functional, balanced creeks, rivers and riparian areas are perpetually self-renewing natural resources providing tangible benefits to people and sustaining nature. Riparian areas are special places; they need preferential treatment and managment.

A functional, balanced riparian area is perpetually self-sustaining. As a renewable resource, riparian areas provide tangible assets to people and contribute to the bounty of nature. If we use and manage the resource wisely, it will continually perpetuate itself and we will perpetually benefit. It only requires that humans do not interfere too much. The key to managing riparian areas is first to understand how they work. Then we must understand how we can make beneficial use of them without upsetting the balance.

Because they are special places, riparian areas need preferential treatment and special management. With a genuine land stewardship ethic, a creative mind, and a basic understanding of how the creek works, the riparian manager will discover the right combinations of techniques and practices to maintain or restore riparian areas for now and for future generations. The material in this booklet is meant to be a catalyst for this.

Author's note: The following poem by Dan Caudle is a fitting way to conclude this booklet. The poem provides a thought-provoking commentary on our management and use of Texas rivers.

Liquid History

by Dan Caudle

Texas rivers are our liquid history –
Chronicles of the past,
Barometers of the present,
Prophets of the future.

Thousands of insignificant tributaries
Contribute their relatively minor aqueous deposits
Into rills, which become rivulets, then creeks
That finally feed into larger watercourses to become rivers –
Major arteries conveying the essential element of life across the land
As they wind their way toward the Gulf.

From the dawn of time rivers have been the focal point for settlement –
The location of cities and towns, the preferred sites for factories and commerce.
They have long been the basis for land ownership, boundary disputes, wars, and lawsuits
Between people, states, and nations, each seeking control of the water
To use for their own purposes and to gain advantage over others.

Our waters have been governed by the laws of six different nations.
They have seen once dominant civilizations and governments disappear entirely
They have witnessed the overnight establishment of bustling communities
Only to see them vanish almost as suddenly as they appeared.
They were the lifeblood of remote frontier outposts
Which have now become densely populated metropolitan cities.

For eons they weaved their way through the countryside
Unencumbered as they charted their own course.
They conformed only to the topography of the land
And yielded only to the laws of nature.

They ran wild and free – sometimes as raging torrents
That might cut a new channel
Leaving an oxbow vestige of the old watercourse.
Other times they just meandered
Lazily and aimlessly across the landscape.

Today the rivers have been subdued and tamed.
No longer are they unconfined and natural.
Now they are controlled and manipulated
To fit the needs and wishes of modern civilization.
Some rarely flow and consist mostly of occasional pools of water.
They run only when torrential downpours occur.
Then they become a thick, soupy, reddish brown mix of water, debris, and soil,
As they churn and stir and overflow their banks,
Destroying lives and structures that encroached into the floodplain.

Conclusion and Summary

Many of the rivers have been altered - straightened, narrowed, deepened -
By engineers, bulldozers, draglines, government planners - all with good intentions.
They have been restricted by artificial barriers,
Civilized by dams, weirs, locks, berms, and levees,
To control their flow and their route.

Rivers and streams are harnessed and contained in earthen reservoirs
To supply the voracious demands of urban landscapes - lush lawns and golf courses,
Water parks and swimming pools, industries, and thirsty city dwellers.
They say there is a desperate need to construct more dams and reservoirs for the future!
More dams to further diminish the rivers and creeks?

Our legacy will not only be recorded in journals,
It is there in the water for all to see.
The handwriting is not on the wall
Or in the pages of a book.
It is in the river.

Texas rivers are our liquid history -
Chronicles of the past,
Barometers of the present,
Prophets of the future.

Literature Citations

Adler, R.W. 1995. Addressing barriers to watershed protection. Environmental Law 2(4):973-1106.

Balch, P. Date unknown. Kansas River and stream corridor management guide.

Bryant, L.D. 1982. Response of livestock to riparian zone exclusion. J. Range Mgmt. 35: 780-785.

Clary, W.P. 1987. Livestock effects on riparian vegetation and adjoining streambank. U.S. Dept. of Agriculture, Forest Service. Boise, ID.

Clary, W.P., Webster, B.F. 1990. Riparian grazing guidelines for the intermountain region. Rangelands 12: 209-211.

Cole, D. 2000. Dispersed recreation. Gen. Tech. Rep. SRS-39. Asheville, NC: U.S. Dept. of Agriculture, F orest Service.

Collins, T.M. 1992. Integrated riparian evaluation guide. Ogden, UT: U.S. Dept. of Agriculture, Forest Service.

Dillaha, T.A., Reneaux, R.B., Mostaghimi, S., Lee, D. 1989. Vegetative filter strips for agricultural nonpoint source pollution control. Transactions ASAE. 32:513-519.

Elmore, W. 1992. Riparian responses to grazing practices. In: Watershed management: balancing sustainability and environmental change. R.J. Naiman (Ed.) New York: Springer-Verlag, Inc. 442-457.

Elmore, W., Beschta, R.L. 1989. The fallacy of structures and the fortitude of vegetation. GTR PSW-110. U.S. Dept. of Agriculture, Forest Service.

Elmore, W., Kauffman, B. 1994. Riparian and watershed systems: degradation and restoration. In: Ecological implications of livestock herbivory in the West. Denver, CO: Society for Range Management.

Fallon, A. 1998. Riparian area management handbook. E-952. Oklahoma Cooperative Extension Service, Oklahoma State University and Oklahoma Conservation Commission.

Hoag, C.; Fripp, J. 2002. Streambank soil bioengineering field guide for low precipitation areas. U.S. Dept of Agriculture, Natural Resources Conservation Service.

Kansas State Conservation Commission.

Kauffman, J.B., Beschta, R.L., Otting, N., Lytjen, D. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries 22(5):12-24.

Keown, M.P. 1983. Streambank protection guidelines for landowners and local governments. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MI.

Kershner, J.L. 1997. Setting riparian/aquatic restoration within a watershed context. Restoration Ecology 5(4s):15-24.

Lane, E.W. 1955. The importance of fluvial morphology in hydraulic engineering. Proceedings of the ASCE. 81(745) 1-17.

Leonard, S. et al. 1997. Riparian area management, grazing management for riparian-wetland areas. U.S. Dept. of Interior, Bureau of Land Management, TR 1737-14, Denver, CO.

Leopold, L.B., Wolman, M.G., Miller, J.P. 1964. Fluvial processes in geomorphology. Dover Publications, New York, NY.

Magilligan, F.J. et al. 2008. The geomorphic function and characteristic of large woody debris in low gradient rivers, coastal Maine, USA. Geomorphology 97(2008) 467-482.

Manning, R.E. 1979. Impacts of recreation on riparian soils and vegetation. Water Resources Bulletin. Minneapolis, MN. American Water Resources Association.

Mosley, J.C., Cook, P.S., Griffis, A.J., O'Laughlin, J. 1997. Guidelines for managing cattle grazing in riparian areas to protect water quality: review of research and best management practices policy. Rept. No. 15. Moscow, ID: University of Idaho.

Myers, L.H. 1989. Riparian area management, inventory and monitoring of riparian areas. TR1737-3. U.S. Dept. of Interior, Bureau of Land Management.

National Research Council (NRC), 1992. Restoration of aquatic ecosystems. Washington, DC. National Academy Press.

Natural Resources Conservation Service (NRCS), 1998. Stream visual assessment protocol. U.S. Dept. of Agriculture, National Water and Climate Center, Tech Note 99-1, Washington, DC.

NRC, 2002. Riparian areas: functions and strategies for management. Washington, DC, National Academy Press.

Orr, D. 1990. Is conservation education an oxymoron? Conservation Biology 4:119-121.

Orr, D. 1990b. The virtue of conservation education. Conservation Biology 4:219-220.

Palik, B.J., Zasada, J.C., Hedman, C.W. 2000. Ecological principles for riparian silviculture. In: Riparian management in forests of the continental Eastern United States. New York: Lewis Publishers.

Platts, W.S., Nelson, R.L. 1985. Streamside and upland vegetation use by cattle. Rangelands 7:7-10.

Platts, W.S.1987. Methods for evaluating riparian habitats with applications to management. GTR INT-221, U.S. Dept. of Agriculture, Forest Service.

Poff, et al. 1997. The natural flow regime: a paradigm for river conservation and restoration. BioScience 47(11): 769-784.

Prichard, D. 1998. Riparian area management, a user guide to assessing proper functioning condition and supporting science of lotic areas. U.S. Dept. of Interior, Bureau of Land Management, TR 1737-15, Denver, CO.

Rosgen, D. 1996. Applied river morphology. Pagosa Springs, CO. Wildland Hydrology.

Skovlin, J.M. 1984. Impacts of grazing on wetland and riparian habitat: a review of our knowledge. In: Developing strategies for rangeland management. Boulder, CO: Westview Press.

Stacy, P.B., Jones, A.L., Catlin, J.C., Duff, D.A., Stevens, L.E., Gourley, C. 2006. User's guide for the rapid assessment of the functional condition of stream-riparian ecosystems in the American southwest. Utah Wild Project.

U.S. Dept. of Agriculture. 1998. Stream corridor restoration, principles, processes and practices. Washington, DC.

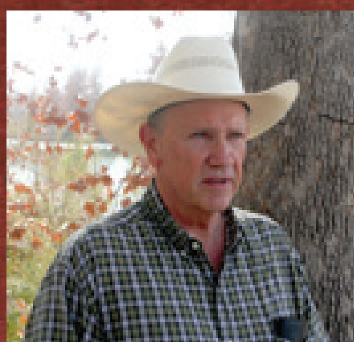
U.S. Dept. of Agriculture, Natural Resources Conservation Service. 1996. In: Engineering field handbook, chapter 16. Streambank and shoreline protection, appendix 12B. Washington, DC.

Weaver, T; Dale, D. 1978. Trampling effects of hikers, motorcycles and horses in meadows and forests. Journal of Applied Ecology. 15(2): 451-457.

Winward, A.H. 2000. Monitoring the vegetation resources in riparian areas. Gen. Tech. Rep. RMRS-GTR-47. Ogden, UT: U.S. Dept. of Agriculture, Forest Service.

About the author

Steve Nelle has 39 years of direct experience with Texas landowners and private lands conservation. In his work with the NRCS as Range Conservationist and Wildlife Biologist, he had the privilege of working on hundreds of ranches across a large part of the state. His work with ranchers, landowners, and natural resource professionals has provided him with relevant and practical insights into land management issues and the desire to better understand the big picture. Since his retirement in 2011, Nelle continues to provide natural resource assistance and helps landowners plan and carry out comprehensive and sustainable range, wildlife, and watershed management practices. Areas of special interest include plant ecology, range and habitat management, land stewardship ethics, and riparian dynamics.



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