Grazing Management for Riparian-Wetland Areas

I. Introduction

Generally, riparian areas are among the most resilient ecosystems. Depending on condition and potential, they usually respond more quickly than drier upland ranges to changes in management. This document presents information from various land managers and researchers to guide livestock management in riparian areas using their unique responsiveness to accomplish management objectives. However, management of riparian areas cannot be extricated from management of the larger landscape. Riparian areas, as interfaces between the aquatic and upland components of the ecosystem, comprise mosaics of landforms, communities, and environments within the larger landscape. The structure and processes of riparian areas, more than any other ecosystem, are influenced by their connectivity to adjacent ecosystems. Riverine ecosystems, in particular, connect headwaters with lowlands to provide for the transfer of water, nutrients, sediment, particulate matter, and organisms both laterally and downstream (Gregory et al. 1991). An ecosystem perspective provides an ecological basis for evaluating current grazing practices and other land uses, identifying riparian management objectives, and developing future management alternatives.

Livestock grazing management in riparian areas is one of the most pervasive issues facing rangeland managers. Most public and private rangeland is grazed, and even though riparian areas constitute only about 8 percent of the total public land acreage, and less than 1 percent of the public land in many of the more arid Western States (USDI 1995), most grazing allotments, including some desert allotments, contain some riparian acreage. Riparian area management is also one of the most complex issues for rangeland managers because:

- Most riparian acreage is privately controlled or intermingled with other ownerships
- Riparian areas are often the primary, and sometimes the only, watering place for livestock that graze on arid rangelands
- Public use of riparian areas is increasing
- Other resource values are concentrated in and dependent on those areas
- Grazing affects a number of resources and uses, both on-site and off-site
- The value of properly functioning riparian systems is not widely understood
- Traditional management practices are often inadequate and difficult to change

Because of these complexities, the involvement and cooperation of private landowners, ranchers, recreationists, other watershed users, and many different disciplines is critical to the success of riparian area management programs.

No single grazing management system has resulted in consistent recovery of degraded riparian areas. Many combinations of sites, resource conditions, and impacts, as well as human perspectives, are involved. The grazing management system for an

area should be tailored to the conditions, problems, potential, objectives, and livestock management considerations on a site-specific basis. From the standpoint of achieving livestock management objectives and minimizing soil, vegetation, and water quality impacts, grazing management plans will vary. There is no set formula for identifying the type of grazing system or management plan that will be best for any livestock operation or allotment. Water quality impacts are closely related to soil erosion and sedimentation, which are often associated with vegetation cover and concentration of livestock. The grazing system must be designed on the basis of soil and vegetation capabilities, water quality considerations, and livestock and wildlife requirements (Moore et al. 1979).

Ehrhart (in press) concluded that the common denominator among riparian areas that were functioning properly, or at least improving, in eastern and central Montana was continual involvement by the operator or manager. As long as there is control of livestock distribution and grazing intensity, the specific grazing system employed may not be important (Clary and Webster 1989). There are, however, grazing strategies and practices that, under given circumstances, make control of livestock distribution and grazing intensity easier or at least achievable.

II. Compatibility of Grazing in Riparian Areas

Livestock grazing can be a compatible use in riparian areas when managed in harmony with land management objectives, and when the function, capability, and potential of the site and the needs of the riparian vegetation guide the development of the grazing management prescription. Regardless of other differences in management objectives, grazing must be compatible with achieving or maintaining "proper functioning condition" to be considered sustainable. Proper functioning condition of riparian areas, as defined by Prichard et al. (1993 and 1994), is when adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality
- Filter sediment, capture bedload, and aid floodplain development
- Improve flood-water retention and ground-water recharge
- Develop root masses that stabilize streambanks against cutting action
- Develop diverse ponding and channel characteristics to provide the habitat and water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses
- Support greater biodiversity

Livestock grazing in riparian areas, however, may not always be entirely compatible with other resource uses or values. Where soils in riparian areas are unstable, the vegetation complex is fragile, threatened and endangered plants and/or animals are affected, aquatic or recreation values are high, municipal watersheds are involved, etc., special livestock management prescriptions must be applied. In some cases, excluding livestock grazing may be the most logical and responsible course of action (at least for a time sufficient to achieve a level of recovery and stability that can support grazing in the context of the management objectives).

The compatibility of grazing in riparian areas depends on the extent to which grazing management considers and adapts to certain basic ecological relationships. Prior to developing grazing management prescriptions for riparian areas, the manager should have some understanding of grazing effects on:

- Natural functions of riparian ecosystems
- Growth and reproduction of woody and herbaceous plants on the site
- Dependency of other animals (mammals, fish, birds, and amphibians) on riparian areas
- Hydrologic and geomorphic conditions and processes
- Soils
- Water quality

III. Management Objectives, Key Areas, and Key Species

A. Management Objectives

Grazing management based only on objectives for nonriparian areas (uplands) does not often maintain or improve riparian areas in the same pasture. Therefore, where maintenance or improvement of riparian areas is desired, land use plan and activity plan objectives (or ranch plan objectives for private lands) and management prescriptions must be attuned specifically to riparian area features while considering the needs of the entire watershed. As mentioned previously, proper functioning condition, as defined by Prichard et al. (1993 and 1994), is the minimum acceptable condition; objectives related to achieving or maintaining proper functioning condition are paramount. Additional objectives related to desired future conditions for land uses and other values are important; however, they should be differentiated from functionality objectives because perceptions of land use and people's values are subject to change over time.

Establishing specific objectives, describing the desired plant community, and selecting key species should be an interdisciplinary effort carried out in close cooperation with range users and other interested parties. Objectives should be dictated by the present condition and trend of the riparian habitat in relation to management goals, the resource potential for change, and the importance of other resource values. Good management objectives should be achievable, measurable, and worthy of the costs incurred to accomplish and monitor them. Major considerations in establishing management objectives include:

1. Vegetation

a. Historical conditions and disturbance regimes.

b. Present plant community.

c. Ecological site potential and capability.

d. Proper functioning condition.

1) Development and/or maintenance of different age classes of plant species for maintenance or recovery.

2) The complex of vegetation cover necessary to minimize trampling damage and reduce the erosive effects of runoff events.

3) Stabilization of streambanks and elimination of bank hoof shearing.

4) Amount and kind of vegetation required to trap and hold sediment deposits during runoff events to rebuild streambanks and restore aquifers.

e. Desired plant community.

1) Health and reproduction of both woody plants and herbaceous vegetation (depending on the riparian objectives and site potential).

2) Vegetation structure necessary for wildlife cover diversity.

3) Value of the site for forage production.

4) Aesthetic effect of a riparian area in good to excellent condition.

5) Period of time that is acceptable or necessary for restoration.

2. Wildlife

a. Restoration or maintenance of aquatic and/or waterfowl habitat.

b. Importance of the riparian community to riparian-dependent wildlife and to wildlife species that occur primarily on upland sites, but that are attracted periodically to riparian areas. In the Great Basin, 79 percent of terrestrial wildlife species are dependent on riparian areas (Thomas et al. 1986); in Arizona and New Mexico, 80 percent of all vertebrates depend on riparian areas for at least half of their life cycle (Cheney et al. 1990).

3. Water

a. Raise in or maintenance of the present water table elevation.

b. Restoration or maintenance of water quality and quantity.

c. Restoration or maintenance of natural hydrologic regimes. In degraded systems, this often means reducing peak flow discharge and increasing minimum flows.

4. Geomorphic

a. Establishment of proper stream channel, bank, and floodplain conditions and their related functions.

b. Maintenance of long-term adjustment processes that may affect channel/riparian zone conditions. Processes may include gully widening and aggradation, bank and floodplain development, meandering, etc. (Van Haveren and Jackson 1986).

c. Reduction of upland erosion and stream sediment load and restoration or maintenance of soil productivity.

See Appendix A for additional information that can be used to formulate objectives.

B. Key Areas and Critical Areas

In many allotments, riparian areas are "key areas" for management, and their condition may indicate whether grazing management is proper for the entire allotment. In other cases, riparian areas may be "critical areas" for management of site-specific concerns and objectives. In critical areas, proper management may severely limit upland use from what would otherwise be acceptable. Key areas and critical areas must be differentiated for analysis and subsequent management recommendations if needed.

As riparian objectives are developed, key areas for monitoring and judging the propriety of management must be located in representative portions of both the riparian area and the uplands. Key areas must possess (or have the potential to produce) all the specific elements contained in the objective(s) because these will provide data for evaluating management efforts. In many cases, it is appropriate to select the key areas first to represent important and/or common resource values and situations, and then develop objectives specific to each.

When an area is functioning properly, stream reaches that are functioning at-risk, with an unapparent or downward trend attributable to livestock use, are prime candidates for key areas. The limiting factors to proper functioning condition can guide the selection of attributes to monitor, as well as management changes needed. For instance, if adequate vegetative cover is the primary limiting factor, monitoring may focus more on annual physical bank damage and residual vegetation relative to duration of pasture use. On the other hand, if type of plant community and recruitment of key species are the primary limiting factors, short-term monitoring may focus more on utilization, incidence of use, or stubble height relative to season of use and/or recovery periods. Community composition would also be monitored in the long-term.

C. Key Plant Species

Key plant species are: 1) forage species that indicate the degree of use of associated species, and 2) those species that must, because of their importance, be considered in the management program (Interagency Technical Team 1996a). Key species should be necessary to natural stream functions, directly related to vegetation management objectives, and monitored as an indicator of grazing management performance relative to those objectives.

Key plant species will vary with the potential of each individual site. A mix of vegetation increases channel roughness and dissipates stream energy. Willows and other large woody vegetation filter larger water-borne organic material, and their root systems provide bank stabilization. Sedges, rushes, grasses, and forbs capture and filter out finer materials, while their root masses help stabilize banks and colonize filtered sediments. On sites with potential for both woody and herbaceous vegetation, the combined plant diversity greatly enhances stream function.

Understanding the physiological and ecological requirements of key woody species (in addition to key herbaceous species) is essential to designing a proper management

program (Thomas et al. 1979). This includes determining the effects of grazing on the particular growth characteristics of the species involved and the probable outcomes in community change.

IV. Grazing Management Principles and Concepts

Once objectives have been formulated, the resource manager, in consultation with the range user and other involved parties, must tailor grazing management strategies to meet those objectives. As potential grazing strategies are discussed, the objectives should be reviewed. Objectives and management must come together before either one is "established." Where management is detrimental, the focus should first be on reducing negative impacts, then on using prescribed grazing management as a tool to achieve objectives (Mosley 1996). Because "it is easier to keep a riparian area degraded than it was to get it that way" (Elmore pers. comm.), changes in season, intensity, and frequency of use, or even temporary exclusion, might have to be implemented to initiate recovery. Then other prescriptive grazing strategies might be used to achieve objectives in plant composition, structure, etc.

Grazing management strategies must also consider the sensitivity of different riparian areas to disturbance, and their resiliency, or ability to recover, once degraded. Sensitive riparian areas experience a high degree of natural stress (or any natural attribute that makes them more sensitive to disturbance, such as noncohesive granitic soils), and therefore can tolerate little management-induced stress without degradation. Conversely, less sensitive systems have low natural stress, and therefore can tolerate more management-induced stress (Elmore and Kauffman 1994). Recovery potential is not always directly related to sensitivity to disturbance. Rosgen (1996) provides a guide to stream sensitivity and recovery potential.

Even though classifications such as Rosgen's can help extrapolate responses of streams to grazing, structures, and other types of management, no two riparian systems are exactly alike. A grazing prescription must: 1) meet the needs of each specific riparian system, as well as other watershed components, 2) be compatible with the entire ranch operation, and 3) have the commitment of the operator/manager to achieve riparian objectives. These criteria have a higher probability of being met if the grazing strategy consciously incorporates (Krueger 1996):

- Animal (livestock) behavior
- Forage selectivity
- Plant responses
- Plant community change
- Hydrology
- Practicality

Plant responses, plant community change, and hydrology usually form the basis for achievable objectives, and thus become the focus of many grazing strategies. However, animal behavior and forage selectivity are the driving grazing management forces affecting those resource interactions.

A. Livestock Behavior

Cattle predominate rangeland, and especially riparian, grazing management concerns. Sheep are generally less of a problem because they tend to avoid low areas where they feel vulnerable to predation (Glimp and Swanson 1994). The switch from sheep or sheep and cattle that has been occurring throughout this century has often increased riparian management problems. Thus, most of this publication focuses on cattle management considerations. However, because any large herbivore (including wild horses, elk, deer, etc.) could cause similar problems or react similarly in specific situations, the term "livestock" will be used throughout this document.

Grazing managers must develop an understanding of the grazing patterns employed by the animals they manage (Stuth 1991). This involves understanding the predisposition of a given species to forage. Foraging behavior involves three distinct levels of selection—spatial (landscape), species, and plant part choice.

An animal with experience in a given landscape will know its boundaries, routes of access and escape, plant communities and their spatial distribution, and the seasonality of desirable species (Table 1). Free-standing water is the principal focus around which most large grazers orient their foraging strategies. Large herbivores are "central place foragers," with the central or home place centered on water (Stuth 1991). The nature of the terrain, concentrations of shrubs, changes in forage availability due to drought, and mobility of an animal all influence spatial use patterns around water sources.

Table 1. Landscape characteristics that influence animal movement patterns (Stuth 1991).

Attribute	Components
Boundaries	Fences, home range, migration routes
Distribution of plant communities	Range sites, soils, aspect, elevation, structure, species composition
Accessibility	Slope, gullies, water courses, shrub density, rockiness, roads, trails, fence lines, cut openings, pipeline/utility rights-of-way
Distribution of foci	Location of water, shade, loafing and bedding sites and other convergent and divergent points in a landscape

An animal's selection of a given plant community is largely related to those attributes of a site that influence its ability to harvest nutrients (Table 2).

Table 2. Attributes at the plant community and patch level that influence the animal's selection of forage sites (Stuth 1991).

Attribute	Function
Moisture-holding capacity of soil	Affects forage supply and stability
Species composition	Affects suitability/stability of the site for general dietary and nutritional needs
Plant frequency	Affects the probability of encounter of plant species by the animal and number of dietary decisions
Abundance	Affects the supply of nutrients
Structure	Affects accessibility and harvestability of plant species and nature of thermal niches provided
Continuity	Affects movement velocity
Size	Affects amount of search area available
Aspect	Affects the thermal characteristics of the site
Orientation in landscape	Position relative to needs foci affects frequency of exposure to grazing

It is difficult to force an animal to perform in a matter that is contrary to natural preferences and instincts. Based on what is known about livestock behavior, grazing programs can be designed to attract animals to specific areas at specific times, encouraging grazing patterns that yield a desirable response to the vegetation. For example, livestock use of riparian zones is known to vary by season. During spring, livestock tend to disperse because of better forage on uplands, better water distribution in shallow reservoirs and natural water pockets, and acceptable or preferable thermal conditions on uplands. During summer, livestock tend to be attracted to riparian zones due to water availability; generally higher concentrations of nutritious, palatable forage; and, if trees or shrubs are part of the system, preferable thermal conditions. During fall, livestock still tend to be attracted to riparian zones primarily due to water availability, and possibly to availability of browse with higher nutrient content and palatability than mature upland forage; however, fall greenup can be a mitigating factor. During winter, livestock might avoid riparian zones if they function as cold air pockets or drainages. The specifics of each riparian zone and its associated upland areas, such as upland water distribution, determine appropriate management options.

Variable weather conditions also affect animal behavior by impacting vegetation production, water distribution, etc. For example, a drought can cause the growing

season to be earlier and shorter. As a result, animals may prefer riparian zones much earlier, and dates of grazing may need to be adjusted. Conversely, a prolonged wet, cool spring and summer may result in longer-than-normal use of a given pasture, which would allow deferment or rest of some other pasture as a possible beneficial treatment. Riparian zones would also be relatively less attractive under such conditions.

The kind (cattle, sheep, etc.), class (yearling, cows with calves, etc.), and previous experience of livestock influence behavior as well. Cows with calves are usually less mobile than yearlings or dry, mature cows. Cows experienced in a pasture prefer certain locations, much like home ranges of big game, and can be expected to head for and stay in a given area. Inexperienced animals initially search for the boundaries of their environment and then for preferred locations, with water being a primary factor. These behavior attributes may provide a means to select animals that use areas beneficial to management objectives, cull those that don't, and train replacement animals appropriately.

B. Forage Selectivity

Selectivity varies by animal species, forage palatability, and preference. Palatability refers to characteristics of a plant that elicit a selective response by a herbivore. It changes throughout the annual plant growth cycle and can vary spatially as a result of soil characteristics. Preference is a behavioral function that involves proportional choice of one plant species from among two or more species. Preference for a particular plant species depends largely upon its abundance, morphological/phenological characteristics, the array of other species available, and the species of animal in question. Preference changes with season, weather, soil moisture (and palatability), and forage availability. Thus, forage selectivity is a dynamic, situation-specific phenomenon. However, some generalizations can be applied. For example, in riparian areas, livestock generally don't browse woody plants if they have a sufficient supply of palatable grass, but, where only a few woody plants are available, animals may seek them out to obtain dietary diversity. Most generalizations have exceptions though, so management must be refined to fit the specific situation.

V. Grazing Management Strategies

A. Key Management Considerations

To properly manage livestock grazing in riparian areas, it is important to recognize that:

- Grazing management practices that improve or maintain an upland site may neither improve nor maintain a riparian area. While riparian areas respond uniquely, they should not be considered independently of uplands. Problematic upland watershed conditions, such as excess runoff and erosion, often reduce the effectiveness of management in the riparian zone. To be managed effectively, the whole pasture containing the riparian zone and the whole watershed containing the pasture should be considered.

- Passive, continuous grazing rarely improves a deteriorated riparian area or maintains a riparian area in good condition without reducing stocking levels to extremely low and uneconomic levels.

- Grazing management must provide an adequate cover and height of vegetation on the banks and overflow zones to promote natural stream functions (sediment filtering, bank building, flood energy dissipation, aquifer recharge, and water storage).

It is also important to recognize that there is a lot of public concern about management of riparian areas. Gaining the understanding and cooperation of everyone involved in riparian area management, including land managers, landowners, users, and the public, improves the chances for success. Through consultation and cooperation with livestock managers, changes can be implemented that benefit other users of riparian areas. Workshops and demonstration areas can promote an understanding and appreciation for the value of properly functioning riparian systems and build support for a sound program. Recognizing operators who have implemented management practices that improved riparian area conditions can demonstrate the benefits of good stewardship and help expand good management into other areas. Ranchers who have experienced the benefits of proper grazing management in riparian areas are some of the best salespeople for changing traditional riparian area management practices.

Finally, it is important to recognize that there are a number of other factors to consider in selecting management strategies to meet riparian objectives, including timing, duration, and frequency of grazing; distribution of livestock; stocking rates; utilization levels and patterns; and pasture design, including topography and seasonal implications of topography. These factors influence the economic feasibility and practicality of the management strategy, which are both essential if commitment to the strategy is to be achieved.

1. Timing, Duration, and Frequency of Grazing

Successful grazing management strategies for riparian areas can usually be achieved using a combination of options, including grazing "prescriptions" that:

- Limit grazing intensity, frequency, and/or season of use, thereby providing sufficient rest to encourage plant vigor, regrowth, and energy storage and minimize compaction of soils.

- Control the timing of grazing to prevent damage to streambanks when they are most vulnerable to trampling.

- Ensure sufficient vegetation during periods of high flow to protect streambanks, dissipate energy, and trap sediments.

In a study of 34 grazing systems in operation for 10-20 years in southwestern Montana, Myers (1989a) found timing of grazing, duration of use, and frequency of fall grazing were important factors in successful management (Table 3). The effectiveness of livestock grazing management was judged based on the vigor, regeneration, and utilization of woody species, as well as on bank stability.

Table 3. Criteria for successful grazing management (Myers 1989a).

Criteria Used	Successful Management	Unsuccessful Management
1. Time provided for postgrazing herbaceous regrowth (average number of days).	35	21
2. Duration of use - total days per season (average number of days).	28	59
3. Fall use duration (average number of days).	21	37
4. Percent of years fall use occurred (average).	31	51
5. Percent of grazing treatments providing residual cover* through rest or regrowth (average).	75	38

*Residual cover was defined as at least 30 days of regrowth.

Successful systems were defined as those demonstrating good or excellent riparian condition or an upward trend if in fair condition. The results highlight the importance of adequate vegetation vigor and regeneration at the end of the growing season and the apparent critical nature of the frequency and duration of fall grazing treatments. Myers suggests that the duration of grazing treatments often prescribed for upland management (60-75 days) be shortened to 25-30 days. Shortening the duration and providing growing season rest in all pastures lessens animal impacts, provides regrowth, and allows stock to be more selective in grazing.

2. Distribution of Livestock

Utilization patterns relative to total forage distribution reveal that livestock distribution, coupled with timing, duration, and frequency of grazing, are often the main problems. Most successful grazing strategies or "prescriptions" also include additional practices or techniques that promote distribution of livestock, such as:

- Techniques that attract livestock away from riparian areas, including stock water development, developing alternative or improved forage, prescribed fire in uplands, careful salt and supplement placement, and fertilization in uplands.

- Techniques that restrict livestock from riparian areas, including fencing or fence relocation, barriers such as thickets or brush wind rows, water gaps in erosion-resistant stream reaches, hardened crossings or water access, and relocation of bed grounds and management facilities.

- Herd management and animal husbandry practices that promote mobility, including herding and culling practices, and managing the kind (sheep versus cattle, etc.), class (steers versus cows with calves, etc.), and breed of livestock.

Research in Idaho, Utah, and Nevada illustrates the importance of livestock distribution throughout the pasture and away from the riparian area. Platts and Nelson (1985) found that livestock took an average of 29 percent, and as much as 40 percent, more vegetation from riparian sites (wildlife use was trivial) than from adjacent upland sites. Although use on the allotments was moderate, use on riparian sites was heavy to severe. Managing and controlling the attractant features of riparian areas usually increases the use of, and improves distribution in, uplands.

Proper distribution of livestock can be an effective and economical tool in managing riparian areas. In some areas that are degraded, some rest may be required, especially where woody species are part of the management objective.

3. Stocking Rates

Total stocking rate problems at the pasture, ranch, or allotment level are the exception rather than the rule in today's operations. The apparent overstocking of some areas while others are only moderately grazed or even ungrazed will not be solved by simply reducing numbers if other factors are not also changed. Reducing stocking rates may reduce the percentage of area in unsatisfactory condition, but the impacts around the foci of highly utilized areas (e.g., riparian areas, other waters, etc.) will remain the same until few, if any animals remain. Many pastures, ranches, or allotments are appropriately stocked for the majority of the area, but a temporary reduction in the stocking rate is necessary to allow recovery of localized problem areas. This is especially true in rest-rotation strategies where part of the area is removed from grazing for an entire season. The rest may not compensate for the increased use during grazing until sufficient recovery is achieved. There are also some operations that are still simply overstocked. No strategy will work until

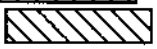
stocking rates are at an appropriate level for the existing conditions and prescribed management.

4. Utilization Levels and Patterns

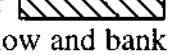
If utilization, timing, and residual vegetation are factors in developing a grazing prescription, the primary focus is usually the physiology of key plant species that must stay healthy and reproduce. The primary focus of associated management techniques is often to achieve better livestock distribution and avoid grazing intensity problems. However, the effects are often intertwined and problems can be addressed in many ways. Utilization mapping is an excellent tool for checking the distribution of livestock use and for identifying management opportunities. However, measurement of stubble height (residual vegetation) is often more straightforward and easier to interpret. Relative use or seasonal use may impact the physiology of key species and guide development of a grazing strategy, but annual measurements vary among years and individual observers. Therefore a range of utilization or stubble heights should accommodate favorable and unfavorable production years.

Due to the variation in riparian sites and management objectives, one standard utilization and/or residual vegetation target is not appropriate. However, utilization and/or residual vegetation should be considered (together with regrowth potential) to ensure that vegetation stubble necessary for natural stream functions is present or other land use objectives (e.g., residual nesting cover for waterfowl) are accomplished. Management plans should recognize that an average stubble height or utilization level generally represents rather complete use of certain plants and partial or no use of others. The first bite may reduce all eaten stems to close to ground level. Other stems on that plant and adjacent plants remain uneaten at first.

In most situations where both upland and riparian sites exist in the same pasture(s), portions of each pasture can be seasonally unusable or unused for grazing because of wet soils, lack of green forage, length or steepness of slope, distance to or lack of water, and absence of shade, etc., as shown in Figure 1 (Elmore pers. comm.).

In pasture A, the corridor along the stream is unsuitable due to saturated soils,  and some of the uplands are not used due to lack of green forage  .

In pasture C, portions of the uplands are unusable due to lack of water and unused due to length and steepness of slope.

In pasture D, portions of the uplands are unused due to length and steepness of slope and lack of water  . Also the stream corridor is of concern due to utilization of willow and bank trampling in excess of allowable limits  that may occur during this period.

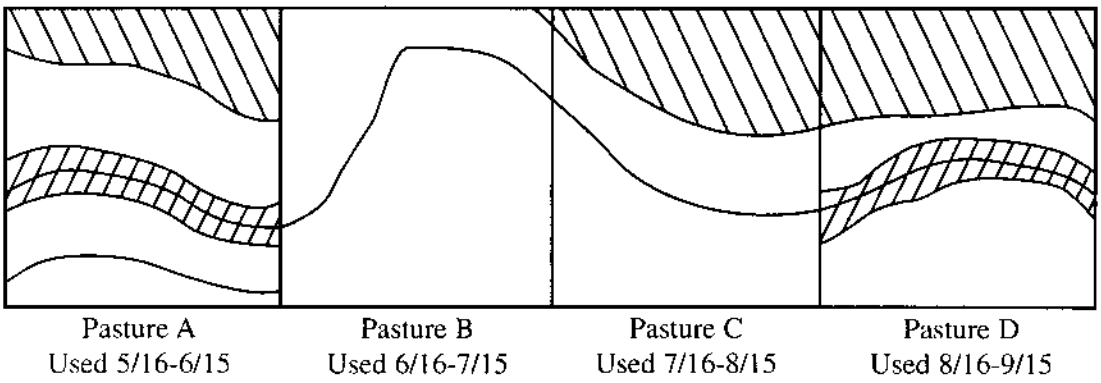


Figure 1. Examples of seasonally unused areas within a pasture.

In pastures C and D, frequent riding and herding of the livestock may increase utilization of the upland and relieve grazing pressure in the riparian areas. This would reduce the need to adjust season of use or numbers of livestock to compensate for heavy riparian area use.

5. Pasture Design

In pasture planning, the pasture should include as much of a stream as possible and not use streams as fenced pasture boundaries (Myers 1981). Small stream sections and other small riparian areas such as springs and seeps within large pastures usually cannot be effectively managed. Exclusion fencing is often the most practical approach for small areas. When pasture boundary fences zig-zag across streams, livestock impacts tend to be concentrated near the stream. Livestock tend to concentrate near and trail along fences, accentuating trampling damage. Also, wire fences across streams tend to catch trash and frequently wash out. Myers recommends trying to center streams within a pasture where possible.

Where a stream must serve as the division line, fencing one or both sides of the stream with water gaps to the stream, if needed, can effectively avert most riparian concentration. Suspending panels of corrugated metal roofing over the stream, between ends of a fence, has proven effective in controlling livestock movement in Oregon. The panels swing with the flow of water, do not catch trash, and are avoided by livestock (Elmore pers. comm.). Other forms of swing panels constructed of hanging pipe or heavy chain have also proven effective.

B. Grazing Treatments

Following are descriptions and examples of grazing treatments for riparian areas. Generalized responses to grazing treatments are provided in Table 4 (Platts and Nelson 1989), Table 5 (Buckhouse and Elmore 1991), and Table 6 (Kovalchik and Elmore 1991). Elmore and Kauffman (1994) caution that the ratings presented in these tables are based on observations in different riparian/stream systems. However they do express similarities for assessing the potential for management success in the northern Rocky Mountain and Pacific Northwest regions.

Table 4. Evaluation and rating of grazing strategies for stream riparian habitats (Platts and Nelson 1989).

Strategy	Level to which riparian vegetation is commonly used	Control of animal distribution (allotment)	Streambank stability condition	Brushy species regrowth potential	Seasonal plant rehabilitative	Stream-riparian	Rating
Continuous season-long (cattle)	heavy	poor	poor	poor	poor	poor	1[a]
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)	heavy to moderate	good	poor	poor	poor	poor	2
Holistic (cattle or sheep)	heavy to light	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)	heavy to moderate	good	fair	fair	fair	fair	4
Stuttered deferred-rotation (cattle)	heavy to moderate	good	fair	fair	fair	fair	4
Winter (sheep or cattle)	moderate to heavy	fair	good	fair	fair to good	good	5
Rest-rotation (cattle)	heavy to moderate	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

[a] Rating scale based on 1 (poorly compatible) to 10 (highly compatible with fishery needs).

Table 5. Generalized relationships between grazing system, stream system characteristics, and riparian vegetation response (adapted from Buckhouse and Elmore 1991).

Grazing system	Steep low sediment load		Steep high sediment load		Moderate low sediment load		Moderate high sediment load		Flat low sediment load		Flat high sediment load	
No Grazing	shrubs	+	shrubs	+	shrubs	+	shrubs	+	shrubs	+	shrubs	+
	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+
	banks	0	banks	0 to +	banks	0	banks	+	banks	+	banks	+
Winter or Dormant Season	shrubs	+	shrubs	+	shrubs	+	shrubs	+	shrubs	+	shrubs	+
	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+
	banks	0	banks	0 to +	banks	+	banks	+	banks	+	banks	+
Early Growing Season	shrubs	+	shrubs	+	shrubs	+	shrubs	+	shrubs	+	shrubs	+
	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+
	banks	0	banks	0 to +	banks	+	banks	+	banks	+	banks	+
Deferred or Late Season	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-
	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+
	banks	0 to -	banks	0 to -	banks	0 to +	banks	+	banks	+	banks	+
Three-Pasture Rest-Rotation	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-
	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+
	banks	0 to -	banks	0 to -	banks	0 to +	banks	+	banks	+	banks	+
Deferred Rotation	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	+
	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+
	banks	0 to -	banks	0 to -	banks	+ to 0	banks	+	banks	+	banks	+
Early Rotation	shrubs	+	shrubs	+	shrubs	+	shrubs	+	shrubs	+	shrubs	+
	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+
	banks	0 to -	banks	0 to +	banks	+ to 0	banks	+	banks	+	banks	+
Rotation	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-
	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+	herbs	+
	banks	0 to -	banks	0 to -	banks	0 to +	banks	+	banks	+	banks	+
Season-Long	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-
	herbs	-	herbs	-	herbs	-	herbs	-	herbs	-	herbs	-
	banks	0 to -	banks	0 to -	banks	-	banks	-	banks	-	banks	-
Spring and Fall	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-
	herbs	-	herbs	-	herbs	-	herbs	-	herbs	-	herbs	-
	banks	0 to -	banks	0 to -	banks	-	banks	-	banks	- to 0	banks	0 to +
Spring and Summer	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-	shrubs	-
	herbs	-	herbs	-	herbs	-	herbs	-	herbs	-	herbs	-
	banks	0 to -	banks	0 to -	banks	-	banks	- to 0	banks	- to 0	banks	0 to +

Note: - = decrease; + = increase; 0 = no change. Stream gradient: 0 to 2% = flat; 2 to 4% = moderate; >4% = steep.

Table 6. Generalized relationships between grazing system and willow and sedge response on willow-dominated plant associations (Kovalchik and Elmore 1991).

Systems highly compatible with willow management		
Corridor fencing	Willows	⇧
	Sedges	⇧
Spring grazing	Willows	⇧
	Sedges	⇧
Riparian pasture	Willows	⇧
	Sedges	⇧
Winter grazing	Willows	⇔ to ⇧
	Sedges	⇧
Systems moderately compatible with willow management		
Two-pasture rotation	Willows	⇔ to ⇧
	Sedges	⇧
Three-pasture deferred rotation	Willows	⇔ to ⇩
	Sedges	⇔ to ⇧
Three-pasture rotation	Willows	⇔ to ⇩
	Sedges	⇧
Systems incompatible with willow management		
Spring-fall grazing	Willows	⇩
	Sedges	⇔ to ⇩
Late-season grazing	Willows	⇩
	Sedges	⇩
Deferred grazing	Willows	⇔ to ⇩
	Sedges	⇔ to ⇩
Season-long grazing	Willows	⇩
	Sedges	⇩

⇧ = highly compatible, ⇩ = incompatible, ⇔ = no change