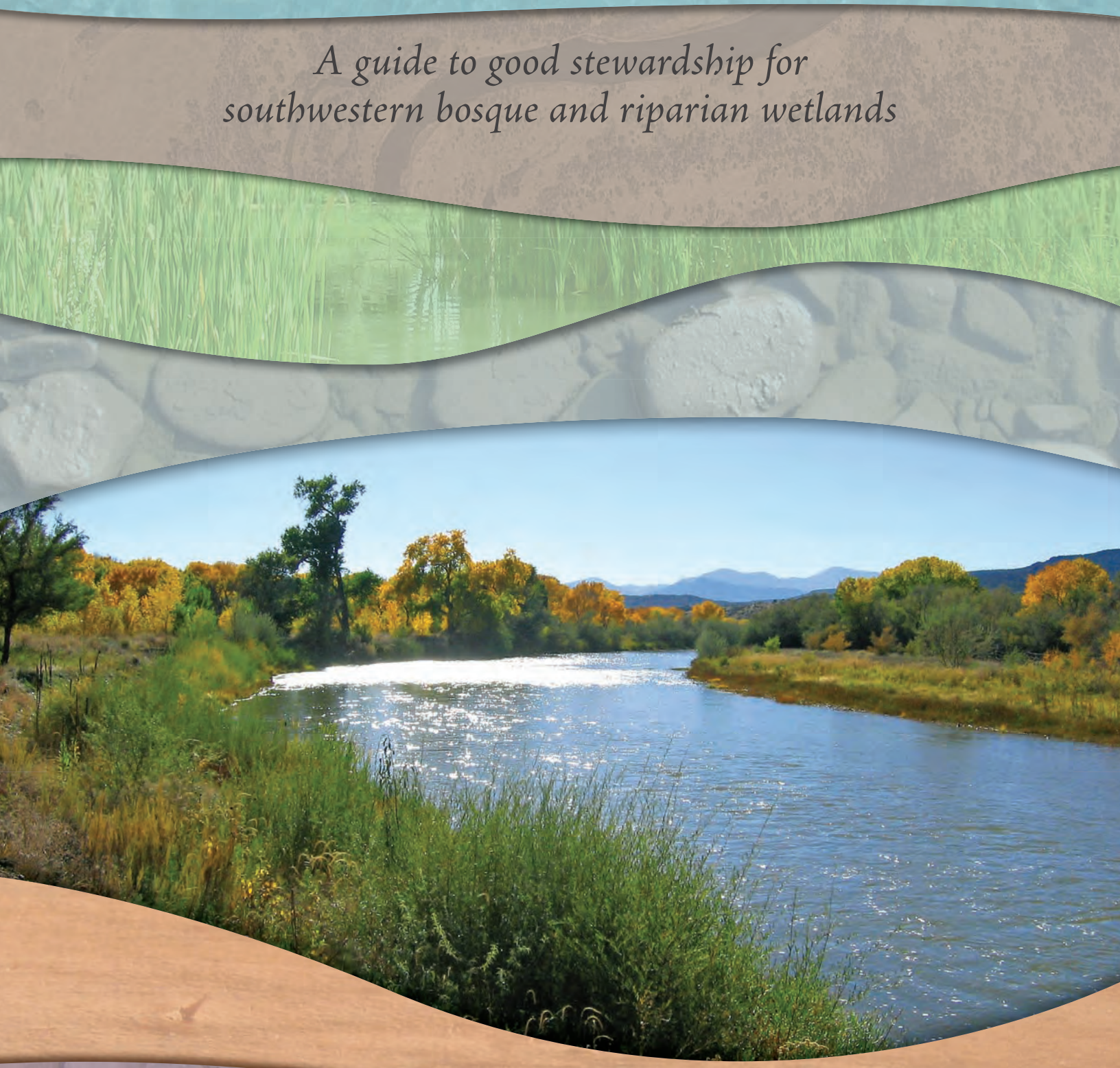
Healthy Streamside Wetlands

A guide to good stewardship for southwestern bosque and riparian wetlands



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NEW MEXICO ENVIRONMENT DEPARTMENT

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CONTENTS

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1. INTRODUCTION

This booklet is for you if you have any kind of streamside or wetland area that you want to take care of and understand better. It is a monitoring and maintenance guide for landowners, volunteers, and anyone else who is responsible for small southwestern *riparian* (or streamside) wetlands, woodlands, restoration sites or protected areas.

It begins with a little background information on how river systems, and the riparian wetlands, woodlands, and meadows on their banks, work in the southwestern United States. There are also some relatively simple, easy, and inexpensive techniques to understand how healthy a riparian area or wetland is, and what to do to help keep it that way, or make it more healthy, functional, and beautiful. It is not a guide for initial, major restoration work—that is a subject far too big, varied, and complex to cover here. Rather, it offers suggestions for how to maintain and manage a riparian area or wetland that is already in reasonably good condition ecologically—in other words, it is not dominated by invasive, non-native trees like Russian olive or salt cedar, and the soil still gets good and wet for at least some of the year. In many cases, this would mean that your area has already benefited from ecological restoration of some kind, like removing invasive trees, perhaps re-planting native plants along bare stream banks, or earthwork to enhance stream meandering.

In this booklet, as in the Spanish spoken in the southwest, the word *bosque* means a streamside or riparian woodland, historically dominated by cottonwood trees and periodically flooded. It is a very useful word, and we will use it interchangeably with "riparian area," as a kind of shorthand term for riverside wetland or woodland that includes any or all riparian communities: giant cottonwoods, dense willow thickets, marshland full of cattails and sedges, grassy meadows, and other streamside plant communities.

1.a] Mature bosque composed of diverse riparian communities

What do you see when you look at a river? You probably see peacefully flowing water, between riverbanks that hopefully support a leafy tapestry of green. But seeing only gentle water and verdant vegetation blinds us to most of the natural processes that actually produce the beautiful cottonwood groves and willow thickets that make our river valleys what they are. In fact, rivers are always changing, sometimes forcefully, through the seasons and over the decades. When we take a closer look, our rivers and their streamside life are ever-changing movies, instead of simple snapshots frozen in time.

2.a] High mountain stream flowing through a bedrock valley

In its mountainous upper headwaters, a river probably cascades down steep, rocky valleys that are almost entirely bedrock and boulders, with little soil or valley-bottom sediment. Before it has flowed very far down from its mountain origins, though, the river valley becomes broader and less steep, and bedrock is buried beneath increasing quantities of sediment—rock, gravel, sand, and silt—carried down by the river itself. Sediment filling the valley may be thousands of feet deep, as it is where the Rio Grande flows through Albuquerque; or perhaps only a few dozens of feet deep, in the case of many streams in mountainous areas. However deep the sediment may be, the sediment surrounding a river channel fills with water, and the flowing stream also moves some of the sediment along with it. A river is not just the water we see flowing. It is an integral system of surface and sub-surface water, and the sediment it flows over and carries with it.

A river in its high mountain headwaters flows where its bedrock valley makes it flow. However, when it gets to a valley big and flat enough, a river meanders back and forth across the valley bottom. When the river rises, with snowmelt in the spring or torrents of runoff after a big thunderstorm, the high water carries some of the sediment of the banks and riverbed along with it. Rapidly moving water scours the riverbed and erodes some of the riverbank on the outside of meander bends. As the water slows down some of the sediment drops out, in backwaters, on point bars along the inside of meander bends, and on the floodplain, enriching these areas with nutrients and organic debris. Almost all this re-arrangement of the river channel happens during high flows—what we think of as a "flood", which is just a normal, unavoidable part of a river's annual cycle of low and high flows. Over time, this process tends to accentuate the meander pattern, and sometimes it becomes so pronounced that eventually high water cuts off a bend entirely and creates a new river channel, leaving the old channel as a cut-off meander or oxbow. And the never-ending pattern continues. Even though we do not usually see riverbanks moving as we watch, over time they are constantly moving and changing, meandering back and forth across the floodplain.

2.b] Meander bends in a valley bottom

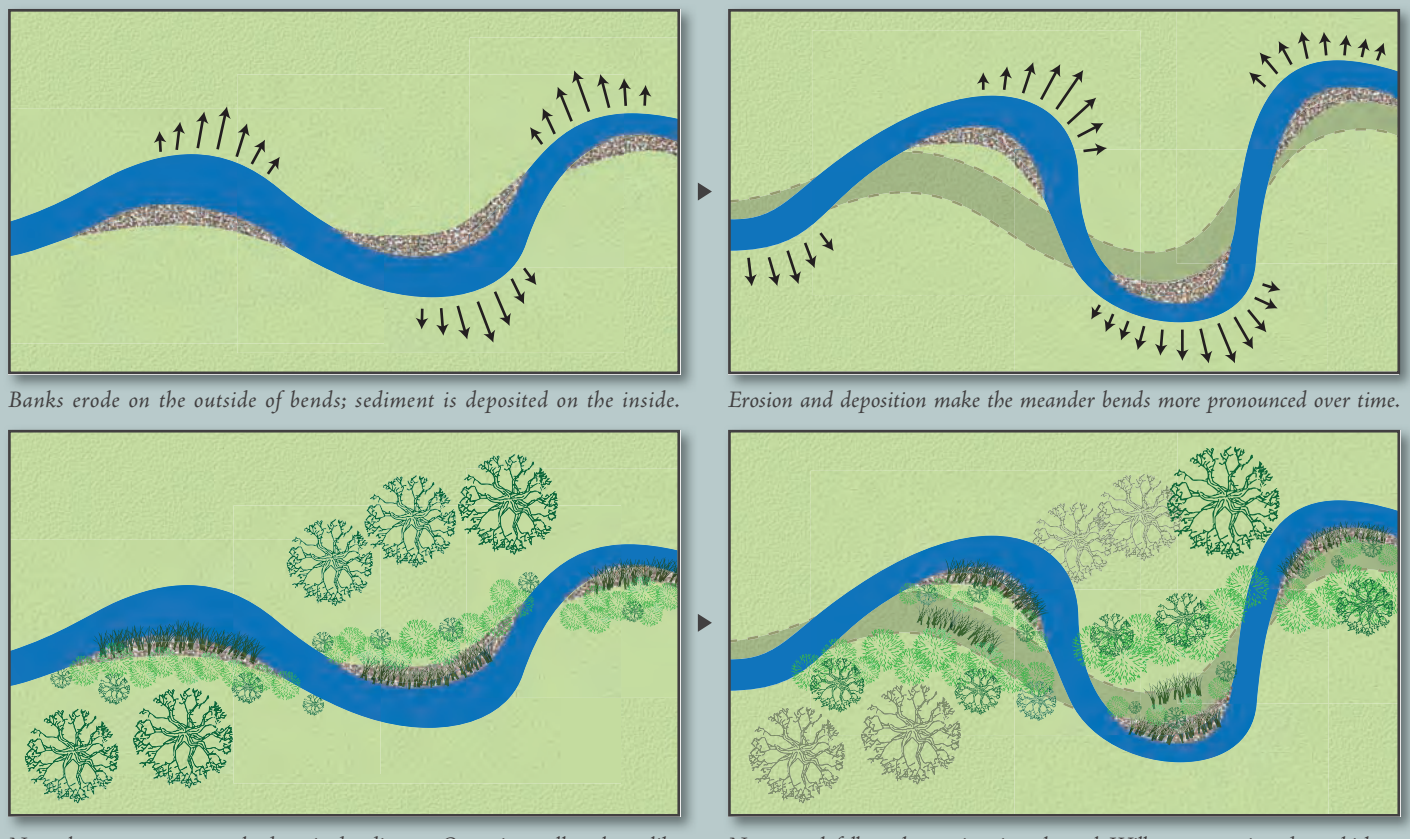
The plants and animals that live along riverbanks in the southwest have evolved to depend on the pattern of natural disturbance caused by river flooding and meandering, and the periodic erosion and re-deposition of river sediment. In fact, without that disturbance many of them could not survive. Cottonwood trees are a good example of riverside vegetation totally dependent on disturbance caused by the cycle of flooding, meandering, and sediment deposition. Cottonwood seeds can only sprout in soaking wet soil, and their seedlings will only grow in wet soil and full sunlight. These are exactly the conditions that exist after spring runoff, when floodwaters have saturated the soil, scoured away dead

leaves and competing vegetation, and have left new islands and point bars along the riverbanks. These are the places, and time of year, when new cottonwoods (and other emergent seedlings) can sprout. There is no such thing as a stable climax woodland of cottonwood trees, with younger trees of different ages growing up beneath the older trees. Instead, a new "generation" of cottonwoods sprouts after a flood, and with luck grows to maturity while succeeding generations of seedlings sprout on other sandbars in other places. Riparian willows and many other plants also cannot reproduce well without flooding and the sunny, wet sediment of newly deposited sandbars.

2.c] New cottonwoods sprout when soil is saturated

Once a community of new vegetation gets established, it begins an inexorable process of change as little cottonwoods and willows grow taller and begin to out-compete their neighbors for sunlight, water, and nutrients. The first rapidly-sprouting spikerushes, horsetails and cockleburs give way over time to slower-growing but taller and more persistent sedges, rushes, or perennial grasses. After a few years, as the cottonwoods, willows, and other trees grow taller and closer together, they may shade out many of the smaller ground-level plants as they develop into the dense thickets that provide habitat for songbirds, rodents, insects, and countless other animals. As more years go by, the cottonwoods keep growing taller and their leafy canopies shade out the sun-loving plants they grew up with.

River meanders (top) and resulting ecological succession (bottom)



Banks erode on the outside of bends; sediment is deposited on the inside.

Erosion and deposition make the meander bends more pronounced over time.

New plants sprout on newly-deposited sediment. Over time taller plants like willows or sedges grow on sediment bars deposited years before. Mature cottonwoods grow along abandoned river channels where they sprouted decades earlier.

New growth follows the moving river channel. Willows mature into dense thickets, and young cottonwoods grow taller, while older trees eventually die. Old river channels, lower than the surrounding floodplain, may remain wet for years to come.

Beneath a mature cottonwood gallery are plants that can take the shade—like New Mexico olives, wild plums, or many varieties of grasses. As the trees grow and pioneer plants and animals give way to others in the process of ecological succession, the river may have meandered far away across its floodplain, repeating the process of flooding and meandering, erosion and sandbar deposition, and the ecological succession that goes with it, over and over again.

Riparian ecosystems change over time as plants grow and riverbanks move in response to floods and meandering. Plant communities also change to some extent in response to changing climatic conditions, especially in drier parts of a bosque farther from the current location of a river. Wet soil near a stream may be little affected by wet or dry years, but a few inches higher in elevation, or farther away from the stream, drier plants like chamisa, four-wing saltbush, Apache plume, along with saltgtrass or dropseeds may expand their range in drier years.

For many reasons, the bosque is not only a mosaic of different plant communities and habitats, it is (or should be) an ever-changing mosaic, and one with moving boundaries. The different plant communities that typically make up southwestern riparian ecosystems are never quite the same in any two places, and often grade into one another, but the examples that follow illustrate some of the typical stages in the ecological succession that happen as the newly-emergent fuzzy green carpet that appears after spring floods develops through the years and decades. One stage will gradually develop into the next over the years, and there are lots of variations in which species are present and exactly what it all looks like, but the vegetation communities illustrated below are typical stages in the succession pattern in most southwestern riparian areas.

2.d] Bosque flooded by annual spring snowmelt, new cottonwoods sprout

But isn't erosion a bad thing?

Erosion, like fire in pine forests, is a periodically occuring natural process. The cycle of erosion, deposition, sediment transport along a river, and the formation of new sandbars, is absolutely indispensable for many riparian plants to survive. Rivers generally maintain a rough equilibrium of erosion, deposition, and sediment movement along their length, where erosion in some places is more or less balanced by sediment deposition in other places. This equilibrium can be disrupted, however, sometimes massively.

A forest fire which can remove soil-binding vegetation, for instance, can send far more sediment suddenly into a river system than river flows can carry downstream. When that happens, a lot of sediment gets eroded off upland slopes and deposited in the river channel. Existing banks can be covered up, and major changes may happen to the riverbed and banks. As the vegetation in a forest regrows, the natural ecological succession will return and native vegetation will reestablish.

Soil damage and exposure caused by human activities like badly managed grazing, poor logging practices, or poorly planned and excessive road-building can have similar effects. So can massive increases in runoff from roofs and paving in developed areas. However, activities like road building and increased runoff from impervious surfaces are usually not reversed over time and can have permanent deleterious affects on a river system. Conversely, dams stop all sediment transport along a river. Reservoirs behind the dam fill up with the captured sediment. Water released below the dam can cause severe erosion because it carries none of the sediment it used to carry and will recapture its sediment by eroding the bed and banks of the river. The consequences are total disruption of the natural equilibrium of the river's plant and animal communities.

Erosion and sediment are neither good nor bad by themselves. They can, however, create problems when an existing balance is disrupted.

Ecological succession

The first new plants

The first plants to sprout on new soil, or where other vegetation has been cleared away, are likely to include spikerushes, rushes, grasses, cattails, little cottonwood or willow sprouts, and fast-growing annuals like cockleburs.

2.e]

Vigorous growth and expansion

After a few years (if the new plants are not washed away by the next year's high water), the woody plants like coyote willow, or perhaps alder, box elder, or Goodding's willow at different elevations, grow taller and closer together and begin to shade out some of the smaller plants. Other shrubs or larger herbaceous plants like seepwillow, false indigo, sunflowers, New Mexico olive, or mesquite, depending on altitude and location, may also be present. Taller trees, like cottonwoods or box elder, will begin to grow above the shrubs, providing singing perches for many birds.

2.f]

In other places, if trees and shrubs do not become densely established and shade out many herbaceous plants, a vigorous wet meadow may develop. Wet meadows occur in places with frequently-saturated soil and often include plants like yerba mansa, Nebraska, field, or Emory's sedges, nutgrass, horsetail, Baltic or Torrey's rushes, three-square bulrush, and dropseed, sprangletop, or salt grasses.

Mature overstory

In 20 or 30 years, cottonwood trees, or perhaps box elders or Goodding's willows in some places, overtop all the other trees and shrubs and may form a closed canopy that shades everything beneath them. Once that happens, plants that need full sun (like willows) no longer do well and tend to die out. Only plants that can tolerate partial shade continue to grow under the mature trees. Often these are grasses, but they may be shrubs like New Mexico olive, sumac, hackberry, or seepwillow as well. In other places, the taller trees may be spread further apart and sun-loving willows or wet meadow plants may thrive around them.

2.g]

Marshland and aquatic plants

In places that are too wet for willows or other woody plants, aquatic plants like cattails, many different bulrushes, pondweeds, smartweeds, duckweeds, water milfoil, hornwort, and duck potatoes grow. Often cattails and bulrushes will form dense and persistent stands.

2.h]

Succession to upland communities

Riparian trees grow fast but do not live for a long time. It is very rare for a cottonwood to live more than 100 or 150 years, and when mature trees die and the bosque dries out, the bosque may develop into an upland community that is hardly riparian at all, unless flooding and river meandering once again create the conditions for new cottonwoods and other wetland plants to sprout. Without new flooding, cottonwoods and willows will give way to juniper, chamisa, sage, apache plume, saltbush, and upland grass.

2.i]

Rivers in the southwest, and the bosques that grace their banks and floodplains, create a dynamic mosaic that is always in the process of becoming something else, even if it changes slowly to human eyes. Along a natural river, the creative disturbance caused by floodwaters is the lifeblood of the bosque and the ultimate reason that it can exist at all in the way we know it. Where natural flooding has been prevented by channelization or dam control, native riparian vegetation usually depends on intentional ecological restoration work that mimics some of the disturbances that flooding would have provided (such as excavation to provide more water, and planting native species like cottonwoods that cannot reproduce without flooding-induced disturbance). In a restored riparian area, just as in one of the few places where a stream can still maintain a healthy native ecosystem on its own, the bosque is always gradually changing into something else in a natural process of ecological succession.

But if streamside vegetation is always changing, how can we tell how our riparian area is doing? Are there some useful milestones to know about on the way? Are there things that can go wrong? The next section offers some suggestions about how to find out.

Bank stability?

Just as erosion is not necessarily bad, stable riverbanks are not automatically good. It is all a matter of degree. Any riparian ecosystem needs enough stability over time that vigorous riverbank vegetation can develop to shade and cool river water, overhanging sedges can help create good aquatic habitat, and rushes, willows and other plants can capture sediment where new plants can sprout. However, a completely stable, unchanging riverbank will not sustain southwestern bosque vegetation in the long run. Because so many riparian plants have to have newly deposited sandbars and islands, or flood-scoured bare soil in order to reproduce, they will eventually disappear if these conditions never happen. If the banks of the Rio Grande, for example, never again flooded, and there was no more bank erosion and never another sandbar formed, eventually nearly all the cottonwoods, willows, and many other bosque plants would disappear and be replaced by plants like juniper, apache plume, chamisa, or grasses. Natural flooding disturbance, and a certain degree of instability of riverbanks and sandbars, is what makes a southwestern bosque possible at all.

Of course, there is such a thing as too much disturbance, and too much instability of a river's banks and channel. If massive flash floods scour out any new vegetation every year before it can really get established, or smother it with too much new sediment, healthy riparian vegetation will never develop. Similarly, excessive, badly-managed grazing can damage a streamside so much that trampled and denuded banks are constantly washing away downstream. A damaged stream tends to cut down rapidly into its banks and bed leaving its natural floodplain high and dry. The result is too little moisture in floodplain soils to support water-loving riparian vegetation any more. The key to healthy riparian ecology is the right amount of disturbance, including a certain degree of change and meandering of riverbanks over time—not too much, and not too little.

A healthy degree of bank disturbance is different for different rivers. For instance, a healthy high-altitude trout stream will have lush vegetation that requires very little bank erosion and sediment input, even at flood stage. Riparian ecosystems in other natural settings are not necessarily adapted to the scale of change and disturbance that our bosques are in the southwest, and their riverbanks may be much more stable over time.

3.a] Monitoring a riparian restoration site

Ecological monitoring is just a systematic way of looking at a piece of land you are interested in, as it changes over time, and comparing it to a vision of how it ought to be. It can be as simple as taking a picture from the same viewpoint every year, or observing the same area consistently over time and taking good notes. There are many straightforward, easy observations you can make that will tell you quite a lot about the ecological status of a riparian area.

Ecological health along southwestern rivers

Most of us would say that our goal or desired condition would be a healthy ecosystem. But what is "healthy," anyway? How do we know what our bosque ought to be like?

It can be easy to recognize what is *not* healthy: a bosque choked with salt cedar that has crowded out most native plants along with many birds and animals, is much less healthy than it was with native vegetation. A riparian area overgrazed and trampled to the point that few plants of any kind can grow is clearly degraded and unhealthy. It is harder to pin down what exactly is ecologically healthy. In many cases it is not as simple as returning to "natural" or "pre-human" conditions, even if these could somehow be known—which often they cannot. The entire Rio Grande, for instance, and almost any other river of any size, has been affected by centuries of human use, with increasing intensity over time. Biological inventories were not made for most places prior to flood control work, or dams, or before the presence of European grazing animals. There are no comparable river systems we can observe unaffected by industrial civilization. There are no reference sites where we can study a southwestern bosque free from human influence.

Key characteristics of a healthy bosque

Few if any invasive plants: An invasive species is a non-native one that tends to crowd out everything else, displacing native plants or animals and reducing biodiversity. Not all non-native species are invasive: for instance, salt cedar, Russian olive, and knapweed are often invasive, while apple, mulberry, or barnyard grass generally are not.

Diversity: Both *structural diversity*, the mosaic of vegetation communities (marshes, cottonwood forests, willow thickets, grassland, and so on); and *species diversity*, the number of different native species present, are good indicators of a naturally functioning bosque.

Micro-habitats: Micro-habitats result from the variety of physical and topographical features. The more physical features and topographical complexity, the more micro-habitats and diversity of plants and animals there will be.

Habitat for sensitive species: Species like southwestern willow flycatchers, meadow jumping mice, or yellow-billed cuckoos require special habitat features. Bosque containing habitat that supports these species is one indication of an ecologically healthy riparian area.

Open water and/or saturated soil: Some of both are needed to support a complete range of wetland and riparian plants and the other living things that depend on them.

Appropriate river disturbance: Some flooding, meandering, and other natural, periodic disturbances provided by the river are essential for southwestern riparian ecosystems to be self-sustaining over time.

3.b] Vigorous, healthy bosque

In addition to these limits on the information we have, the river and its bosque exist in a state of perpetual (if mostly gradual) change, a dynamic equilibrium—quite apart from any human influences. As we have discussed above, the bed and banks of any functional river continually move and rearrange themselves as water and sediment move downstream, and the bosque responds with an ever-changing pattern of ecological succession.

There is no simple, universal prescription for a healthy bosque, or set of numbers that describe a functional riparian area. There are, however, several general characteristics of a riparian area where natural processes are functioning properly and ecological communities are thriving. We can observe whether these characteristics are present, and by monitoring over a period of at least a few years, we can tell whether desirable characteristics are stable, becoming better established, or diminishing. It is difficult to specify hard, numerical targets that define health, but fortunately it is much easier to spot positive or negative trends, and indicators of problems.

Of course how much all these desirable characteristics are possible will be different in different places. Even in the most ideal conditions, an acre of bosque cannot have all the diversity and different micro-habitats that ten or a hundred acres could have. A mountain stream at 8,000 feet will have different ecological communities than a desert river at 3,000 feet. Many places do not have the space or conditions to support habitat for willow flycatchers or other particular kinds of wildlife. Overbank flow may be controlled by a dam, or meandering prevented by flood control levees. So inevitably we have to work with what we have, but the more of the characteristics listed above, the better a riparian area is ecologically—especially if it is getting better over time.

What to look for

We have some idea of the indicators and trends that show whether a riparian area is developing in an ecologically healthy way. Now, what do we go and look for on the ground?

Invasive plants

A healthy riparian area has few if any non-native invasive plants, and that is something we can usually control with some success. It is much easier to get rid of a few small invasive plants than a large, dense, and deeply rooted invasion, so it is extremely valuable to be able to recognize them and to look in the places they are most likely to get established. Often that will be in places that have been recently disturbed, whether by restoration activities, roads, grazing, paths, or even completely natural sandbar formation. In Section 6, Gallery of Common Invasive Plants, you can find a rogue's gallery of the most highly invasive plants found in southwestern riparian settings, along with notes about where they are most likely to occur. Please be sure to look through Section 6 so you can recognize these unwanted plants, and help get rid of them wherever you see them. Techniques for controlling them are discussed in Section 4, Maintaining Ecological Health.

3.c] Purple loosestrife is a highly invasive plant

The best way to monitor for invasive plants is simply to walk over as much of your site as possible, as often as you can, paying particular attention to the places they are most likely to occur. Unless you are sure to remember, it is a good idea to flag the location, make a note and sketch a map, or take GPS coordinates of any outbreaks you come across , so you can come back and do something about it. Otherwise you may not recognize them again when they are not flowering or at different times of the year.

Diversity

If you could have a good, clear aerial photograph of your bosque taken every year, it would probably be easy to keep track of how many different kinds of vegetation communities there are and how they change over time. If your site is fairly small and you can climb a tree or sit on a canyon wall above it, you can also perhaps simply watch over time, and take photographs. However, if you do not have a situation like that, you may want to observe and record these changes in other ways.

With a GPS unit and compatible software, you could make a map by walking with the GPS recording the places where new emergent plants are sprouting along the river, or willows form dense thickets, or whatever different kinds of vegetation communities you have, and downloading it to a computer. Also be sure to walk along and record what you see at the river's edge. Then, if you make a similar map after say three to five years, you can see how things have changed. The drawing on the left, below, shows such a sketch map.

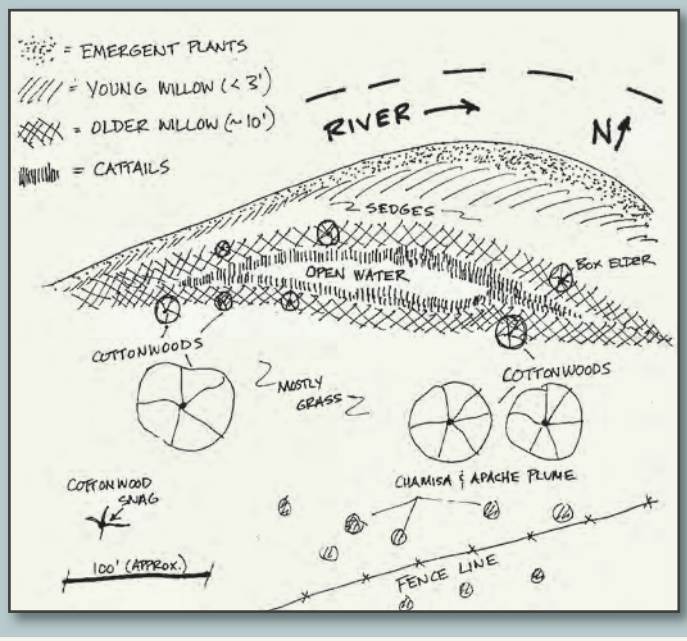
You can also do some simple transect sampling of your site to record which plant communities you come across. This technique will probably give you a clearer picture if you can combine it with even a simple sketch map of the site. Follow a compass bearing or sighting of a distant landmark as you walk in a straight line across the width of a riparian area, writing down which communities you are walking across, and how many paces it takes to cross them. The line that you walk is called a *transect (TR)*. You can, of course, also set up a long tape measure and record distances across community types in feet or meters. Then walk another transect some distance up or down stream of the first transect, and do enough transects to walk across all the major plant communities there are. Sources of aerial imagery like Google Earth® can help you draw a useful sketch map, even though the images themselves may be too fuzzy and low-resolution for you to see many features of the landscape. They are a great help in sketching out the basic outlines of a site, and you can fill in the details and distances on the ground with your transect notes.

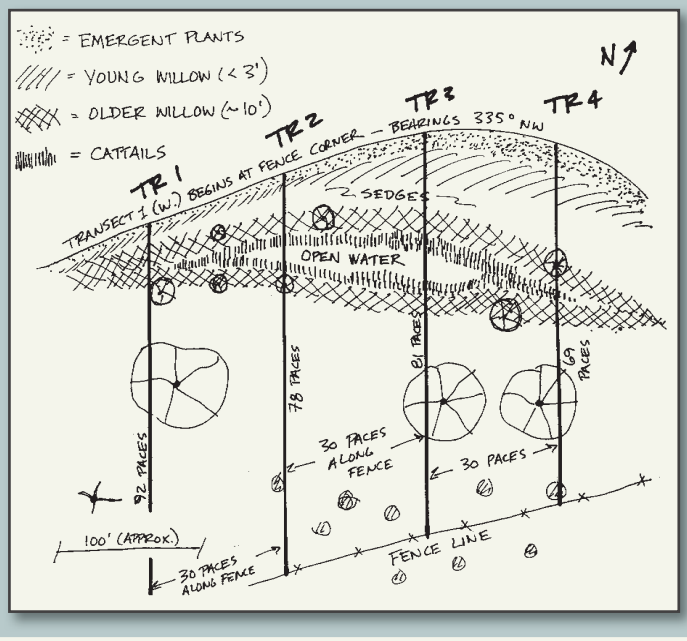
The drawing on the right, below, illustrates how transect sampling and a sketch map could be used to record the size and locations of different vegetation communities or micro-habitats in a bosque.

To measure and keep track of species diversity, you need to count how many plants there are in a manageable area, usually in a sample plot of a square yard or square meter. It is ideal to be able to identify the plant species you find, and with a little practice and a good plant identification book—or even better, with someone who knows plants—you may be surprised just how easy it is to recognize many bosque plants. But don't worry if you are not a botanist. Most people can accurately tell how many different kinds of plants they see in a given area even if they have no idea of their names. It helps to separate the plants into woody plants (usually seedlings or small shrubs, in a small plot), leafy plants (forbs), and grasses or grass-like plants (grasses, sedges and rushes). Most people are pretty reliable at telling different plants apart, even without identifying them. If you find eight different kinds of plants in a plot this year and twelve when you come back in five years, there probably really are about 50% more plant species present in the plot.

It is a good idea to sample a few, or even several, different plots for species diversity in each of the different kinds of plant communities there are. The more plots you have time to sample, the better idea you will have of what is really going on over your whole site. It is also a good idea to sample in the early to late summer when many plants are in flower and easier to identify.

Examples of monitoring sketch map (left) and transect locations (right)





Micro-habitats

You can easily determine the distribution and relative abundance of microhabitats by using the transect method described above. You can record wildlife mounds and burrows, rocks and logs, river side channels, tree-fall holes, floodplain scour pools, and the general unevenness of the ground. These hydrologic and physical landscape features may coincide with your plant communities or not. Micro-habitats set the stage for more plant and animal diversity by providing different conditions for the many life stages of plants and animals in your bosque.

Sensitive species habitat

It takes a lot of training to find and monitor most sensitive species of plants or animals. However, it not nearly as difficult to understand the kinds of habitat they need. Southwestern willow flycatchers are the principal, and most widely distributed, endangered species found in southwestern riparian areas. They are endangered almost entirely due to habitat loss. The habitat they need is the kind of dense thicket (often willow) that develops as a fairly early stage in bosque ecological succession, perhaps 10 years after a new sandbar or flood-scoured riverbank is first created. Their lack of habitat is a clear indication of how much the patterns of flooding and sandbar creation needed to maintain healthy riparian ecology have been disrupted throughout the southwest by dams and river channelization.

Some of the best information about southwestern willow flycatcher habitat can be found at the US Fish and Wildlife Service Arizona Ecological Services web site at *fws.gov/southwest/es/Arizona/*, by clicking on Document Library, then Recovery Plans, and then Southwestern Willow Flycatcher Recovery Plan, and finally by downloading Appendix D on Southwestern Willow Flycatcher Habitat.

Southwestern willow flycatchers are the legally protected species, but the habitat they need benefits countless other plants and animals as well. The meadow jumping mouse, for example, is a candidate for protection under the Endangered Species Act that needs similar habitat, and hundreds of other migratory songbirds, raptors, water birds, amphibians, rodents, insects, and fish need it as well. Unless your site can offer perhaps an acre or more of open water and saturated soil, and conditions where the kind of nesting trees (usually willows or box elder) will grow densely and vigorously, it will probably not develop into flycatcher habitat as such. However, the kind of dense, wet thicket flycatchers need is still very valuable for migration and foraging, even in patches too small for nesting. It is worth looking to see if you have this kind of habitat, or places where it could develop, and keep watching them over time to see if it does. You can easily do this at the same time you are looking for invasive plants and observing other kinds of vegetation structural diversity. You may also be able to encourage it by planting additional willows and other plants.

Key requirements for southwestern willow flycatcher breeding habitat

Dense, early-successional native riparian vegetation, with significant areas dominated by coyote willow or similar trees/shrubs from ground level to a height of 6 to 15 feet and including some taller trees used as higher singing perches.

Immediately adjacent or overlapping marshy areas of shallow, slow-moving open water and/or saturated soil to provide insect habitat needed as a food source.

Diverse surrounding ecological mosaic of healthy native bosque types, including cottonwood gallery forest, grassland, marsh, wet meadow, and thickets of other shrubs in addition to coyote willow.

Dependable surface and ground water supply through the growing season that maintains soil moisture and open water patches, and a vigorous and diverse ground-level herbaceous plant community, to ensure adequate insect populations for foraging.

Protection from disturbance and grazing by buffer zones, fences, and gated access.

3.d]

Water, wetland, and healthy streambanks

Open water is all too rare along southwestern streams these days, and if you have some in your bosque, as ponds, springs, or old oxbows full of cattails, you are lucky. Be sure to include these in your notes, sketches, or maps and keep track of them over time to see if they are stable, expanding, or shrinking. The saturated soil around the edges of these, along the edges of the stream itself, and even in places without actual open water, is equally important for ecological diversity. You can tell if soil is saturated with water by digging a little hole with a stick or trowel and seeing if any water oozes from the soil into the hole. You can also tell if soil has been saturated during the growing season for more than a couple of years because the plants growing in it will be *obligate* wetland plants, plants that require shallow water or saturated soil (and grow vigorously when they have it). Common wetland plants include cattails, rushes ("wiregrass"), bulrushes, sedges, horsetails, and pondweeds. Wetland plants are an important vegetation community worth noticing, and it should be included in any mapping or vegetation monitoring you do. You should also look carefully for invasive plants, especially purple loosestrife and salt cedar, in saturated soil.

Streambank disturbance associated with flooding and meandering is important in streams where it is the driving force behind plant reproduction and ecological regeneration. The higher the gradient of a stream, the less dependent its riparian ecology is likely to be on meander processes. As streams flow out of the mountains and into broader valleys, they become more dependent on sandbar and island dynamics to maintain healthy riparian ecology. The "right" amount of flooding disturbance can be a matter for discussion, and for ecological purposes it is better to look directly for the results: successful plant

3.e] Spikerushes are among the first plants to sprout on a new sandbar

reproduction. The important thing is the presence of young plants and different soil and moisture regimes. In lower-gradient streams with broader floodplains where flooding and sandbars are crucial, you will find most young plants in precisely those places: where there has been sunny, wet new soil in the past few years. If you find none of these places, and in any river ecosystem if you find few or no young plants, there is a problem. As with wetlands and open water, the places where you find emergent young plants are important to be aware of and to track over time.

Notes and photo points

Along with looking for the specific information suggested above, it is very valuable to simply take photographs and write your observations in a notebook (or computer), especially if you keep doing it through the seasons for a few years. Both photos and written notes are even more helpful in understanding trends over time if some of them are taken from the same point of observation. A fixed location where photos are repeated time after time is a *photo point*, and is sometimes marked with a fencepost or stake in the ground, tag on a tree, or other permanent marker, unless it is a natural feature like a rock or major tree that is unmistakable.

Of course repeated photos need to be taken of the same view, facing in the same direction, and during the same season to be most useful. Your observations can similarly be noted from the same points or along the same walking route, through the seasons and year after year.

Photo points

3.f] Before revegetation

3.g] After revegetation

3.h] Species observation, identification and notes

A whole lot of information per hour of (hopefully pleasant) time can be gathered by repeating photographs from photo points, and repeating observations of the same area over time—so while you are looking for the invasive plants that are hopefully not there, set up some photo points and write down all sorts of things you see. Some important information you will want to include are the date and time of day, wildlife sightings and scat, and the weather.

There are many more specialized or intensive observations and kinds of monitoring you can do if you are interested. It may also be that these brief suggestions leave you with questions, or seem less clear than you might have hoped. It is always easier to get started at a new activity with some guidance from someone who has done it before. In any case, there are several sources you may be able to turn to for help, including more information, opportunities to participate in on-the-ground monitoring, and suggestions about how to interpret what you find.

For recent listings of groups and contact information, visit the SWQB Wetlands Program website at *nmenv.state.nm.us/swqb/wetlands/*.

The next section offers some suggestions for what you can do about what you learn in the course of monitoring the ecological condition of your site.

Resources for monitoring information and learning

Local watershed associations and similar groups

Neighbors who have a similar interest and prior experience

Volunteer groups doing river restoration, cleanup, and similar activities

Your local Cooperative Extension Service

Ecological restoration consultants may offer affordable monitoring training and assistance to individuals or groups

3.i]

3.j]

3.k]

3.l]

Monitoring information can tell us quite a lot about how close our particular riparian site comes to the characteristics of a healthy bosque. But what can we do to help improve and maintain ecological health? Some of the characteristics are easier to achieve than others. Weeds and invasive plants are very common in restoration sites, and far from uncommon in even relatively undisturbed, healthy riparian areas; but they can also be controlled by determined human action. The ultimate ecological mosaic that will develop at a site is largely determined by non-biological factors, especially the presence or absence of water, the connection to the flood activity of the adjacent river system, and also by altitude, soil types, topography, and the acreage available in the floodplain or riparian area. However, it can also be strongly affected by the availability of seed or colonizing plants and competition from non-native plants or animals, and we have a lot of influence on these factors. Within the general mosaic pattern, we can also influence how many different species are present. For example, the grassland around mature cottonwoods could be dominated by non-native cheatgrass, or it could be a much more diverse and productive meadow composed of half a dozen or more native grass species—and this depends on our management. Habitat for sensitive species cannot exist without certain background conditions, but if those conditions are present or could be enhanced, we can certainly expand the extent or speed up the development of the right kind of habitat.

4.a] Controlling invasive plants is a helpful kind of bosque maintenance

On the other hand, bringing more open water, surface flows, or even saturated soils to a site is often considerably more involved and resource-intensive than planting additional native species or controlling invaders. It can certainly be done, but is usually one of the key parts of a major restoration project, requiring heavy equipment and/or water sources from off-site, rather than something done by way of maintenance after initial restoration work is completed. There are

4.b] New native transplants along a restored streambank

sometimes ways to increase water supply to a riparian site without major excavation, though, and we will consider some below. It is also generally (but not necessarily) a major undertaking to enhance the meander patterns or overbank flows along a river, and is usually a major focus of a restoration project from the beginning.

In addition to the ecological characteristics we have mentioned, a healthy bosque should be relatively free from intense fires. A more or less natural bosque with a mosaic of different vegetation types, including some water and wetland, will be much less prone to large and devastating fires than the unnaturally dry and invasive-choked bosque typical of many southwestern rivers. Still, there are useful measures we can take to reduce the chances of fire starting and spreading, especially around homes and recreation areas.

This section will explore various ways we can help a particular riparian area achieve and maintain more of its ecological potential, within its physical limitations and our resource limitations.

Weeds and invasive plants

Unwanted plants (including trees and shrubs) are probably the most common problem in restored riparian areas. Fortunately, it is also the problem we are best able to tackle, although it may take a lot of work. We should distinguish between *weeds*, which are in the simplest definition any plants not wanted where they are; and *invasive plants*, which are plants that tend to out-compete almost all other plants over a significant area and form a near-monoculture that will persist more or less forever. For clarity, we will use the term *weed* to mean a plant that grows vigorously, especially in a recently disturbed area, and may be undesirable but is not likely to permanently alter the ecological characteristics of the place where it grows. Many weeds are annual plants (sometimes native) that colonize rapidly in the early stages of ecological succession, and eventually give way to a more

stable and diverse plant community made up largely of perennials. An example would be (non-native) kochia or (native) wild sunflowers that often grow in profusion when riparian land has been disturbed by excavation, but give way over time to grass, shrubs, and/or wetland species.

Invasive plants, on the other hand, are usually not native, often perennial, and tend to form permanent near-monocultures that crowd out native plants, reduce biodiversity and wildlife habitat value, and very much alter the ecological character of the places they invade.

Web resources for more information on invasive plants

Much more information is available on the internet and through other sources about non-native invasive plants and noxious weeds than we can present here, and it is regularly updated. A good general resource for information about invasive plants is the web site of the Center for Invasive Plant Management. The National Network of Invasive Plant Centers website has contact information for local Cooperative Weed Management Areas (CWMA) and potential partnerships to prevent and manage invasive plants and support healthy ecosystems. Your local Natural Resources Conservation Service and Cooperative Extension Service have lots of information on invasive plants, and can also put you in touch with your local CWMA that can offer advice and assistance. One of the most useful sources for information on legally recognized noxious weeds is the US Department of Agriculture web site. There are also state web sites, including New Mexico, with more information about noxious weeds.

Center for Invasive Plant Management
weedcenter.org

National Network of Invasive Plant Centers
invasiveplantcenters.org/cwmamap.cfm

US Department of Agriculture
plants.usda.gov/java/noxiousDriver

New Mexico Department of Agriculture
nmda.nmsu.edu/animal-and-plant-protection/noxious-weeds

The Nature Conservancy, Global Invasive Species Team
invasive.org/gist/handbook.html

Control methods

Don't panic about weeds. Weeds, as we are using the term here, are plants that sprout quickly and grow vigorously when they get an opportunity to get started without too much competition, but will become much less dominant over time. Often they are annual plants that are a natural early step in ecological succession. Riparian examples might include cockleburs, sunflowers, kochia, barnyard grass, Russian thistles, and wild clematis. Some are native and some are not. It is true that it may take several years for anything else to begin to replace these plants, but over time more perennial plants will generally begin to grow beneath or around the weeds and will eventually cover bare soil and prevent more and more weed seeds from sprouting. It is often possible to speed up the succession process by planting seeds of the perennial plant community you want (often grasses) in the winter or spring, when the weeds are dead or dormant, and then cutting the weeds a few times through the growing season so they cannot make so many seeds. After a year or two of this, most weeds will largely give way to the perennials.

> Some weeds are even edible. Russian thistle sprouts and purslane, for example, are edible when very young and tender. You can use them in a garden salad.

Invasive plants, on the other hand, are generally perennial, out-compete everything else, and will never give way to other plants unless they are intentionally removed and kept from coming back. Ways to control invasive plants fall basically into two categories: mechanical or cultural controls, like hand-pulling, cutting, mowing, and providing competition; and chemical herbicide treatment. Most of us would like to use as little herbicide as we can, and would prefer to use alternative control methods where possible. In theory, almost any plant can be killed if its above-ground parts are constantly cut off so that no leaves are ever allowed to send any nutrients to the roots. Unfortunately, however, for most invasive plants this would require almost daily cutting of any green shoots for weeks, months, or even years for well-established plants—a task beyond all but the most ambitious of us. Some plants can be pulled, or dug up by hand or shovel, roots and all, and killed completely; but most mature plants just break off at the ground, leaving an extensive root system to re-sprout with a vengeance. Given our current state of knowledge and available resources, large-scale control of invasives in many situations is just not possible at present without some use of herbicides.

Cutting and hand pulling

Maybe it seems a little quirky, but for some of us pulling up Russian olive or salt cedar sprouts can be remarkably satisfying. Faced with acres of sprouts on a sand bar, of course this is hopeless—but in a few acres of restored riparian woods where there are manageable-sized outbreaks here and there, it may be the best way to get rid of them. Hand-pulling works beautifully for sprouts from seed, where the whole root comes out with the rest of the plant. However, if the top just breaks off and roots are still in the ground, they will sprout back again. With just a little practice, you can easily tell whether you are looking at a seed-sprout, which will be slender, and have smaller leaves that taper to almost a point at the tip of the plant; or at a root-sprout (sprouts from an existing root system), which will have relatively larger leaves and a bushier, less tapered shape. You will also soon learn how big a seed sprout can be pulled up roots and all—usually only a few inches tall for Siberian elms and salt cedar, but a foot or maybe even two feet sometimes for Russian olives.

Hand pulling works fine for most herbaceous plants, too, as long as the whole root comes out. What this usually means is that smaller, younger plants can be pulled out or perhaps cut with a hoe, but most older, mature ones cannot be successfully pulled. Some plants, however, have such large and persistent root systems that by the time you even see the plant it is probably hopeless to pull it up, and breaking off the top may even accelerate its spread. This is especially true of Russian knapweed.

Mowing and cutting alone are seldom effective at killing most invasive plants, because they are perennials that just grow back. However, it can be useful to cut off and remove flowers and seed heads, especially if you have isolated patches of plants that can be kept from spreading. When you cut seed heads, be sure to bag them up and remove them from the site altogether, either for waste disposal or complete burning where they cannot be carried off by the wind. While cutting or mowing mature invasive plants alone will not usually control them, cutting can be a valuable part of an integrated control strategy along with carefully targeted herbicide application at the right times of year. Cooperative extension agents, NRCS staff, and restoration professionals can suggest the right ways to control particular invasive plants.

4.c] Sprout control by mowing and hand spraying

It is especially unwise to cut or pull leafy spurge, because its sap is very irritating. Wear safety glasses, gloves and protective clothing if you are working around these plants. Contact with eyes or skin may require immediate hospitalization.

A note about cattails

The common cattail (*Typha latifolia*) is native to North America and is common in wetlands of New Mexico. It requires saturated soils or standing water and often produces dense monotypic stands. Although it is a native species, it can be an invasive and persistent plant. It can actually alter water chemistry and reduce water depth by its prolific growth and transpiration. Cattails are a food and habitat resource for fish, muskrats, amphibians and birds like redwing blackbirds and marsh wrens, but too much of it reduces plant diversity and open water habitat. If you want to maintain a variety of wetland plants, you may have to manage your cattails aggressively by removing the leaves and roots until other wetland plants are well established.

4.d]

The value of native competition

Ultimately, in controlling invasive plants, the best offense is probably a good defense—if we can create appropriate conditions for native plants and make sure there are plenty of them to compete with non-native plants, there is less opportunity for the non-natives to become established and invasive. It can be particularly helpful to sow native grass seed beneath a patch of early-successional weeds like sunflowers, kochia, or cockleburs, and then mow the weeds a few times to interfere with their seed production. And in the long run, it is impossible to keep any invasive plants in check without vigorous native competition.

A cautionary word about fire and grazing

Fire is not a useful technique for bosque weed or invasive plant control. While fire is a natural and inescapable part of the physical conditions that occur in some upland forests (in ponderosa and mixed conifer forests, for example) and a source of disturbance that those plant communities have adapted to over evolutionary time, this is not the case in riparian woods and wetlands. Flooding and meander disturbance are the driving physical forces behind bosque ecology, not fire. Most invasive species, especially salt cedar and Russian olive, are much more fire-adapted than many native bosque plants and will sprout back sooner and more vigorously after a fire, becoming ever more dominant. Riparian invasives are only encouraged by fire.

4.e]

Grazing has only very limited applications as an invasive control method, and is not generally useful in a bosque situation. There have been many attempts to control invasive trees and plants using goats, and indeed goats will pretty well strip even Russian olive or salt cedar trees, as high as they can reach them. However, they do not generally eat the bark or girdle the trees, and a single visit by a herd of goats, no matter how hungry and dedicated, will not kill invasive trees and plants. They may even cause lasting damage to desirable, sensitive, native plants. Repeated and frequent goat visits over an extended period of time may kill most of the smaller invasive trees, but would probably kill most smaller native trees and other plants as well, reducing overall plant diversity. Any grazing animals, not just goats, will eat small seedlings and sprouts of most trees, invasive or not. However, some herbaceous, invasive plants are toxic to grazing animals. In general, grazing animals are very unlikely to help remove invasive trees, leave native plants alone and maintain species diversity.

4.f]

Herbicides

Most of us faced with the task of controlling invasive plants in riparian areas eventually have to make some use of herbicides. The distribution and use of herbicides, along with other pesticides, are subject to extensive federal and state regulations, and a complete information source for all of them is beyond the scope of this guide. In general, any product intended to control pests (animals, insects, fungi, or plants) must be registered with EPA before it can be sold anywhere in the United States. Individual states have parallel registration requirements, and some products are registered in some states and not others. Among all the registered herbicides, some are *Restricted-Use* herbicides that can only be purchased or applied by licensed applicators. Other herbicides not listed as Restricted-Use can be purchased by anyone, although most are not widely available, and have to be purchased from farm suppliers or agricultural chemical distributors. Another general provision of state pesticide regulations is that no one can apply any herbicide for hire (restricted or not) on someone else's property without an applicator's license—although, in general, you can apply any non-restricted herbicide yourself, in accordance with the label directions, on your own property. Fortunately, restricted-use herbicides are not generally needed for controlling invasive plants in the bosque, and any herbicide application in a maintenance situation can be confined to careful, direct application to individual plants to be controlled.

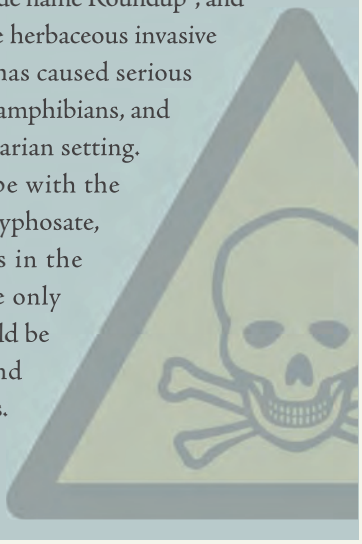
4.g] Use of herbicide to control Russian olive root sprouts

The most widespread and generally successful herbicide application in bosque maintenance has been the use of Garlon® (triclopyr) sprayed or brushed on cut stumps and root sprouts of salt cedar, Russian olive, and other invasive woody species. Triclopyr can be purchased at low concentrations at some garden supply stores (or online) under trade names like Advanced Brush Killer Plus®, Brush-b-Gon®, or Vine-x®, or can be purchased in concentrated form as Garlon® at pesticide dealers and diluted with a carrier (or *adjuvant*) to a desired concentration. Concentrations of one part Garlon 4® to three or four parts adjuvant, applied to cut stumps or small sprouts, have proven highly effective in controlling most woody plant species. However, it may be necessary to treat root sprouts for two to three years in succession.

Other herbicides are more appropriate for controlling herbaceous plants, including Rodeo® (the aquatic formulation of glyphosate); Milestone® (aminopyralid), and Habitat® (an aquatic formulation of imazapyr). Before using any herbicide, be sure to fully understand the directions and appropriate safety precautions. Assistance with understanding, selecting, and using herbicides can be found at your local Cooperative Extension Service, some pesticide dealers, some ecological restoration consultants, and herbicide web sites, including the New Mexico Department of Agriculture website pesticide page at *nmdaweb.nmsu.edu/pesticides*. There is also a very valuable resource at *invasive.org/gist/handbook.html*, a handbook of invasive species control methods, including a detailed discussion of herbicide types, uses, and effects, that was put together by staff at The Nature Conservancy.

Be careful with herbicides around water and wetlands!

DO NOT let any herbicide come in contact with open water, and be careful about which herbicides you use near any wetland or in a bosque area. Glyphosate is by far the most widely used herbicide under its familiar trade name Roundup®, and is effective at controlling some herbaceous invasive plants. However, Roundup® has caused serious problems for frogs and other amphibians, and should *NOT* be used in a riparian setting. The problem seems not to be with the active herbicide ingredient, glyphosate, but rather with the carriers in the Roundup® formulation. The only kinds of glyphosate that should be used anywhere near a wetland are special aquatic formulations.



For isolated, small patches of invasive plants, in situations where you can provide frequent, consistent treatment, physical techniques and vigorous competition may be enough. For larger patches, or where the intensity of effort needed for physical control alone is not possible, herbicide treatment will probably be needed. In all cases, competition from native species is vital, and a combination of physical and herbicide control, along with native plant competition, will work best. If restricted-use herbicides are needed, a licensed applicator must be employed.

Maintaining diversity

It is difficult to say how many native species ought to occur in a particular riparian area, or even how many different plant comunities there ought to be, because there are so many variables involved. However, as a rough guide, many areas considered to be among the best restored and naturally-occurring riparian wetland sites at elevations of 5,000 to 6,000 feet typically have 5 to 10 different native plant species in square meter sample plots, and perhaps 30 to 60 different native plant species per acre.

4.h] Many different sizes and species of plants all contribute to diversity

As we discussed above, it is always desirable ecologically to have a diverse mosaic of habitat types present within a larger riparian area. Under natural flooding and flow conditions, floodplains are dynamic ecological systems. Substrates vary from cobble bars to rich organic muck and fine sediment. Water tables fluctuate depending on whether they are being recharged by spring runoff and rainfall events or drained by low flows in the adjacent river channel or drought. The bosque floor itself may be a mixture of terraces, side channels and swales, all modified by erosion and deposition and carpeted with organic debris, downed trees, and leaf litter. Because of the disturbance patterns created by flowing water, a healthy bosque will have at least some river margins dominated by early stage pioneers like spikerushes, emergent sedges, and woody seedlings like willow and cottonwood. Other places should be covered with young stands of willow or alder

4.i] Planting native wetland species to increase diversity

shading the river edge, while others are freshly eroding. There may also be taller and denser willows, with a few cottonwoods, box elders, or Goodding's willows beginning to reach above them, and some meadows with fully-grown taller trees with an understory of grass or grass-like wetland plants like sedges beneath them. In low spots or shallow water, there might also be cattails, bulrushes and other obligate wetland plant communities. Shrubs like baccharis, three-leaf sumac or New Mexico olive may dot the bosque landscape. Any given site may not support all these different kinds of bosque vegetation, but diversity is good.

It is hard to make a big difference in the overall habitat mosaic without large-scale restoration work that introduces additional water, re-creates river meandering, or changes the topography. Some things can be done on a less dramatic scale, however. For example, large expanses of cattails can be made more diverse by either digging up the cattails, including the roots (with a backhoe!), or cutting the cattails off in the spring below the normal water level, especially along the edges of the cattail marsh, and planting native sedges (like Nebraska sedge) or three-square bulrush. Stands of coyote willow have a limited life span (roughly 20 to 30 years), and towards the end of this time many willow stems will begin to die and the stand will include more and more standing but dead willows. These dead willows shade and inhibit the growth of the still-living roots. In a natural setting, beaver would rejuvenate the willow plants by cutting the stems for food and building their lodges. However, we can cut and remove the dead willows, break them off with a backhoe, or even drive over them with a bulldozer or tractor in the winter when the ground is drier or frozen, to revitalize the entire patch and start a new growth cycle.

In places that tend to be slightly higher topographically, further from water, or for whatever reason are not colonized extensively by willows or wetland plants, you might plant other riparian shrubs, especially fruit-bearing ones that provide food for songbirds and other animals. Some of these shrubs that are native to the southwest include currants, New Mexico olives, chokecherry, wild plums,buffaloberry, sumac, serviceberry, and wolfberry.

Where the water table is at least two, but no more than 4 or 5, feet below ground, cottonwood and other riparian trees can be planted as "poles" - saplings or branches cut off without roots. The bases of cut poles *must* be kept wet continuously once they are cut, and must be planted (as soon as possible after cutting) with the cut end of the pole below the water table when it is at its lowest level, which usually happens during the winter. Poles must be planted in the winter or very early spring, well before the trees start to sprout. They should also have most buds and branches pruned off, so that the roots have plenty of time to grow before the leaves.

Increasing Species Diversity

The best way to increase species diversity is to plant appropriate native plants where they will have a chance to get established without too much competition. It is generally not worth planting additional plants where there is already nearly complete ground cover, or where there is already some variety in the species present. The best places to consider additional planting would be where there has been some ground disturbance (excavation work, road maintenance, or fire, for instance), and where invasive plants have been removed or need as much native competition as possible. For example, cheatgrass (*Bromus tectorum*) is practically impossible to control without vigorous native competition, and the best strategy is to sow a variety of native grass seed and mow the cheatgrass early and repeatedly to restrain seed production and give native seeds a chance to get established. Alternatively, native seed can be sown after herbicide treatment of the cheatgrass. The diversity of monocultural cattail stands can be increased by planting larger sedges or bulrushes, or even coyote willows, into parts of the cattail stand (after cutting or removing some of the cattails). Increasing native biodiversity is a leading benefit of successful restoration, but is highly site-specific and is best done in consultation with a qualified native plant supplier or a restoration ecologist with local experience in your area. For a list of native plant suppliers for bosque and wetlands and local restoration contractors, visit the SWQB Wetlands Program website at *www.nmenv.state.nm.us/swqb/wetlands/*.

Sensitive species habitat—The gift of stewardship

Some landowners may be concerned at the very idea that their property might be home to an endangered animal or plant, because they worry about government interference with their land use choices. It is true that there are legal protections for endangered species, even on private land, but they are less onerous than many people have been led to believe. The US Fish and Wildlife Service can be quite helpful in working with private landowners about endangered species issues. And what could be more helpful to the environment than becoming a steward of rare and unique habitat for a species in peril?

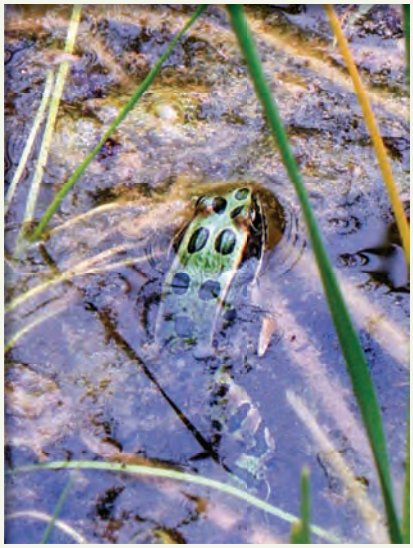
A key provision of the Endangered Species Act likely to benefit a bosque landowner inclined to create habitat for an endangered animal like the southwestern willow flycatcher is the *Safe Harbor Agreement*. Is essence, a Safe Harbor Agreement gives a landowner legal assurance that if they benefit endangered species on their property in a way agreed with the US Fish and Wildlife Service, the Service will impose no other land use restrictions on the property and, at the end of the agreement, the landowner could (if they wanted to) alter the habitat improvements or make other changes to their land, even if these changes impacted the endangered species, so long as the situation became no worse than it was at the beginning of the agreement. In other words, if a landowner was successful in creating southwestern willow flycatcher habitat where there had been none before, they would not be restricted in their future land use options because of the flycatchers. More information about the Endangered Species Act and the US Fish and Wildlife Service's role in it can be found at *www.fws.gov/endangered*, and a fact sheet on Safe Harbor Agreements can be found at *www.fws.gov/Endangered/factsheets/harborqa.pdf*.

4.j] Expanding a willow patch for flycatcher habitat

Willow flycatchers aren't the only sensitive species

There are other threatened, endangered and sensitive species in southwestern riparian ecosystems besides southwestern willow flycatchers. There are other birds, as well as fish, amphibians, and mammals. Some important examples include: Leopard frogs, Jemez Mountain salamanders, meadow jumping mice, river otters, yellow-billed cuckoos, Rio Grande silvery minnows, cutthroat trout and raptors.

Updated information can be found at the New Mexico Department of Game and Fish web site at gmfsh.state.nm.us, or at the US Fish and Wildlife Service web site at fws.gov/endangeredspecies/lists/ListSpecies.cfm.



4.k] Leopard frog

Water, wetlands, and river connection

Usually it takes a fairly major restoration project to make much of a change in how much water is available in a riparian area. Creating new (or re-connecting old) wetland, allowing more overbank flows, raising a down-cut river channel, or enhancing meander patterns generally require careful and experienced planning, significant earthmoving, and the services of an excavation contractor with sensitivity and experience in restoration work. In most cases, what is really needed is for this kind of river restoration to be done for significant reaches (hopefully, miles at a time) of entire rivers, which inevitably becomes a public project to be done in collaboration with private landowners and stakeholders along the river.

Short of comprehensive large-scale river restoration, however, it may still be possible to get a little extra water to parts of your bosque. If your riparian area is along a smaller stream, there are techniques that can actually be done by hand for enhancing meander patterns and re-connecting riparian areas to the streams that sustain them. A brief introduction to some of these techniques is published as ***An Introduction to Induced Meandering*** by Bill Zeedyk, and can be downloaded for free at *quiviracoalition.org*. A new book with much more detailed explanation of these techniques is ***Let the Water Do the Work*** by Bill Zeedyk and Van Clothier, and can be purchased from the Quivira Coalition online. Be aware that any earthmoving that involves a stream or arroyo channel is likely to require a permit from the Army Corps of Engineers. More information can be found at *spa.usace.army.mil/reg/*. Other permits also may be required for earth moving projects. Visit the SWQB Wetlands Program website at *nmenv.state.nm.us/swqb/wetlands/* for a list of possible permits that may be needed and contact information to get started.

4.l] Post vane on the Pecos River has captured sediment to support sedges, willows, and other riparian vegetation and encourage river meandering.

In other situations, there may be other ways of helping the wetness of your wetland. Any irrigation system needs to divert more water from a stream than is actually used on the fields, to ensure adequate flows through the network of ditches. The excess water flows back into the stream at various outlets, often through riparian areas. These return flows can be allowed, or encouraged, to flow back through current or former wetlands, abandoned river channels, or old oxbows. Where they do, they contribute invaluable water to the riparian area, especially in all-too-common instances where streams can no longer inundate the bosque at high water as they should naturally. You may also be able to simply use a little irrigation water intentionally to support wet meadows or marshes in the bosque. You will, of course, need to have water rights to do this, but the amount of water needed is quite small and can often be done in conjunction with irrigating nearby pasture or cropland.

Even though an important focus of riparian restoration is often to get more water into places that used to be much wetter, the drier parts of the bosque are still ecologically valuable and should not be undervalued. The outer edges of floodplains, higher land within bosques, and other drier places are beautiful in their own right and form a valuable part of the mosaic. They should be monitored and kept free of invasive plants. It is also worth encouraging native diversity in drier places where the natural vegetation tends to be saltbush, chamisa, sage, Gambel oak, mountain mahogany, or grass.

Creating appropriate disturbance patterns

Just as it is likely to be a major undertaking to change the amount of water available in your site, it is not easy to change the patterns of sediment erosion and deposition that govern bosque ecology. In fact, the two are inextricably intertwined. Indeed, the techniques for controlling channel downcutting and encouraging meandering that we mentioned above for increasing the wetness of a site are the same tools we can use to influence the patterns of vegetation regeneration that are necessary for long-term ecological functioning. They are also easier and much less expensive on smaller streams.

In many circumstances it will not really be possible to change the degree of flooding and sediment transport disturbance at your site without a comprehensive restoration program, beyond the scope of anything reasonably called maintenance work. Nevertheless, in some cases, especially on smaller streams, you can enhance meander patterns, trap sediment at high water, or perhaps re-connect parts of the bosque cut off from the stream and encourage the wet, bare soil that enables wetland plants to reproduce. The key information you need is whether your site has an appropriate degree of ecological disturbance arising from natural river dynamics—enough disturbance for native plants to regenerate, but not so much that they are constantly washed away or have no place to sprout.

One of the best indicators of too much disturbance would be excessive erosion of riverbanks at normal low stream flows. Some periodic bank erosion (and re-deposition) at flood flows is normal and necessary for ecological health on southwestern rivers, but normally you should not see banks caving in or being eroded at low water. If you do, there is a problem that needs to be addressed. The real problem may not even be on your stream reach, and the potential causes and remedies are beyond the scope of this booklet to cover, although there are stream restoration techniques you may be able to use on your own site. You should consult a stream restoration professional, or read further in sources like Zeedyk and Clothier's book ***Let the Water Do the Work***.

Conversely, if there is nowhere you find any little cottonwood or willow seedlings, or a green fuzz of little spikerushes, horsetails, or grass-like plants sprouting on a sandbar or along the edge of the stream, you may not have enough natural disturbance for your riparian ecosystem to be self-sustaining. It may seem paradoxical, but some of the same techniques that can be used where banks are eroding excessively (like structures for trapping sediment or encouraging meanders) can also be useful where there is too little change in river banks over time. In this situation also, detailed diagnosis and restoration are very site-specific and beyond the scope of this guide. Some of the same resources on stream restoration you might consult for excessive erosion, such as Zeedyk and Clothier, or ***Applied River Morphology*** by Dave Rosgen (available at *wildlandhydrology.com*), may help find the right remedy where there is too little erosion and deposition.

Maintaining fire resistance

The dramatic increase in bosque fires over the past couple of decades is largely due to the increase in fire-prone invasive trees like Russian olives and salt cedars, along with the drying-out of many riparian areas as rivers have become more disrupted by dams, levees, and the downcutting of river channels. If you have ever walked through parts of the Rio Grande bosque in Albuquerque, you may notice the thick cover of dry leaves and debris, sometimes feet thick. Under a normal flooding regime, these thick mats of dried vegetation would be carried away by flood waters or would be converted to rich soils by moisture and active microbial and insect activity. The mosaic pattern of healthy native bosque and wetland vegetation can be less prone to fires and quite effective in restraining the spread of a fire if it gets started. As an example, one fire along the Rio Grande north of Española in the 1990s, in an area thick with Russian olive, burned over 300 acres in an afternoon, jumping back and forth across the river. After a series of successful restoration projects re-established native vegetation in the area, another fire that started in almost exactly the same location, at the same time of year, in very similar wind and moisture conditions, burned only 36 acres.

Bosque fires are practically all started by people. They almost always happen in the springtime, when there is lots of dead and dry vegetation from the year before, weather conditions are dry, it is often windy, and people are likely to be burning trash or weeds along irrigation ditches. Fire can certainly start and spread in native riparian vegetation, and even if it may not spread as fast or as far as it would in a thicket of salt cedar or Russian olive, it is worth giving some thought to preventing it.

Hopefully this section has provided some useful information about how to understand and take care of the riparian area you are interested in. The last section discusses a few of the other activities, land uses, and situations that often affect riparian areas, and how they can (or sometimes may not) be compatible with an ecologically healthy bosque.

Reducing fire risk

There are several simple things you can do to reduce fire risk a great deal, in addition to clearing invasive trees:

Get rid of dead vegetation around places people are likely to use recreationally, especially places where you or anyone else might want to build a campfire or use a barbeque.

Clear shrubs, brush and tall herbaceous plants away from buildings and outdoor living areas near the bosque to create a defensible space, just as you would in a coniferous forest.

Try to prevent "fire ladder" conditions from occurring in recreation sites or around homes. Grass and ground fires can spread into shrubs or low tree branches and then into taller trees.

Consider a fire break, or at least prevent fire ladders, along the boundaries of your property, especially if you have neighbors who still have salt cedars or Russian olives.

Don't burn trash, and be extremely careful, with plenty of water and fire extinguishers handy, if you burn ditch banks or start any other fires in the bosque. Try to find other alternatives to fire when dealing with these situations if possible.

Healthy rivers and riparian ecosystems are vital resources for countless native plant and animal species in the southwest, and sources of beauty and joy for us humans, as well. They are ecologically indispensable, but that does not mean they can never support any other uses, with a little care and attention.

5.a] Recreation is an important use of riparian areas.

Grazing management

A healthy bosque can certainly be used by grazing animals, but both the *timing* and *duration* of grazing have to be managed carefully. In this regard grazing in riparian areas is no different than grazing anywhere else in the southwest: grazing animals have to be controlled and managed, not just turned loose. As with river channel restoration, grazing management is a vast subject that is well beyond the scope of this booklet to consider in full, but there are some considerations about grazing in riparian areas in particular that should be given some attention.

New vegetation is extremely vulnerable to grazing damage in a way that more mature plants, with more developed roots, are not. With this in mind, all grazing animals should be kept out of newly-restored sites (where additional plants, shrubs, or trees have been seeded or transplanted) for at least one full growing season, perhaps longer. It is important that the new plants have all had time to become well-established and able to withstand grazing pressure. Grazing in the first year is likely to just pull up most of what you have planted, roots and all. It is a good idea to avoid grazing in any riparian area, restored or not, in the spring when newly-emergent plants along river banks are at their most delicate and vulnerable. Even if they are not actually grazed, they are much more easily damaged by trampling than they will be later in the season.

Many ranchers have found that grazing riparian areas during the dormant season is the best option. During the late winter a number of bosque plants still offer animal nutrition. They are finished storing nutrients and carbohydrates for the next growing season but are not currently flowering or producing seed, so their reproduction is not affected. If there are (as we hope) seedlings of willows or cottonwoods, they will not have leaves during the winter and will be less attractive to grazing animals. There are anecdotes of ranchers who have managed summer riparian grazing successfully, but the timing and intensity of animal access would have to be controlled more precisely and the effects of grazing monitored more carefully and frequently to ensure that growing-season grazing was not damaging a riparian area in ways that may not be apparent at first.

To be sure that grazing is not damaging a riparian area, you should pay special attention to the most palatable plants—the ones livestock eat first—and the plants most sensitive or vulnerable to grazing pressure, like new woody seedlings and other emergent vegetation. The rule of thumb that grazing animals should not remove more than 40 or 50 percent of any plant's biomass over the course of a year is generally appropriate in a riparian as well as in a rangeland setting, but it is important to be sure that you do not miss over-utilization of favored plants in all the profusion of growth in a healthy bosque.

5.b] Dormant season grazing generally causes less riparian disturbance

Other principles of managed grazing, like keeping animals in a relatively small area and moving them frequently, leaving adequate time for re-growth, and minimizing opportunities for invasive plants in areas of high use, are just as important in riparian areas as anywhere else.

Recreational use

Recreational use of riparian areas does not usually cause much trouble, so long as people do not let fires get out of control, or trample the same small area constantly. Both of these potential problems can be addressed fairly easily.

One of the best ways to minimize the chances of starting a bosque fire is to avoid building any fires during the springtime when the soil and dead vegetation are dry, and conditions most likely to be windy. It is also common sense to keep any recreational fires within prepared fire rings, and clear any brush, weeds, and dead vegetation away from the fire ring to prevent a "fire ladder" situation. Shovels, buckets, and fire extinguishers are good things to keep handy in the bosque, as in any outdoor places that get recreational use.

In areas that get walked on heavily enough to keep grass and other plants from growing, it is a good idea to protect the ground surface. This not only reduces erosion and mud, it minimizes opportunities for invasive plants to get established. One simple way to do this is to install geotextile or landscaping fabric over the soil in high-traffic areas and trails, and cover it with at least a couple of inches of gravel or mulch to keep it out of the sun. The gravel and landscaping fabric will support foot traffic, keep your feet out of the mud when it is wet, and make it more difficult for weeds and invasive plants to get started. You should be aware, though, that landscaping fabric will break down and probably have to be replaced after five to ten years.

There are other ways to provide mechanical support in areas that get a lot of use, even including vehicle traffic. These are erosion control paving products and involve various kinds of permeable plastic, metal, or concrete grid that provide support but still allow natural vegetation to grow through the grid and water to infiltrate into the soil. They are more expensive and require more effort to install, but last a long time and may be worth installing in heavily used areas, roads or vehicle access points, or places where a level surface is needed. Many kinds can be found in a web search for "erosion control paving".

Living with wildlife

Riparian areas are critically important to countless species of southwestern wildlife. There is a great variety of both plant and animal species, and many opportunities to see different birds, mammals, and other wildlife, in any healthy bosque. You can maximize the number of different wildlife species you see by encouraging habitat diversity, and you can minimize the chances of conflict with certain wild neighbors, if they turn up.

One of the best ways to see as many different kinds of birds and animals as possible in your bosque is to encourage variety in the kinds of micro-habitat possible in your particular situation, as discussed above. Water birds like ducks and geese need areas of open water for feeding and nesting, of course, ideally with some islands if space allows. Raptors, such as eagles, ospreys, and many hawks, need *snags* – tall, dead trees they can perch on with good

Minimizing recreational ground disturbance

Structural support products that allow natural vegetation to grow through can help prevent muddy, trampled areas and at the same time minimize the effects of heavy recreational use on native plant communities. There are concrete products as well as similar recycled plastic ones.

It can also be very helpful to build small bridges, boardwalks, or even decks (perhaps out of recycled plastic "boards") in places where a raised trail or walkway would disrupt natural water flow patterns. These structures are sometimes more expensive initially than other kinds of trail, but may last longer and require less maintenance.

5.c] Concrete vegetation support blocks

5.d] Small bridge over wetland water channel

5.e] Beavers are important contributors to wetland and riparian ecology. They create open water and marshy conditions that would sometimes be very scarce without them. As their dams are built and then abandoned, they contribute to the ecological mosaic so important for healthy bosques, and help create the kinds of disturbances that allow new plants to grow and sustain the dynamic of ecological succession.

visibility—along with plenty of smaller mammals, birds, and fish as food supply. Songbirds and other smaller birds thrive in many kinds of localized habitats, from treetops through understory trees and shrubs of all kinds right down to grassland for ground-nesting birds like killdeer and quail. Deer are especially interested in shrub-level browsing, while elk tend to prefer grazing on grass and sedges. Both need dense brushy cover in addition to more open patches for grazing and browsing. Fish and muskrats rely on diverse aquatic habitat just as many young riparian and aquatic plants need variety and change in streambank and island habitats.

Occasionally, wildlife may present some challenges for us human neighbors. Beavers, for instance, are notorious for blocking culverts or irrigation ditches. However, many beaver problems can be fairly easily resolved by fencing around culverts or other places beavers want to dam in a way that makes it difficult for beavers to successfully back up water. These kinds of fences are called "beaver deceivers", named by their inventor, wildlife biologist Skip Lisle. In some designs the fences are constructed to come to one or more sharp points upstream of the culvert inlet or spillway so that it is very difficult for beavers to pack sticks and mud against them. In other designs the wire-mesh fence is built trapezoidally, with the big side upstream of the culvert. In these beaver deceiver designs, the fence is far enough upstream of the culvert that not only is it difficult to successfully build a dam against the fence, but the beavers feel less urge to build the dam at all because water is not flowing past the fence with any velocity. More information and several designs can be found with a web search for "beaver deceiver".

Bears are not necessarily bosque dwellers, but they may occasionally turn up. Whether a bear visits your bosque is probably more related to hard times in its normal habitat than to conditions in the bosque, but bears tend to be very fond of ripe fruit. So, if there are wild plums, old apples, or apricot trees in the bosque, or domestic fruit trees near riparian areas, they may attract bears as the fruit gets ripe. If you live near a riparian area and are concerned about bears, or have seen bears nearby, there are bear-safety guidelines you can follow around your home. More information about living with bears can be found at almost any state wildlife department (the Colorado Division of Wildlife web site, for instance, is at *wildlife.state.co.us/bears*), but some of the key points for bear safety include:

- ***Use bear-proof trash and compost containers***
- ***Remove bird feeders except when bears are inactive for the winter***
- ***Store pet or other food, and BBQ equipment, inside a secure place***
- ***Remove food, beverages, and scented items from cars***
- ***Keep doors and windows closed at night and when you are away***

5.f] Beaver deceivers need to include sharp angles that are difficult to build a dam against. They should also be far enough upstream of culverts that water is not rushing past the beaver deceiver, so beavers are less instinctively driven to build a dam.

Trees and shrubs

Salt cedar seedlings grow in exactly the same places as cottonwoods or willows—wet, sunny soil, often along riverbanks and on sandbars and islands. The other trees are more likely to sprout in the shelter of other plants, a little ways away from the stream itself, and they do not require full sunlight or completely saturated soil. As with any invasive plant, they are likely to sprout in places where existing plants have been disturbed by something. All these trees will sprout back very vigorously from cut stumps and roots left in the soil.

Salt cedar [6.a]
Tamarix spp.

Russian olive [6.b]
Eleagnus angustifolia

You already recognize these familiar banes of the bosque, right? Here are what the seedlings and sprouts look like so you can manage them before they get out of hand.

Siberian elm [6.c]
Ulmus pumila

Siberian elm spreads prolifically from seed and sprouts from its roots. The seeds are even edible, if you gather them in the spring when they are green and tender.

Tree of heaven [6.d]
Alianthus altissima

Don't overlook these invaders. In New Mexico, they are not as common as salt cedar, Russian olive or Siberian elm, but they can spread very rapidly.

Herbaceous plants

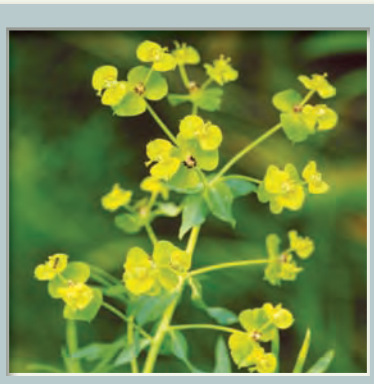
Purple loosestrife is a true wetland-obligate plant that is spreading in New Mexico in the same places as, and even among, cattails. It requires very wet soil and can tolerate some permanent standing water. In these conditions it can spread explosively.

Purple loosestrife [6.e]
Lythrum salicaria

Blue verbena [6.f]
Verbena hastata

Be sure not to confuse it with blue (swamp) verbena (Verbena hastata), a most desirable native wetland plant.

Leafy spurge, perennial pepperweed, thistles, and toadflaxes are all plants that require the moisture of riparian areas but do not need completely saturated soil, and grow in slightly drier places than purple loosestrife. As with all invasive plants, they are especially likely to sprout where existing plants have been disturbed.



Leafy spurge [6.g]
Euphorbia esula

Don't handle this plant without skin and eye protection! It is best not to pull this plant at all, because it has an extensive root system and will just re-sprout.

Perennial pepperweed (or Whitetop) [6.h]
Lepidium latifolium

Root segments as small as one inch are capable of producing new shoots.

Herbaceous plants (cont.)

Canada thistle [6.i]
Cirsium arvense

Musk thistle [6.j]
Carduus nutans

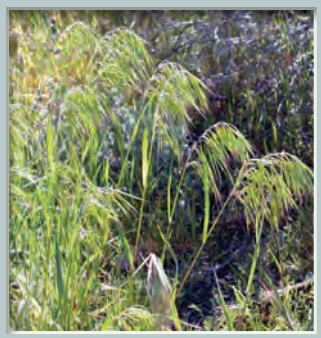
Canada thistle [6.k]
(sprout)

Bull thistle [6.l]
Cirsium vulgare

Dalmatian toadflax [6.m]
Linaria dalmatica

Yellow toadflax [6.n]
Linaria vulgaris

Cheatgrass, along with the knapweeds and starthistles, require the least water of any of the invasive plants shown here, and may occur farther from streams and open water. In fact, they are often found in rangelands far from anything riparian. Nonetheless, they thrive in moist riparian areas and are a rapidly increasing threat there.



Cheatgrass [6.o]
Bromus tectorum

This annual grass mainly reproduces by seed and can be controlled by mowing before seed production.

Russian knapweed is one of the most difficult invasives to control. Pulling and cutting alone are ineffective, because its main mode of reproduction is sprouting from buds on its creeping root system, which will seek moisture as deep as 75 feet. Seek professional help to control this increasingly common invasive weed.

Russian knapweed [6.p]
Acroptilon repens

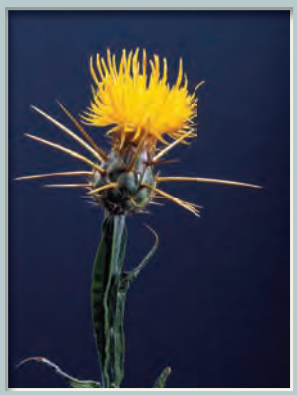
Russian knapweed [6.q]
Acroptilon repens

Spotted knapweed [6.r]
Centaurea stoebe

Purple starthistle [6.s]
Centaurea calcitrapa

Spotted knapweed [6.t]
Centaurea stoebe

Yellow starthistle [6.u]
Centaurea solstitialis



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