PROJECT GUIDELINES

ABOUT

The New Mexico Department of Game and Fish Project Guidelines provide conservation measures to minimize impacts of land use and development projects on wildlife and wildlife habitats. This set of guidelines addresses the management of grazing in riparian areas. For more information on this topic, please call 505-479-1269.

ERT for NM

The Environmental Review Tool (ERT) for New Mexico is a web-based system that quickly screens land use and development projects for potential impacts to wildlife and wildlife habitats. The ERT provides best management practices and guidance to mitigate these impacts. Evaluate your project with the ERT at: https://nmert.org/home.

EEP SECTION

The Ecological and Environmental Planning (EEP) Section's Technical Guidance Team coordinates the Department's environmental review process and works with community, private sector, state and federal government, nongovernmental organizations, and other project proponents to protect and enhance wildlife habitats. The Section implements the Share with Wildlife program and maintains BISON-M, a database of New Mexico's wildlife species. It also participates in the development and application of wildlife-related information management and planning tools.

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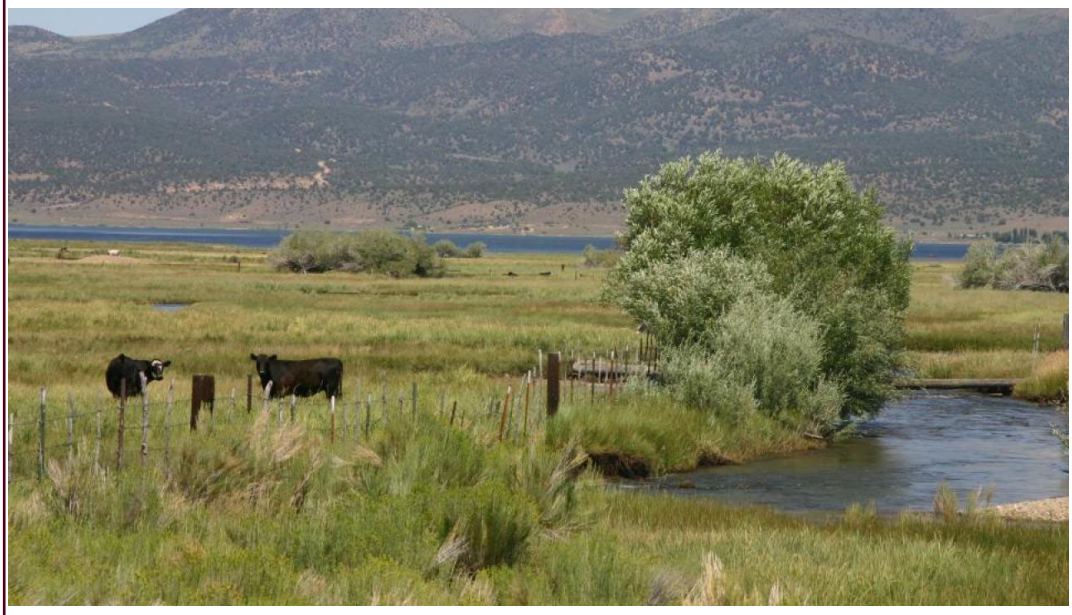
Guidelines for Grazing Management in New Mexico's Riparian Areas: Towards Protection of Wildlife and Fisheries Resources



Cattle grazing near a riparian habitat. Ken Tate

The New Mexico Department of Game and Fish (Department) acknowledges the economic and cultural benefits of livestock grazing for individuals, communities, and the state. However, the Department also recognizes that intensive grazing by livestock has significantly impacted the ecological and environmental conditions of Southwestern rangelands, especially riparian areas (i.e., interfaces between land and inland waters). These land-water interfaces, which are important habitats for wildlife, have undergone dramatic changes since the region's settlement by Euro-Americans. Most of these changes are attributable to the historical grazing practices of domestic livestock owners over the past 400 years, along with other landscape-altering practices such as mining, logging, beaver removal resulting from trapping, and development. By the early 1870s, observers recorded a rapid deterioration in range conditions across the Southwestern U.S. (Calamusso 2005). Scurlock (1998) identified the primary causes of this decline in range condition as the consistent overstocking of upland and riparian habitats and drought throughout the late 1880s. As a result, vegetation was stripped from riparian slopes leading to greater streambank erosion and a loss of the ecosystem services riparian habitats could provide. In more recent years, cattle grazing has affected riparian/aquatic ecosystems in New Mexico and elsewhere by interacting with other, concurrent land uses, including recreation, energy production, and water management (Armour et al. 1994, Fleischner 1994, Belsky and Blumenthal 1997, TWS 2022). In response to the known negative impacts grazing can have on riparian habitats, including those listed above, the Department has synthesized this guide, which outlines the importance of riparian habitats and compiles the best livestock management practices to reduce and minimize impacts to wildlife from grazing in New Mexico's diverse riparian areas.

What are Riparian Areas?

Although they make up less than 2% of New Mexico's total land area, riparian corridors are the most significant ecosystems for wildlife in the state. These corridors provide essential resources to both livestock and wildlife, including water, food, cover, and shade. At least 80% of New Mexico's vertebrate wildlife uses riparian areas at some point in their life cycles and 50% are reliant on these corridors as riparian obligates. More bird species utilize riparian areas during the breeding season than any other habitat in the state. These areas also provide essential ecosystem services, including filtering sediments from overland flows, slowing the release of run-off from upland areas into

Box 1: Traits of Intact and Degraded Riparian Wetlands

Rio Cebolla. J.N. Stuart

Intact riparian wetlands

1. High water table and increased soil water storage capacity
2. High forage biomass production and reproduction
3. Good shade and bank cover; stabilized stream banks
4. Clear water and lower evaporation rates
5. High water quality, including high dissolved O_2
6. High wildlife habitat diversity
7. Vegetation, including roots, present to stabilize banks
8. Increased late summer stream flows

Grijalva River. D. Moreno-Mateos

Degraded riparian wetlands

1. Low water table and decreased soil water storage capacity
2. Low forage biomass production
3. Little shade or ground cover; unstable banks
4. Murky water and higher evaporation rates
5. Poor water quality, including low dissolved O_2
6. Low wildlife habitat diversity
7. Little or no vegetation, including roots, to stabilize banks
8. Reduced late summer stream flows

Valles Caldera National Preserve. WildEarth Guardians

Consequences from Livestock

1. Alteration of plant species composition, including decreases in density and biomass of individual species, reduction of species richness, and changing community structure
2. Disruption of ecosystem functioning, including of nutrient cycling and community succession
3. Modification of vegetation structure, leading to decreased soil stability, elevated soil erosion, altered channel morphology, and decreased availability of high-quality water

streams, and slowing floodwaters. However, because of the availability of water, shade, and the quantity and variety of plant species that are typical of riparian communities, cattle exhibit strong preferences for these areas, which can lead to severe degradation if livestock access is left unregulated (Kauffman and Krueger 1984, Schulz and Leininger 1990, Belsky et al. 1999). New Mexican vegetation communities developed under light grazing pressure by native ungulates, making them vulnerable to degradation by intense livestock grazing (Elmore and Kauffman 1994).

An *intact riparian zone* consists of vegetation that typically progresses from water-loving flora at the water's edge to more upland vegetation that can thrive with a lower water table. In general, riparian vegetation has larger, shallower root masses than upland vegetation, which are particularly effective at helping to sustain stream bank stability (Prichard et al. 1998). High root and stem densities also help to slow floodwaters, which lessens erosion, enhances water infiltration into the soil, and traps sediments. In addition to reducing sedimentation, the vegetation in riparian areas helps to filter contaminants and pollutants, thus improving water quality (Box 1; DeBano and Schmidt 1989). Intact riparian zones also provide shade, which helps regulate water temperature, which is important to many aquatic species.

A *degraded riparian zone* lacks the capacity to provide the previously described ecosystem services, which can lead to reduced bank stability, increased water temperatures and stream flows, and degraded and decreased wildlife habitat features, mainly through the loss of vegetation diversity (Box 1; Kauffman et al. 1997). Livestock grazing can lead to these and other negative impacts on streams and riparian areas, including changes in watershed hydrology and stream channel morphology (typically becoming wider and shallower), soil compaction and erosion, and riparian vegetation destruction. Damage to stream banks and channels from grazing and trampling can result in fine sediment accumulation and decreased water quality (Kershner et al. 2004).

It is becoming increasingly apparent that restoration, enhancement, and protection from further deterioration are required for many of New Mexico's riparian areas. With proper management of riparian ecosystems, water quality may improve, the consequences of flooding may be lessened, and vegetative biomass production may improve, thus benefiting livestock, fish, and wildlife. Riparian system management should go beyond consideration of benefits to livestock to include the full ecosystem, and associated ecosystem services, and resource needs of aquatic and terrestrial animals (TWS 2022).

Impacts of Grazing on New Mexico's Wildlife

Fishes

It is essential to prevent livestock from loafing in backwaters, marshes, or still water bodies where they can trample sensitive vegetation and aquatic fauna, stir up sediment, and contaminate the water. Prevention is especially important where there are threatened, endangered, sensitive (TES), or rare fish species present. Fish rely on these areas as breeding and brooding grounds. The reproductive success of aquatic organisms is likely to be negatively impacted by pollution and siltation resulting from cattle loafing, which impacts local water quality, especially by reducing the amount of dissolved oxygen in the water and increasing water turbidity. A review by Ohmart (1996) found that riparian degradation from grazing threatened the habitats of native trout species by changing channel structure and reducing water quality. Thus, proper grazing management is important for protecting New Mexico's threatened Gila trout (*Oncorhynchus gilae*). Loss of riparian woody vegetation resulting from grazing also impacts other TES fish in New Mexico, including the Southern redbelly dace (*Chrosomus erythrogaster*), round-tail chub (*Gila robusta*), and Chihuahua chub (*Gila nigresens*) (NMDGF 2022).

Rio Grande cutthroat trout. J. Caldwell

Meadow jumping mouse. J.N. Stuart

Mammals

The federally-endangered New Mexico meadow jumping mouse (*Zapus luteus luteus*) relies on intact meadows and dense, herbaceous vegetation along streams. The most immediate threat to this habitat and the meadow jumping mouse is the loss or degradation of streamside vegetation resulting from intense grazing and drought (NMDGF 2022). Reduction and degradation of habitat by livestock grazing also threatens other riparian mammals including the Arizona montane vole (*Microtus montanus arizonensis*) and the North American least shrew (*Cryptotis parvus*) (Zwartjes et al. 2005, Frey 2021, NMDGF 2022). Small mammals are particularly sensitive to disturbances in plant communities, including the removal of herbaceous plant cover resulting from grazing, and therefore can be indicators of riparian ecosystem health (Frey 2018). These species are also threatened by water management, use, and scarcity; drought; climate change; and wildfires (NMDGF 2022). Riparian corridors are also important for many species of bats, some of which have been shown to prefer densely-vegetated riparian areas compared to neighboring livestock pastures (Rogers et al. 2006, de la Peña-Cuéllar et al. 2015).

Narrow-headed garter snake. T. Pierson

Beavers (*Castor canadensis*) are often removed from riparian areas by landowners because they impact human infrastructure or are perceived as pests, however, their presence can be beneficial to both the landscape and to livestock. Beaver dams can raise the water table, provide a stable source of water year-round, and create wetland habitats, which promote vegetation growth that is beneficial to the beavers, other wildlife, and livestock as forage material (Zwartjes et al. 2005). In addition, streams that have healthy beaver populations are often excellent habitat for a wide range of other wildlife, including small mammals such as mice, shrews, and voles; reptiles and amphibians; and a variety of waterfowl (Pollock et al. 2018).

Southwestern willow flycatcher. M. Watson

Herpetofauna

Many species of reptiles and amphibians rely on the dense, herbaceous vegetation found in healthy riparian areas along streams. For example, the Rio Grande cooter (*Pseudemys gorzugi*) will use this vegetation cover for nesting, and garter snakes rely on dense wetland vegetation to hunt for prey and for cover (Zwartjes et al. 2005). Other herpetofauna that utilize riparian habitats include the threatened Chiricahua leopard frog (*Lithobates chiricahuensis*) (Rorabaugh and Sredl 2014) and the plain-bellied water snake (*Nerodia erythrogaster transversa*) (Degenhardt et al. 1996). Livestock use of riparian areas can reduce vegetation cover, decrease water quality, and increase siltation and erosion of streambanks, therefore degrading both aquatic and riparian habitats important for herpetofauna. This can directly impact

Bumblebee. J. Wilson

some species like the narrow-headed garter snake (*Thamnophis rufipunctatus*), which requires clear, high quality water to hunt fish (NMDGF 2022). Furthermore, if grazing causes the vegetation composition to become dominated by non-native species, it may be harmful to some herpetofauna, such as narrow-headed garter snakes and Mexican garter snakes (*Thamnophis eques*; USFWS 2013).

Birds

Because riparian areas are heavily utilized by migrating and local birds, it is imperative that these habitats are protected from deterioration. Grazing should be discontinued immediately in areas that encompass breeding and foraging grounds for state or federal TES species of birds. For example, Southwestern willow flycatchers (*Empidonax trailii extimus*) nest in shrubby vegetation in riparian and meadow areas. Although salt cedar (tamarisk) may be used for nesting, this bird species prefers areas with thick stands of willows and understory growth, which can be inhibited by livestock overgrazing. Another example is the yellow-billed cuckoo (*Coccyzus americanus*), which nests in native riparian forests (Johnson 2009). Grazing should be avoided in known willow flycatcher and yellow-billed cuckoo nesting sites to allow native woody plants, important to these birds, to grow. While cattle are present, care should be taken to ensure that no more than 20% of the annual, leader growth of hardwood seedlings is browsed (USFWS 2002).

Pollinators and Insects

Riparian connectivity and system health are important to native bees and other pollinators (DeBano and Wooster 2004, Williams 2011, DeBano et al. 2016, Roof et al. 2018). Grazing in riparian areas has been shown to reduce floral abundance and diversity (Mitchell 2020), limiting the richness of flowers available to native pollinators. For example, Cole et al. (2015) found a greater number of bumblebees and butterflies in riparian areas compared to a neighboring grassland used for livestock grazing due to a higher concentration of flowers in the riparian zone. They also found an even greater bumblebee abundance in riparian areas for which fencing was used to exclude livestock (Cole et al. 2015). This suggests that the reduced ground cover, trampling, and preferred species removal caused by livestock disrupt riparian health and are detrimental to pollinator survival (Mitchell et al. 2021). Riparian grazing has also been shown to decrease the number and diversity of freshwater insects (Herbst et al. 2012) and input of terrestrial insects, which are also an important food source for fish, to stream systems (Edwards and Huryn 1996).

Grazing Management Recommendations

Determining Riparian Condition Prior to Grazing

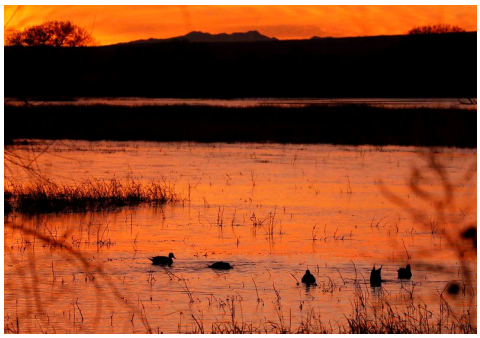
Riparian condition and functional state should be evaluated *before* developing a grazing management plan. This allows ranchers and managers to tailor their plan to the needs of the riparian habitat. An integrated, multi-resource strategy for quick evaluation of the functional state of riparian habitats in the Southwestern U.S. was described by Stevens et al. (2005). This strategy focuses on the following five functional groups of stream and riparian ecosystem traits:

1. Quality, availability, and function of waterbodies
2. Morphology of floodplains and stream channels
3. Habitat availability and quality for aquatic species
4. Vegetation structure and species composition (including non-native species)
5. Habitat suitability for terrestrial wildlife, including TES species

Smilar evaluation criteria are outlined in the Bureau of Land Management's (BLM) publication, "Riparian Area Management: Process for Assessing Proper Functioning Condition" (see Additional Resources).

Prioritize Riparian Restoration

Landowners and managers should include maintaining or improving riparian condition as a grazing management objective (Baker et al. 2001). The steps to improve riparian systems are site-specific and largely dependent on the system's existing condition. If a riparian area is severely degraded and is in poor condition, it should *not* be grazed. Degraded riparian habitats can only recover if livestock are completely excluded (Leonard et al. 1997). However, because of their high productivity and resiliency, Southwestern riparian areas can recover rapidly when causes of degradation are removed (Ebersole et al. 1997). It may take only a year for some grass species to regrow, whereas woody plant regrowth and recruitment may require multiple years of rest.



Sunrise at Bosque del Apache. M. Watson

Gila River. E. Nortemann

Grazing Management Strategies

Timing, duration, and intensity are important factors to consider when developing a grazing management strategy. Continuous and high intensity grazing pose significant threats to riparian habitats while rest or deferment from grazing and active management are effective in improving riparian conditions (George et al. 2011). The following recommendations are intended to help land managers design a sustainable grazing regime that is beneficial to livestock, riparian areas, and wildlife:

1. Avoid passive, continuous grazing. This is defined as grazing in one pasture throughout the year, with little or no effort to monitor or control livestock distribution or stocking rate. Typically, passive, continuous grazing leads to riparian areas being overgrazed. Riparian areas may also be overgrazed with a prolonged grazing season , as may occur with rotational deferred or rest-rotation grazing. Limit season-long grazing to those situations where animal use and distribution can be carefully controlled, including the use of riparian or other special use pastures, and where stubble height requirements for different wildlife species can be maintained.

2. Implement deferred and rotational grazing systems. Deferred grazing or stocking is a non-systematic rotation of livestock to other land units, and rotational deferred grazing is the systematic rotation among land areas within a grazing management unit (Allen et al. 2011). Both strategies have been successful in restoring and improving riparian areas. For best outcomes for riparian areas, don't include extended seasons of continuous grazing with these grazing systems.

3. Closely monitor spring and fall grazing. Grazing in both spring and fall usually fails to meet riparian vegetation needs since it doubles potential grazing impacts within a single growing season. However, grazing earlier in the growing season has been shown to be an effective strategy and may allow for greater plant recovery time than either summer or fall grazing. Thus, spring grazing may improve vegetation growth in riparian areas if carefully monitored. On pastures grazed only in spring, limit utilization of streamside herbaceous growth to about 65% of the available vegetation, and remove livestock by July 15 to allow sufficient time for plant regrowth. Combining early and late growing season riparian grazing practices is acceptable if vegetation has matured to the point that it is not adversely affected by livestock. Retain residual vegetation in the fall to protect the area from high stream flows before the next growing season.

4. Restrict summer season grazing. Heavy or repeated utilization of riparian areas during the summer growing season generally results in negative impacts to these areas. Overuse of riparian areas in the summer may result from upland forage becoming dry and unappealing while riparian areas continue to offer shade and green vegetation. Summer grazing may not allow plants sufficient time to recover during the remainder of the growing season. Make upland water and shade structures available to livestock to minimize their impacts on riparian areas during the summer. Limit streamside utilization of herbaceous forage in summer-grazed pastures to 40-50% of the available vegetation.

5. Utilize winter grazing when possible. Grazing during the winter may have minimal detrimental impacts to soils (which are typically frozen) and dormant vegetation if riparian areas are available (i.e., no snow is present; Leonard et al. 1997). Conversely, if not closely monitored, winter use has the potential to remove excessive amounts of vegetation cover just prior to spring runoff, a time when most stream banks need carryover vegetation (from the previous growing season) for bank protection and sediment trapping. Winter grazing may be the least detrimental to riparian areas if sufficient forage is available. However, long term use of this management option may eventually lead to a decline of preferred, and increase of less desirable, forage species. Woody vegetation may also be at risk during the winter if other resources are depleted.

6. Designate riparian pastures as separate units. A riparian pasture is particularly applicable where the riparian zone encompasses an area large enough to be managed separately from the adjacent uplands. Because it is separate from the rest of the ranch or allotment, it can be grazed or rested depending on current riparian vegetation conditions and stream and riparian habitat needs (Elmore and Kauffman 1994), thus providing the maximum control and flexibility.

7. Increase the number of pastures. Existing large pastures alongside riparian areas can be divided into smaller pastures to be managed separately. Grazing duration should decrease as the intensity increases within the smaller pastures. Further, with a greater number of pastures, grazed areas can rest and regrow while livestock are rotated through other areas.

8. Incorporate fencing. Rehabilitating degraded riparian areas may require limiting or totally excluding livestock. No riparian grazing system will enable a severely degraded riparian plant community or stream channel to restore itself. Where practical, fencing degraded sections of the pasture to exclude grazing seasonally or long-term is the best option for recovery (Rickard and Cushing 1982, Skovlin 1984, Elmore and Beschta 1987, Beschta et al. 1991, USFWS 2002, George et al. 2011). If a riparian corridor has become severely degraded, it may require up to 15 years of rest to return to a productive state (Clary and Webster 1990). Once the riparian vegetation has sufficiently recovered, managers can consider reintroducing carefully managed livestock grazing to the formerly degraded area.

9. Consider redistribution practices. To alleviate grazing pressure on riparian habitats, distribution practices have been shown to be effective methods of redirecting livestock away from riparian areas and into upland habitats (George et al. 2011). These include herding, strategic placement of drinking water developments and salt grounds, and enhancing upland forage by planting palatable forage species or placing supplemental feed away from riparian areas. Alternative water tanks for cattle may also provide habitat to TES species such as the Chiricahua leopard frog (Rorabaugh and Sredl 2014).

10. Monitor vegetation response to grazing system implementation. Closely monitored, seasonal use of the riparian corridor is acceptable in most cases. Monitoring should occur multiple times per season to understand how the riparian vegetation changes over time. After grazing, standing herbaceous vegetation should be high enough that livestock does not start browsing woody vegetation. The available literature indicates that, in some areas and depending on the type of herbaceous forage available, negative impacts on woody riparian vegetation (e.g., willows) can be avoided by not allowing the stubble height of herbaceous vegetation to be reduced below 3 to 6 inches (Cook and Harris 1968, Clary and Webster 1989). For habitats where TES species occur, or where stream banks are highly erodible, the herbaceous stubble height criterion may need to be increased to greater than 6 inches (e.g., Frey 2021); under extreme conditions, the area may need long term or permanent protection from livestock use.

11. Closely and frequently monitor livestock. Overgrazing and subsequent damage to riparian areas can occur when livestock herds are unmanaged and left unattended. Ranchers and land managers should continuously assess the impact of their livestock's grazing on the riparian area(s) of interest. To assess these impacts, managers must obtain and utilize quantitative information regarding:

a. Grazing intensity (stocking rate, utilization, or residual dry matter)
b. Frequency of grazing (length of grazing periods and rest periods)
c. Season of grazing (related to plant growth stage)
d. Range response (monitoring and evaluation)

Factor in Environmental Variability

Vegetation: Riparian areas vary broadly in terms of their altitude, slope, aspect, hydrology, and ecosystem function across the state, and locally across any tract of land. These varying conditions influence each riparian site's capacity for vegetation growth. While grasses, rushes, and sedges are the primary ground cover in some riparian ecosystems, woody vegetation, including cottonwoods and willows, is dominant in others. As a result, neighboring areas may require different management strategies depending on their condition and dominant vegetation type. For instance, while resting a riparian area for a single growing season might be sufficient to allow grasses and sedges to recover from grazing, multiple seasons of rest may be required for woody plant regrowth and recruitment, especially for species that reproduce by seeds such as cottonwoods (Milchunas 2006). Land managers should gain sufficient familiarity with local conditions to judge the resiliency of the local riparian ecosystem, including how much use it can withstand and still be able to recover to previous conditions.

Cow elk and calf. M. Watson

Climate and Precipitation: Seasonally, avoid grazing in riparian areas during the summer monsoon season when intense storms can soften the stream banks; also avoid grazing post snowmelt events. Wet soil trampling by livestock may increase erosion, compact soils, and prevent seedling establishment. Alternate with upland pastures seasonally to maintain the health and productivity of the land while providing the best forage opportunities. However, seasonal weather is likely to become less predictable in future years. Climate change projections for the Southwestern U.S. focus on three significant changes over the next several decades: increased average temperatures, decreased average precipitation, and an increase in locally extreme weather events, including heat waves and heavy precipitation (Hick et al. 2022). Additionally, climatic conditions are now considered the overriding factors determining the outcome of rangeland management actions (Curtin 2002) and may be key to determining the length of rest.

Long-billed curlew. M. Watson

Wildlife: Animal movements are difficult to predict but in designated critical habitats or types of riparian habitat known to support TES species, management strategies should take these species into consideration. Taking wildlife requirements into consideration will also lessen the likelihood of future wildlife-livestock conflicts during drought conditions. Infrastructure, such as wildlife-friendly fencing, may be used to mitigate such conflicts. If stock ponds or artificial water sources

are created to redistribute livestock away from riparian areas, these will most likely attract wildlife as well.

Rio Grande Nature Center. J.N. Stuart

Cow in a riparian area. G. Wuerthner

Mimbres River. Department

Closing Remarks for Managers

A successful grazing program can be designed by incorporating the following:

- Continuous assessment of riparian conditions prior to and while implementing a grazing plan. Example assessments: Proper Functioning Condition (PFC) assessment outlined in Prichard et al. (1998) and BLM (2017).
- Tailoring the grazing system to each stream or stream reach to address changing conditions and generate the proper vegetative response (Skovlin 1984, Elmore and Kauffman 1994, Ohmart 1996).
- Identifying alternatives to current systems that will enhance vegetation in an increasingly arid climate.
- Maintaining the flexibility to change (raise or reduce) stocking rates, rotation frequency, and other parameters based on a measured vegetation condition or in response to unforeseen circumstances.
- Rapid assessment of the grazing system's ability to meet objectives, using tools to evaluate the body condition of cattle and keeping in mind that body condition may be slow to decline compared to vegetation condition. Include riparian restoration as an objective.

Remember, the level of utilization occurring on a site, including in riparian areas, is the most important consideration in the management of livestock grazing. Most riparian grazing results suggest that good management is substantially more important than the specific grazing system used (Clary and Webster 1989).

Additional Resources

Developing a Grazing System for Arid Climates.

Strategies for Livestock Management in Riparian Areas in New Mexico.

Managing Rangelands and Cattle in Drought-Prone Areas of the Southwest.

Irrigated Pasture Management in New Mexico.

A Rapid Stream-Riparian Assessment Protocol and its Utility in the Grand Staircase Region, Utah.

Methods for Evaluating Riparian Habitats with Applications to Management.

Using a Supplementation Program as a Grazing Management Tool.

Riparian Area Management: Process for Assessing Proper Functioning Condition (BLM Technical Reference 1737-9).

Table 1. Evaluation and rating of grazing strategies for stream riparian habitats. Adapted from Platts (1989)

Strategy*	Level to which riparian vegetation is commonly used	Control of animal distribution (allotment)	Streambank stability	Brushy species condition	Seasonal plant regrowth	Stream-riparian rehabilitation potential	Rating**
Continuous season- long (cattle)	heavy	poor	poor	poor	poor	poor	1
Holding (sheep or cattle)	heavy	excellent	poor	poor	fair	poor	1
Short duration-high intensity (cattle)	heavy	excellent	poor	poor	poor	poor	1
Three herd-four pasture (cattle)	moderate to heavy	good	poor	poor	poor	poor	2
Holistic (cattle or sheep)	light to heavy	good	poor to good	poor	good	poor to excellent	2-9
Deferred (cattle)	moderate to heavy	fair	poor	poor	fair	fair	3
Seasonal suitability (cattle)	heavy	good	poor	poor	fair	fair	3
Deferred-rotation (cattle)	moderate to heavy	good	fair	fair	fair	fair	4
Stuttered deferred- rotation (cattle)	moderate to heavy	good	fair	fair	fair	fair	4
Winter (sheep or cattle)	moderate to heavy	fair	good	fair	fair to good	good	5
Rest-rotation (cattle)	moderate to heavy	good	fair to good	fair	fair to good	fair	5
Double rest-rotation (cattle)	moderate	good	good	fair	good	good	6
Seasonal riparian preference (cattle or sheep)	moderate to light	good	good	good	fair	fair	6
Riparian pasture (cattle or sheep)	as prescribed	good	good	good	good	good	8
Corridor fencing (cattle or sheep)	none	excellent	good to excellent	excellent	good to excellent	excellent	9
Rest rotation with seasonal preference (sheep)	light	good	good to excellent	good to excellent	good	excellent	9
Rest or closure (cattle or sheep)	none	excellent	excellent	excellent	excellent	excellent	10

*See definitions on the next page; **Rating scale based on 1 (poorly compatible) to 10 (highly compatible) with fishery needs.

Definitions Adapted from Platts (1989) and Leonard et al. (1997)

Continuous season-long: one pasture system where livestock have unrestricted access to grazing.

Holding: keeping livestock in a selected area at high stocking rates or for an extended period of time.

Short duration-high intensity: grazing occurs in a pasture for a short period of time, however the intensity is high due to a high stocking rate.

Three herd-four pasture: each pasture is grazed continuously for one year, followed by a four-month nonuse period. Nonuse is staggered among the pastures by four-month periods such that over the course of four years (or 48 months), each pasture is rested three times (e.g., Pasture 1 is rested in months 1-4, 17-20, and 33-36; Pasture 2 is rested in months 5-8, 21-24, and 41-44, etc.).

Holistic: utilizes "time-control grazing", which concentrates livestock impacts in space and time to avoid regrazing areas before they can recover and avoid overresting areas adapted to herbivory. The rate of rotation varies with the rate of plant growth.

Deferred: non-systematic rotation of livestock among pastures within a grazing management unit.

Seasonal suitability: restricts the use of vegetation to a single season by dividing an area into separate pastures based on the plant species and community type, growth and seasonality, and accessibility conditions.

Deferred-rotation: a multi-pasture system in which livestock are rotating from one pasture to the next at varying intervals.

Stuttered deferred-rotation: a multi-pasture system in which grazing in one pasture is deferred to a certain part of the growing season. Grazing deferment is rotated among the different pastures in following years.

Winter: allowing grazing to occur during winter months when there is little to no vegetation growth and the impact to soils is minimal.

Rest-rotation: a multi-pasture system in which livestock are rotated from one pasture to the next at varying intervals and one or more pastures do not get grazed for at least a year. Also known as "rotational stocking."

Double rest-rotation: a multi-pasture system in which one or more pastures is grazed for two consecutive years, then rested (i.e., no grazing or livestock allowed) for two consecutive years.

Seasonal riparian preference: allowing upland grazing to occur early in the growing season (i.e., spring) when upland vegetation is still green and appealing and temperatures are not too hot, thus alleviating grazing pressure on riparian habitats due to livestock spending more time in upland areas.

Riparian pasture: a discrete unit of riparian zone that is large enough to be managed separately from uplands, allowing it to be treated separately from other pastures so the riparian corridor can be rested and grazed according to the management plan.

Corridor fencing: building fencing around riparian corridors to prevent livestock from grazing and congregating in riparian areas, allowing the habitat to recover.

Rest rotation with seasonal preference (sheep): similar to the rest rotation strategy with cattle defined above, except sheep herds are rotated by managers. Sheep typically graze in upland areas, which allows riparian habitats a chance to recover from intensive grazing. This strategy works best in the spring, specifically while temperatures are cooler.

Rest or closure: totally excluding livestock from an area for several years; typically used when riparian areas are severely degraded or when woody plant regeneration above a certain height is desired.

Cattle grazing. T. Hudson

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