RIPARIAN AREA MANAGEMENT

TR 1737-20

Grazing Management Processes and Strategies for Riparian-Wetland Areas

2006

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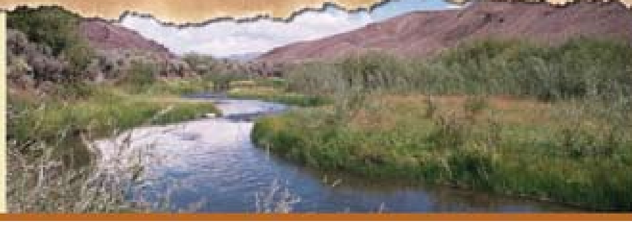

RIPARIAN AREA MANAGEMENT
Grazing Management Processes and Strategies for Riparian-Wetland Areas

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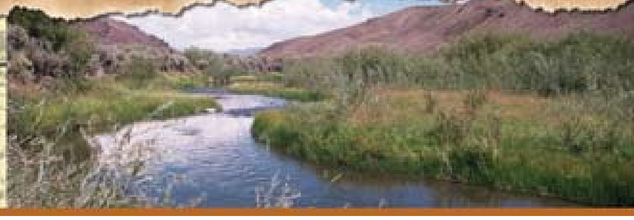

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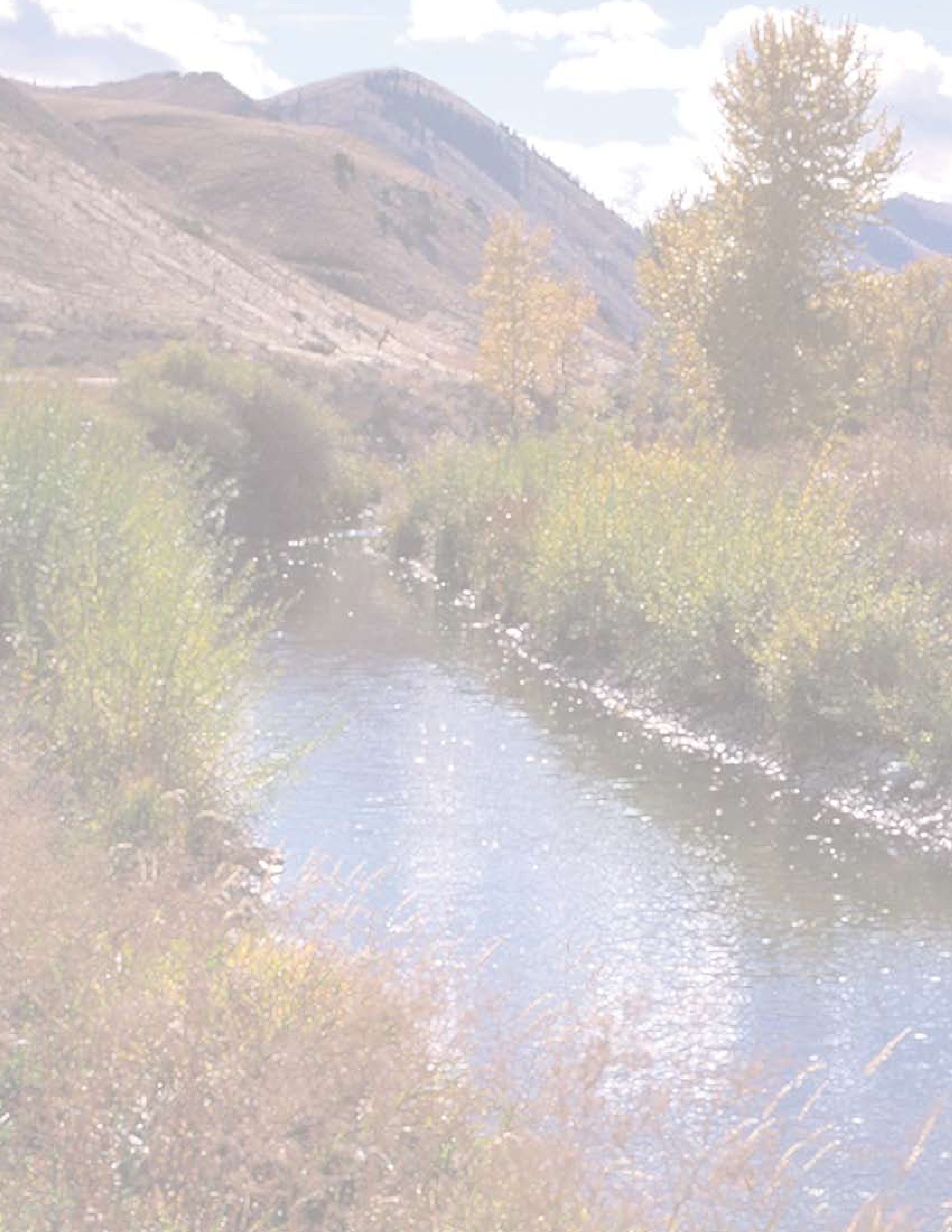
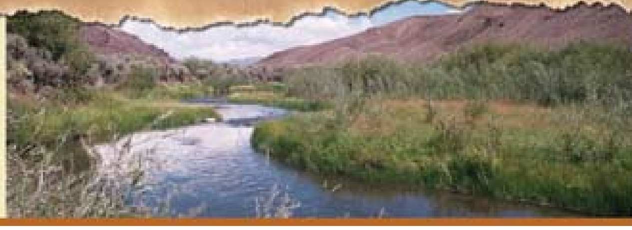
DEDICATION

This publication is dedicated to the livestock operators and land managers who work to solve private and public land resource issues both now and in the future. Their commitment to sustainable resource management will help maintain rural lifestyles, open space, and properly functioning watersheds.





PREFACE

Grazing management in riparian-wetland areas has been a major issue facing rangeland managers for more than three decades. In the late 1960s, growing concern about the environment prompted landowners, land managers, land users, and a highly interested public to take a critical look at land management practices, with an eye toward reducing adverse environmental consequences resulting from use of the land. That critical look identified management of livestock grazing in riparian-wetland areas as a significant issue that has assumed permanence on both private and public grazing lands.

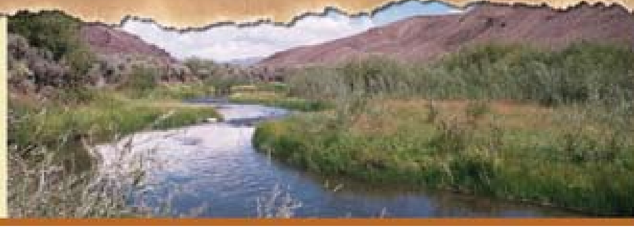
To help address this issue, Kinch (1989) developed Technical Reference (TR) 1737-4, *Grazing Management in Riparian Areas*. Throughout the 1990s, management actions were implemented and monitored in riparian-wetland areas. The resilience and quick response of riparian-wetland areas to these actions provided new information that was subsequently incorporated into TR 1737-14, *Grazing Management for Riparian-Wetland Areas* (Leonard et al. 1997). The implementation of grazing management strategies for riparian-wetland areas and the evaluation of their successes and failures continue to provide valuable information, emphasizing the need to periodically update this grazing management reference.

Accordingly, this technical reference provides the most current information to further assist livestock operators and land managers in developing successful riparian-wetland grazing management strategies across a wide array of land types. It is also the core document for the Grazing Management for Riparian-Wetlands training course. The training course is periodically conducted by an interagency, interdisciplinary team for a broad audience that includes ranchers; local, county, State, and Federal agencies; and the interested public.

Because of the complexity of riparian-wetland areas and issues, this technical reference does not set forth a specific formula for identifying the type of grazing strategy best suited for an area. Rather, it provides information to help design appropriate grazing strategies so that soil and vegetation aspects, water issues, and wildlife and livestock needs are addressed in a collaborative manner.

Basic topics covered in this technical reference include riparian-wetland area attributes and processes, resource assessments and inventories of riparian-wetland areas, development of good resource management objectives, management strategy factors, grazing treatments, and collaborative monitoring. Examples of tools, techniques, and treatments are provided, but they do not represent all of the "tools in the toolbox" that are available to resource managers. Although the term riparian is used alone throughout this document, riparian-wetland area is implied. While examples in this document feature running water (lotic) riparian-wetland areas for the most part, these principles are applicable to standing water (lentic) areas as well. This document is intended to provide the background and information necessary to allow managers to develop practices that will help protect riparian area resources while maintaining the viability and economic soundness of the grazing enterprise.

Management of the associated uplands can directly affect conditions in the riparian area. Consequently, it is important to consider the entire watershed and its resources when developing a grazing management strategy. A successful grazing management strategy meets the needs of the operator, livestock, wildlife, and upland and riparian resources. Continued success is achieved by monitoring how well the strategy meets these needs and making timely adjustments as necessary.



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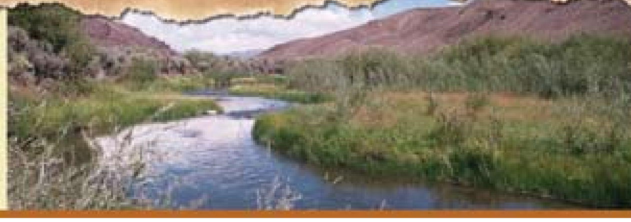


I. INTRODUCTION

Marshes, wet meadows, shallow swamps, estuaries, and land adjacent to rivers, streams, and lakes are typical riparian areas. These areas can range in extent from a few square feet, such as around small springs, to tens of thousands of acres or more, such as in large wetland complexes. Riparian areas make up a relatively small, but productive and resilient portion of the landscape, exhibiting vegetative or physical attributes reflective of the influence of water. They are important for the ecosystem services they provide, such as floodplain and ground-water storage, water transport, improved water quality, and fish and wildlife habitat. Riparian areas are also economically important, particularly to the livestock industry, because of the water, forage, and cover they provide for livestock. No other landscape feature connects ecosystems and people as effectively as streams and riparian areas. For this reason, all land managers, both public and private, must work together to develop management strategies that reflect this connectivity.

Most livestock grazing pastures or allotments include some riparian areas, and managing livestock in those areas is one of the most contentious issues facing rangeland managers. This issue is complex because livestock operators and land managers must resolve conflicting economic and environmental issues, as well as other issues. For example:

- Most riparian acreage is privately controlled or intermingled with other ownerships.
- Riparian areas are often the primary, and sometimes the only, watering places for livestock grazing on pastures and rangeland.
- Public use and fragmentation of riparian areas are increasing.
- Other resources and uses, such as wildlife, fisheries, and recreation, are concentrated in and dependent on these areas.
- Grazing by livestock and wildlife can affect a number of resources and uses, both onsite and offsite.
- The value of properly functioning riparian systems is not widely understood.
- Traditional management strategies, practices, and thinking are often inadequate and difficult to change (Leonard et al. 1997).

These complexities often make the participation and cooperation of landowners, recreationists, other watershed users, agencies, and resource specialists from various disciplines critical to the success of riparian area management.

"Land managers currently face over a century of riparian manipulation and often incompatible management actions. We must remember that successful riparian management and restoration require patience and persistence."

Wayne Elmore,

Retired BLM Riparian Ecologist

Successful livestock riparian grazing strategies are developed by considering site-specific resource conditions, soil and vegetation capabilities, water quality requirements, livestock and wildlife needs, and human perspectives. While no single grazing system will maintain improved riparian areas or consistently help recover degraded areas, combinations of strategies can be used to customize an approach for each site (Leonard et al. 1997, Lucas et al. 2004). In fact, Clary and Webster (1989) thought that the grazing system selected may not be that important as long as there is direct control of livestock distribution and grazing intensity. Ehrhart and Hansen (1998) reported that in studies in Montana, riparian area conditions improved if the operator or manager was seriously committed and constantly involved. With this in mind, managers must work together to find grazing strategies and practices that make control of livestock distribution and grazing intensity easier and more effective or at least achievable (Leonard et al. 1997).

Any attempt to improve grazing management **generally** follows these basic principles:

- Avoid grazing the same place at the same time year after year.
- Provide for plant development prior to or plant recovery following the grazing period.
- Defoliate the primary forage plants only moderately.
- Provide for livestock needs throughout the year.
- Manage for maintenance or improvement of riparian area physical functionality.

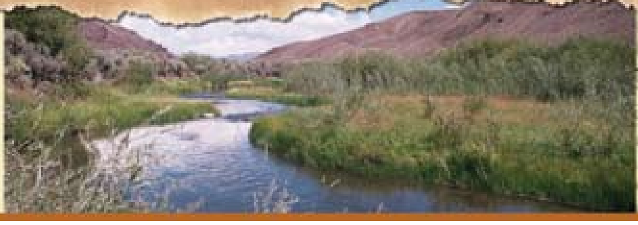
- Assess riparian area condition at a frequency adequate to enable, if necessary, prompt corrective management action to protect the health of the riparian area.

The case studies throughout this technical reference illustrate successful livestock grazing strategies and the consequent maintenance or recovery of riparian area function. These are just a few examples of riparian area improvement through livestock grazing that have occurred in the past 20-30 years on private and public land throughout the West. The compatibility of grazing in riparian areas depends on the extent to which the selected grazing management strategy considers and adapts to certain basic ecological and economic relationships. Prior to developing grazing management strategies for riparian areas, managers should have some understanding of grazing effects on the following:

- 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 and quantity
- Recovery rates
- Upland conditions
- Other uses and demands for the site (e.g., recreation, domestic water)

An ecosystem perspective is critical to successful riparian area management. Leonard et al. (1997) stated that the structure and processes of riparian areas, more than those of any other ecosystem, are influenced by their connectivity to adjacent upland ecosystems. An ecosystem or watershed perspective provides a comprehensive basis for evaluating current grazing practices and other land uses, identifying riparian management objectives, and developing future management alternatives. Analyzing trends from an adaptive management perspective will help determine if goals and objectives are being met and what changes may be needed to move toward the desired outcome.

The information presented in this document will further enhance the ability of livestock managers to develop and implement successful riparian area grazing strategies. More information is available from other sources such as the Web sites listed in Appendix A.



II. GRAZING AND RIPARIAN-WETLAND AREA ATTRIBUTES AND PROCESSES

"There is good agreement that riparian plants influence the stability of riverbanks, and root reinforcement of banks is arguably the most important way vegetation enhances stability."

Abernethy and Rutherford (2001)

Livestock can indirectly and directly affect stream condition through soil compaction, bank shearing, or severing of roots of riparian vegetation, which are needed for plant survival and bank stability (Behnke and Raleigh 1978). Depending on site, soil, and substrate characteristics, channel degradation generally takes one of two forms:

- If a restrictive soil (claypan, organic, or bedrock) layer is in the channel bed, bank erosion causes channel widening and stream depth decreases (Figures 1 and 2). Stream temperature may also rise and affect aquatic habitat when floodflows can no longer access the floodplain. Little water is retained in the streambanks for later use by vegetation or delayed release back into the stream.
- Conversely, if the restrictive soil layer is lower, the channel can downcut, and the stream gradient and energy can increase and move excessive sediment downstream (Figure 3). Water cannot access the floodplain as well or at all, the water table is lowered, and associated meadows dry up and become much less productive. Water is not stored for later use by vegetation or delayed release back into the stream.

Figure 2. Bank erosion caused by a bedrock channel bottom. (Photo by J. Staats, NRST.)

Figure 1. Bank erosion caused by channel widening and stream depth decreases due to an organic restrictive soil layer in the channel bed (arrow). (Photo by J. Staats, NRST.)

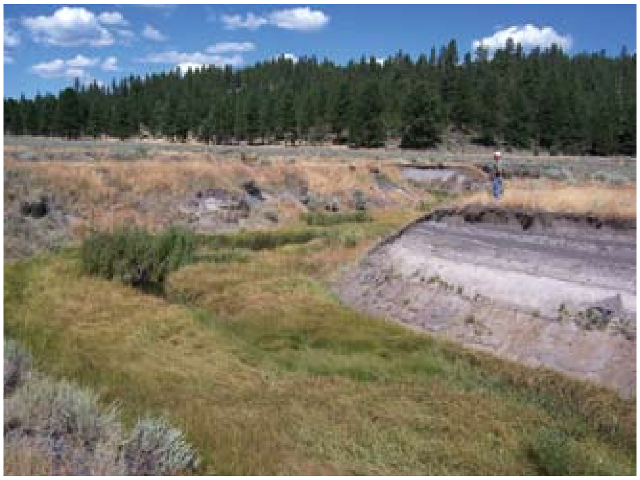


Figure 3. The restrictive soil layer is lower and the channel has downcut with a new floodplain. The water table is lowered. (Photo by J. Staats, NRST.)

Livestock grazing that promotes and is compatible with healthy riparian vegetation contributes to sustainable levels of aboveground biomass, root growth, and root strength in streambanks. Through overbank flows, riparian vegetation is naturally defoliated or buried by stream and sediment deposition. Livestock can contribute to the maintenance of vegetation by defoliating dormant or dead growth in between these overflow events, thus increasing green matter and hence root strength and growth. If the root strength of riparian vegetation and the surface roughness is sufficient, sediments will be deposited, not eroded away. Riparian vegetation is critical in maintaining channel stability during high flows to allow maintenance of proper stream shape, pattern, sinuosity, and gradient. Vegetation is critical in most low- (<2 percent) and moderate-gradient (2-4 percent) streams. Riparian vegetation can play an important role in shading streams to improve or maintain water temperatures for fisheries by narrowing channels and intercepting solar radiation.

If the harmful impacts from grazing are greater than the recovery response, detrimental changes will occur in the system. Harmful impacts stem from defoliation of important plants at times that do not allow recovery, for long periods that lead to many repeated defoliations, or at intensities that set back plant growth. Fragile soils in some areas may require total livestock exclusion for at least a short period of time (2-5 years). Conversely, if the recovery of the vegetation or site is greater than the disturbance, then recovery should occur. For example, in 1977, Bear Creek in central Oregon was nonfunctional after years of continuous hot season grazing (Figure 4).

Figure 4. Bear Creek in central Oregon was nonfunctional in 1977.

A change in management to a late winter-early spring grazing strategy allowed this system to recover and increased the available animal unit months (AUMs) (Figure 5).

Figure 5. A change to late winter-early spring grazing allowed the Bear Creek system to recover (1996). (Bear Creek photos by Wayne Elmore, retired, BLM.)

Excess herbivory or trampling damage can lead to greater erosion or deposition, changes in channel geomorphology, and less soil moisture (Skovlin 1984, Legge et al. 1981). For example, Pearl Creek in Nevada in 1982 lacked the attributes needed to maintain bank stability under high-flow events. The streambanks lacked woody vegetation recruitment and the riparian herbaceous stabilizing species that would have maintained this system (Figure 6). In 1983, Pearl Creek had downcut, lowering the water table and losing frequent floodplain access (Figure 7). By 1988 Pearl Creek had stopped downcutting and had started to widen, creating a new floodplain at a much lower elevation (Figure 8).

Figure 6. In 1982, Pearl Creek in Nevada lacked bank stability.

Figure 7. Pearl Creek had downcut in 1983.

Figure 8. Pearl Creek started to widen by 1988. (Pearl Creek photos by BLM.)

Understanding the relationship between vegetation and channel stability is critical in the planning and design of grazing management strategies that are compatible with riparian area maintenance or restoration. Understanding that the condition and management of the associated uplands can directly affect conditions in the riparian area is also important. Change in management of the upland should not be to the detriment of the riparian area and vice versa.

A. Vegetation

Vegetative attributes that can change in response to a grazing strategy include:

- Plant community composition, distribution, and production
- Plant species diversity
- Rooting characteristics (deep-rooted or shallow-rooted)
- Vegetation contribution to percentage of soil organic matter
- Amount of bare ground vs. vegetated ground cover
- Plant community structure including woody plant size, diverse age classes, location, and abundance

The U.S. Fish and Wildlife Service's *National List of Plant Species that Occur in Wetlands* (Reed 1988) rates each species on the estimated probabilities (frequency of occurrence) of plants in a wetland versus nonwetland area across the entire distribution of that species. These species have been further grouped into wetland community types and or plant associations or "an assemblage of native vegetation in equilibrium with the environment on a specific fluvial or water formed surface" (Kovalchik 1987).

Micheli and Kirchner (2002) have shown that riparian species, especially obligates, are six to ten times more effective in providing bank stability and in resisting the forces of water than those plant species adapted to drier environments. Riparian plant community types are important because they are more suitable for maintaining and enhancing the stability of streams. The roots of these plants have four basic characteristics that affect bank stability. They are:

- Root biomass
- Total root length
- Resistance to compressive force (hoof action)
- Linear or stretching strength.

In developing grazing management strategies, both woody and herbaceous vegetation communities should be considered for maintenance of channel and bank stability (Winward 2000, Cornwall 1998). Willow root biomass, including root length and depth, corresponds closely to the size of the aboveground stems and branches. This biomass relationship fits well with watershed protection needs of mountain and valley settings. However, some stream systems neither require, nor have the potential for, woody vegetation. Other systems need woody vegetation, such as willows and cottonwoods, and some require a conifer component as well.

B. Channel Stability

Plants differ in their ability to protect streambanks. Winward (2000) assigns riparian vegetation communities a stability class rating, ranging from 1 (least) to 10 (greatest), which reflects their ability to buffer the forces of moving water (Figure 9). A minimum rating of 7-8 is needed for some alluvial stream systems (0-2 percent slope), but on higher gradient streams (4–6 percent slope) minimum ratings can be as low as 6 if there is ample embedded large wood or rock.

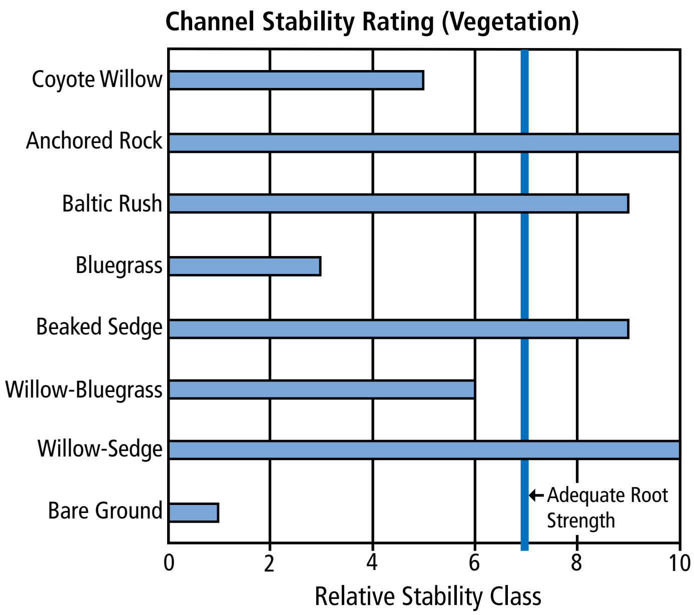


Figure 9. Channel stablility rating (adapted from Winward 2000).

Winward's rating system and others, such as the multiple indicator monitoring methodology (Cowley and Burton 2005), when integrated with existing classification documents, allow managers to assess riparian areas for site potential and set reasonable goals and objectives for maintenance or restoration, development of alternatives, and design of management strategies. These systems are also extremely important in assessing trend and ultimate attainment of desired plant communities.

One frequently overlooked period when grazing strategies can be critical for recovering streams is during droughts. These periods of low flows and reduced stream energies allow vegetation to expand roots and aboveground biomass into areas that were previously in the active channel. The increase in root biomass enhances stream stability and resistance to both lateral widening and vertical incision. This is especially important in alluvial systems composed of finer sediments. Grazing strategies should allow these processes to occur (Walters et al. 1980).

C. Upland Connection

Consideration must be given to management effects on other types of ecological sites within a pasture or watershed, including upland areas, when planning livestock grazing in riparian areas. There are many factors that need to be evaluated, including landscape and animal behavioral interactions. For example, cattle tend to use primarily riparian areas during the hot season on steep landscapes. If this condition is not adequately addressed during the planning stages, the result may cause significant degradation to the riparian area.

In many parts of the West, a reduction in fire frequency and intensity, primarily in pinyon and juniper woodlands, has allowed woody plants to encroach into grasslands. These additional shrubs and trees have caused a variety of effects. A shift from plant communities dominated by grasses and forbs to those dominated by woody plants can result in substantial changes to the hydrology of an area. For example, a switch from herbaceous to woody-dominated vegetation has the potential to alter runoff patterns, infiltration, and ground-water recharge or discharge. These changes can, in turn, alter the flow regime of area streams. In addition to altering the hydrology, woody plant encroachment may also affect livestock use patterns. Thick stands of woody plants may limit livestock access to portions of a pasture and consequently put more pressure on other more accessible areas of the pasture (Bartos and Campbell 1998). Prescribed fire is a tool that can be used to address such concerns. Wildfire effects can promote riparian health and restoration as well as create many riparian problems. Accumulated fuels can increase fire intensity and watershed effects leading to debris flows and flooding. Flood damage is likely to be more severe where riparian vegetation has been consumed in hot fires fueled by accumulated wood.

III. GRAZING MANAGEMENT PLANNING

The development of a successful grazing management prescription requires consideration of riparian area functional attributes, ecological processes, and an understanding of grazing effects. This understanding is exercised during the basic planning process. Collaboration in the planning process is extremely helpful in designing successful grazing management strategies when two or more individuals or parties are involved (see Appendix B). There are numerous examples across the West of collaborative processes that have involved local communities in achieving resource goals. Coordinated resource management (CRM) is one such process that has brought diverse groups of people together to resolve resource management issues (Cleary and Phillippi 1993). People are generally more dedicated to plan implementation and adaptive management in an environment of collaboration.

In situations involving Federal land or dollars, National Environmental Policy Act (NEPA) and other legal requirements need to be met. The NEPA effects analysis should be broad enough to provide for effective adaptive management. Local, State, and Federal requirements, such as the Clean Water Act [303(d)/Total Maximum Daily Loads], Federal Advisory Committee Act, Endangered Species Act, and State best management practice requirements, also need to be followed, as applicable.

The basic components of a grazing management planning process are illustrated in Figure 10.

Because streamside vegetation is one of the primary ecological attributes affected by grazing, an inventory or assessment of current vegetation condition in relation to the potential condition is necessary to identify limitations or opportunities. Additional issues may be identified through social processes or legal requirements. Goals and objectives are developed to address issues associated with grazing management. These may include individual objectives of livestock operators and land managers as well as resource objectives and legal obligations required by the Endangered Species Act, Clean Water Act, and others.

Following the development of goals and objectives, a grazing management strategy with associated tools or improvements is developed and implemented to address all identified objectives. If planned management will not likely address one or more specific objectives, either the objective or the planned management should be

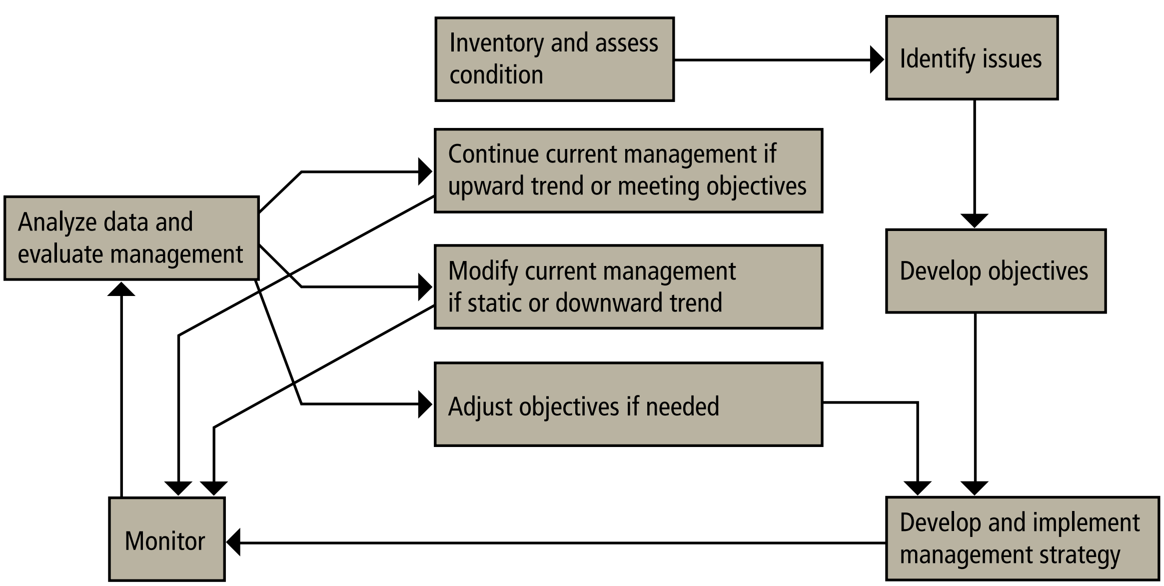
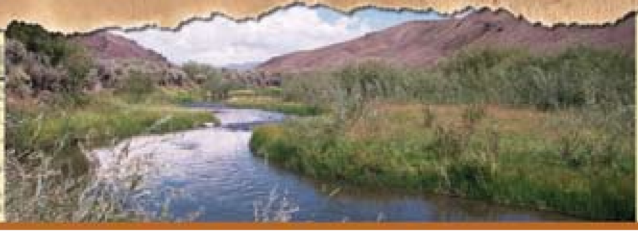


Figure 10. A grazing management planning process.



reconsidered. Monitoring data are collected to determine whether or not progress is being made toward meeting specific objectives. Therefore, it is critical that the monitoring plan is designed to collect useful, quantified data that addresses objectives. Short-term monitoring consists of collecting information on actual livestock use and indicators of use, as well as annual events such as weather, fire, disease to indicate whether long-term objectives can reasonably be achieved. Long-term monitoring consists of measurements to determine if progress is actually being made toward objectives or objectives have been achieved. Adaptive management consists of refinements to the management strategy based on annual analysis of short-term monitoring data or analysis of mid- and long-term monitoring information relative to short-term events and indicators. These analyses help determine whether or not additional resource information (inventory) may be needed, issues have evolved, objectives were reasonable and achievable, or any management strategy needs to be changed. Once adjustments are made, continued monitoring is necessary to determine the effectiveness of the changes. Monitoring is discussed in more detail in section III.E.

A. Assess Resource Conditions

A properly designed grazing strategy requires a basic understanding of the short- and long-term ecological processes that can occur within a riparian area. Soils, vegetation, hydrology, climate, geomorphology, and the animals using the resources are just a few of the important factors that require consideration (Meehan and Platts 1978). A variety of assessments and inventories are available to determine resource conditions and management concerns in riparian areas. They provide information needed to make adaptive management decisions and to monitor ecological change. Baseline information is critical for determining if the land and livestock goals and objectives are being achieved. A common question heard in planning meetings is, "How do you know where you are going if you don't know where you are?"

The following tools are useful for determining the potential, capability, and desired resource conditions of vegetation in an ecological site in different topographic locations. Contact local Bureau of Land Management (BLM), USDA Forest Service (USFS), Natural Resources Conservation Service (NRCS), Soil and Water Conservation Districts (SWCD), or county extension field offices for local information.

1. Classification

Riparian classification systems have been developed to help identify, describe, communicate about, and manage riparian communities. Determining the potential vegetation community is important in developing objectives and designing a grazing system that will restore the stream's ability to withstand moderately high-flow events and approach potential natural community. Several documents are available (or under development) that help determine what plant communities should exist in a particular setting and what the management implications are. Riparian classification systems have been completed in many of the Western States and are used to develop goals and objectives for grazing allotments or pastures. For example:

1. *Riparian Zone Associations: Deschutes, Ochoco, Fremont, and Winema National Forests* (Kovalchik 1987) and *Mid-Montane Wetland Plant Associations of the Malheur, Umatilla, and Wallowa-Whitman National Forests* (Crowe and Clausnitzer 1997) describe vegetation classification systems used in Oregon.
2. *Central Nevada Riparian Field Guide* describes plant associations but also considers the differing soil-water characteristics of a given fluvial surface. These differing soil-water characteristics result in different plant community expressions of the same potential (Weixelman et al. 1996).
3. The *Classification and Management of Montana's Riparian and Wetland Sites* (Hansen et al. 1995) is a system of wetland species dominance type (based on cover).
4. *Riparian Community Type Classification of Utah and Southeastern Idaho* (Padgett et al. 1989) is an abstract grouping of plant communities based on floristic and structural similarities.

2. Ecological Site Descriptions

Ecological site descriptions are currently being developed by the NRCS, in cooperation with other State and Federal agencies, to update the original range site descriptions. They are available in local NRCS field offices. Ecological site descriptions expand the original descriptions and add management implications. Grazing land ecosystems, including riparian areas, are complex (USDA NRCS 2003), and an adequate understanding of these ecosystems is essential to proper, sustainable management.

An ecological site is a distinct area of land that, because of its physical features, including soils, topography, and climate, will differ from other sites in its ability to produce a unique kind, abundance, and proportion of vegetation (USDA NRCS 2003). The plant community that is produced on an ecological site will differ from other sites in the composition of plant species, either in proportions or production.

Basic ecological relationships and dynamics essential for effective grazing management in riparian areas include nutrient cycling, energy capture, hydrologic and geomorphic conditions and processes, soil processes, and basic plant physiological requirements. All of these relationships are important on upland and riparian areas. However, the channel and floodplain hydrology and geomorphology are important in riparian area dynamics and thus must be included in the state and transition model. (See Appendix C for an explanation and example of a state and transition model.)

Ecological site descriptions also provide insights into the potential effects of grazing management strategies on different sites. Historic climax plant communities (HCPC) or potential plant communities for each site are also described in detail. The ecological processes, or pathways, that allow a site to return to HCPC and those that can move communities away from historic climax, are described as well. An example of an ecological site description can be found in the *National Range and Pasture Handbook* (USDA NRCS 2003), which is available in most NRCS field offices or online (See Appendix A).

3. Proper Functioning Condition Assessment

The current physical functionality of a stream is an important consideration that should be addressed at the start of a restoration, maintenance, or planning project. The USDA NRCS (2001) provides a variety of assessment and inventory techniques for determining conditions of riparian areas. The authors of this technical reference typically use the proper functioning condition (PFC) assessment (Prichard et al. 1998). The PFC method is not only an assessment tool, but also a communication tool.

PFC is one qualitative method of assessing the physical function of riparian areas while taking into account the system's potential and capability. The term PFC is used to identify the assessment process and a defined, on-the-ground condition of a riparian wetland area (Prichard et al. 1998). It has been shown to be a consistent approach for considering hydrology, vegetation, and soil erosion and deposition attributes and processes. A checklist used for the PFC assessment (Appendix D) synthesizes information that is foundational in determining the overall physical functionality of a riparian area. An interdisciplinary team determines a rating of proper functioning condition, functional–at risk, or nonfunctional based on the checklist information.

Proper functioning condition of riparian areas, as defined by Prichard et al. (1998), exists 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 floodwater 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

Functional–at risk (FAR) riparian areas are still functioning; however, an existing attribute (soil, water, vegetation) makes them susceptible to degradation. Riparian areas that are clearly not providing adequate vegetation, landform, or large woody debris to dissipate stream energy, improve floodwater retention and ground-water recharge, and stabilize streambanks are **nonfunctional** and cannot sustain desired values.

On the ground, PFC refers to how well the physical processes are functioning. PFC reflects a state of resiliency that enables a riparian area to hold together during high-flow events (5-, 10-, or 20-year flows). This resiliency allows an area to produce desired values over time, such as fish habitat, neotropical migratory bird habitat, and livestock or wildlife forage. Management actions focus on functions important to all resource users by setting objectives and planning to, at a minimum, address the limiting attributes and processes identified by the PFC assessment (those "No" responses on the checklist that indicate particular attributes or processes are not functioning as they should be). A grazing strategy that is compatible with those objectives can be developed and implemented by understanding the condition of a riparian area and attributes that are important to sustain functionality and values.

To understand whether or not grazing management is facilitating riparian area recovery, an understanding of recovery rates and grazing impacts is necessary. As an example, BLM Idaho State Office compiled data from streams in southern Idaho showing recovery and degradation rates of herbaceous and woody vegetation, the channel, and water quality (Cowley 1997). The data showed that herbaceous and woody vegetation recovered first (Figure 11) and that water quality and channel configuration took 10-20 years to improve. Degradation rates showed the same pattern: vegetation degraded first and the channel and water quality last (Figure 12). Cowley's example suggests that water quality and channel measurements are not appropriate tools to evaluate grazing strategy changes in the short-term and that vegetation attribute measurements may be more appropriate. Recovery is highly variable due to the influences of climate, soils, available moisture, and streamflow. Recovery is also more of a "first come, first served" situation. If sedges and rushes are first to revegetate a recovering area, they can inhibit or delay woody species recruitment on sites that are fully capable of supporting woody vegetation. If riparian woody and shrub species are among the first species to come in, sod competition is not present to inhibit their increase in the riparian area.

After attending a PFC workshop, ranchers in Silver Lake, Oregon, were able to assess current management of riparian areas on their properties. They determined that one riparian area they felt was falling apart was actually recovering and another riparian area that appeared to be fine was functional–at risk with a downward trend. The assessment allowed the ranchers to adjust their management accordingly.

J.Eisner, BLM Fish Biologist

Understanding expected recovery rates for the specific riparian area is necessary to develop achievable objectives that can be met within a designated timeframe. Figure 13 illustrates a decision tree that may be used to assist in the planning process.

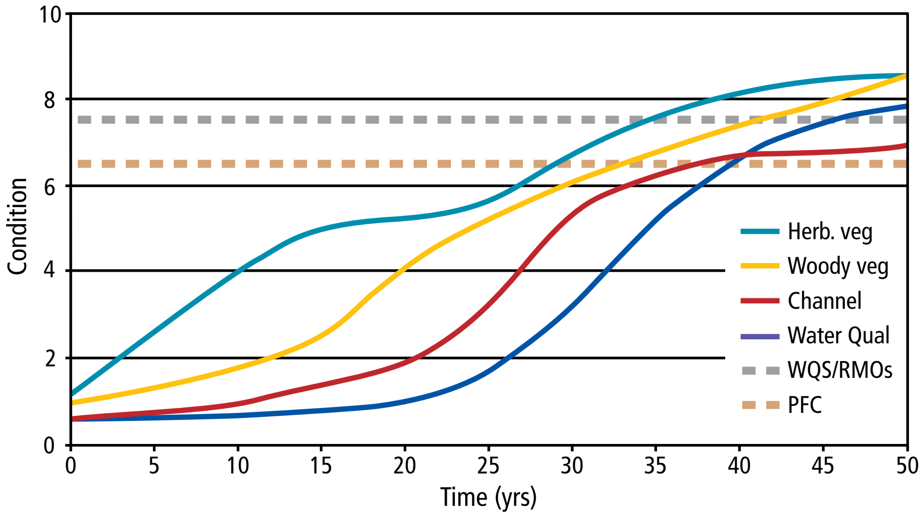


Figure 11. Recovery rates on a nonfunctional system in southern Idaho.

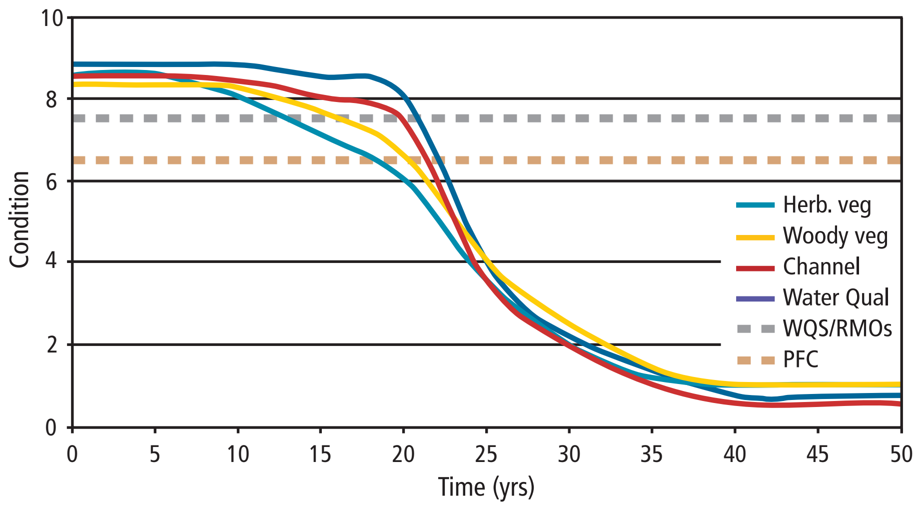


Figure 12. Degradation rates on a southern Idaho stream.

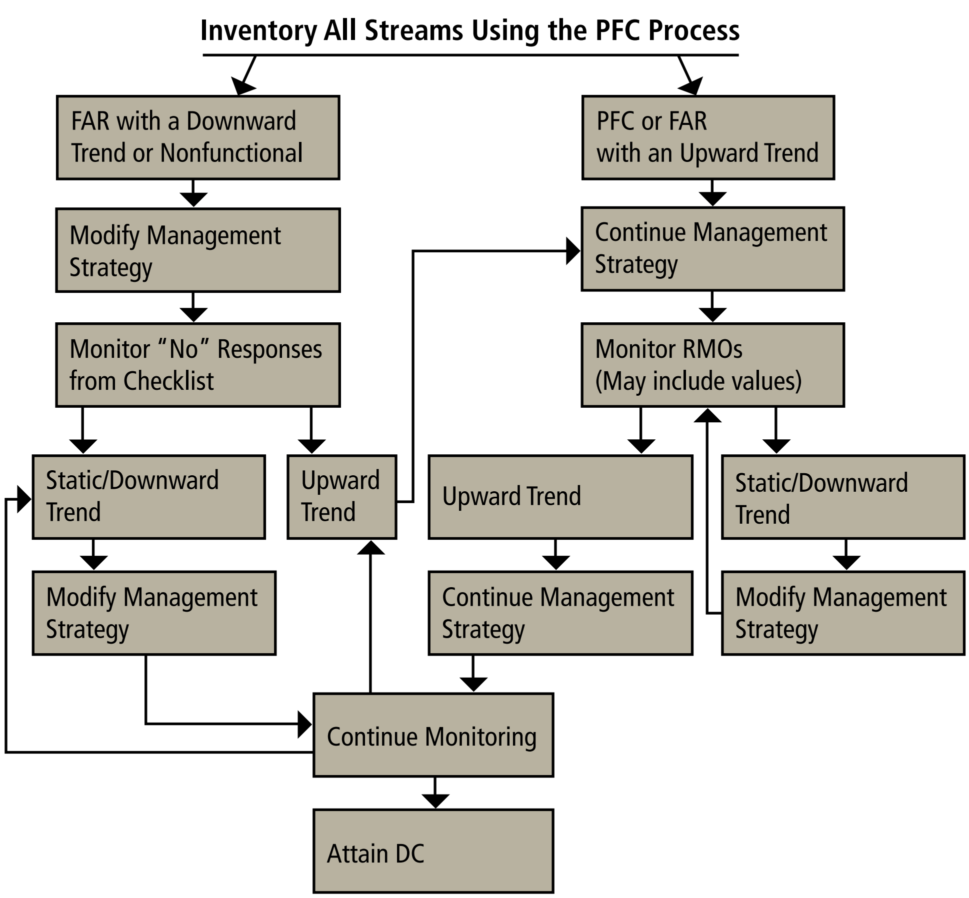


Figure 13. Proper functioning condition (PFC) assessment flow chart. RMOs = resource management objectives, FAR = functional–at risk, DC = desired condition.

B. Identify Issues

Issues are identified based on the inventories and assessments completed for the area, along with the associated management activities. The next step is to evaluate and prioritize resource concerns. For example, a high priority may be placed on those stream reaches that were assessed as functional–at risk in an unapparent or downward trend.

One method to organize the data and help identify issues is the Grazing and Spatial Analysis Tool (GSAT) (USDA NRCS 2005). Management objectives can be developed once the resource, economic, and social issues have been evaluated, which may focus management on specific areas.

C. Develop Management Objectives

The process of setting objectives helps livestock operators and land managers develop management plans that maintain or restore riparian values. Site-specific objectives (short- and long-term are most effective) should be tailored to the exact needs of the situation. For example, cattle, sheep, feral horses, and wildlife prefer different habitats and plants depending on the time of year. Management objectives that anticipate animal preferences will help managers design grazing strategies that balance livestock needs with ecological processes and resource values. A thorough understanding of site conditions and limitations provides the information necessary for making decisions regarding objectives and practices.

Objectives developed for uplands do not necessarily translate into appropriate riparian area management. Livestock operators and land managers often need to include objectives and prescriptions specifically designed for riparian areas.

Riparian area function often changes through a sequence of events. Thinking through a series of events helps increase understanding of the link between the element of time and the important attributes for setting objectives. For example, planned grazing management may result in the following sequence of events:

1. A level of streambank vegetation residue is left that provides the opportunity for regrowth and recovery of plants, which
2. Allows colonizing herbaceous vegetation to induce sediment deposition along streambanks by slowing water movement, which
3. Provides a setting for streambank stabilizing plants to establish, with more of them having stronger and deeper roots, which
4. Allows an increase in stable streambanks, floodplain access, and effects that dissipate flood energy and resist erosion, which
5. Improves floodwater retention and ground-water recharge, which
6. Further improves the functionality of the riparian area, which
7. Leads to narrower and deeper streams, which
8. Creates hiding cover for fish and improves water quality.

Of all of these, improvements in the plant community are the most measurable and pivotal to subsequent improvement. They are also the improvements most influenced by grazing management. In this example, mid-term objectives (3 to 5 years) could focus on the anticipated vegetation changes (e.g., an increased proportion of selected plant communities along the greenline), with a long-term objective (10+ years) of improved channel form (e.g., a narrower active channel and, eventually, increased sinuosity) or a desired age-class distribution.

1. Objectives Based on Riparian Attributes

Development of site-specific riparian area objectives begins by describing the existing riparian attributes and how they need to change. These changes depend on hydrologic events as well as time for succession. The amount of change in a given time period is difficult to determine unless it addresses only very obvious and predictable responses to management. Fortunately, the stream reaches that are functional–at risk and most likely to be targeted for management and monitoring are often the reaches where change is most needed and most predictable in the coming years. Some riparian areas may change slowly because they are not ready to respond to management or because they have already changed and the rate of additional change will be slower. The key to successful riparian area management is the quality of the interdisciplinary (ID) team that makes the assessment and carries the information forward into the management objectives and plan. Those who demand a high degree of precision or even accuracy among managers' expectations and real opportunities for response may not be satisfied with the tools offered in many places. Those who recognize that the journey through adaptive management is the real meaning of management will find that setting objectives and learning from monitoring the attainment of those objectives is a good approach.

The amount of change needed for detection depends on the variation in the data (which depends on many factors) and on the amount of data. Generally, in monitoring, representative areas, key areas, or designated monitoring areas are used to indicate change or lack of change. Within these areas, subsamples are used to indicate the trend. This sampling method is different from replication needed for statistical significance, but it does help to indicate trend from variable data.

In general, objectives should:

- Describe the desired plant community, list key plant communities, or list key species and indicate where in the riparian area these attributes should be located or where their abundance should be increased.

- Be guided by the present condition and trend of the vegetation in relation to riparian functions and management goals and by the inherent potential for change.
- Consider the complexity and diversity of riparian areas, which often requires interdisciplinary expertise to ensure that systems have the potential to respond to planned management and meet objectives.
- Be set in close cooperation with other affected parties when necessary.
- Be achievable and measurable in the designated timeframe and worthy of the costs needed to accomplish and monitor them.
- Assume and clearly state that adaptive management is a part of the planning process and that if objectives are not met in a designated timeframe, either the management, the objective, or the timeframe may need to be adjusted.
- Be consistent with the letter and the spirit of the law.

An objective identifies the intended accomplishment in relation to an attribute that is important to the system. Objectives should be easily measured and identify specific milestones along the route to a longer term goal. They must be tied to clear, concise monitoring methods and be reaffirmed from the monitoring information. There must be a commitment to monitoring the associated riparian area or watershed in order to determine if the objectives are being met in an appropriate timeframe and to ensure that the appropriate information is collected to understand why they are or are not being met. The use of adaptive management requires that definite parameters and specific timeframes for evaluation are set. At the end of that time, another evaluation of the expectations, implementation, management scheme, **uncontrollable disturbances**, and time period may be necessary.

Short-term monitoring often focuses on the management actions. Considerations such as remaining residue or not-to-exceed amounts of bank trampling are **not** objectives for resource conditions. However, they often trigger management actions or provide an indication of relative success in implementing a management action plan. Short-term monitoring is important for interpreting information about the attainment of objectives through the implementation of management actions. This allows managers to update plans through the adaptive management process.

Management of riparian areas and rangeland is an art based on partial science rather than a direct application of science. Resource managers should not fall into the trap that they are required to prove they have met (or will meet) an objective in order to continue adaptive management. This would be a no-win situation and falsely assumes that "nothing" can be done. Any "nothing" would be a form of management, but it often would not be the best form of management.

2. Elements of an Objective

A good objective states (Maser 1988):

- The **component**
- What is to be **accomplished**
- The **amount** of **change**
- The **location**
- A **timeframe**

The component selected should reflect important processes in riparian areas and should vary in response to management rather than from unrelated natural processes. Often the components of objectives are derived from the "No" answers on a PFC assessment checklist. A component for an objective does not simply describe the trigger used for a management action in each year. Rather, it reflects the changes in attributes that result from cumulative impacts of management actions over time.

Each objective should specify where it applies. The component may change quickly or may depend on processes that take time or stem from several other processes. What is to be accomplished could be an increase, decrease, or no change. Although it is important to be clear about the amount of change expected, it is also important to realize that the amount of change often depends, in part, on natural events that are beyond the control of management. In many cases, it is simply unknown how much change can be expected in a given period because processes can depend on both management and natural events. Therefore, objectives should be realistic and conservative and maintain flexibility. Objectives should be based on a full set of goals that reflect consideration of all resource issues and societal concerns.

Following is an example of a good objective relating to grazing management:

> Increase stabilizing or late seral riparian vegetation (Winward 2000) along Deer Creek greenline transect at Key Area 2 from the present 25 percent to 35 percent within 5 years after implementation of the grazing strategy.

For more examples of objectives, see Appendix E.

D. Develop and Implement Management Strategies

1. Management Strategy Factors

Once objectives have been formulated, appropriate management strategies should be developed to meet those objectives. As potential grazing strategies are discussed, the objectives should be continually reviewed. Objectives and management strategies must come together before either one is "established." Where current management practices are detrimental, the focus should first be on reducing [their] 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, changes in season, intensity, and frequency of use, or even temporary exclusion, might be necessary to initiate recovery. Other grazing strategies might be used to maintain or achieve objectives in plant composition, structure, etc. (See section III.D.3 for a discussion of these topics).

Grazing management strategies must also consider the sensitivity of different riparian areas to disturbance and their resiliency or ability to recover. 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 (Figure 14). Conversely, less sensitive systems have low levels of 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.

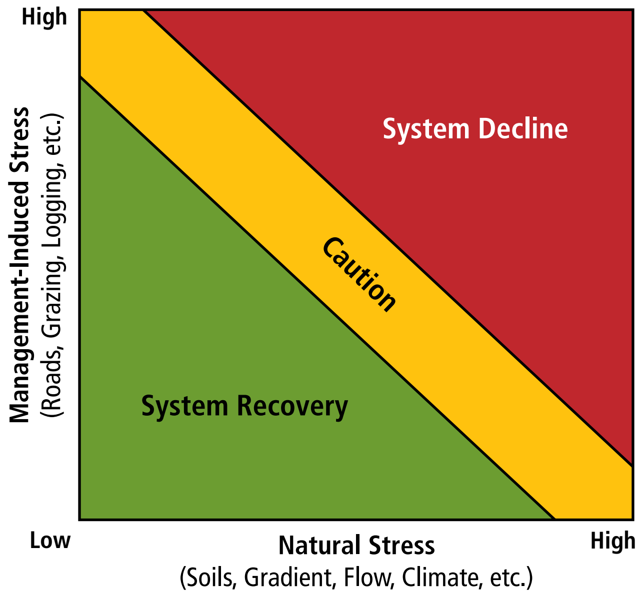


Figure 14. Management-induced stress vs. natural stress (Elmore and Kauffman 1994).

Even though stream classifications such as Rosgen's (1996) can help extrapolate responses of streams to grazing, structures, and other types of management, no two riparian areas 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: animal behavior, forage selectivity, plant responses, plant community change, hydrology, and practicality (Krueger 1996).

Plant responses, plant community change, and hydrology usually form the basis for achievable objectives and thus become the focus of many grazing strategies. Animal behavior affects those resource interactions and the **ability to achieve the objectives**. Understanding the principles of behavior can help improve the probability of successfully managing for riparian and other social, economic, and resource objectives.

Practicality is critical. A prescription should not only be feasible, it should be practical and achievable by the operator, with the flexibility built into the prescription to make adaptive management changes. As noted by Ehrhart and Hansen (1997), "the only *required* ingredients (for developing and implementing an appropriate prescription for any given riparian ecosystem) are a serious commitment and personal involvement on the part of operators and managers."

a. Animal Behavior

Animal behavior is a function of consequences (Provenza 2003). Positive consequences reinforce and lead to an increase in the associated behavioral response, whereas negative consequences typically lead to a decrease in that response. These behavioral responses can be influenced by (1) social management activities (e.g., low stress vs. high stress), (2) location on the landscape (e.g., upland vs. riparian), and (3) forage selection (e.g., nutrient requirement vs. nutrient and toxin contents of various plants and plant parts). Climate, soils, plants, herbivores, and people are interrelated facets of systems that change constantly. As stated by Provenza (2003), the "key to survival for herbivores and the people who manage them is to continually explore new possibilities and to know when to adapt." Some of the social, landscape, and forage selection factors that influence behavior are discussed below.

(1) Social

"When it comes to managing pastures and rangelands that contain a variety of foods and terrain, managers must understand how social factors influence both the foods creatures eat and the location where they forage, both of which influence carrying capacity" (Provenza 2003). Both also influence the use of riparian areas.

Howery et al. (1998) demonstrated the substantial influence of mother cows on the behavior of their young. Experiences early in life influenced the distribution patterns of offspring later in life, but peers and environmental factors also influenced distribution. In the 4-year study, researchers identified cows that had a propensity to spend time near either of two adjacent creeks in the same allotment. Calves from some of the cows from each creek were cross-fostered to cows from the other creek. Two other groups of cows and calves, one group from each creek, were also studied. Distribution behaviors of the four groups of calves were followed for 4 years; i.e. as calves, as yearlings, as first-calf heifers, and as second-calf 3-year-olds. During the first summer, calves stayed with their mothers (natural and foster) and stayed on their respective creeks. The fall of the first year, calves were weaned and wintered as a group. The second year, the influence of peers from wintering together resulted in a greater distribution of the yearlings away from the areas occupied by their mothers. During the third year, a drought dried up one of the creeks. The 2-year-olds from the dry creek drainage extended their range to access water. The animals from the drainage that continued to have streamflow stayed within their home range. During the fourth summer, all of the then 3-year-olds occupied the home range that they had occupied with their mothers during the first year. Results indicated that early learning from the mother had a substantial influence on subsequent behavior over the following 3 years. Peer influence and environmental conditions (e.g., drought) resulted in modified distribution, but the influence of the mother during the first year was still very strong. Management implications from this study include:

- Cull animals with undesirable habitat use characteristics.
- Retain those with desirable habitat use characteristics.
- Herd routinely to change distribution, and implement practices that foster a predictable social environment (e.g., separate young animals with desirable distribution patterns from young animals with undesirable distribution patterns).

Left to their own devices, cattle will form social groups similar to bison. Bison form intact family units including offspring, mothers, fathers, grandmothers, and grandfathers. Young animals benefit from the knowledge of social behavior, food, and habitat selection of older generations (Provenza 2003). Managing family or social units of livestock appears to have potential for modifying habitat preferences and reducing time spent in riparian areas. The Nature Conservancy's Red Canyon Ranch in Wyoming uses riders to move cattle subgroups (social units) to upland sites and to settle them as a group (Figure 15). Over a 3-year period, the riders were successful in modifying habitat preference from riparian to upland (3 years seems to be approximately how long it takes to adapt and perform with new management techniques). Individuals separated from their subgroup tended to return to their former location in an attempt to reunite with the group (Provenza 2003); however, if moved as a social or family group, they tended to stay together.

Figure 15. Moving cattle within their social group decreases stress and the desire to move back to their previous location. (Photo by F. Provenza, Utah State University.)

Social learning provides benefits to the animal and a tool for the manager to modify behavior and address management objectives. According to Provenza (2003), socializing enhances the learning efficiency of the group. For example, once one animal learns to drink from a water device that requires pressing a lever, others learn by example. Young learn the locations of water, forage, shade, and cover from their mothers. Experience carries over from generation to generation, which provides efficiency and an opportunity for behavior modification. In the Red Canyon Ranch example described above, the young learned along with their mothers that uplands were good places to be, and they then passed that experience to their young. Over a 3-year period, the behavior desired by the managers became adopted by the livestock and the preferred behavioral pattern became established.

(2) Landscape

Grazing managers must develop an understanding of the grazing patterns employed by the animals they manage (Stuth 1991), including 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). Large grazers in particular focus their foraging strategies around free-standing water and are considered "central place foragers," with the central or home place centered on water (Stuth 1991). The nature of the terrain, distribution of shrubs, changes in forage availability due to drought, and mobility of an animal all influence spatial use patterns around water sources. Figure 16 (Stuth 1991) illustrates many of these points. In this depiction of a pasture, forage along the road is used as a result of animals entering or exiting through the upper gate. The rocky outcrop on the slope serves as a barrier, and the slope itself serves as an impediment to access to the forage on the slope. The upper left corner has no water, so it receives little use. The majority of the grazing use occurs at the bottom of the pasture, on level terrain, within easy reach of the only water in the pasture. The gully or ditch in the lower right corner and the dense stand of trees near the water trough also serve as barriers and restrict access to forage.

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

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

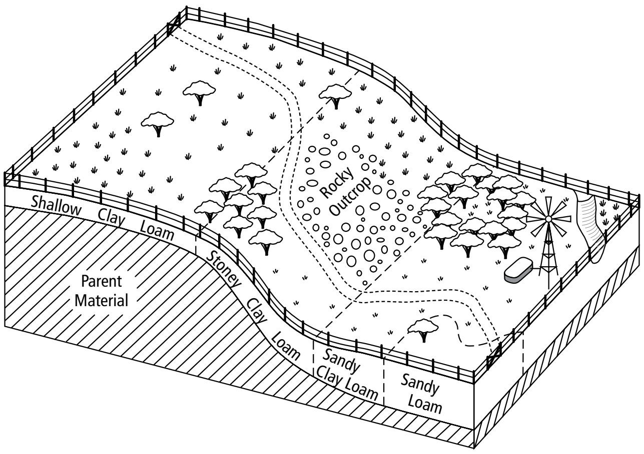


Figure 16. Landscape configuration reflecting the unique set of forage resources, water locations, and terrain constraints that affect use patterns by grazing animals. Reproduced from Stuth (1991) with permission.

An animal's selection of a given plant community for forage is largely related to those attributes of a site that influence plant species composition and density (Table 2). Plant species composition and density depend on site characteristics, past management, and the availability of nutrients and water.

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 and 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 or exposure to grazing

Based on what is known about livestock behavior, grazing programs can be designed to entice animals to specific areas at specific times, encouraging grazing patterns that yield a desirable vegetative response. For example, livestock use of riparian areas is known to vary by season. During spring, livestock tend to disperse to uplands because of higher quality forage, better water distribution in shallow reservoirs and natural water pockets, and acceptable or preferable thermal conditions. During summer, livestock tend to be attracted to riparian areas because of water availability; relatively 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 areas primarily due to water availability and the potential availability of browse with higher nutrient content and palatability than cured upland forage. During winter, livestock might avoid riparian areas if they function as cold air pockets or drainages, or they might be drawn to them by the availability of wind protection and nutrients in available browse. The specifics of each riparian area and its associated upland areas, such as upland water distribution, determine appropriate management options.

Variable weather conditions also affect animal behavior by impacting conditions such as vegetation productivity and water distribution. For example, drought can cause the growing season to be earlier and shorter. As a result, animals may move to riparian areas much earlier, and dates of grazing may need to be adjusted. Conversely, a prolonged wet, cool spring and summer may result in less time spent in riparian areas and allow longer-than-normal use of a given pasture. This would allow deferment or rest of some other pasture as a possible beneficial treatment.

The kind (e.g., cattle or sheep), class (e.g., yearling or cows with calves), 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 big game home ranges, and they can be expected to head for and stay in a given area. Inexperienced animals initially search for the boundaries (e.g., walking the fenceline) of their environment before identifying preferred locations, with water being a primary factor. These behavioral attributes provide an opportunity to train livestock to prefer habitats like uplands and to minimize time spent in riparian areas.

Bailey (2004a) has found that genetics may influence where cattle tend to spend their time. In a study of two groups of livestock, Bailey found that one group of cows used steeper slopes and traveled further horizontally and vertically from water than the comparison group. Both groups were crossbred from the same two breeds, but the breed that was dominant in each group differed. The group that traveled further had a greater percentage of a breed that was developed in mountainous country. The group that stayed closer to water and used more gentle topography had a greater percentage of a breed that was developed in more gentle terrain (Bailey et al. 2004c). Provenza (2003) also noted that genetics may have an influence on behavior, but he added that behavior can often be modified through appropriate training as illustrated by the Red Canyon Ranch in Wyoming and their use of low-stress stockmanship and working with social groups to change behavioral patterns [refer to the previous discussion in section III.D.1.a.(1)].

A rider may be able to train cows and calves to use uplands and discourage their use of riparian areas by consistently moving them away from riparian areas to other locations (Butler 2000). As described previously, this works best if family or social groups are moved intact, and if low-stress movement techniques are used (see section III.D.2). Behavioral principles can be used to determine the most effective timing of movement. When moving animals to another location to forage in a familiar environment, it works best to move them before they have fed and watered. At the new site they experience positive reinforcement from eating nutritious foods in the area (Provenza 2003). This allows the livestock to associate sites away from riparian areas with desirable qualities, thus making those sites preferred locations. If done repeatedly, cattle learn to move readily because good things happen when they do. When moving to new loafing areas, however, it works best to move cattle after they have fed and watered. Once they arrive, they are ready to settle down.

When cattle are regularly herded from riparian areas to uplands, generally the best practice is to herd cattle away from the stream after they have watered, during late morning or early afternoon (Butler 2000, Bailey 2004). Cattle travel to the streams during midday to drink and loaf. The goal is to allow animals to water and minimize the time they remain in the riparian area. If cattle are herded away from the stream early in the morning, they will likely return to the riparian area during midday to drink. Herding during midday after cattle water reduces the amount of riding required.

Like people, individual animals have their own personalities. Some do not respond to behavior modification. To achieve management objectives, they (and their offspring) may have to be culled.

Bailey and Welling (1999) found that strategic placement of a supplement resulted in cattle spending more time and grazing more in areas with the supplement than areas without. In this study, salt did not have much effect, but the low-moisture block supplement was effective. The effect was greater in moderate terrain than in difficult terrain. In a subsequent study, Bailey et al. (2001c) found that placement of low-moisture blocks in rugged topography attracted cattle use. Areas within 600 meters of the supplement were grazed by cattle even though the supplement sites were on some of the steepest terrain and in areas farthest from water. In ongoing research, Bailey (2004b) has found that herding combined with strategic placement of a desirable supplement appears to be even more effective in attracting cattle to graze previously underutilized areas than either supplement or herding alone. The technique requires less time and lessens the impact on riparian areas. Better distribution increases useable forage and thus capacity of a pasture or allotment. It may also result in the ability to keep livestock in management units longer because they spend less time in areas of concern, such as riparian areas.

(3) Forage Selectivity

In a general sense, forage selectivity varies by animal species, forage palatability, and preference. Palatability refers to characteristics of a plant that elicit a selective response by an 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 and phenological characteristics, the array of other species available, and the species of animal in question. Preference changes with season; weather; soil moisture; and forage palatability, availability, and variety. Thus, forage selectivity is a dynamic, situation-specific phenomenon. However, some generalizations can be applied. For example, in riparian areas, cattle generally don't browse woody plants much if they have a sufficient supply of palatable grass. On the other hand, where only a few woody plants are available, animals may seek them out to obtain dietary diversity. Grass becomes less palatable, less digestible, and loses nutrient content with maturity, whereas shrubs tend to retain nutrient content longer. To satisfy their nutritional needs, livestock preference tends to shift to shrubs as grasses senesce, even when the amount of grass available is not limiting (Figure 17). Most generalizations have exceptions though, and an animal's experience, health, stress level, and nutritional status have a great deal of influence on forage selectivity.

Figure 17. This cow is browsing rather than grazing even though sufficient grass appears to be available. (Photo by M. Borman, Oregon State University.)

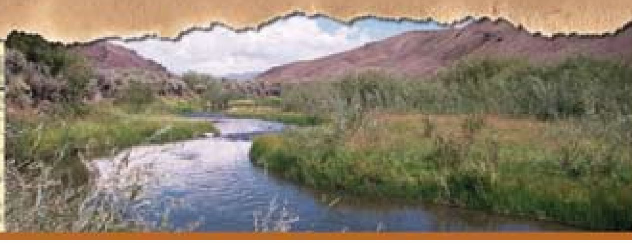
Young animals learn about foods from their mothers (Provenza 2003). Provenza states that learning begins very early because the flavors of foods the mother eats are transferred *in utero* and after birth, in milk. Once they begin foraging, young learn from their mothers what to eat and what to avoid. Young also learn foraging skills from their mothers, which increases efficiency of ingesting foods of different forms (i.e., grasses, forbs, and shrubs).

As young animals age, they increasingly interact with peers and encourage one another to explore new foods and environments (Provenza 2003). As this occurs, adults learn from younger animals to explore different foods because the younger animals are more likely to eat novel foods.

Young animals cope with change more readily than adults because their food and habitat preferences are more malleable. Exposing young animals with their mothers to a variety of foods and locations, especially those they will experience later in life, can lessen problems with transitions. Animals make transition from familiar to unfamiliar environments better if they are moved to areas where the foods and terrain are similar to what they have experienced.

Palatability is more than a matter of taste (Provenza 2003). He found that animals associate flavors of specific foods with their postingestive consequences. If the consequences are positive (e.g., response to needed energy and protein), animals will increase intake of those foods until they become a regular part of their diets. If consequences are negative (e.g., nausea from intake of toxins), animals will limit intake of those foods in accord with the concentrations of toxins in the food. Satiation is also a factor in palatability. Plants that are deficient in energy or protein will tend to have low palatability, but palatability will also decrease for foods too high in energy or protein. Excess protein causes excess production of ammonia, which is toxic. Excess energy can result in acidosis, which reduces palatability. Each animal is unique. Some individuals need more energy or protein and some less. Some are better able to tolerate a larger intake of various toxins than others. Having a variety of foods available allows an animal to select for an appropriate balance of nutrients and toxins.

The physical structure of a plant also influences selectivity. Because of the size and shape of its mouth, a cow has a hard time selecting short or prostrate plants. Hall and Bryant (1995) noted that as stubble heights of preferred species drop below 3 inches, preference will tend to shift to other species of plants that have not yet been grazed to that height or to shrubs. Below a 3-inch stubble height, the vegetation becomes too short to be pulled in by the tongue. At that point cattle must begin to eat in bites, which take more time and effort to obtain sufficient fill. Cattle seldom graze below 2 inches from the ground unless forced to do so to obtain forage. A 3/4-inch stubble height effectively requires a shift to



"Effective riparian grazing management should begin on the skyline rather than the greenline. Simply reducing numbers of livestock without developing improved grazing strategies will not solve a riparian problem."

Floyd Reed, Retired USFS Rangeland Management Specialist

another forage source because of physical limitations of a cow's mouth. "Wolfy" plants (plants containing standing dead material from previous growth) are also generally avoided, especially when plants without standing dead material are available. Separating green, nutritious leaves from among the dead leaves and stems slows the rate of intake and reduces the desirability of wolfy plants.

b. Principles of Grazing Management

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

- Grazing management practices that maintain or improve an upland site may or may not maintain or improve a riparian area and may be detrimental to them. Problematic upland watershed conditions, such as excess runoff and erosion, often reduce the effectiveness of management in the riparian area. Although riparian areas respond uniquely, they should not be considered independently of uplands.
- 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.
- The grazing management plan must address the livestock needs.

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; pasture design, and wildlife management. 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 by using a combination of options, including grazing treatments that:

- Limit grazing intensity, frequency, or season of use, thereby providing sufficient opportunity to encourage plant vigor, regrowth, and energy storage and minimize compaction of soils.
- Control the timing of grazing to prevent damage to streambanks, the transition area between the wet and dry area of the meadow or streambank, and wet and semiwet meadows when they are most vulnerable to trampling damage.
- Ensure sufficient vegetation during periods of high flow to protect streambanks, dissipate energy, and trap sediments.
- Intensify grazing, in certain situations, to increase hoof action to trample wolfy plants and stimulate regrowth while reducing time and duration of exposure so animals do not have adequate time or need to move to less preferred riparian plants (sedges and woody plants).

Timing of grazing is particularly important in pastures that are large and include a high proportion of upland forage. This upland forage is more palatable than riparian forage during certain seasons (generally spring, early summer, and fall if green-up occurs). Grazing in these seasons will shift use away from riparian areas especially if water is available close to the upland forage. Although preferences for certain areas are a factor in smaller riparian pastures, distribution is much more important as pastures increase in size and in their proportion of upland forage. The use of tools like the GRI (USDA USFS 1996) (Appendix F) may assist livestock managers in determining if the timing, intensity, and duration are appropriate for the grazing unit.

Parsons et al. (2003) found that season of use (early versus late summer) affected cattle distribution relative to the riparian area, with late summer pastures having more concentrated use of riparian vegetation. More uniform cattle distribution within the upland and riparian areas occurred in early summer than in late summer.

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 post-grazing 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 fair condition with an upward trend. 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 suggested 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, deferment, or recovery in all pastures lessens animal impacts, provides for growth or regrowth, and causes livestock to be less selective in grazing (Provenza 2003).

(2) Stocking Rates

Stocking rate problems at the pasture, ranch, or allotment level are the exception rather than the rule in today's operations. However, there are some operations that are still simply overstocked. 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 used areas (e.g., riparian areas or other water) 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 may be 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 to achieve sufficient recovery. No strategy will work until stocking rates are at an appropriate level for the existing conditions and prescribed management. Stocking rates should be determined by evaluating current grazing effects (i.e., residual vegetation and distribution patterns), use periods in relation to growth periods, historical use and trend data, and management objectives.

"There are no cookbook or 'one size fits all' prescriptions for livestock grazing in riparian areas."

Wayne Elmore,

Retired BLM Riparian Ecologist

(3) Utilization or Residual Levels and Patterns

If utilization, timing, duration, or residual vegetation is used to develop a grazing prescription, the primary focus is usually the physiology of key plant species that must stay healthy and reproduce. The key to associated management techniques is usually to improve 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 in a landscape setting. However, measurement of stubble height (residual vegetation) is often more straightforward and easier to interpret than utilization data. Use within a season may impact the physiology of key species and can be a guide to develop grazing strategies. However, annual measurements often vary among years and individual observers. Therefore, a range of utilization or stubble heights should be used to accommodate favorable and unfavorable production years (see section III.E for a discussion of short-term indicators).

Due to the variation among riparian sites and management objectives, one standard utilization or residual vegetation target is not appropriate. However, utilization or residual vegetation should be considered (along with regrowth potential) to ensure that vegetation stubble necessary for natural stream functions is present or other land use objectives are accomplished (e.g., residual nesting cover for waterfowl).

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, plant species preferences, length or steepness of slope, distance to or lack of water, and absence of shade, and other factors, as shown in Figure 18. In pasture A, as shown in the schematic below, 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.

There are no limitations in pasture B for that period of use.

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

Water provided in the preferred grazing areas in pasture A could reduce the use of and damage to the saturated streambank areas.

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.

(4) Pasture Design

Small stream sections and other small riparian areas such as springs and seeps within large pastures usually cannot be effectively managed without the use of exclusions. Exclusion fencing is often the most practical approach for small areas. In pasture planning, however, the pasture should include as much of a stream as possible and not use streams as fenced pasture boundaries (Myers 1981). Instead, Myers recommends trying to

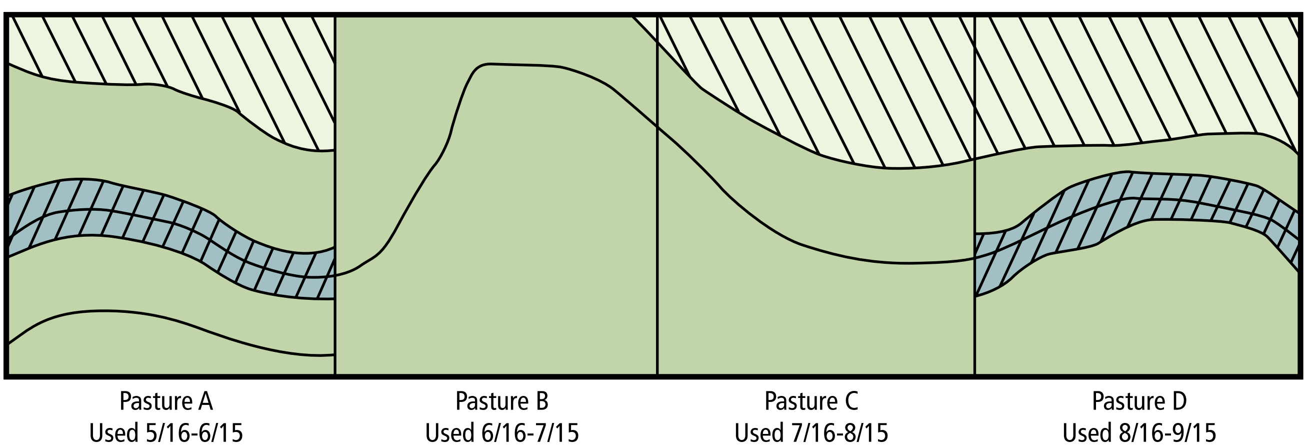


Figure 18. Examples of seasonally unused areas within pastures.

center streams within a pasture where possible. 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 debris and frequently wash out (Figure 19).

Figure 19. Cross fence collecting debris is susceptible to washing out. (Photo by S. Wyman, NRST.)

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. These parameters should be considered when developing riparian pastures as well [refer to section III.D.2.C.(3)].

(5) Wildlife Habitat Considerations

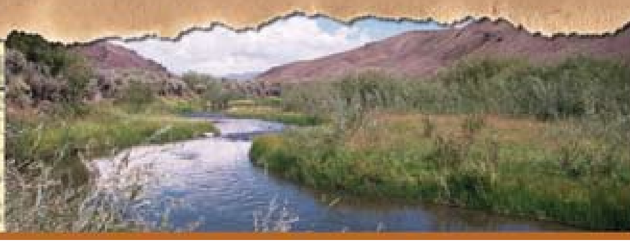
The development of a grazing management strategy should also consider wildlife habitat requirements. Concerns usually revolve around how wildlife and livestock compete while ignoring the positive influences wildlife and livestock have on each other (Knight 2004). Knight stated that minerals and supplemental food put out for cattle are often used by wildlife. In many parts of the West, water tanks, constructed and maintained for livestock, allow big game and other wildlife to use areas that would otherwise be used only during wet times of the year. Predator control to protect livestock also reduces predation on deer, antelope, and other wild prey. Livestock and wildlife forage and browse requirements may overlap or be compatible depending upon the species involved and the timing, frequency, and duration of grazing. For example, it may be beneficial to graze livestock in early summer to improve elk diets, but previous grazing by elk may reduce subsequent diet quality for cattle, deer, and elk (Damiran et al. 2003).

Livestock can also be purposely grazed at high stock densities to control wild ungulate distribution (Mosley 1999). Mosley states that livestock at high densities can help distribute wildlife away from highways in locales where wild ungulates are colliding with vehicles. Livestock grazing at high densities can also be used to deter wildlife depredation of nearby crops, pastures, or haystacks. Social dominance between ungulates and within species intensifies as resource conditions deteriorate, and subordinate animals are displaced (Mosley 1999). Mosley also stated that the knowledge of these relationships between social dominance and habitat selection can be used to improve management of rangeland, livestock, and wildlife resources.

The Deseret Land and Livestock Ranch in north-central Utah placed a band of sheep in Hornet Gulch to alter elk use patterns and improve riparian vegetation. There had been no cattle grazing in Hornet Gulch for over 20 years, but 300-400 elk calved and summered in this gulch. Sheep were placed with dogs on about June 15th to move elk out of the gulch. Elk avoided the area while sheep grazed the upland, allowing for 3 to 4 weeks of rest on the riparian area. Elk use had suppressed willow growth, and with a month of rest, an increase in willow production has occurred.

R. Danvir, Deseret Wildlife Manager

Crane's (2002) research indicates that early spring and winter cattle grazing may improve forage conditions for elk. Results of habitat selection analyses demonstrated that elk preferred selected feeding sites where forage residue was reduced by summer cattle grazing and avoided ungrazed sites in all three seasons. In the winter and spring, elk preferred feeding sites with moderate amounts of forage residue. This condition corresponded to areas that were moderately grazed by cattle the preceding summer. These results suggest that elk respond to forage conditions that are mediated by the selection of feeding sites by summer cattle grazing and that



moderate summer cattle grazing is a viable tool to enhance foraging opportunities for elk during critical winter and spring seasons (Crane 2002).

2. Management Tools and Techniques Common to All Grazing Strategies

Successful grazing strategies generally involve a combination of management tools and techniques that aid livestock managers. These tools can help extend grazing periods within pastures by promoting distribution. The economic implications of using various management tools and techniques should be evaluated during the development of the grazing plan. Livestock operators and land managers need to consider the cost of a variety of techniques, including the following:

- Installation of improvements and practices
- Loss of grazing area
- Extra hay, grazing land, and leases
- Decrease in stocking rate
- Change in management
  - Initial time and cost for setup
  - Amount of time involved in ongoing management practices and maintenance

Livestock operators and land managers should also consider the potential benefits of:

- Increased time and use (AUM) within a pasture or allotment
- Decreased use of leased land at a higher cost than privately owned or Federal land
- Accelerated upward trend of riparian and upland area (function and forage)
- Decreased peak and increased base waterflows
- Improved livestock health and weight gain
- Aesthetic benefits to interested public
- Recreational benefits of healthy streams and riparian areas (e.g., fishing, hunting, and wildlife viewing)
- Increased ranch value
- Quality of life for family

Economic considerations often determine the applicability of a grazing plan. Managers need to ask the right questions to determine what the costs and benefits could be with the implementation of various tools. Will the use of low-stress stockmanship and low-moisture nutrient supplement blocks increase the length of time a pasture or allotment may be grazed? Will it improve animal performance? Will the costs of installation or use of different techniques be offset by the benefits? Stillings et al. (2003) found that the installation of offsite water and salt on a ranch in northeast Oregon improved livestock distribution, increased consumption of upland forage before maximum riparian utilization was reached, and increased weight gain. Expected annual net returns to the ranch for the project ranged from $4,500 to $11,000 depending on cattle prices and precipitation levels. Economic outputs will vary on a case-by-case basis, as will the applicability of different grazing strategies.

Utilization patterns relative to total forage distribution reveal that livestock distribution, coupled with timing, duration, and frequency of grazing, is often the main problem with unsuccessful management approaches. 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. The degree to which livestock can be attracted away from riparian areas depends on season, topography, vegetation, weather, and behavioral differences (McInnis and McIver 2001).

Most successful grazing strategies include management tools and techniques that promote distribution of livestock, such as:

- Techniques that attract livestock away from riparian areas
- Herd management and animal husbandry practices that promote mobility
- Techniques that restrict livestock from riparian areas

a. Techniques that Attract Livestock Away from Riparian Areas

(1) Offsite Water Developments

Water development in upland areas that lack water is often a key factor in reducing livestock concentrations in riparian areas. Ganskopp (2004) found that moving portable stock tanks or closing access to specific watering points within pastures is very effective at altering the distribution patterns of beef cattle on arid rangelands in Oregon. A south-central South Dakota rancher found that distributing water tanks throughout a large pasture and having the ability to turn the water on and off at each tank worked well to distribute livestock to various parts of the pasture and decreased the amount of interior fence needed in rough terrain.

Offsite water can be developed by installing solar, hydraulic ram, or conventional pumps; developing springs, seeps, wells, or guzzlers; and piping water to several troughs. Mobile systems can provide watering sites in different pastures with the use of one pump and existing water sources.

Solar-powered pumps provide offsite water opportunities in areas where electricity is not available or is too expensive to install (Figure 20). Mobile solar-powered pumps with portable tanks placed on the edge of the riparian area decrease the amount of time livestock spend in the riparian area (Figure 21). Livestock prefer to drink from a tank rather than from a stream (Chamberlain and Doverspike 2001). Livestock do not have to stretch their heads below their front feet to drink out of a tank. They prefer this because of problems with depth perception and behaviors adapted for predator avoidance. Tanks also provide easier access for the animals; they do not have to push themselves through shrubs or trees, so trampling impacts to young seedlings, sprouts, or saplings are reduced or eliminated.

Pasture nose pumps are another option for offsite use of water from the stream, pond, or shallow well (Figure 22). Nose pumps are most effective for small herd situations, and each pump is able to water 25-50 animals, depending upon the brand of pump. Livestock use their noses to pump water into a small trough. Pumps are portable and can be moved to different pastures as livestock are rotated.

Figure 20. Mobile solar powered pump.

Figure 21. Mobile solar powered pump and tank. (Solar pump photos by D. Chamberlain, OSU Extension.)

Figure 22. Pasture nose pump mounted on railroad ties. (Photo by S. Wyman, NRST.)

Frost-free nose pumps are becoming available for winter use (Kuipers 2002). Developed in Alberta, Canada, the frost-free pump can be used from a well or from stream or pond water diverted underground to the bottom of a culvert that supplies water to the pump. The nose-powered lever operates a piston pump submersed in the culvert, which is similar to how old hand pumps work. This pump requires no energy, other than the energy the cow uses to operate the lever.

Even within riparian areas or riparian pastures, water developments, ponds, or troughs can reduce streambank trampling damage (Miner et al. 1992). However, they tend to concentrate disturbance rather than distribute it. Water developments should not create new problems, such as excess soil erosion or vegetation and habitat impacts. Creating shade and locating rubbing posts and oilers nearby may augment the effectiveness of water development in helping to reduce the time livestock spend in riparian areas.

(2) Upland Seeding

Planting palatable forage species on depleted upland areas or cropland can attract livestock away from riparian areas. Livestock are drawn to the upland forage, decreasing time and use on the riparian area. When developing a seeding plan, the season of use (e.g., use cool-season grasses if trying to decrease early-season use within the riparian area) and the use of native or nonnative plant species should be considered. Contact your local County Extension or Natural Resources Conservation Service office for recommended species mixes and seeding rates.

(3) Prescribed Burning, Brush Beating, and Tree Clearing

Prescribed burning and other vegetation treatments that favor herbaceous plants, such as brush beating or tree clearing, often enhance forage production, accessibility and palatability, and correspondingly increase upland use. In fact, the attraction of livestock to the burned areas often enables temporary rest of riparian areas until vegetation recovers. Wildlife habitat needs should be considered when developing prescriptions. A mosaic pattern is more conducive to wildlife habitat needs than block-shaped treatment areas. However, treating only one or a few small patches may not be effective, and may unintentionally attract wildlife or livestock to these small areas.

In much of the West, plants and plant communities are adapted to periodic fire. Without a natural disturbance regime to shift the competitive balance, woody species increase and eventually dominate. Highly competitive shrub and tree species, such as juniper or pinyon pine, may displace herbaceous vegetation, leading to accelerated soil erosion, loss of habitat for some wildlife, hotter fires when the accumulated fuels eventually burn, and increased risk of invasion by noxious weeds or species such as cheatgrass or red brome. A well-designed treatment and followup management actions that are implemented before crossing an ecological threshold keep the watershed functioning and keep plant communities in a dynamic equilibrium. This equilibrium supports wildlife with a diversity of habitat needs through disturbance and succession cycles. Watershed areas benefit when treatments shift use away from impacted streams. Prescribed burning, brush beating, and tree clearing are alternatives that can be used to mimic or replace natural fire regimes.

(4) Grass Reserves

Grass reserves are pastures that are set aside for use when alternate forage sources are needed, such as during a drought or following a fire. A grass reserve was used by the Malpai Borderlands Group to provide forage in exchange for a conservation easement. The participating rancher was able to rest his land by grazing his livestock on the largest of the Malpai ranches in New Mexico (Gripne 2005).

The Wyoming Nature Conservancy also used grass reserves on its Heart Mountain Ranch near Cody to provide local producers with forage alternatives and promote long-term conservation improvements (e.g., prescribed burning or grazing deferment) on rangelands by providing forage at a discounted fee. Livestock forage values can be exchanged for a desired resource outcome on land that is under restoration while the cattle graze the grass reserve (Gripne 2005).

(5) Supplementation as a Livestock Distribution Tool

Placing salt, hay, grain, molasses, and other supplements only in upland areas away from riparian areas improves livestock distribution. In general, supplements should be placed no closer than 1/4 mile, and preferably 1/2 mile or more (depending on the topography), from riparian areas and intermittent drainages, except where salt and supplements are used intentionally to localize animal impacts (Riparian Habitat Committee 1982). If supplements are placed near riparian areas, livestock use of shrubs and other riparian forage may increase and needs to be closely monitored to prevent overuse.

Proper salting improves both distribution and utilization. At least one livestock operator relates that sawing salt blocks in half allows frequent movement of salt stations to minimize localized impacts of concentrated use. Although strategic salt placement is an inexpensive and effective distribution tool, recent research has shown that it is not as persuasive in modifying livestock distribution patterns as water developments (Ganskopp 2001) or the strategic placement of energy or protein supplements such as low-moisture blocks (Bailey and Welling 1999). Protein supplements containing products such as cottonseed or soybean meal can increase consumption of cured, low-quality grasses and are especially attractive to livestock as forage matures and becomes dormant.

On one Montana ranch, the use of low-moisture blocks increased the number of livestock that used the east half of the ranch by 35 percent. Low-moisture blocks were an effective attractant for cattle in both moderate and difficult terrain (Bailey and Welling 1999). Over a 7- to 10-day period, forage utilization increased by 20 to 25 percent in nearby areas when low-moisture blocks were placed in moderate terrain (10- to 20-percent slopes and 1/4 to 3/4 mile from water) and by 10 to 15 percent when placed in difficult terrain (15- to 25-percent slopes and 1/5 to 1-1/4 miles from water). In a comparable area within the same pasture that did not contain low-moisture blocks, forage utilization did not change during the same period. The increase in forage use extended for about 600 yards from the location where low-moisture blocks were placed. In a second Montana study (Bailey et al. 2001c), forage use in difficult terrain increased by 14 percent, from 6 to 20 percent, during a 2-week period for areas up to 600 yards from placements of low-moisture blocks.

The type of energy or protein supplement is an important consideration when it is used as a tool to modify livestock grazing patterns. "Self-fed" supplements can provide nutrients on a continuous basis and are more effective and often less costly to use than supplements that are "hand fed." The effectiveness depends on distribution costs, availability, and ease of providing the supplement. Low-moisture blocks are self-fed, and intake is restricted by the hardness of the product. Intake of low-moisture blocks has averaged 0.5 to 0.75 pounds/cow/day and new blocks are usually placed in a new location once every 2 weeks. Range cake (cubes) are usually hand fed several times per week. For example, many ranchers feed 4 pounds of cake per animal 3 times per week. In a Montana study, cows spent about 5 hours per day within 100 yards of low-moisture blocks and only 1 hour per day within 100 yards of where range cake was fed. After consuming the cake, cows appeared to return to preferred areas, while cows fed low-moisture blocks were more likely to remain nearby. The study showed that cattle fed strategically placed low-moisture blocks used higher elevations than cows that were hand fed range cake.

Liquid molasses supplements are self-fed and can be used to attract cattle, but they are more difficult to transport to rugged terrain than low-moisture blocks. Liquid supplements must be carried in a tank on a truck. In contrast, low-moisture blocks contain less than 5 percent moisture and can be readily transported to rugged terrain by using all-terrain vehicles (ATVs) (if allowed in the ATV's use guidelines and restrictions). Some ranchers have transported low-moisture blocks into mountainous rangeland using pack horses.

Ranchers also use pressed blocks and loose, dry mineral formulations to supplement livestock on rangeland. A study conducted in New Mexico (Bailey et al. 2004b) showed that both low-moisture supplements and pressed blocks attracted cattle to areas far from water, but low-moisture blocks were more effective. Consumption of the pressed blocks was lower than the low-moisture supplements and much lower than the manufacturer's recommendations for the pressed supplement. Supplements will not be as effective in luring animals to underused upland areas if the consumption of the supplement is relatively low.

Loose, dry mineral formulations are usually mixed with salt and fed in open containers. They, like salt, are attractive to livestock. A study conducted in Montana (Bailey and Welling 2002) found that although cattle were willing to travel to consume the dry mineral product, low-moisture blocks were more effective for modifying cattle grazing patterns. Cows spent more time near low-moisture blocks than near the feeders containing dry mineral formulations.

Supplements should be placed in a restricted area so that social interactions among animals are more likely to occur and the placement site is more likely to become a loafing area. In research studies in Montana, eight low-moisture supplement containers were placed in a 200- by 200-yard area. Salt was also placed in this area because salt was not added to low moisture supplement products. If supplements are repeatedly placed in the same area, nearby forage use becomes excessive. New supplement barrels should be placed at least 300 yards from old sites to improve livestock distribution and forage use. This becomes an anticipated reward (conditioned response) when livestock are herded from one portion of the pasture to another.

Even though supplements are nutritious, animals must become familiar with a product and learn to prefer it before it can be used as an attractant. Offering animals a supplement in a dry lot or a small pen is the quickest and most effective method for getting animals to sample new supplements. A good time for training animals to consume new types of supplements is during calving when animals are near the ranch headquarters. Showing animals where a supplement is located is a good practice, especially if it is moved a long distance from its former location. Cows can be herded, "called," or "honked" to a new supplement location. Not all cows need to be shown the new location. Generally, the entire herd will find the location if 30 to 50 percent of the herd is shown the supplement site once. If new supplement barrels are placed only a short distance (200 to 400 yards) from their previous locations, animals will readily find them. With this method, animals only need to be herded to the first supplement location. The idea is to place the supplement along an area (e.g., ridge) that typically receives little grazing.

When placing supplements, other uses and values, such as wildlife needs, should be considered. For example, supplements should not be placed in elk winter use areas unless the goal is to reduce the amount of wolfy, decadent vegetation to stimulate more nutritious regrowth for elk use.

b. Herd Management and Animal Husbandry Practices

(1) Culling Practices

Culling practices are traditionally employed to improve some aspect of animal performance such as conception rates, weaning weights, or conformation. However, some operators also cull on habitat use tendencies and foraging characteristics. Several studies found that within herds, or even within breeds, certain individuals tend to spend more time in the bottoms while others tend to forage widely (Roath and Krueger 1982, Howery et al. 1996, Bailey 2004a).

A 3-year study in northern Montana demonstrated that individual animal selection has the potential to improve grazing distribution patterns (Bailey et al. in press; Bailey et al. 2004c). Differences in individual grazing patterns observed in common pastures persisted even after animals were separated. Cows that were previously observed on steeper slopes and in areas farther horizontally and vertically from water (hill climbers) continued to use steeper and higher terrain and areas farther from water than cows that were previously observed in gentler slopes near water (bottom dwellers). Terrain use of hill climber and bottom dweller cows not only differed statistically, but common forage stubble height standards for riparian areas (e.g., 5 inches) treatments were higher in the hill climber treatment area than in the bottom dweller treatment area.

Although the results from the Montana study were favorable, more research is needed before individual animal selection can be widely applied to improve uniformity of grazing. First, the selection pressure simulated in this study was high, because the herd was ranked and then split in half. Selection strategies based on culling (typically 10 to 20 percent of the herd are removed each year) would result in less selection pressure. Genetic progress from culling alone without sire selection is slow even when heritability is relatively high (Falconer 1960). Second, the relative contributions of genotype and early learning on terrain use patterns of cattle must be determined. If terrain use is reasonably heritable, grazing patterns can be modified by sire and family selection. If early learning is important (Howery et al. 1998), terrain use could be modified by management and training when replacement animals are calves.

(2) Kind of Livestock

Changing or incorporating different kinds of livestock can affect both the distribution pattern and forage preference. Unrestricted use by those cow-calf pairs, which tend to concentrate, loaf, and forage in bottoms, may impact riparian areas more than use by some other kinds or classes of livestock. Yearling cattle, particularly steers, generally tend to be wider ranging and use more of the adjacent uplands. Horse grazing during the winter may result in bark being stripped from deciduous trees in some areas (Kindschy pers. comm.). However, horses are primarily regarded as grass eaters, and generally congregate less than cattle (Stoddart et al. 1975). They graze an area and then move onto an ungrazed area, whereas cattle tend to stay in a grazed area waiting for vegetation regrowth. A concentration of feral horses on riparian meadows was reported to adversely impact that area (Platts pers. comm.), and Crane et al. (1997) found that sedges in streamside and bog and meadow areas were important forage for feral horses. Problems have occurred in other locations because of concentrated use of springs or seeps by feral horses. Horses pull plants out by the roots from areas that have moist soils more than most other animals (Pieratt pers. comm.).

Herded sheep offer several options for achieving proper management in certain riparian areas. Sheep use may be more desirable than cattle use in some areas due to the herders' control over location, timing, degree, duration, and frequency of use. Sheep prefer hillsides to the confining nature of riparian bottoms. The herder can easily move sheep to upland or ridgetop areas rather than bedding them in a riparian area meadow. Generally, herders want to keep flocks or bands moving to facilitate forage selectivity. The quality of herding controls impacts to riparian areas and rates of gain in the lambs (Glimp and Swanson 1994). When properly herded, sheep cause less trampling damage than cattle (Stoddart et al. 1975).

Sheep and goats may do less physical damage to herbaceous plants due to their nibbling characteristics, whereas cattle and horses can dislodge plants from the soil because they graze with a pulling motion. Sheep and goats may also be used to control invasive plant species such as leafy spurge and knapweed. Because different animal species have different plant preferences, the integration of multiple grazing species may improve plant species composition. This integration could alleviate overuse of desired forage species, decrease the potential for increaser species to dominate an ecological site, and enable selective control of undesirable plant species without resorting to the use of herbicides, which is tightly restricted close to water.

As previously noted in section III.D.1.b.5, the Deseret Land and Livestock Ranch in north-central Utah placed a band of sheep in Hornet Gulch to alter elk use patterns to improve riparian vegetation (Danvir pers. comm.).

Free-roaming sheep (without a herder) consumed spring willow growth in Oregon even though adequate herbaceous forage was available. Heavy browsing of young willow growth by unherded sheep was also observed in southern Wyoming during spring, summer, and fall where the herbaceous vegetation was dominated by coarse forage such as sedges and rushes.

Goats can effectively control a variety of problems or invasive plants such as leafy spurge, multiflora rose, knapweed, and brush species. They can reduce the need for herbicides, fertilize the soil, and control weed species in areas that are difficult to treat with other methods. Ranchers have incorporated goats into their livestock operations to help maintain and increase herbaceous forage species through invasive plant control. Individuals will sometimes contract with ranchers and farmers to provide forage for the goats, which in turn control weed species. Goats typically prefer forb and browse species, so there is not an overlap of use by goats and cattle (Coffey 2002).

(3) Breed of Livestock

Most livestock operators would not consider a change in breed of livestock simply to improve distribution. However, grazing patterns might become a consideration in breed selection if an operator is considering a change for other reasons. Higher heat tolerance (and related foraging characteristics) of Brahman, Brahman crosses, and other Zebu types is often a consideration in Southern and Southwestern States. For example, Herbel and Nelson (1966) found that Santa Gertrudis cattle (3/8 Brahman) traveled further when foraging than Hereford cattle in a study in southern New Mexico.

For extensive and rugged pastures, livestock producers and land managers may be able to improve uniformity of grazing by selecting breeds that were developed in more mountainous terrain. Tarentaise cattle developed in the French Alps consistently climbed higher and used higher elevations (greater vertical distance to water) than Herefords on northern Montana rangeland (Bailey et al. 2001b). Additional research compared terrain use of cows sired by Angus, Charolais, Piedmontese and Salers bulls. Cows sired by Piedmontese bulls used higher terrain than cows sired by Angus bulls (VanWagoner et al. 2006, Bailey et al. 2001a). Piedmontese cattle were developed in the foothills of the Italian Alps, whereas Angus cattle were developed in flatter terrain in eastern Scotland.

c. Techniques that Exclude Livestock Use or Promote Avoidance of Riparian Areas

(1) Fences

Fencing, when properly located, well constructed, and maintained, can be an effective tool for controlling distribution of livestock. Fencing facilitates management of riparian areas by either including or excluding livestock use, depending on management objectives. Sometimes exclusion fencing may be the most practical approach for initiating rapid riparian recovery or improving highly sensitive areas (Figures 23-25). It can also be a temporary measure for initiating recovery. The loss of forage from exclusion fencing may be inconsequential on streams in poor condition that lack vegetation. Fencing water sources at springs and seeps and piping the water to adjacent areas for use is often the only effective measure for protecting small riparian areas.

Figure 23. Mahogany Creek, 1975.

Figure 24. Mahogany Creek, 1978 after exclusion.

Figure 25. Mahogany Creek, 2004. (Mahogany Creek photos by BLM.)

Fencing may also restrict wildlife and livestock movements in an undesirable manner. In addition, fence construction and maintenance can be costly and time consuming. Temporary electric fencing can be an effective tool for improving distribution so that parts of a pasture can be grazed while others are rested (Figure 26). Temporary fencing is also useful for evaluating multiple placement locations before constructing more expensive permanent fencing. Using temporary fencing from year to year to break up grazing patterns and facilitate implementation of rangeland management practices provides flexibility in obtaining long-term objectives.

Livestock acclimate to temporary electric fencing easier in a controlled environment, such as a spring calving pasture, as opposed to much larger rangeland pastures. Livestock need to learn to respect the fence as a barrier. It is important to note that temporary electric fencing does not provide the same level of control as permanent

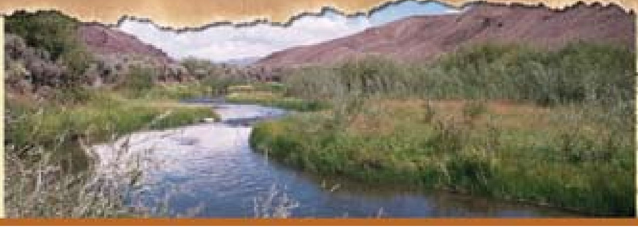


Figure 26. A temporary fence is used to rest sections of the pasture while allowing grazing in the remainder of the pasture. (Photo by M. Borman, Oregon State University.)

barbed-wire or wooden-rail fencing and should be used to influence rather than control animal behavior.

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. Other forms of swing panels constructed of hanging pipe or heavy chain have also proven effective.

(2) Barriers

Barriers formed by placing trees and brush on streambanks may discourage livestock use and help stabilize eroding banks. Placing boulders (10 to 20 inches or larger) along streambanks where livestock trail and cause trampling damage can effectively displace livestock use and promote recovery (Myers pers. comm.).

(3) Hardened Crossing and Water Access Points

Hardened crossings and water access points are coarse gravel pads that provide livestock sure footing on a gentle grade to water, either for crossing a stream or for drinking (Figure 27). Livestock prefer gravel pads over steep, overhanging streambanks or soggy low areas to access the water in the stream channel (Milesnick pers. comm.). During a roundup, cows will run for the gravel pad before trying to negotiate the streambanks (Massman 1998). Berg and Wyman (2001) suggest locating crossings or access points in areas where the streambed is stable (Figure 28) and avoiding sites where:

- The channel grade or alignment changes abruptly
- The channel bed is unstable
- Head cuts exist
- Large tributaries enter the stream
- There is a recently located or constructed channel
- A culvert or bridge is immediately upstream or downstream
- Water velocity and depth are excessive

Figure 27. Hardened livestock crossing on a class 1 trout stream in Columbia County, Wisconsin (2000). (Photo by B. Nichols, NRCS.)

Figure 28. Stable livestock water access in Jefferson County, Montana (2001). (Photo by G. Kramer, NRCS.)

Locating water access in rocky areas (natural or manmade) minimizes trampling damage to streambanks and streambeds. Narrow water access (water gap) discourages livestock from loafing at the water source (Leonard et al. 1997)

(Figure 29). Ice and high flows need to be considered when locating water access points and hardened crossings in some areas.

Figure 29. Narrow water access (water gap or gap) discourages loafing. (Photo by NRCS.)

Fish spawning and rearing areas should be considered when determining the location of the water gap or crossing. Although the vegetation has expressed itself in Figure 30, there are some key fisheries habitat areas (black ovals) that need to be addressed to ensure that a grazing strategy is successful. These include:

- *Pool formation and cover:* Are cattle impacts preventing pool formation and overhanging cover on the outside of the meanders?
- *Margin habitat:* Is there adequate vegetation in the margins to provide habitat for fry or minnow species?
- *Spawning area:* Are there trampling impacts to spawning areas?

The red oval at the end of the point bar is an area cattle would likely use to water due to the gentle gradient. The red line is another area cattle may use to water and where they would prefer to cross. This shallow at the break between a pool and a riffle is just downstream from where salmonids can spawn. Although the preferred livestock access areas are close to redds in this example, there are few observations of livestock trampling redds in the Western United States.

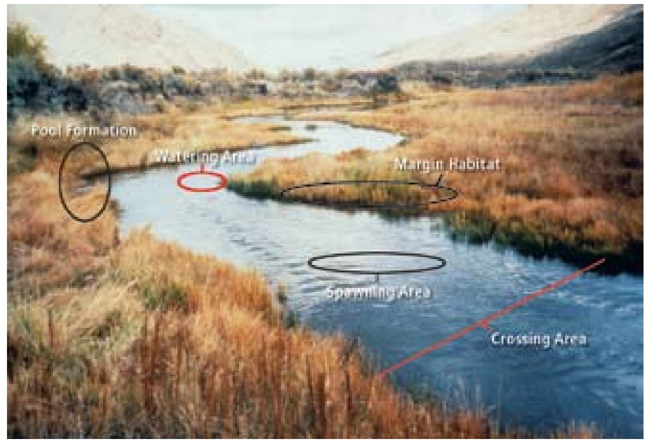


Figure 30. Areas of fish and livestock use.

(4) Bedding Grounds

Bedding grounds and other livestock handling facilities should be located away from riparian areas (Riparian Habitat Committee 1982). The use of low-stress stockmanship and salt, mineral, or other supplements (e.g., low-moisture blocks) may be useful for establishing or relocating bedding grounds away from riparian areas.

(5) Livestock Turnout Locations

Placing livestock far away from overused riparian areas when they are moved to a new pasture (turnout) may help regulate the timing, duration, and amount of riparian use in large pastures that contain adequate stock water (Gillen et al. 1985). It is beneficial to change turnout locations each year to vary behavior patterns.

(6) Drift Fencing

A drift fence is an open-ended fence used to retard or alter the natural movement of livestock; it is generally used in connection with natural barriers (SRM 2004). Drift fencing in conjunction with gullies, cliffs, and other natural barriers can regulate natural trailing or loafing by livestock in some riparian areas.

(7) Stockmanship

Frequent range riding and herding can effectively control livestock distribution in many situations. On some rough or poorly watered ranges, proper stock manship may increase breeding, conception, and calf crops (Stoddart et al. 1975). Several of the successful strategies reported by Massman (1998) and Masters et al. (1996a, 1996b) also incorporate riding and herding into overall management. Low-stress stockmanship techniques are once again becoming more popular as a tool to distribute livestock.

Low-stress stockmanship is a method of handling livestock with prompts rather than force. Age-old principles and techniques of animal handling take advantage of some inherent traits of livestock, encouraging herds to stay together where they are placed. Livestock usually become more controllable with these techniques and their productivity and health often improve because the handling is low-stress and their health is monitored more effectively by the riders. Well-handled range livestock will want to stay together, instead of scattering or hiding in favorite places (such as meadows and riparian areas). Properly placed animals will go to water, such as a creek or trough, drink, and then return to bed down and graze around the area in which they have been placed. This allows the rider or range manager to readily control the results of grazing to a high degree, even on large expanses of unfenced range and on steep or brushy terrain.

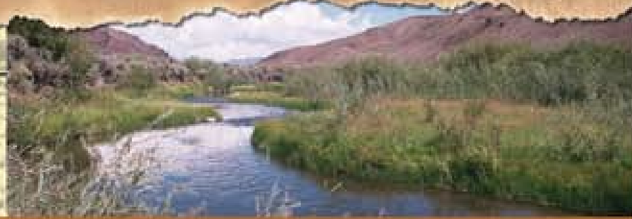
Successful application of low-stress stockmanship enables the rider or range manager to control the duration that plants and soils are exposed to grazing animals. This controls overgrazing and overresting, both of which lead to deterioration of range health. Proper handling can thus improve livestock distribution and rangeland condition and trend, and it can lead to improved riparian conditions that benefit fisheries and wildlife while improving water quality. Livestock can be moved away from critical habitats at critical times to minimize social displacement of wildlife (e.g., elk and deer winter range, fawning sites) (Mosley 1999).

Low-stress livestock handling facilitates all grazing management strategies because the animals are readily moved and are comfortable where they are settled. Whereas good stockmanship is important with high-intensity, short-duration grazing systems, it can mean the difference between success and failure with rest-rotation, deferred-rotation, and seasonal grazing strategies on large pastures or open range because areas within the large pastures may be overgrazed without intensive management. When management prescriptions require livestock grazing during one of the critical times, or in high livestock densities, a rotation grazing system can be used to provide wildlife the opportunity to move into pastures where livestock are not present (Mosley 1999). Incorporation of offsite water developments along with the placement of salt, mineral, and protein blocks has been found to complement low-stress stockmanship.

Bailey (2004b) evaluated moving cow-calf pairs during midday by using low-stress handling techniques (with and without low-moisture supplement) as a management tool to protect riparian areas. Bailey reported important differences between the free-roaming control cows and the herded cows (with and without supplement). The study clearly showed that herding (with and without supplement) can reduce the time cows spend near streams and riparian areas and increase the time spent in uplands, and the change in cattle grazing patterns with herding will result in less forage use and higher stubble heights near streams.

Learning low-stress stockmanship skills requires dedication and a shift in both attitude and how livestock are viewed. Also, the mishaps can be big if smaller herds are combined into one large herd. In some areas, existing water developments may lack the capacity to handle the number of animals in a larger herd. The herd may need to be kept split into smaller herds based on available water and forage.

See Appendix G for information about the benefits, economics, and sustainability of the ranch operation using low-stress stockmanship.



Case Study: Morgan Creek, Challis, Idaho (Gowan and Camper 2000)

The Morgan Creek allotment was converted from season-long grazing to a rest-rotation grazing strategy in 1972. A collaborative approach, considered state of the art at the time, resulted in improved upland conditions, but improvements in riparian function were not well documented or apparent.

The chinook salmon was added to the Federal endangered species list in 1992. Numerous requirements were put in place in an attempt to ensure compliance under the Endangered Species Act. Permittees found it difficult or impossible to comply with the new requirements, which were developed without their participation. By 1994 the management changes resulted in:

- Up to 13 riders patrolling the drainages daily to herd cattle off of riparian areas.
- Failing to meet grazing standards in 7 of 7 key areas.
- A 68 percent reduction of animal unit months on the allotment.
- Agricultural and environmental community dissatisfaction.
- An impasse between permittees, agencies, and other interested parties.

The Morgan Creek Team was formed, and through a combination of collaboration and low-stress stockmanship, it planned:

- On-the-ground management that emphasized a shared vision and goals.
- Continuation of rest on 1/3 of the pastures, but with much greater flexibility.
- Subdividing the three-pasture system into several smaller grazing units divided by topographic features rather than fences.
- Strict stubble height standards within riparian areas.
- Active monitoring, including photo points, of stream sediment, willow abundance, redds, bank stability, and disturbance.
- Flexible management with ongoing adjustments as the grazing season progressed.

Results (Figure 31):

- Standards were met or exceeded on 8 of 11 key areas the first year; greater success was achieved in subsequent years.
- Permittees were able to graze a full season.
- Consultation was shorter and less contentious.
- Costs were decreased. The Morgan Creek Cattleman's Association reported saving $10,000 in 3 months over one season, even with the cost of hiring two full-time riders.
- A positive environment for working together was established.
- Stress on both livestock and the environment was reduced.
- Livestock production increased; riparian conditions improved.
- The Forest Service received the Forest Service Chief's Award for Excellence in Rangeland Management.
- The system worked as long as there was institutional support and the collaborative process was followed.

Morgan Creek Team requirements for application of low-stress stockmanship included:

- **Use livestock to mimic impacts of prehistoric wild ungulates.**
- **Allow animals to bite each plant only one time.**
- **Adopt Bud Williams' low-stress stockmanship techniques.**
- **Allow use of livestock as a vegetation management tool.**

Today the Morgan Creek Team still strives for sustainable resource management. Turnover in participating agency personnel and decreased institutional support in the collaborative process have created new obstacles for the group to overcome. As with any collaborative process, continued support by all parties is the key to long-term changes on the land.

Before (1995) **Year 3 (1997)** **Year 5 (1999)**

Figure 31. Changes to the Morgan Creek allotment, Idaho. (Photos by C. Gowan and R. Camper, USFS.)

3. Grazing Treatments

No matter which grazing treatment is selected, success ultimately depends on the livestock managers' cooperation or support of the grazing management plan (Ehrhart and Hansen 1998, Evans Draft). Ehrhart and Hansen (1997) analyzed 71 stream reaches, located primarily on private land throughout Montana, rated as functioning properly or in an upward trend. They found that the operators employed the full range of seasons of use as well as lengths of grazing periods and concluded that **"the manager is more important than a particular approach."** Selection of a grazing treatment differs depending upon the location, extent, and condition of the riparian area within the pasture(s), compatibility with the overall ranch management plan, people involved, agency requirements, weather patterns, livestock, wildlife, and so on.

The treatments described in this section have succeeded in many places and failed in many others. Any treatment that is implemented without at least some of the management tools and techniques mentioned earlier is likely to fail. The grazing treatment selected should be designed to meet the resource needs of the area, fit with the livestock operator's management plan, and be closely managed by the livestock operator.

Ecologic and economic considerations should be evaluated when designing a grazing treatment. Livestock that remain in the riparian area waiting for the vegetation to grow high enough to bite will not gain as much as those animals that are using upland areas and filling their stomachs in less time. It can take twice the effort and time for a cow to fill her stomach in areas with less than 3-inch stubble height due to a change in bite pattern and the amount of forage a cow can pull into her mouth with each bite (Hall and Bryant 1995). The result is a shift to more quickly eaten and less palatable forage and less weight gain.

Concerns about the detrimental affects of season of use on wildlife are based on the assumption that a single pasture is used the same season year after year. However, by maintaining the proper stocking rate, managing the duration of grazing, and monitoring, use during any season can benefit the plant community and selected wildlife species life cycle needs based on the land use plan (Miller pers. comm.).

As for the grazing systems themselves, the more intense systems (e.g., twice over, short-duration, high-intensity systems) can provide excellent benefits for waterfowl (Barker et al. 1990) and upland game birds (Kirby and Grosz 1995, Svedarsky and Van Amburg 1996). The short grazing periods allow for regrowth that provides cover later in the season, but intense systems may substantially reduce current-season nesting cover for many ground-nesting species depending upon timing of use. A short grazing period may provide excellent regrowth and residual cover for next year, but this year's nesting cover may be diminished in those particular pastures grazed at the time of year that affects cover. Kirby and Grosz (1995) hypothesize that grazed areas are centers of human and livestock activity and have reduced levels of cover for mammalian predators. These factors may make grazed areas unattractive to predators as foraging sites. In contrast, the seclusion and cover provided by nongrazed areas may actually attract greater numbers of predators.

Impacts to individual fish and their habitat differ depending on season of use, climate, fish species present, and other factors. Grazing strategy impacts are determined by short- and long-term effects on vegetative structure and the long-term effect of vegetation and livestock on channel morphology. Grazing strategies should address impacts to, or objectives for, cover because fish require overhead (canopy) and instream cover, including overhanging banks and deep pools. Strategies could also address factors that influence water quality, including temperature and dissolved oxygen, and spawning habitat components (clean gravel) if such changes are likely within the management timeframe. Eutrophication concerns should be addressed for areas with lakes and ponds.

One problem in multiple-pasture systems is allowing livestock to drift among pastures rather than moving them more quickly. In his evaluation of 30 grazing systems on 44 stream reaches in Montana, Myers (1981) and others concluded that livestock should be moved between pastures rather than left to drift over a period of several days or weeks. In this analysis, riparian vegetative response seemed to be better in allotments where the livestock were moved and the gates closed, as opposed to where livestock drifted and simultaneously used two pastures. **Movement requires a strong commitment from the livestock operator to clean the pasture**. Without it, some livestock will stay in a pasture eating regrowth even with adequate palatable forage in the next pasture. One recommended approach, which can minimize livestock stress and encourage better dispersal, is to open the gate in late afternoon on day one, allow drift on day two, and clean the pasture and close the gate on day three (Hagener pers. comm.). Supplements can also be used to help attract livestock to the next pasture. Techniques that work well will vary, depending on local conditions. Some ranches do not have adjoining pastures, which makes livestock movement more difficult. This is not an insurmountable obstacle if considered during the planning phase.

Successful grazing strategy planning takes into account that:

- The grazing strategy needs to be designed for resource needs and for the rancher that will be implementing the strategy.
- No one size fits all.
- Commitment by the livestock manager is needed to succeed.
- There is often a 3-year learning curve between initial implementation and indications of success or improving trend (Provenza 2003) in the resource and livestock condition.
- The more intensive the management strategy, the better the chance for a serious mishap.
- The objectives and expectations need to be clearly understood by all concerned.

Following are descriptions and examples of various grazing treatments and their effectiveness for improving or maintaining riparian areas in specific situations.

a. Winter (Dormant-Season) Grazing

Winter grazing is the use of a pasture during the plants' dormant season. Dormant-season grazing provides total growing season rest every year. Though some browsing does occur on the riparian woody vegetation, such use is often minimal because drainages are colder than adjacent uplands. Normally, there is little or no vegetation growth during winter, so grazing affects plants less. Winter use is usually the least detrimental to soils (especially where they are frozen) and to dormant herbaceous vegetation. However, winter use also has the potential to remove excessive amounts of vegetation cover just prior to spring runoff. Most streambanks require carryover vegetation for bank protection and sediment trapping during high-flow events. Furthermore, winter may be the period of greatest use of woody browse species by both livestock and wildlife depending on temperatures, snow depth and duration, availability of other feed, animal concentration, forage and browse preference, and the extent of the woody plant community. Many riparian areas and some entire pastures are unavailable for grazing during a major part of the winter due to snow depth.

In areas that can be grazed, winter can be a season of use with minimal impact if grazing is closely monitored and controlled (especially use of woody plant growth and browse species). Even though plants are dormant, use levels should be managed because winter grazing can reduce residual herbaceous cover for ground-nesting birds and calving or fawning ungulates. Some woody plant communities can benefit from occasional, prescribed winter use. Light browsing can stimulate leader production, increasing the density (cover value) of individual shrubs. Winter grazing can reduce canopy cover, benefiting the herbaceous layer and preventing a secondary cycle of erosion on some soils (Miller pers.comm.).

Offstream water can be effective for reducing streambank impact during the dormant season and for helping livestock avoid slippery and icy streambanks. However, this requires keeping offsite water ice free.

On many ranches winter feeding costs are the most expensive component of raising livestock, and a grazing cost of even $18 per AUM compares very favorably to feeding hay at roughly $60-$70 per AUM. An analysis of Humboldt and Elko, Nevada, cow-calf budgets showed winter feed costs were about 36-42 percent of the total cost of the cow-calf enterprise. The cost with supplement tubs was $174 per AUM for Humboldt and $188 per AUM for Elko. Reducing winter feeding costs in the Great Basin can impact the financial stability of the operation by thousands of dollars (Riggs pers. comm. and Curtis et al. 2005a and 2005b).

Wickiup Creek in northern Nevada has been grazed in the winter by cattle since 1910 (Masters et al. 1996a). Winter grazing has maintained stable riparian conditions for decades (Figures 32 and 33). In addition to winter grazing, management practices include placing salt well away from riparian areas, culling riparian loafers, and varying turnout locations from year to year.

Figure 32. Wickiup Creek, Nevada, 1939.

Figure 33. Wickiup Creek, Nevada, 1991.

Winter (Dormant) Season Grazing

Potential Advantages:

- Soil compaction and bank trampling are minimal if soils are frozen.
- Use of the herbaceous species is not detrimental if the plants are not grazed down enough to change the root crown temperature.
- It is usually easy to control livestock distribution.
- Total growing-period rest is provided every year.
- The fish-livestock interaction is usually minimal due to the unfavorable climate in the riparian area for livestock.

Potential Disadvantages:

- Browsing and damage to trees and shrubs occurs from trampling, rubbing, or possible bark chewing.
- There is potential for soil compaction if livestock are on thawed, moist soils.
- The removal of vegetation can reduce streambank protection, sediment entrapment, and fish cover just prior to runoff.
- There is a potential for livestock to impact fish spawning areas (species-dependent).
- Livestock may be using key wildlife winter range, causing wildlife to shift to lower quality habitat.

Case Study: Winter Grazing Practices of the Five Dot Land and Cattle Company

The Five Dot Land and Cattle Company near Standish, California, which has been operated since 1959 by Todd Swickard, acquired a 3,000-acre pasture in 1985. Long Valley Creek is the primary water source in the pasture. The pasture had previously been grazed 8-10 months of the year, and Swickard's primary objective was to improve resource conditions on the upland and riparian areas. Although he wanted to produce forage, he also wanted to decrease erosion, increase wildlife, and heal the creek (Swickard pers. comm.).

Swickard's operation, which includes several BLM permits along with the Long Valley Creek pasture, changed to a dormant-season grazing prescription (October–January) with 500 cow/calf pairs in 1985. Leaf drop had already occurred on the willows, and vegetation was not as palatable in riparian trees as in upland areas where livestock spend most of their time. Because of the change to dormant-season use, Swickard saw an improvement in upland as well as riparian vegetation (Figures 34-37).

Today, Long Valley Creek supports a large variety of sedges, grasses, forbs, cottonwoods, and willows. Swickard hasn't done any planting or structural restoration to accomplish his objective of improving the riparian area to increase forage production. Noxious weeds, primarily whitetop (hoary cress or perennial pepperweed), are sprayed annually.

Figure 34. Long Valley Creek, 1986.

Figure 35. Long Valley Creek, 2000.

Figure 36. Long Valley Creek, 1987.

Figure 37. Long Valley Creek, 2000. (Long Valley Creek photos by T. Swickard, Five Dot Land & Cattle Co.)

Swickard has started working with the BLM to increase bitterbrush browse for winter deer use. He recently adjusted his grazing plan on his private and public land pastures. Cattle are now moved onto the BLM pasture in early spring and then to the Long Valley Creek pasture in July and August. The creek is fed by several hot springs, and good regrowth occurs in late summer and early fall. He removes the cattle before they begin browsing willows.

Swickard is committed to remaining flexible, working collaboratively with agencies, and managing his livestock operation to maintain an ecologically and economically viable business.

b. Spring Grazing

Spring grazing is the use of a pasture during the early growing period when upland vegetation is highly nutritious. It enables riparian areas to be largely ungrazed during a large portion of the critical growing period. Cool-season vegetation growth begins and peaks in spring. Warm-season plants begin growing during mid- to late-spring. Spring use normally results in better livestock distribution between riparian and upland areas due to flooding, generally cooler temperatures of riparian areas, and highly palatable upland forage. In late summer, upland forage has senesced and is lower in quality than riparian vegetation. In contrast, forage quality of riparian areas and uplands are both high in spring and early summer. Consequently, livestock are likely to graze more uniformly, because alternative choices of sites to forage within the pasture are relatively similar (Bailey 2005). Spring use provides more opportunity for regrowth and plant recovery than summer or fall use and also results in more residual cover. Barker et al. (1990) concluded that the value of this cover far outweighs any disturbance or trampling factors for ground-nesting birds.

In a 10-year study on Stanley Creek in central Idaho, Clary (1999) found that riparian habitats are compatible with light to medium late-spring use by cattle. Improvements were found in stream channel configuration and riparian plant communities after all three treatments (none, light, and moderate grazing use) on historically heavily grazed pastures in a cold mountain meadow riparian area on the same creek.

Regrowth is important for sustaining the important physical functions of a riparian area (e.g., shading, insulation, sediment filtering), as well as for buffering the effects of peak runoff on streambanks. For example, in the BLM's Prineville District, in Oregon's sagebrush- and juniper-dominated high desert, spring grazing has been used to improve riparian conditions on Bear Creek. Prior to 1977, the area was a single pasture, permitted for 75 AUMs from April to September in most years. This strategy depleted streamside vegetation (low diversity and productivity) and deeply incised the stream channel, causing it to actively erode (Figure 38). Summer streamflow was often intermittent and low in quality.

In 1977, the BLM decided to rest the area to restore the productivity of the riparian area. After 3 years of attempted rest, the area was used for 1 week in September in 1979 and 1980. In 1983, juniper trees were removed from the uplands to improve range condition and watershed health. In 1985, a grazing treatment authorized use from the time of spring runoff (mid-February) until April 15 in a three-pasture system. In 1988, authorized grazing use (permitted AUMs) was nearly five times greater than the forage obtained from the area under season-long use. The permittee reportedly cut his annual hay bill by $10,000 (1988 dollars). The riparian area continues to improve (Figures 39 and 40). The resulting improvement in quality and quantity of streamflow allowed the reestablishment of redband trout in Bear Creek. Although this early-season riparian grazing treatment works well on this site's sandy loam soils, it might not work as well on medium- and heavy-textured soils with high moisture-holding capacity (clay).

In the spring, seed and litter can be trampled into wet soil by hoof action. However, on some moist or saturated soils, grazing animals more easily uproot plants and compact soils or shear streambanks. Subsequent rest is often required to encourage root growth and other biological activity, which offsets the effects of soil

Figure 38. Bear Creek, Oregon, 1977.

Figure 39. Bear Creek, Oregon, 1996, after continued spring use.

Figure 40. Bear Creek, Oregon, 2003. (Bear Creek photos by W. Elmore and BLM.)

Late Winter–Early Spring Grazing

Potential Advantages:

- Use of riparian vegetation by livestock is reduced because upland plants have similar or higher nutritional content than riparian forage.
- The amount of riparian soil compaction and bank trampling is reduced because the cattle use the uplands.
- There is time for regrowth of vegetation.
- Palatable herbaceous plants reduce pressure on woody plant species.
- The fish-livestock interaction is usually minimal because of the unfavorable climate for livestock in the riparian area.
- Overhanging riparian herbaceous vegetation is usually not available for grazing because of high streamflows or the presence of trapped sediment in the vegetation.

Potential Disadvantages:

- The potential for soil compaction and bank trampling may be greater depending on soil type.
- Use occurs during the critical period of upland plant growth and development if grazing is extended until grasses are in the boot stage of phenology.
- Repeated grazing of desirable herbaceous species at this time may affect plant vigor (a short grazing season is beneficial).
- Wildlife may be adversely affected (calving, fawning, and nesting cover).
- There is a potential for livestock to impact fish spawning areas (species-dependent).

compaction prevalent during spring. In a southwestern Montana study, most bank damage resulted when soil moisture was over 10 percent, which normally occurs prior to midsummer in arid and semiarid areas of the West (Marlow and Pogacnik 1985). The soil moisture content that minimizes bank damage differs with soil texture.

c. Hot-Season Grazing

Hot-season grazing is the use of pastures during the critical growing season for riparian plants. Summer is usually the period of greatest photosynthetic activity, especially for riparian and warm-season plants. Upland and cool-season plant growth and forage quality is diminished due to reduced soil moisture content. During the hot season, livestock concentrate in or near the riparian area when upland forage becomes rank or dry, water distribution is more limited, and the desire for shade is more intense. Where free-choice grazing is allowed in the summer, use of riparian vegetation is high and regrazing of the same plants can occur. Darambazar et al. (2003) suggest that cattle grazing in late summer in mountain riparian pastures will begin using shrubs intensively when the quality and quantity of grasses and the abundance of forbs decline. They recommend that late-summer grazing should be light or avoided if grasses have become dormant.

Streambank damage relates to many factors, including soil moisture content, soil type, absence of woody plants and root systems, bank rock content, stock density (animals per acre), availability of offstream water, and duration of grazing. Streambank damage due to livestock trampling of wet soils, and where other factors are not controlling, may be avoided by deferring grazing until bank soil moisture content is less than 10 percent.

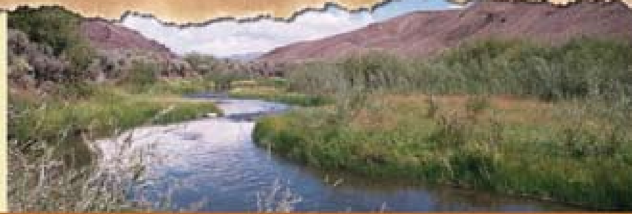
Summer is also the time that grazing can cause the greatest levels of stress in most riparian plant species, which over time can reduce the abundance of desirable plants. There is less time for regrowth and replenishment of carbohydrate reserves during the summer than spring, and additional leaf area is needed. Continuous hot-season grazing can favor invasive plant species and can reduce residual herbaceous cover for ground-nesting birds, fish, and calving and fawning ungulates.

However, most riparian areas should have available moisture and time for herbaceous plant regrowth, which can provide greater residual cover than that resulting from winter grazing. Woody species, where present, may suffer from browsing during the hot season. Long-term use of passive, continuous hot-season grazing may result in severely hedged (high-lined), single-age-class stands of woody plants.

Annual grazing throughout the hot season (essentially the same as season-long use) is nearly always detrimental to riparian vegetation, especially in large pastures with small riparian areas that are not managed separately. Therefore, some form of indicator or trigger is needed to monitor and reduce frequency, intensity, and duration of riparian use. One of the other grazing management strategies should be considered. Offsite water, herding, proper use of supplements, or other practices may be needed as well.

Myers (1981) found that in the foothills of southwestern Montana, the frequency of hot-season use from July 10 to September 1 (period of heavy use) appeared to be a critical factor in developing and maintaining satisfactory riparian area conditions. Grazing systems with hot-season use in more than 1 year out of 3 or 4 met riparian habitat goals on only 5 of 21 streams. Grazing systems lacking hot-season use, or with no more than 1 year of hot-season use in 3 or 4 years, met riparian habitat management goals on 18 of 20 streams evaluated. Utilization or residual vegetation data were not available in this study.

Myers (1989a) also analyzed the duration of hot-season (July 1-September 15) grazing treatments to determine the corresponding impacts on riparian areas. He found that successful treatments averaged only 12.5 days, whereas unsuccessful treatments averaged 33.4 days. In this study, willow utilization data was available. The length of the grazing period was also important from the standpoint of physical damage, regardless of utilization or regrowth potential, because livestock watered frequently and they preferred shade while loafing. The impact of the duration of grazing on the success of the grazing treatment depended on vegetation and stream type.



There are situations where hot-season use works well. Most of these examples employ other management tools and techniques to facilitate proper use of the riparian areas. Deferring use in a riparian pasture until the hot season extends the green-feed period of nutritious forage and may provide an economic incentive for better riparian management. However, duration of use needs to be restricted to avoid repeat defoliation, overuse, and streambank trampling. Swamp Creek, a tributary to the North Fork of the Malheur River in Oregon provides an example of hot-season use (Figure 41). It is deferred during early summer and grazed every year from July or August through September. A 4-inch stubble height is required at the end of the growing season. There is offstream water, in most pastures, and some herding to keep livestock from "camping" on the river. One pasture that hasn't been grazed by livestock for 5 years had browse use by wildlife on the sprouts and young willow and alder similar to that in the grazed pastures.

Figure 41. Swamp Creek, Oregon, 2004. (Photo by S. Leonard, retired, BLM.)

Hot-Season Grazing

Potential Advantages:

- Streambanks are more stable than earlier in the year.
- There is frequently sufficient riparian soil moisture to allow for regrowth.
- Riparian herbaceous vegetation may be more palatable and nutritious than desiccated upland plant material.
- Bird nesting and calving and fawning by native ungulates is usually completed.
- Fish spawning and incubation is completed for some species and has not started for others.

Potential Disadvantages:

- There is a greater tendency for livestock to remain and concentrate their use in the riparian area and stream channel.
- There may be reduced plant vigor and possible changes in vegetation communities.
- Tree and shrub species may be damaged.
- Animal performance may be reduced.
- Adverse fish-livestock interactions are generally the greatest due to the tendency of livestock to remain in the riparian area and the stream channel.
- Possible damage to riparian herbaceous vegetation, which is needed for canopy and instream cover, may occur.
- There is an increased potential for conflict with recreationists.

d. Late-Season (Fall) Grazing

Deferment is the delay of grazing to achieve a specific management objective (Society for Range Management 2004). Skovlin (1984) suggests that deferring use until the late season (fall), until restoration of habitat is acceptable, offers a good measure of protection without great expense.

Fall use is usually less critical than summer use because many perennial plants are completing their storage of carbohydrates and no longer need active leaf area. Upland cool-season species may again produce palatable forage, which, together with cooler temperatures, may shift livestock use to the uplands and relieve grazing pressure in riparian areas.

Livestock are often assumed to leave riparian areas to use upland range in fall, but they may not. On one long glaciated U-shaped valley in Idaho, Platts and Raleigh (1984) found that a late-season grazing system helped restore riparian quality because livestock moved to the uplands in late summer and fall when a cold air pocket formed over the bottomlands. However, at another study site in a flat broad valley 15 miles away, livestock were drawn to the riparian areas during the late season because those areas contained the only remaining succulent vegetation. The orientation of the drainage (valley) can affect use by cows (e.g., south-versus east-facing slopes). Heavy fall riparian use can leave streamside vegetation depleted and banks vulnerable to damage from floating ice or spring runoff.

Deferring grazing until after seedripe can benefit sedge and grass communities if sufficient residual vegetation protects banks and retains sediment during the next high-flow event (Elmore and Kauffman 1994). Woody species utilization must be carefully monitored because during the later part of the hot season, livestock tend to concentrate in riparian areas. Such concentrated use was found to retard woody plant succession on gravel bars even though the diversity and productivity of meadow communities were maintained (Green 1991). Kovalchik and Elmore (1991) noted that systems with late-season grazing may be incompatible with willow management.

Late-Season (Fall) Grazing

Potential Advantages:

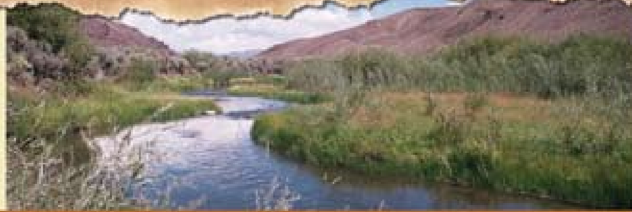
- Fish-livestock interactions depend on the climate and precipitation cycle. If the riparian area is working as a cold air sink, then the advantages resemble winter or spring use. If the riparian area is providing thermal cover, then the advantages resemble summer use.
- Most herbaceous vegetation has completed its growth for the season, thus making it less susceptible to overgrazing.

Potential Disadvantages:

- Livestock are more likely to browse woody species, which can limit canopy cover and recruitment of instream cover.
- Regrowth of vegetation needed for instream cover and stream function generally does not occur.
- There is a potential for livestock to impact fish spawning areas (species-dependent).
- Livestock distribution is poor.

e. Passive, Continuous Grazing: Spring-Summer, Summer-Fall, or Season-Long Grazing

In this document, the term "passive, continuous grazing" means grazing throughout the growing period with little or no effort to control the amount, duration, or distribution of livestock use in particular areas. Riparian areas will usually be overgrazed under passive, continuous spring-summer, summer-fall, or season-long grazing (Figures 42 and 43). During hot portions of the grazing period, riparian sites are usually preferred by livestock



over upland sites on arid and semiarid ranges, as they provide water, lush forage, cooler air, shade, and relatively flat terrain. Until use becomes excessive, livestock do not need to spend as much time and effort to forage in riparian areas as they do on uplands to satisfy their daily nutritional requirements (Skovlin 1984). In Montana, during August and September, approximately 80 percent of the forage used by livestock may come from riparian sites, even though these sites often make up less than 4 percent of the total pasture (Marlow 1985).

Figure 42. An example of typical impacts from passive, continuous grazing. (Photo by Wayne Elmore, retired, BLM.)

Figure 43. Passive, continuous grazing can result in bank hoof shear, lack of vegetation on point bars, encroachment of dry-land vegetation, willows well above the channel elevation, heavily hedged willows, presence of only one age class of willows, lack of adequate vegetation for sediment entrapment and bank protection, and wide, shallow stream profile. (Photo by USFS.)

Passive, Continuous Grazing: Spring-Summer, Summer-Fall, or Season-Long Grazing

The advantages and disadvantages are not listed for passive, continuous grazing as this treatment rarely works well for the maintenance or recovery of riparian function.

f. Spring and Fall Grazing

Spring and fall grazing in the same year may work in some cases, but it usually fails to meet riparian vegetation needs because it adds the potential limitations of spring grazing to those of fall grazing. If temperatures are still warm when fall grazing begins, livestock concentrate in the riparian area while palatability of both herbaceous plants and willows is high. Appropriate use on willows can easily be exceeded, and residual vegetation for protection of banks during high flows is removed before uplands are grazed (Figure 44). Livestock preference for the riparian area is compounded the following spring because the absence of standing dry matter increases the palatability of riparian forage over ungrazed upland plants. Excess stress may be added to upland plants that are already grazed in the spring if fall use of riparian areas is avoided due to cold in the bottoms and the palatability of upland fall greenup. Careful monitoring of grazing and browse use is essential for the success of this type of grazing strategy.

Figure 44. An example of winter use on the left compared to spring and fall use on the right.

Spring and Fall Grazing

Potential Advantages:

- Use of riparian vegetation is reduced due to livestock focus on nutritious upland plants in spring and avoidance of cooler bottom areas in late fall.
- There is time for growth of vegetation before and after use.
- The pasture may be used more completely, with some areas being preferred in one season and other areas preferred in the other season.
- The period of nutritious forage may increase by focusing animals on upland vegetation when it is palatable and on riparian areas at other times.
- The ease of livestock movement may offset a disadvantage of any required light use.

Potential Disadvantages:

- Use occurs during the herbaceous growing season and when riparian woody plants are often browsed.
- The banks may not be protected during high-flow events if use is excessive.
- Use occurs when soils are most compactable (spring) and when soil is susceptible to dry ravel (fall).
- There is more opportunity for livestock to disturb nesting, calving or fawning and to impact fish spawning in spring or fall.
- Use may need to be more limited or the duration shortened to avoid the added negative effects of spring and fall use.
- A use pattern set up in spring may be perpetuated with the same areas used in fall.

Successful spring and fall grazing was observed by the National Riparian Service Team on a private, irrigated riparian pasture in south-central Idaho. Factors contributing to success in this case included plentiful herbaceous forage, water availability throughout the pasture, and a short duration of use (approximately 2 weeks) in the fall. Ehrhart found similar successes in several places in Montana. **The critical point in these examples is that the owner or operator monitored use daily and moved livestock when target use levels were met**.

g. Deferred and Rotational-Deferred Grazing

Deferred grazing is the delay of grazing in a nonsystematic rotation with other land units, and rotational-deferred (deferred-rotational) grazing is a systematic rotation of the deferment among pastures (SRM 2004). Both strategies have been successful in restoring and improving riparian areas. Both strategies were found to be statistically similar in the amount of bank sloughing that occurred on nongrazed controls on Meadow Creek in northeast Oregon (Buckhouse et al. 1981). The common thread of successful application, except for riparian pastures used in a deferred strategy, has been to use many pastures to shorten the duration of use and provide greater flexibility. Many riparian grazing successes in Montana use from 7-38 pastures (Massman 1998). Masters et al. (1996b) concluded, "Four-pasture, five-pasture (or more) rotation schemes with no rested pasture may be more suitable to areas that require increased streambank vegetation. The additional pastures or smaller riparian pastures allow for a shorter grazing season and greater flexibility in rotation schedules." Figure 45 shows Van Duzer Creek around 1900 when it was turned upside down with intense mining and overgrazing. By 1982, recovery had taken place (Figure 46), but with a change to a five-pasture deferred rotation strategy, even more recovery occurred (Figure 47).

Figure 45. Van Duzer Creek was turned upside down with mining and overgrazing around 1900.

Figure 46. Recovery on Van Duzer Creek had taken place by 1982.

Figure 47. A five-pasture deferred rotation strategy allowed even better recovery by 1991 on Van Duzer Creek.

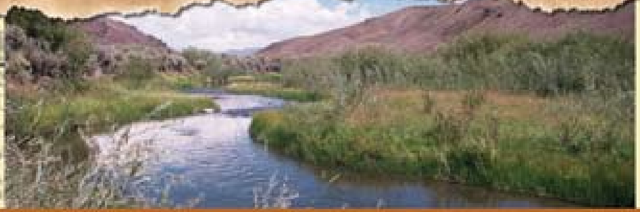
Deferred and Rotational-Deferred Grazing

Potential Advantages:

- Riparian area livestock grazing and concentration does not occur every year.
- The grazing season is shorter and changes in the timing, frequency, and intensity of grazing decrease the likelihood of multiple defoliations of desired riparian plant species, allowing for longer periods of plant recovery.
- Livestock may be less selective in pastures where use is concentrated into shorter periods.

Potential Disadvantages:

- Every year livestock will be in some pasture when they are most likely to concentrate in riparian areas and damage riparian vegetation or stream channels.
- This may or may not be offset by recovery in other years when the pasture is grazed in a different season.
- With few pastures, the duration of the grazing season may be too long for some riparian areas.
- There is an added expense for fence and fence maintenance.
- Fences may interfere with wildlife movement.



Research at the Red Bluff Research Ranch near Norris, Montana, suggests that implementation of a grazing system based on seasonal preference for riparian and upland forage may be beneficial. In this area, livestock spend most of their time during June and July in the uplands, moving to the riparian sites in late July where they graze until October. Bank trampling damage is reduced by deferring grazing until after late July when soil moisture content has decreased to 8-10 percent or less. This system requires a minimum of three pastures and uses a 3-year cycle. Stocking rates in the pasture used first are based on forage available on both the upland and riparian sites. Stocking rates on the two pastures used later are based on 20- to 30-percent utilization of forage on the riparian sites. Although this may appear to drastically limit the length of time a pasture can be used, riparian zones usually produce three to four times the forage of upland areas. The regrowth potential of riparian species is great enough that, during most years, regrazing of the same pasture can occur at 30- to 40-day intervals until frost. Consequently, there is little, if any, change in the amount of forage a rancher has available to his livestock in the grazing season. Once the target level of use is reached, livestock are moved to the next pasture. Each pasture receives 2 years of deferment during periods when soil moisture exceeds 10 percent (June-July). The pasture used early the first year is grazed progressively later during the second and third years.

Marlow (1985)

h. Rest-Rotation Grazing (Rotational Stocking)

Rotational stocking is a grazing method that uses recurring periods of grazing and rest among two or more paddocks in a grazing management unit throughout the period when grazing is allowed. Words such as "controlled" or "intensive" are sometimes used in an attempt to describe the degree of grazing management applied with this grazing method. These words are not synonyms for rotational stocking (SRM 2004). Rest-rotation grazing is a management scheme in which rest periods for individual pastures, paddocks, or grazing units, generally for the full growing season, are incorporated into a grazing rotation (SRM 2004). Rotational stocking differs from rotational deferred grazing in that the rotation includes a year (or full growing season) with no grazing for each pasture at least once in each cycle. Hormay (1976) emphasized that each rest-rotation system should be designed to meet the resource needs of the area. The amount of rest, stocking rate, and season of use should be determined based on the growth requirements of all the vegetation present. Rest-rotation does not dictate heavy grazing under any treatment.

As with deferred and deferred-rotation strategies, a system that uses more pastures is usually better than one that uses fewer; however, in practical application, rest-rotation grazing frequently has been a three-pasture system. Cost and simplicity have often been factors in choosing a three-pasture system, and riparian objectives historically have rarely influenced pasture design and grazing strategy.

There are great differences of opinion on the value of rest-rotation grazing, as generally applied, in the proper management of riparian areas. Variation in ecological conditions and among stream types with different sensitivities to disturbance have contributed to mixed results of rest-rotation systems. Successes and failures have occurred, sometimes in the same management unit. Elmore and Kauffman (1994) cited 10 years of continued channel degradation in a high-gradient, high-energy stream system under three-pasture, rest-rotation grazing (Figure 48). Yet, in the same allotment, with the same system and the same livestock, another stream made an excellent recovery (Figure 49). The differences are due to stream type, sensitivity to disturbance, vegetation potential, and kind and amount of vegetation required to stabilize each stream. Rest-rotation favors herbaceous bank-forming vegetation, which is entirely adequate for the low-gradient stream depicted in Figure 49. However, the high-energy stream in Figure 48 continued to show a downward trend because of the lack of willows needed to stabilize the streambanks. Buckhouse et al. (1981) found no statistical difference in the amount of bank sloughing between a properly managed rest-rotation pasture and nongrazed control pastures.

Masters et al. (1996b) provide examples of two, three-pasture rest-rotation strategies in Nevada; one was successful, the other was not. The goals on Strawberry Creek (Figure 50) were to maintain healthy streamside vegetation and stable channel conditions. The continued success since the strategy was implemented in 1969 is attributed to cooperation among agencies and the permittee, inherently stable stream channel conditions, long-term attention to resource conditions, and careful herd management practices, including salt placement and livestock herding to improve distribution. On Wildcat Creek (Figure 51), past management had resulted in unstable, eroding banks and deteriorated ecological conditions. Applying a three-pasture, rest-rotation strategy in a degraded system without adjusting livestock numbers resulted in the overgrazing of two pastures, and one year of rest did not allow system recovery. In this case, temporary exclusion to allow a "jump start" in the recovery process was probably warranted. In addition to limitations imposed by the initial conditions, **specified herd management practices were not followed, upland water developments failed, and salt blocks were still placed near the stream channel.**

Figure 48. Higgins Creek, 1984. Channel degradation continued with 10 years of a three-pasture, rest-rotation system. (Photo by W. Elmore, retired, BLM.)

Figure 49. Beaver Creek, 1984. A three-pasture, rest-rotation system provided recovery of herbaceous bank-forming vegetation and associated channel characteristics. (Photo by W. Elmore, retired, BLM.)

Figure 50. Strawberry Creek, Nevada, maintained properly functioning riparian conditions with a three-pasture, rest-rotation system.

Figure 51. Wildcat Creek, Nevada, did not improve under the same kind of system.

Rest-Rotation Grazing

Potential Advantages:

- Plants periodically receive a full growing season of rest for recovery.
- The duration of grazing season is shortened from season-long and frequency of defoliations is decreased.
- The combination of a shorter grazing season with occasional or frequent periods of no grazing within the growing season allows plants to prosper in most, if not all, years.
- The timing of pasture rotation frequently corresponds to grass phenology, and many riparian grasslike plants respond well to this treatment and timing.

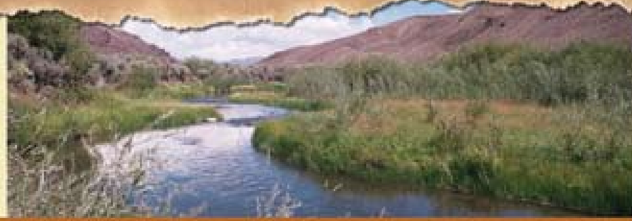
Potential Disadvantages:

- Moving animals to a pasture after seed ripening on upland grasses will likely concentrate animals in the riparian area.
- Resting a pasture for a complete year will either add pressure to other pastures or require a decrease in herd size.
- Every year livestock will be in some pasture when they are more likely to concentrate in the riparian areas and damage riparian vegetation or stream channels.
- This may or may not be offset by recovery in other years when the pasture is grazed in a different season.
- With few pastures, the duration of the grazing season may be too long for some riparian areas.

i. Short-Duration Grazing

A short-duration grazing strategy is characterized by relatively short periods (days) of grazing and longer periods (week to months) without grazing. Periods of grazing and nongrazing are based upon plant growth characteristics. Short-duration grazing is separate from intensity of grazing use (SRM 2004). The duration may be short (a matter of a few days, but the intensity can vary depending upon stocking rate and the size of the grazing area.

Short-duration grazing prevents frequent defoliations within a grazing period by moving livestock frequently when plants are growing rapidly. With grazing periods as short as a few days, few if any individual plants will have regrown sufficient leaf material to be regrazed. Thus regrowing plants have full opportunity to recover from defoliation without further defoliation stress.



Short-Duration Grazing

Potential Advantages:

- Plant root and shoot growth is less impacted with no or with only a few repeated defoliations.
- There are long periods of growth and recovery.
- Depending on the season of use, ground-nesting birds and other wildlife species needing shade and cover may benefit.
- There is decreased time of exposure to grazing and trampling.
- Enhanced monitoring by the livestock operator is required.
- Fly problems are decreased as the livestock rotation breaks the fly larvae cycle.
- There is a decrease in potential diseases and the livestock manager can provide earlier treatment for sickness or injury.
- Animals may be less selective, using more areas (better distribution) and more plants (more forage).

Potential Disadvantages:

- Cover for ground-nesting birds and wildlife may not be adequate during and right after grazing.
- Intensive management is required (frequency of monitoring and moving animals).
- There are high fencing requirements unless herding techniques are used.
- Mistakes in the timing of moves can lead to excessive grazing intensity with animal concentration.

Case Study: Short-Duration Grazing at Milesnick Ranch

Tom and Mary Kay Milesnick are the third generation on the Milesnick Ranch north of Belgrade, Montana. The ranch was purchased in 1936 and expanded over the years to the current 1,400 acres in the Belgrade unit and 4,800 acres of mountain pasture near Livingston, Montana. The Milesnicks raise Red Angus-Simmental cattle commercially.

From 1936 to 1970, all of the cattle were run in a single herd. They grazed a single pasture continuously and were fed supplemental forage during most of the winter months. From 1970 to 1991, the herd was rotated through three pastures, grazing each for 20 to 22 days, and resting each for 45 days before regrazing.

In 1992, Milesnick's interest in the environment led him to make some fundamental changes in grazing management on the home ranch. Public environmental pressures stressed a need for all riparian areas to be fenced from livestock use, but Tom wished to demonstrate that cows could effectively use the riparian areas on the "world-class fly-fishing streams" that run through his property. He began a 17-pasture short-duration system, with grazing periods ranging from ½ to 3-½ days and grazing up to five times per year in any one pasture with 250 cow/calf pairs. Two 12-hour pastures are grazed at night to accommodate fishermen who use the property during the day.

The short-duration grazing schedule has completely eliminated historical asthma problems in the cattle. Cattle gains have increased from 450 pounds to 675 pounds since 1972 because of genetics and short-duration grazing (Milesnick pers. comm.).

The Milesnicks use a variety of tools to facilitate their grazing plan. They have installed water access points to decrease streambank trampling. Size depends upon how many animals are watered at one time. An 8-foot width has been sufficient if there are fewer than 175 head. They also use spring water to provide offsite water 50 feet from a meandering stream on the Livingston unit to decrease the amount of time cattle spent in and along the stream channel (Figure 52).

Milesnick strives for a 6-inch stubble height on sedges and rushes when removing cattle from the pasture. He does not manage stubble height on Kentucky bluegrass as it is not the primary (key) species. He attempts to leave adequate leaf material for photosynthesis to occur on key plant species for plant vigor and maintenance and to provide more shade for fishery habitat.

Milesnick also recognized the need to diversify his operation and started the Milesnick Recreation Company in 1999, which provides fee fishing (Figure 53), waterfowl hunting, and archery elk hunting. The Milesnicks are managing the vegetative resources for fish habitat. Fishing and hunting supply approximately 5 percent of the gross profits of the ranch, but the fishing and hunting operation yields an 80 percent net profit.

Figure 52. Offsite water from a spring has allowed this stream channel at Milesnick Ranch, Montana, to heal.

Figure 53. Cattle grazing on a blue-ribbon trout stream at Milesnick Ranch in Montana. (Photos on this page by T. Milesnick.)

j. High-Intensity, Low-Frequency Grazing

High-intensity, low-frequency grazing strategies are multipasture, single herd systems (USDA NRCS 2003). Stock density is high to extremely high; however, the length of the grazing period is moderate to short, with a long rest period. Dates for moving livestock are set by the use of forage, and grazing units typically are not grazed the same time of year each year. The number of grazing units and grazing capacity of each unit determines how often, if ever, the same grazing unit is grazed during the same period of the following year (USDA NRCS 2003). Intensive grazing management attempts to increase production or utilization per unit area or production per animal through a relative increase in stocking rates, forage utilization, labor, resources, or capital. Intensive grazing management is not synonymous with rotation grazing (SRM 2004).

Unlike short-duration grazing, use periods are not based on the rate of plant growth. However, grazing periods may be short. The purpose of high-intensity grazing is to avoid use patterns, overresting of plants adapted to herbivory, unused forage, and favoring of less palatable plants. With all or most plants used well, forage plants have an equal opportunity to recover. This diminishes tendencies for increasers to outcompete decreasers. The low frequency is provided by having many pastures and long recovery/growth periods. Desirable forage species often benefit from this grazing system, but animal nutrient intake and corresponding livestock performance usually decline because the forced higher utilization levels reduce selectivity (Hart et al. 1993, Pfister et al. 1984, Pieper et al. 1978, and Smoliak 1960).

Trlica et al. (2000) found that in a montane riparian ecosystem along a small headwater stream in northern Colorado, heavy grazing may result in increased nonpoint source pollution if grazing occurs in close proximity to the stream. Runoff rates from heavily grazing plots were 70 percent greater than runoff rates from ungrazed control plots.

High-Intensity, Low-Frequency Grazing

Potential Advantages:

- Long periods of rest are allowed.
- Ground-nesting birds and other wildlife species needing shade and cover may benefit, except during or soon after intensive use.
- There is decreased time of exposure to grazing and trampling.
- Enhanced monitoring by the livestock operator is required.
- Fly problems are decreased as the livestock rotation breaks the fly larvae cycle.
- There is a decrease in potential diseases.
- The livestock manager can provide earlier treatment for sickness or injury.
- The long period of rest provides for adequate litter and ground cover.
- The competitive advantage of unpalatable plants is reduced.

Potential Disadvantages:

- Adequate cover for ground-nesting birds and other wildlife may not be available during and right after grazing.
- Intensive management is required (frequency of moving animals).
- There are high fencing requirements unless herding techniques are used.
- Soil compaction is possible if grazed when soils are wet.
- High intensity in the fall may fail to provide adequate vegetation cover for trapping spring sediment.
- High levels of grazing intensity may reduce livestock performance.
- Heavy grazing may result in reduced stream water quality if grazing occurs in close proximity to the stream (Trlica et al. 2000).

Case Study: High-Intensity, Low-Frequency Grazing at Banister Ranch

The Ray Banister Ranch is located in Wibaux County in eastern Montana. Banister manages 5,500 acres of private rangeland by using a high-intensity, low-frequency grazing strategy (what Banister calls "Boom-Bust") that consists of intensive periods of grazing followed by two growing seasons of rest (Provenza 2003). He uses half of his 38 pastures each year (Massman 1998). Although pasture sizes differ, each pasture is grazed heavily by the herd for about 20 days every other year. This method stresses soils, plants, and herbivores with intensive grazing pressure and then allows them to recover. High-intensity grazing allows the cattle to open up thick patches of brush. Once sunlight penetrates dense, brushy areas, grasses can compete better with noxious weeds. This type of "hard hit" on a pasture helps trample grass seed into the soil and makes room for the establishment of new seedlings. Banister found that after providing a long rest, it is not necessary to vary the season of grazing, and the short amount of time in each pasture decreases the opportunity for regrazing individual plants. He also allows light grazing of the pastures during dormancy. Banister worked with the Natural Resources Conservation Service to develop livestock water (Figure 54), pasture and hayland renovation, and cross fencing.

Banister feels that the riparian areas are healthy because the high-intensity, low-frequency strategy allows 23 months of rest (Figure 55). Riparian vegetation becomes rank, palatability is lower, and cattle preference increases for plants on the uplands increases (Banister pers. comm.).

Banister's Hereford cattle had to adapt from eating the most palatable plants that were available to eating all the plants. The 220 cow/calf pairs, 20 heifers, and 10 bulls are allowed to move only when they have used high levels of the least palatable plants (sagebrush, snowberry, and various weeds). This reduces the competitive advantage unpalatable plants have over more preferred plants. It took Banister's cattle 3 years to adapt to this style of management. Weaning weights of calves plunged from well over 500 pounds to 350 pounds, and then rebounded back to over 500 pounds. Weight gains or losses will vary depending upon the situation, current health of livestock, and livestock requirements. Banister recommends allowing a minimum of 3 years to allow livestock to adapt to new management changes before deciding whether the strategy will or will not work. "There is no control over anything in riparian areas. There are too many variables, so the best strategy is to follow the rules of proper management" (Banister pers. comm.).

Banister has found that this grazing strategy is beneficial for a large variety of wildlife species, including mule deer, white tail deer, antelope, greater sage-grouse, Columbian sharptailed grouse, and ring-neck pheasants, and many other bird and wildlife species, as well as the health of his land (Banister pers. comm.).

Figure 54. Excellent wetland vegetation along a stockwater pond under high-intensity, low-frequency grazing system at Banister Ranch in Montana. (Photo by R. Banister.)

Figure 55. Willows after grazing under a high-intensity, low-frequency strategy at Banister Ranch in Montana. (Photo by R. Banister.)

k. High-Intensity, Short-Duration Grazing

High-intensity, short-duration grazing management is used to concentrate animal impacts in time and space, thereby avoiding regrazing and overresting of plants adapted to herbivory. This treatment copies the short-duration idea of not regrazing a plant during a grazing period by moving animals faster during rapid growth. It also uses the high-intensity idea of grazing all or most plants severely so that regrowth is balanced among species. To do this well requires appropriate numbers of animals to balance the forage available with the proper timing and desired use level. This treatment often uses many more pastures than high-intensity, low-frequency or short-duration grazing, so animal numbers must be sufficient in order to still meet goals, because use periods can be very short. Depending on how well it is planned and implemented, this technique can be good for riparian management.

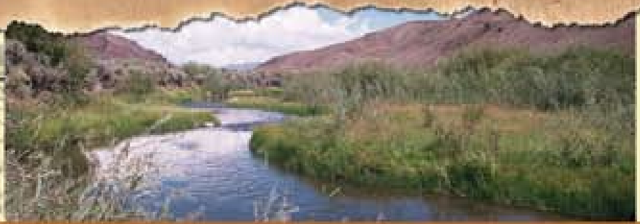
High-Intensity, Short-Duration Grazing

Potential Advantages:

- The positive plant regrowth opportunities of short duration are combined with the positive plant stimulus and equal recovery benefits of high intensity.
- Riparian concentration is diminished with more equal use of the uplands.
- Depending upon the season of use, riparian vegetation recovery is possible over an extended period due to availability of soil moisture.

Potential Disadvantages:

- Residual cover for ground-nesting birds and other wildlife may be inadequate immediately after grazing.
- High-intensity use after the growing season may leave riparian areas with little cover for trapping sediment during high-flow events.
- Stocking rates need to be adequate for proper intensity of use of vegetation, which varies depending upon amount and timing of precipitation.
- Intensive management and an increase in fencing (unless low-stress stockmanship is used to move livestock) are required.
- Livestock performance may suffer if grazing intensity levels are sufficient to reduce animal selectivity.



Case Study: High-Intensity, Short-Duration Grazing at Deseret Ranch

High-intensity, short-duration grazing has been used to improve general range and riparian conditions on the Deseret Land and Livestock Company Ranch in northeast Utah. Prior to implementation of this method, much of the rangeland on the ranch was in a deteriorated condition (Secrist pers. comm.). Sagebrush filled many gullies in the lower elevations. Muddy water flowed in the drainages during snowmelt or following heavy rains. Riparian herbaceous vegetation was absent in most drainages and no willows could be found.

A high-intensity, short-duration grazing program was initiated on the ranch in 1979, with the objective of making a profit while improving the health of the range. Because grazing animals were originally part of the ecosystem, livestock were chosen as the tool for accomplishing this objective. Cattle, sheep, elk, and buffalo are managed to control the timing and duration of grazing, as well as animal impact. Adaptive management is practiced by evaluating research and monitoring information, applying rangeland restoration projects, and revising the grazing strategy as needed (Danvir pers. comm.).

Flexibility in time control has been achieved by grouping animals into large herds (from 2,000 yearling heifers to 5,000 cow/calf pairs and 2,000 yearling steers) and creating more pastures through fencing. Three cattle herds and two bands of sheep use 100 pastures on the ranch. Depending on range conditions, vegetation, and economic goals, pastures are used one to three times per year; the majority is only used once and usually receives more than 12 months of rest. Stock density has ranged from 0.5 to 3.5, depending on pasture size. Time in each pasture is determined by how fast plants are growing. When growth is rapid, pasture moves are frequent. When growth is slow, the livestock stay longer in each pasture. When plants are dormant, lack of forage and animal performance determine when livestock are moved. Time in each pasture has ranged from 3 days (during rapid growth) to 60 days (during dormancy). During the growing season, the grazing animals are moved from pasture to pasture in an attempt to graze each plant only once, and then allow it to recover from the effects of defoliation before it is grazed again. Sheep and cattle are moved by herding; however, most cattle have learned to move to the next pasture (with their calf at their side) when gates are opened (Danvir pers. comm.).

The Deseret Ranch manager believes that animal impacts resulting from herding include: (1) hooves break up soil crusts, enrich soil, and provide cover by incorporating manure, litter, and seeds into the soil surface (this can be detrimental in areas where microbiotic crusts are an important component), (2) urine adds urea to the soil, (3) hoof prints create seedbeds and pockets for collection of litter and precipitation where seeds are pressed into contact with mineral soil, and (4) grazing, trampling, crushing, etc., prune plants to stimulate new plant growth. New plants result in additional pathways for water to get into the soil reservoir where it is stored, purified, and slowly released into riparian areas. Animal impact, when properly managed, is very important to the health of these rangelands. The herding effects, particularly the hoofprint seedbeds, improve microsite conditions for the germination of seeds and establishment of seedlings, which can be the weakest link in the natural function of many range ecosystems.

The ranch manager believes that this method of grazing results in an increase in ground cover, water infiltration, and soil moisture and restores some of the natural hydrologic function to the watershed. Riparian vegetation has reestablished in the drainages, serving as a sediment trap that raises the water table. As this process continues, the bottom of the drainage rises in elevation, thus deepening and widening the riparian aquifer. As a result, riparian vegetation expands into the edges of the uplands and floods sagebrush.

Clear water flows year-round, and willows have established themselves where they did not exist before. The streambed in one drainage has raised more than 6 inches in elevation. Gully banks are slumping and are being vegetated by riparian plants. Sagebrush is dying where the riparian areas expand. Though precipitation and runoff were far above normal, the additional ground cover in the uplands and the improvement in the riparian habitat prevented significant erosion damage on the ranch in spite of increased stocking rates (Table 4) (Simonds pers. comm.). The ranch continues to sustain higher stocking levels of cattle and elk than in 1979 (Danvir pers. comm.).

Table 4. Stocking levels on the Deseret Land and Livestock Company Ranch.

	1979	1986	2005
Cattle	4,500	10,460	9,000
Sheep	12,000	10,000	3,000
Elk	350	1,500	2,300
Buffalo	0	230	0

Case Study: High-Intensity, Short-Duration Grazing at Rio Oxbow Ranch

The Rio Oxbow Ranch in the San Luis Valley of Colorado is owned by Alan and Patricia Lisenby and managed by Dale and Anne Pizel. The 1,600-acre ranch is located at the headwaters of the Rio Grande and borders the Rio Grande National Forest in the San Juan Mountain Range.

The Lisenbys and Pizels use a time-controlled grazing strategy to maintain and restore properly functioning riparian areas. Their primary objectives are to improve the riparian areas, fisheries for fly fishing, and wildlife habitat. The ranch was rested from 60 years of overgrazing for 5 years along 6 miles of the Rio Grande River (Figure 56). Intensive grazing through 6 pastures with 1,000 cow/calf pairs of the neighbor's cattle began in the fall of 2000. The cattle graze in the spring or fall, which has proven effective in transforming vertical river banks to more normal angles of repose and stimulating new plant growth of riparian grasses, willows, and cottonwoods (Figure 57). Noticeable results occurred in the first year. The riverbank stabilized and the rocky shoals, which had no growth for many years, sprouted numerous willows throughout the river's 6 mile reach (Pizel pers. comm.). Livestock are turned in around June 10 and again around October 10 and are in each pasture 2-5 days. The dates are adjusted according to weather conditions (drought) and USFS adjustment of turn-in dates. They also try to rest each pasture every couple of years.

Riverbank stabilization and wildlife enhancement projects were completed with the help of the NRCS Environmental Quality Incentive Program (EQIP) and Wildlife Habitat Improvement Program (WHIP) (Blenden 2003). Projects included installation of rock barbs and extensive willow and cottonwood plantings. Pizel found that most of the willows died and undercutting of the reshaped banks occurred. It wasn't until livestock were used that recovery started to occur. Minimal fencing to allow for better control and use of the riparian area and to maintain a wildlife-friendly ranch has been installed. Fencing allows for careful control of the time and timing of grazing, which aids in riparian function improvement.

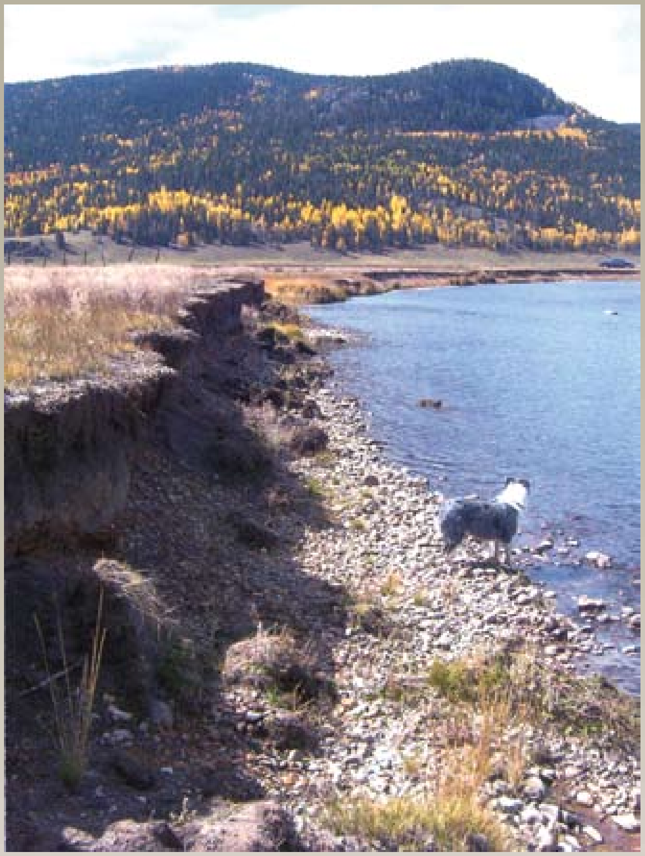


Figure 56. Rio Oxbow Ranch, Colorado, after 5 years of rest from overgrazing (2000).

Figure 57. Rio Oxbow Ranch, Colorado, 3 years later (2003), with grazing. Young age class willows are present. (Photos by D. Pizel, Rio Oxbow Ranch.)

The Rio Oxbow Ranch is an example of using livestock to improve wildlife habitat and riparian area function. "Livestock are a tool, just like a hammer is a tool. If you hit your thumb with the hammer, you are using the tool incorrectly. The same analogy can be said of livestock grazing" (Pizel, pers. comm.).

The effects of this grazing treatment are strikingly evident in photos of two pastures on the ranch. "Both pastures had not been grazed for 5 years. This is spring on the exact same day, a couple of hours apart. The brown pasture (Figure 58) had not been grazed the year before. The green pasture (Figure 59) was grazed with 1000 pair for 30 days, the fall before. Again this is the same day, different sides of the fence, in very comparable environments. It is May 1st and as you can see one side has a good start on summer, and at 9000 feet that is important. What was shocking to me was the life. The brown side of the ranch appeared dead, it even smelled bad. There were no elk, birds, ducks, bugs, and frogs; there was silence. I would not let my children touch it. On the green side the life was deafening. There were ducks that refused to leave, water insects, and the frogs were quite honestly deafening. They were loud. They were everywhere! My little girls took their pants off and went wading, (swimming, when they were done). It was life re-born! They had moved back in, in one season. We really have to manage the elk now as they are causing overgrazing; they won't leave" (Pizel, pers. comm.).

This type of change can occur when decadent and dead plant material is removed exposing plants to solar energy, allowing for earlier greenup. Insects, amphibians, waterfowl, and wildlife are attracted to the exposed green leafy material.

Figure 58. A pasture at Rio Oxbow Ranch, Colorado, that was not grazed the previous year lacked flora and fauna vigor and life.

Figure 59. In another pasture at Rio Oxbow Ranch, Colorado, livestock grazing removed dead material, exposing new, growing leaf material. (Photos by D. Pizel, Rio Oxbow Ranch.)

l. Rest

Depending on the riparian area objectives, available tools and finances, and time prescribed for achieving objectives, temporary nonuse may be the best alternative for realizing the most rapid improvement. A deteriorated riparian area with few trees or shrubs, or one where the objective is to get woody plant regeneration above the reach of livestock, may require rest, at least for a few years (Davis 1982).

Skovlin (1984) found that exclusion of livestock has produced improved riparian and aquatic habitat following 4 to 7 years of rest, woody plant (shrub) recovery following 5 to 8 years of rest, a doubling of fish biomass following 3 to 5 years of rest, and attendant positive responses in birds and small mammals. A study on Big Creek in northeast Utah concluded that a minimum of 6 to 8 years of rest was necessary to restore a deteriorated streamside riparian area to the point where livestock grazing could be allowed at reduced levels (Duff 1983). However, substantial recovery of streambanks and vegetation was observed following 4 years of rest from grazing through the use of fencing.

Elmore and Kaufmann (1994) state that riparian exclusion should only be used in conjunction with an upland management plan designed to restore the entire landscape or when there are situations where the most rapid recovery possible is necessary (i.e., for habitat restoration of federally listed threatened or endangered salmonids).

Rest

Potential Advantages:

- Plants are not affected by herbivory, and streambanks are not affected by livestock trampling.
- Woody riparian plants are allowed to reach escapement height.
- There is a quick recovery period, especially in the first few years after grazing is eliminated.
- Areas outside that are still grazed can be compared and evaluated.
- Residual vegetation may be used as cover by fish and wildlife.
- The time to build up fuel for prescribed burns in riparian areas is decreased.

Potential Disadvantages:

- Plants may become decadent with rest.
- Nutrients can become tied up and residual plant material can impede light getting to young seedlings and sprouts.
- The rested area may attract wildlife and replace livestock herbivory, so goals and objectives may not be met.
- Without herbivory, some plants become less palatable, and residual dead vegetation can prevent wildlife foraging on live material.
- Some weeds may flourish in the absence of grazing as a biological control.
- Economic hardship may occur.

m. Riparian Pasture

Riparian pastures are designed to protect riparian values. They may be smaller areas of rangeland containing both upland and riparian vegetation that are managed together as a unit to achieve riparian objectives, or they may be streamside pastures containing only riparian vegetation.

In riparian pastures containing both upland and riparian vegetation, the balance of forage between upland and riparian areas is important. Forage in the upland sites should not limit proper distribution or use. For example, there should be enough forage in the upland and riparian areas so that livestock do not overgraze either when managed for overall appropriate use. Forage balance may vary with changes in forage preference, depending on season of use and kind or class of livestock.

Platts and Nelson (1985) found that on six 10-acre pastures in Idaho, Nevada, and Utah, the timing and location of grazing in specially managed riparian pastures could be controlled much more effectively than in large allotment pastures, providing an easier way to make grazing compatible with other resource uses. Using riparian pastures offers alternatives to eliminating livestock grazing and fencing riparian boundaries, which can be costly. By experimenting with different types of riparian and upland range, different sizes and shapes of pastures, and different ratios of riparian forage to upland forage, it may be possible to efficiently graze riparian vegetation without damaging this sensitive area. In mountain meadow ranges, special management pastures would need to be larger to better match the costs of fencing with benefits derived from improved riparian and fish habitat. The influence of a livestock herd's home range on grazing use requires careful analysis; pastures may have to be larger than a herd's home range in less productive ecological types, in which case, techniques to draw the herd to all parts of the pasture are essential. When fencing narrow streamside corridors or eliminating livestock are the only alternatives for maintaining productive riparian and aquatic habitats, the cost of special management pastures may not seem exorbitant.

Riparian pasture use is applicable in areas where riparian areas encompass a large enough area to be managed separately from uplands (Elmore and Kauffman 1994). Each riparian area may be managed individually or in combination with other allotments or pastures and can be grazed or rested depending on current conditions and stream riparian needs (Elmore and Kauffman 1994). Riparian pastures can be used seasonally, in conjunction with rotation strategies, or as special-use pastures (e.g., gathering pastures, horse pastures, bull pastures). Considerations when developing riparian pasture designs include:

- Desired grazing period and duration.
- Ability to control use of riparian area.
- Benefit to degraded stream types.
- Cost of installation and maintenance (including possible offsite water developments).
- Ability to meet livestock manager objectives.
- Inclusion of upland area in pasture to decrease pressure on riparian area.
- Need for close monitoring to avoid switch from livestock grazing to browsing.

Figures 60 and 61 show results of a change from season-long use on the North Fork of the Humboldt River in Nevada in 1994 to a riparian pasture for use by yearling bulls and cows for several weeks between late April and late June. Figure 62 shows continued recovery through 2004.

Figure 60. North Fork of the Humboldt River, Nevada, 1989.

Figure 61. North Fork of the Humboldt River, Nevada, 1994.

Figure 62. North Fork of the Humboldt River, Nevada, 2004. (North Fork photos by C. Evans, BLM.)

The Goosey Lake Flat (Nevada) riparian pasture (Figures 63 and 64) has generally been used as a gather or turnout pasture since it was changed from continuous, season-long use. The grazing plan calls for use in early June for 1 year out of 3 and for 2 weeks in September for gathering during the remaining 2 years (Masters et al. 1996b).

Figure 63. Goosey Lake Flat Creek, Nevada (1965).

Figure 64. Goosey Lake Flat Creek, Nevada (1991). (Goosey Lake Flat Creek photos by BLM.)

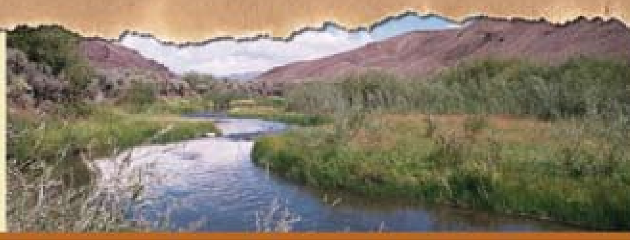
Riparian Pasture

Potential Advantages:

- There is closer management and control to achieve goals and objectives.
- It is possible to graze these pastures more frequently, but they should be evaluated on a case-by-case basis.
- A riparian pasture can be used as seasonal pasture, in conjunction with rotational strategies, or for a special use (i.e., ultimate flexibility without forgoing use of uplands).
- Upland use objectives can be met without sacrificing the riparian resource condition.
- Use of the riparian area is allowed.

Potential Disadvantages:

- It is often short in duration.
- Close management is required.
- Riparian areas may provide the only water for surrounding uplands.
- Riparian fences without a proper design can be a problem for recreationists and wildlife.
- The amount of upland needed to prevent upland overuse within the riparian pasture must be carefully determined.
- Topographic features may inhibit development of riparian pastures or employing other practices.
- Fencing may be more expensive than for a riparian exclosure due to size.



E. Monitor Vegetation

1. General

No discussion of grazing management would be complete without addressing monitoring. Once objectives have been established and a grazing strategy selected and implemented, the only way to evaluate whether or not objectives are being achieved is through monitoring. All stated management objectives require some strategy for monitoring their attainment. Likewise, all monitoring should tie directly to the analysis and accomplishment of specified objectives. This may seem obvious, but an analysis of 20 public land grazing allotment management plans in northeastern California and northwestern Nevada found that none combined all the elements of a systematic process by linking goals, issues, and objectives with action, monitoring, and evaluation (Olson 1989 and Olson and Burkhardt 1992).

Olson stated, "Management objectives, overall, were not measurable or realistic, providing no solid vegetative benchmarks for determining management successes. In the cases where management objectives were both measurable and obtainable, the supporting monitoring studies and evaluations were incomplete." Other subsequent program reviews have identified similar problems in virtually every location to one degree or another. Monitoring that has no direct relationship to objectives is a frequent problem that increases costs and usually detracts from necessary monitoring and administrative tasks. Private land monitoring plans also have similar problems, although public land situations may be more complicated due to budgets, personnel, administrative needs, and so on.

Due to seasonal, annual, and cyclic events such as fire, insect infestations, disease, weather, and associated hydrologic phenomena, success in grazing management depends on adaptive management. Adaptive management treats each management practice as an experiment and evaluates and adjusts the practice over the short- and long-term. Monitoring plans should include implementation (within season and end-of-season) and effectiveness (mid- and long-term) strategies to support adaptive management. Implementation monitoring includes annual documentation of implementation activities, events, and interpretive measurements (annual indicators) or observations of effects that influence progress toward objectives. Effectiveness monitoring documents achievement of and should measure trend toward objectives, usually over a period of years. Many agency, interagency, and cooperative extension references guide the planning, method selection, analysis, and interpretation of monitoring data. Therefore, the following discussion will present general concepts common to all and primarily address vegetation monitoring. Initial baseline data may also include channel morphology and stream measurements and macroinvertebrate inventories to evaluate water quality (Rasmussen et al 1998).

a. Key and Critical Areas

In many grazing operations, riparian areas, or portions of riparian areas, are "key areas" for management, and their condition may indicate whether grazing management is proper for the entire pasture or operation. 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.

When selecting key areas to be monitored, consideration should be given to how these areas represent the use that is occurring and the objectives to be reached. Collectively, key areas should possess (or have the potential to produce) all the specific elements contained in the objective(s) because these will provide data for evaluating all management efforts. In many cases, it is appropriate to first select the key areas that represent important or common resource values, situations, and general goals, and then develop objectives specific to each.

Stream reaches that are functional–at risk, with an unapparent or downward trend that can be attributed to livestock use, often are prime candidates for designation as key areas. The limiting factors to proper functioning condition can guide the selection of attributes to monitor, as well as needed management changes. For example, if adequate vegetative cover is the primary limiting factor, then the objective and long-term monitoring may focus on the percent of the greenline in riparian species. Short-term monitoring would focus on incidence of use on those woody species or stubble height on those herbaceous species that would expand next along the greenline or possibly in adjacent flood-prone areas. Monitoring the dates of use, kind and class of animal, and other management factors would help interpret long-term trends relative to short-term results and help adjust management toward desired conditions. Limiting factors to PFC can also help determine locations to monitor. For example, along a stream with little floodplain access due to incision, the best place(s) to monitor would be where the incision had already widened. Newly formed floodplain or floodable areas that could become a vegetated floodplain are appropriate locations as well.

b. Key Plant Species

Key plant species are forage plants that indicate the degree of use on associated species and those species that must, because of their importance, be considered in the management program (Interagency Technical Team 1996). In riparian areas, key species selected for monitoring should be necessary to natural stream functions, directly related to vegetation management objectives, and sufficiently abundant to respond to management and meet those objectives. Key species for riparian areas should have root masses capable of withstanding high-streamflow events. These plants are most commonly the more robust sedges, rushes, and bulrushes, as well as a very few grass species such as bluejoint reedgrass. Bluegrass species, most tame pasture grasses, or forbs typically do not root to an adequate depth or produce a root mass dense enough to withstand high-streamflow events.

Manning et al. (1989) compared the length and mass of roots of four species: Nebraska sedge, Baltic rush, Douglas sedge, and Nevada bluegrass. The results showed a significantly higher (remarkably so) amount of roots under Nebraska sedge compared to the other species, especially Douglas sedge and Nevada bluegrass. Nebraska sedge contained over 200 cm of root length per cm3 of soil. This translates to over 22 miles of roots in a column of soil 12″x12″x16″, making these plants effective in protecting streambanks and riparian areas. Douglas sedge was similar to Kentucky bluegrass and Nevada bluegrass, as expected of an upland species, had fewer roots. There was also a significant difference in root mass, with Nebraska sedge having the greatest root mass, followed closely by Baltic rush and then Douglas sedge. Although having much less root length, Baltic rush has a much higher root mass per length with more rhizomes and coarser roots than the other species.

Understanding the physiological and ecological requirements of key species (whether woody or herbaceous) is essential to designing a proper management program (Thomas et al. 1979, Winward 2000). In addition, the grazing impacts on the particular growth characteristics of the species involved and the probable outcomes of plant community and channel change from the plant species requirements need to be determined.

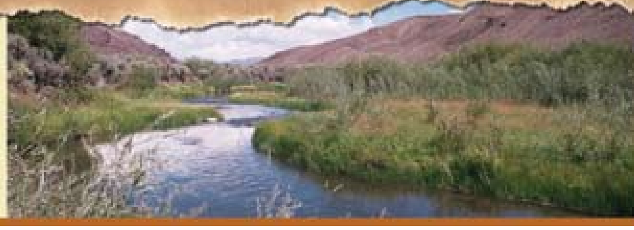
Key plant species may differ with the potential of each individual site. A mix of vegetation increases channel roughness and dissipates stream energy. Willows and other large woody plants filter larger water-borne organic material, and their root systems provide bank stabilization. Sedges, rushes, grasses,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

Additional plants away from the greenline may also be key species because of their unique resource values, e.g., aspen and subirrigated meadow species. Cross sections, utilization measures, or other methods can be used to monitor these areas away from the greenline. Ecological site descriptions and plant community classifications may aid in determining key species for a particular site.

c. Unusual Events

Monitoring studies require documentation of important unusual events such as fire, insect or disease infestations, severe weather, and associated hydrologic phenomena. Such effects must be distinguished from the effects of grazing when making evaluations. Fires, floods, and droughts have beneficial and detrimental effects on riparian plant communities and channel characteristics.

Wildfire effects can promote riparian health and restoration as well as create many riparian problems. Fire, depending upon the intensity of the burn, may kill the vegetation in the upland and riparian area.



The accumulation of too much fuel can increase fire intensity and watershed effects leading to debris flows and flooding. Flood damage is likely to be more severe where riparian vegetation has been consumed in hot fires fueled by accumulated wood. The removal of litter and canopy cover may increase water runoff and sediment from sheet and rill action into the stream system from the watershed. Fire may also open up the canopy, allowing new herbaceous growth, and initiate new plant suckering of various woody plant species (willows and cottonwoods). A prescribed burn plan should evaluate the current conditions and the effects of too little or too much fuel in any given situation. Livestock may be used to reduce an overabundance of fine fuels to reduce the heat of a fire.

Floods may widen channels and increase width/depth ratios, which is generally not beneficial. However, floods may also redistribute sediments to floodplains, recharge shallow aquifers, and initiate recruitment of many plants (especially willows and cottonwoods) depending on timing, discharge, channel shape, and floodplain access. Key points to be considered in monitoring are:

- whether or not livestock management before or after a flood led to additional widening or to the capture of sediment along banks and the formation of appropriate channel features
- whether the grazing strategy allowed for establishment of plant species that depend on floods for recruitment

Droughts increase moisture stress on plants and tend to cause livestock and wildlife to concentrate in riparian areas even more than they normally do. Pastures slated for rest are sometimes grazed during periods of drought. However, low flows associated with droughts reduce the stress on streambanks, and there is often enough water in channels to continue to support hydric, bank-forming vegetation. Given the opportunity, most perennial vegetation aids in channel narrowing and bank building with fine sediments transported after reduced flows. Key points to be considered in monitoring are

- whether or not the timing, intensity, and duration of grazing during the drought allowed for plant colonization and stabilization of exposed banks or wide channel edges
- whether the grazing strategy left enough residual vegetation (or regrowth) to trap and retain fine sediments for bank building

2. Implementation Monitoring

Implementing a grazing system as planned is critical. The best management plan is likely to fail if it is not properly implemented. However, it may also fail if it is blindly followed without consideration of, and modification in response to, changing conditions such as within-season precipitation patterns or temperature regimes that are different than those expected. Deviations in the grazing plan should be documented to evaluate the effectiveness of management changes and to avoid criticism of a planned grazing strategy that was not used. Implementation monitoring, which includes within-season monitoring and end-of-season monitoring, is essential to successful adaptive management.

a. Within-Season Monitoring

The manager needs to document whether livestock are in the right place, at the right time, in the right numbers and that any additional measures necessary to improve distribution, such as use of offsite water, supplements, or riding, are being recorded. For example, when livestock are moved from a management pasture, it is often easy for a few animals to be overlooked. If a few undetected livestock remain or drift back to a grazed pasture through faulty fences or ineffective natural barriers, they can quickly "undo" any progress that deferment or rest might have accomplished. It only takes a few days or weeks of unplanned use or overgrazing to set back years of progress in improving riparian areas (Duff 1983). In one stream, Myers (1981) found that annual use by a few head of livestock left in the pasture throughout most of the hot season had nullified positive riparian habitat responses of an otherwise excellent grazing system. When such things happen, they should be recorded to ensure proper interpretation of other monitoring results. Trigger indicators that define when livestock should be moved should also be noted. These indicators include stubble height, streambank alteration, or use of willows or other important riparian species.

b. End-of-Season Monitoring

Along with documenting annual timing, frequency, and duration of livestock use, endpoint indicators should be considered as a means to assess resource impacts of current-year grazing. Endpoint indicators provide information to help determine if the annual timing, frequency, and duration of livestock use **appear** to be appropriate in relation to desired objectives. As such, they are not purely for implementation monitoring, but rather, they help bridge the gap between pure implementation monitoring and effectiveness monitoring. The critical time for discussing triggers is at the end of the growing season when the results become apparent. Without end-of-season monitoring, there is no timely way to verify that the established trigger ensures that the stream and associated riparian area will be in a condition that remains steady or is moving toward management objectives. Although other monitoring procedures that measure such parameters as vegetative cover, composition, and channel morphology are useful in establishing trend over the mid- to long-term (at least 3–5 years, up to decades), endpoint indicators can help determine whether current-year management has been appropriate.

As discussed previously, livestock grazing primarily affects riparian areas and stream systems through herbivory or direct mechanical damage (both to plants and streambanks). The most appropriate endpoint indicators for stream and riparian areas measure vegetation (herbaceous or woody riparian species) that can protect and build streambanks and evaluate any mechanical damage that can leave streambanks vulnerable to the increased energies experienced during high flows. The appropriate time to measure and evaluate endpoint indicators is typically after the end of the current growing and grazing season and before the next high-flow event that may reach or exceed the bankfull stage, often the following spring. The following elements should be considered when choosing triggers and endpoint indicators:

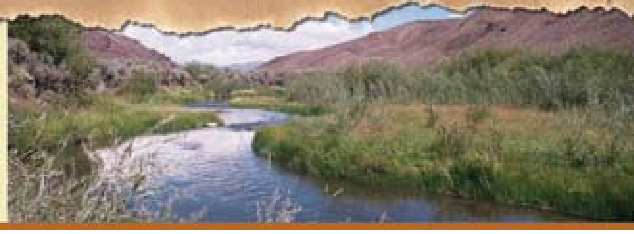
1. Measure residual vegetation height on preselected **key riparian species** on the greenline (not the average height on all herbaceous species).
2. Measure residual vegetation height **and** percentage ground cover on drier riparian "islands" within the riparian area, where species such as Kentucky bluegrass dominate settings away from the greenline, if these areas were identified by management objectives.
3. Record incidence of use on key riparian woody browse species (trees and shrubs).
4. Record streambank alteration as a result of livestock grazing (bank trampling).
5. Measure residual vegetation height or utilization of selected herbaceous species or incidence of use of key woody species in **upland settings**, such as threatened and endangered species or regenerating quaking aspen where they need special concern and attention.

Note that the above list expands the focus beyond the greenline, including upland sites. This expanded focus is important because effects on soil and vegetation outside the immediate greenline can also have critical adverse effects on aquatic systems.

It is a relatively common practice to factor in expected regrowth when setting within-season triggers for vegetation, particularly herbaceous stubble height. In these cases, end-of-season monitoring is important to evaluate if the trigger is appropriate. At times, expected regrowth does not materialize either due to lower than expected precipitation or overly optimistic estimates of the actual length of the growing season or rate of growth.

When using both within-season triggers and endpoint indicators, allowable numeric values should be established. The monitoring strategy must not only ensure that measurements are recorded and used to determine whether or not the allowable numeric value was met, but also evaluate whether the numeric value used as the criterion is correct. Due to site-specific differences across the landscape, the initial determination of allowable numeric values must rely largely on professional judgment. Current research can provide a starting point, but it is not precise enough to apply in a "cookbook fashion" so site-specific data collection is needed.

The lack of site-specific information reinforces the need for adaptive management, which involves using the selected within-season triggers, endpoint indicators, or other indicators to evaluate whether these numeric values are useful in making management adjustments



to meet riparian objectives. These values also should be continually refined along with the current management prescription to determine if desired results are being achieved. Determining proper numerical criteria for annual indicators may, in some cases, require trial and error through monitoring, analysis, and evaluation of the results after adjusting management. Because initial results may differ from expectations, the manager should not hesitate to change key species or utilization guidelines to meet established objectives.

Although the triggers and endpoint indicators appear simple and straightforward, there are important considerations that must be examined when selecting and using each indicator.

(1) Residual Vegetation Height

Residual vegetation height can be an excellent tool for warning of impending damage to riparian areas (Hall and Bryant 1995). However, residual vegetation height as an annual indicator of grazing use in riparian areas should only be used where existing science suggests that it is an appropriate indicator and in combination with long-term monitoring of vegetation and channel parameters. Measuring progress toward long-term resource objectives, such as increases in bank-stabilizing plant communities, key species, stream narrowing, or fish habitat is the real measure of successful management and may require years of intervening management.

Residual vegetation height has been shown to be related to two areas of concern: (1) the effect of grazing on the physiological health of the individual plant, and (2) the ability of the vegetation to provide streambank protection and filter out and trap sediment from overbank flows. A summary of the literature (Clary and Leininger 2000) suggests that residual vegetation heights can also be correlated to streambank trampling and shrub (willow) browsing on the greenline. Boyd and Svejcar (2004) also found that adequate regrowth occurred on most sites tested in Oregon by leaving a 4- to 6-inch stubble height. They concluded that it is important to have an understanding of how various stubble heights impact belowground production dynamics and the role of residual vegetation in influencing bank building processes and site development.

Residual vegetation height sampling is relatively quick and simple and reasonably accurate. It can be used to monitor large areas in less time than traditional utilization study protocols require. In some situations, however, accuracy can be adversely affected by stand characteristics. Difficulties with stubble height arise, for example, in irregularly grazed nonhydric bunchgrasses or stands of inconsistent plant composition with varying palatability. Stubble height measurements should focus on key riparian plant species or species groups important for providing bank stability, minimizing surface runoff, and filtering sediments. Also, although streambank or greenline residual height is the critical factor for trapping sediments and providing bank stability, residual height farther from the edge of the bank or greenline may be a better indicator of livestock use (Marlow and Finck 2002). Kentucky bluegrass is not desirable with respect to bank stabilization, but it is highly preferred by livestock and is useful for determining if changes in grazing management have been effective in minimizing the time cattle spend in riparian areas.

(2) Utilization

Utilization maps describe the pattern of livestock use relative to topography, vegetation, water, salt and other supplements, season, and all other management factors. Utilization mapping relative to plant growth and community distribution can provide more insight to the appropriateness of a particular grazing strategy than utilization of a key area alone. It can guide adjustments better than most other forms of monitoring information. However, accuracy and precision limitations of utilization measurements should be recognized in all interpretations. There is often high sampling variability among sites and among observers, especially for shrubs. Because of these limitations, high confidence levels require intensive sampling and more time and money. In addition, relative utilization (utilization determined at any time other than peak standing crop) may have little relationship with utilization at peak standing crop for determining plant or community response to defoliation. Interpretations should be made with caution!

In spite of the potential limitations of utilization and because they lack a better tool, many managers have chosen to establish utilization guidelines for short-term management considerations. To establish utilization guidelines, knowledge of the growth habits and characteristics of the key plant species; of their response to grazing and browsing; and of the characteristics, preferences, and requirements of the grazing and browsing animals is needed. When using utilization information to make management changes, consideration should be given to the timing of utilization of key species with respect to plant phenology, which often affects subsequent growth and reproduction more than the amount of utilization does. Rasmussen et al. (1998) provide one example of worksheets used to record utilization measurements along with an example of a utilization gauge. Many of the Western States have developed a State monitoring guide, which may be available in local county extension offices in your State.

(3) Woody Species Monitoring

The amount and timing of defoliation of riparian shrubs and trees can have tremendous effects on their growth and survival. Unfortunately, utilization measurements by traditional methodologies appear impossible to accurately replicate either between individuals or over time (Hall and Max 1999). Until more acceptable methodologies are developed, it is suggested that preference changes be used as a within-season trigger. Stubble height and greenness of herbaceous species are critical elements in palatability and cause shifts in cattle forage preference, such as changing from grasses and sedges to shrubs (Hall and Bryant 1995). These preference changes, especially later in the season, should be used as a trigger to manage the livestock and protect sprouts and young of the woody species. The end-of-season indictor would be incidence of use, which is the proportion of browsed twigs versus unbrowsed twigs. Although there is no relationship to the amount of material removed, there is a relationship to degree of impact on the plant. The method is quick and repeatable. It is especially important that measurements be taken on sprouts and young, as these plants must have an opportunity to develop into mature plants over time (Winward 2000).

(4) Streambank Alteration

Streambank alteration results from both hydraulic (e.g., channel-altering flows) and mechanical processes (e.g., herbivores such as elk, moose, deer, cattle, sheep, goats, and horses walking along streambanks or across streams; beaver activity; or uncontrolled off-highway vehicle activity). The protocol used to measure streambank alteration should identify the degree of impact attributable to domestic livestock for subsequent use in management decisions. Discrimination is necessary for considering modifications of the current grazing strategy.

Setting numerical criteria to manage mechanical impact from livestock can be complex. The type of soil composing the streambank greatly influences the degree of alteration produced by a particular level of livestock use. Vegetation cover and composition also affect the degree of impact from livestock. A site with well-developed, dense plant communities composed of sedges, rushes, bulrushes, and spike rushes will exhibit significantly less impact than a site with a less developed plant community or one composed of species that do not have the desired rooting characteristics. The establishment of numerical criteria for use in reducing mechanical impacts from livestock in riparian areas should be treated as an adaptive experiment, with ongoing refinement that reflects site-specific experience.

3. Mid- and Long-Term Monitoring

If the relationships between objectives and monitoring are clear, and management and monitoring are maintained, mid- and long-term trend studies are well underway. Useful and appropriate monitoring techniques vary widely because of the inherent variety in appropriate management objectives. No short list could be complete, and each technique requires a detailed description to guide its proper application. However, there is one aspect of vegetation trend monitoring in riparian areas that is sometimes confusing and significantly different from monitoring in uplands. Riparian ecological sites or plant communities move as streams move. They change their distribution and extent over time as attributes such as the water table change (Winward 2000, Gebhardt et al. 1990, Winward and Padgett 1986,). Objectives tied to kind, proportion, or amount of vegetation may be monitored either by methods that account for changes along the stream edge as it moves (greenline) or throughout the riparian complex (valley cross sections) (Winward 2000). Other methods account for dynamic changes along the riparian area (e.g., Rasmussen et al. 1998, Cowley and Burton 2005). Winward's (2000) three-part monitoring also includes woody species regeneration along the greenline.

a. Greenline

The kind, amount, and location of vegetation are crucial to the function of most riparian systems. Greenline monitoring measures the vegetation along the edge of streams. It samples community type composition on both sides of a stream in a selected section of a stream (within one riparian complex) and compares the composition with past measurements and objectives. Objectives may be based on a "standard" required for proper functioning of that particular stream type. Winward (2000) suggests the standard and rates each community type's ability to buffer the forces of moving water. Greenline data can be used to develop a rating of both ecological status, (i.e., the existing kind and amount of vegetation on that particular section of stream in relation to the amount and kind of vegetation that might potentially occur on that stream section) and average physical strength for buffering the effects of moving water (streambank stability). Greenline data at the same location through time can be used to evaluate long-term trend.

b. Vegetation Cross Section

Vegetation cross sections provide a quantitative measurement of the nature of riparian vegetation across the valley floor. Many earlier vegetation measurement processes calculate changes in species composition. This process measures change in percentage of area occupied by different community types. Trend is determined by whether the changes are moving toward preferred types (desired condition) or desired ecological status. Ecological site descriptions, plant community classifications, or reference areas that have similar soils, hydrology, and geomorphology but are managed differently are helpful in determining potential and setting objectives.

c. Woody Species Regeneration

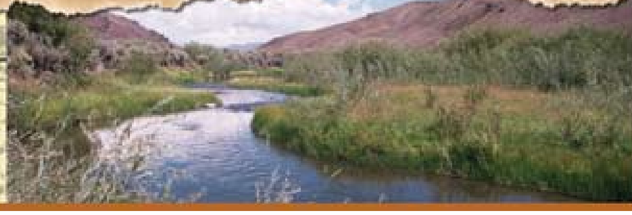
Woody species regeneration provides a measurement of the density and age-class structure of each woody plant species that occurs along a greenline. It provides a way to compare changes in woody structure through time. It is based on the premise that populations require reproduction and growth to attain appropriate population levels or maintain themselves through time.

4. Photo Monitoring

Photographic monitoring is quick and effective for documenting changes in vegetation and determining if management in an area has been successful (Hall 2001, 2002). Permanent photo points are recommended, no matter what monitoring plan is developed. Pictures are relatively inexpensive and provide a wealth of information: they truly are "worth a thousand words." The photo sites should also be tied to specific management goals and objectives. The characteristics of the vegetation or landscape that the photos address and how those characteristics will be evaluated require careful consideration when developing the photo monitoring plan (Reynolds 1998). Advances in digital photography, both still and video, have made it possible to take large numbers of high resolution photos for little cost or no more cost than that incurred in getting to and from monitoring locations. An added bonus is that images can (and should) be reviewed while still on location and, if necessary, more or better photos can be taken at the time (Hilliard pers. comm.).

Photographic monitoring should be conducted during the same season each year (Rasmussen et al. 1998). Vegetation structure and color change seasonally, making comparisons among different seasons difficult in many community types. Other tips for improved interpretation are to:

1. Include the skyline or prominent features to help the photographer reshoot the same scene and the viewer to recognize the area
2. Include a card or slate in the photo with the date and location (large enough and exposed correctly so that it can be read)
3. Include something for scale (location card, person, ruler, etc.) to help viewers gain perspective
4. Use lighting and exposure conditions to illuminate attributes related to objectives
5. Avoid too much sky or sunlight reflecting off water because this tends to darken the areas of interest
6. Use the same lens or focal length so the picture angle remains constant



7. Avoid using a lens with too wide of an angle (26-35 mm) which can make the objects of interest too small in the photo, and a lens with too much telephoto or zoom, which makes objects of interest lose their context
8. Check the readability of the card or slate in the photo and label the photos with location, date, camera or lens
9. Print out digital photos, store them in a safe place, and back up digital data so that changes in technology do not make historically valuable photos unusable

A variety of photo monitoring methods is available, consequently the complexity, scale, time, and cost of the photo method should be considered when developing the monitoring plan.

5. Cooperative Monitoring

A recent large-scale evaluation of the University of Arizona Cooperative Extension's rangeland monitoring program, indicates that cooperative monitoring programs have: (1) made a positive difference in the knowledge, skills, and practices of individual participants; (2) shown a strong association between rangeland monitoring and the implementation of beneficial land and grazing management by permittees; and (3) demonstrated improved relationships among permittees and agency staff (Fernandez-Gimenez et al., 2005). In an effort to build on these types of successes, the Public Lands Council (representing sheep and cattle ranchers in 15 Western States who hold Federal grazing permits) recently signed a memorandum of understanding (MOU) with both the USFS and the BLM for the implementation of a cooperative rangeland monitoring program (USDA USFS 2004, USDI BLM 2004). "The MOU establishes a framework for voluntary, collaborative work [among] grazing permittees and the USFS (and BLM) to improve the quality and quantity of short and long-term, allotment level monitoring information on public rangelands" (USDA USFS 2004). Supporters note that this approach will benefit all involved "by improving the relationships [among] parties and by producing the information needed for sound stewardship of the resources" (USDA USFS 2004).

Case Study: Cooperative Monitoring with Eastfork Livestock Ranch

The Eastfork Livestock Ranch, owned and operated by Joel Bousman, is a family-run cow-calf and yearling operation located in Sublette County, Wyoming. In 1996, Bousman participated as a member of the Silver Creek Grazing Association in an effort to develop a voluntary permittee monitoring program that allowed permittees to actively and cooperatively monitor their rangeland on the Forest Service (USFS) Silver Creek common allotment. He organized a committee of cattlemen, sheepmen, and agency personnel to work with the University of Wyoming Extension office (Bousman 2003).

The committee worked cooperatively to develop short- and long-term monitoring objectives relating to grazing management changes made in 1989 and identify basic, field-based, achievable methods for collecting data (Bousman 2003) (Figure 65). Short-term monitoring focused on utilization, production, precipitation, and AUMs by season with dates. Long-term monitoring focused on the collection of trend data. Specifically, the group used 100-foot trend transects with permanent photo points to determine cover by life form. They also relied on the Winward (2000) methodology (supported by photos) to identify streambank stability and vegetation condition over time (Bousman 2003).

According to Bousman (2003), the monitoring reports were viewed as cooperative statements because all of the monitoring activities were conducted as a group. Signatures were included on the monitoring report to certify that the data had been collected, documented, and cooperatively approved by the USFS and

the grazing association. The cooperative report then became part of the official USFS allotment files. In addition to collecting monitoring information, the group also led public tours of the allotment at various times during the year.

"Those truly concerned with benefiting the land understand that real conservation will only occur with the participation and concurrence of all stakeholders. Litigation only serves to drive wedges between people who should be working together…."
Eisenberg (2004)

Advantages of Cooperative Monitoring:

1. Cattle distribution and performance improved after 1989 management changes, but it was the monitoring program and associated documentation of improved resource condition that enabled the Bousmans to increase their grazing season by 2 weeks. This resulted in about $5,000 in savings.

2. The program helped develop and maintain trust, understanding, and good working relationships. Getting the parties involved to talk about conditions, concerns, and objectives on the ground helped provide a learning opportunity for the permittees, agency officials, and the public. It also helped reduce the stress and uncertainty of one party not knowing what another party wants or thinks is possible.

3. The program helped demonstrate accountability and responsibility and documented stewardship. Public land grazing remains a controversial issue—one that is constantly in the public spotlight, which can be seen as a problem or as an opportunity. The permittees, who have initiated or participated in similar voluntary cooperative rangeland monitoring programs, have embraced the public spotlight as an opportunity to demonstrate their good stewardship of the land.

Disadvantages of Cooperative Monitoring:

1. There is an initial economic cost to the livestock manager (monitoring equipment, camera, report preparation, film development, etc.) (Bousman pers. comm.).

2. There is a time requirement by livestock managers, agencies, universities, and others to properly set up the monitoring program (Bousman pers. comm.).

(Note: In the long-term, the costs should be more than recouped by improvement in the resource and the trust ultimately developed among the cooperating partners. It is hard to place a dollar value on trust, but it is a benefit to everyone.)

Figure 65. Silver Creek Common Allotment, USFS, WY, 1997. Permittees and USFS and BLM staff teaching and learning monitoring techniques together. (Photo by E. Peterson, Univ. of Wyoming Extension.)

F. Evaluate Progress

Grazing prescriptions and associated management of riparian areas should be monitored, evaluated, and reconsidered regularly. Managers should not hesitate to identify problems and make changes in grazing treatments. They should use adaptive management when taking risks and trying new alternatives to achieve objectives. **Flexibility to change or adjust** should be part of any grazing management plan. But along with that flexibility, it is important to document conditions under which each system does and does not work.

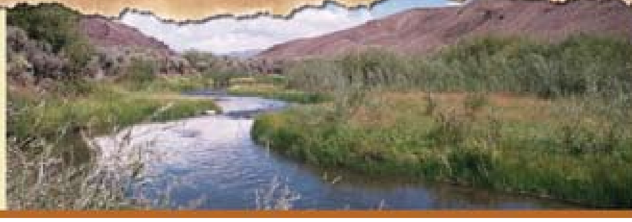
Decisions will need to be made regarding future management prescriptions when the monitoring data and current year's grazing management plan have been evaluated. The decision may be to:

- Continue current management if it is meeting objectives or if there is an upward trend
- Modify current management if it is static or in a downward trend
- Adjust objectives if needed

Any riparian monitoring plan should include before and after photos, with backup data, to show the effects of management. Photos can often clarify the data, allowing people to see and understand riparian trends (Sipple and Swanson 1995). Documentation of pretreatment resource conditions provides a basis for interpreting results, avoiding past mistakes, and providing a "springboard" for exploring other options. Documentation of successes, as well as of failures, is essential for learning from past efforts.

The Grazing Response Index (GRI) (Reed et al. 1999 USDA USFS 1996,) was developed to evaluate the effects of annual grazing pressures and the effects of repetitive defoliation during the growing season. The GRI was developed to assess the use of herbaceous species in both the riparian and upland plant communities. The assessment is particularly well suited to be conducted from horseback so that a more complete assessment of the entire grazing unit can be accomplished, rather than having to be restricted to only key areas. It assesses how much of a plant was grazed, when it was grazed, and how many times it was defoliated during the growing season. The index is a way to incorporate a number of factors into a general evaluation of what potential effects the current grazing system may have on rangeland plants. It puts grazing use (utilization or stubble height) in context with season and duration of use. Multiple options can be considered when making adjustments to a grazing program. It is relatively easy to learn, easy to communicate, and is based on general observations rather than time-consuming, precise measurements. The GRI is not intended to be the only method for resolving major conflicts. **It should be used for situations where resource issues are considered to be at a low to moderate level of intensity**. (See Appendix F for GRI forms and directions.)

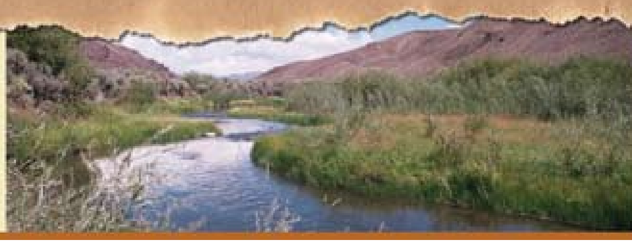
The use of state and transition models is one way to evaluate whether current management is achieving long-term objectives (Appendix C). These models show management pathways and potential plant communities for a particular ecological site. They increase a manager's ability to invest wisely for achievable and important objectives. Information obtained from monitoring and evaluation of vegetation responses can also be helpful to fine tune the model, particularly for specific site conditions.



IV. CARDINAL RULES FOR PLANNING AND MANAGING LIVESTOCK GRAZING IN RIPARIAN AREAS

Though each management situation is unique, there are still some general rules that can help ensure successful riparian area management:

- Adapt grazing management to the conditions, problems, potential, objectives, public concerns, and livestock management considerations on a specific site.
- Include all those willing to learn the details and contribute ideas or work for enhanced management throughout the planning process.
- Consider overall watershed goals and objectives and all important resource issues including watershed dynamics and issues associated with the receiving water or the stream reach the grazing activities are located on (water quality and quantity, threatened and endangered species concerns).
- Manage grazing so there is sufficient vegetation growth and postgrazing stubble on the banks and overflow zones to permit the stream to function naturally.
- Identify and implement alternatives to passive, continuous grazing.
- Employ rest or deferment from livestock grazing whenever appropriate.
- Take advantage of seasonal livestock preference for uplands in grazing prescriptions.
- Ensure that expertise from appropriate professional disciplines is represented on the planning team.
- Ensure that everyone involved clearly understands the issues and agrees with the management objectives, as well as understands the changes that can occur and how they can benefit from proper management and improved riparian conditions.
- Build flexibility into grazing management to accommodate any changes that are needed.
- Implement frequent (sometimes daily) supervision by the parties involved once management is in progress, so that adverse impacts (e.g., trampling damage and excessive utilization) can be foreseen and avoided.
- Don't rely on a grazing system alone to improve conditions. Management tools and techniques work hand in hand with selected grazing systems.
- Document mistakes so they are not repeated.
- Use management successes to encourage proper management in the future and to promote good riparian area management elsewhere.



APPENDIX A
REFERENCE WEB SITES

More information about grazing management and related topics may be found on the following Web sites. This is not meant to be a comprehensive listing of all Web sites, but is intended to provide a few sites that the reader may access for more information.

Agencies and Organizations:

Boise Aquatic Sciences Lab (Research and Publications)
  http://www.fs.fed.us/rm/boise/teams/techtran/techtran_home.htm

Cows and Fish Program, Alberta's Riparian Habitat Management Society
  http://www.cowsandfish.org

Environmental Management Systems
  http://www.epa.gov/ems

Grassbank (Grass Reserves)
  http://www.grassbank.net

National Riparian Service Team
  http://www.or.blm.gov/nrst

Natural Resources Conservation Service
  http://www.nrcs.usda.gov

Quivira Coalition
  http://www.quiviracoalition.org

Society for Range Management
  http://www.rangelands.org/srm.shtml

Stream Systems Technology Center
  http://www.stream.fs.fed.us

Sustainable Rangelands Roundtable
  http://sustainablerangelands.cnr.colostate.edu

The Western Rangelands Partnership
  http://rangelandswest.org

Articles and Publications:

BEHAVE (Behavioral Education for Human, Animal, Vegetation and Ecosystem Management)
  http://www.behave.net

Behavioral Principles of Livestock Handling
by Dr. Temple Grandin
  http://www.grandin.com/references/new.corral.html

Helping Livestock Expand Their Diets and Their Turf plus Herding and Supplementation Studies
by Derek Bailey.
  http://www.behave.net/projects/riparian_bailey2003.html

Monitoring Streambanks and Riparian Vegetation—Multiple Indicators
by Ervin Cowley and Tim Burton
  http://www.id.blm.gov/techbuls/05_02

National Management Measures to Control Nonpoint Source Pollution from Agriculture
  http://www.epa.gov/owow/nps/agmm

Natural Resources Conservation Service Electronic Field Office Technical Guide (EFOTG)
  http://www.nrcs.usda.gov/technical/efotg
  http://www.glti.nrcs.usda.gov

Ranching for Profit
  http://www.ranchmanagement.com

Riparian and Wetland Tools for the Great Basin and Intermountain West Regions
  http://plant-materials.nrcs.usda.gov/idpmc/riparian.html

University of Idaho Stubble Height Study Report (2004)
  http://www.cnrhome.uidaho.edu/documents/Stubble_Height_Report.pdf&pid=74895&doc=1

APPENDIX B
COLLABORATIVE PLANNING

A 'stakeholder' is defined as a person or organization that:

1. *Has an interest or concern (self-identified),*
2. *May be needed to implement the outcome or solution, or*
3. *May try to undermine your effort.*

Examples are:

- *Federal and State grazing permittees*
- *Public and private landowners and managers*
- *Livestock managers*
- *Interested publics*
- *Other user groups*

The successful use of grazing management strategies in the maintenance and recovery of riparian areas has been widely documented. However, riparian grazing remains one of the most pervasive issues facing rangeland managers. The management of these areas is socially, as well as technically, complex. Successful management cannot be achieved through reliance on scientific and technical information alone. Riparian and watershed resources are typically geographically nested within a complex maze of jurisdictional and administrative boundaries, so a collaborative approach is often needed.

A. What is Collaboration?

Collaboration is the pooling of appreciations or tangible resources (e.g., information, money, or labor), by **two or more stakeholders** to solve a set of resource problems that no one party can solve individually (Gray 1985). It is grounded in a belief that if the right people are brought together, in constructive ways, with good information, they will produce better, more informed, effective, sustainable, and popular decisions; improved relationships; and sustainable communities and landscapes (Field and McKinney 2004). The range management community has been using this collaborative philosophy for many years under the name of coordinated resource management (CRM). CRM is a proactive process in planning for improvement of natural resources (Cleary and Phillippi 1993).

Within this document, collaborative planning is presented as a process designed to strengthen existing planning and decisionmaking approaches (e.g., expert-based, NEPA-based, litigation, legislation, and regulation). Collaborative planning can work very effectively when it is integrated with the NEPA public involvement and analysis process (Swanson 1994). When addressing complex issues, collaboration is a good tool for promoting decisions that are informed, understood, accepted, and feasible (USDA 1999). However, participation in collaborative efforts is strictly voluntary, and individuals remain free to pursue more traditional approaches at any time. Furthermore, pursuit of a collaborative approach does not interfere with the exercise of private property rights nor does it suggest that Federal or other land managers abdicate their decisionmaking authority.

The collaborative model has shown advantages over more traditional planning and decisionmaking approaches under the following conditions (Gray 1989):

1. The problems are ill-defined, or there is disagreement about how they should be defined.
2. Several interdependent stakeholders have a vested interest in the problem.
3. The stakeholders are not necessarily known in advance or organized in any systematic way.
4. There may be differences in power or resources for dealing with the problems among stakeholders.
5. Stakeholders may have different levels of expertise and different access to information about the problems.
6. The problems are often characterized by technical complexity and scientific uncertainty.
7. Differing perspectives on the problems have resulted (or could result) in adversarial relationships among the stakeholders.
8. Existing processes for addressing the problems have proved insufficient and may even be making them worse.

Successful collaborative efforts adapt to the conditions of a particular situation **(there is not a recipe or cookie-cutter approach)**. Typically, successful efforts focus on

"It is important that all of the people who need to be there are there. Even though it [the subject] may be a contentious issue, it is important that everybody is there together so they can hear the same things, talk and come to conclusions as a group. Simply getting a copy of a written report is just not the same thing as having been there and been part of that conversation."

J. Staats, USFS Hydrologist

a particular place; secure the involvement of all relevant stakeholders upfront; and identify durable, practical, and flexible solutions (adaptive management). Finally, they often rely on the use of a trained, neutral facilitator or conflict manager and the use of consensus-building techniques. The intent is not to dispel conflict, but to help groups or individuals reach enough agreement that they are able to do something mutually beneficial on the ground. Often this involves creating a new solution that no individual had thought of or could implement alone.

B. Collaborative Planning Process

The first step in collaborative planning is to define the planning area. The planning area should include public and private lands as necessary to allow the development of a comprehensive management plan to resolve the problem. However, the participation of private landowners in a specific planning effort is strictly voluntary.

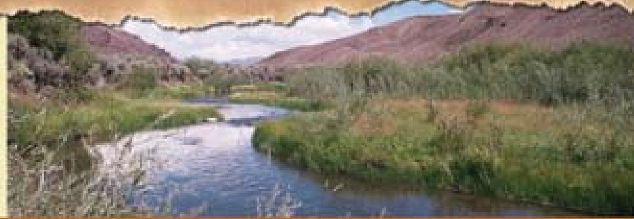
The next step is to engage key stakeholders. The exact makeup of a collaborative group will be different in each situation. Depending on the size and scope of the planning area and the nature of the issues involved, collaborative efforts can be as small as two private landowners working together to build and maintain a fence or as large as a multicommunity working group tasked with developing a watershed plan. The key is that in each of these efforts, participants are working together to develop and implement mutually beneficial solutions, rather than one party imposing a solution on another.

Securing the voluntary participation of key players early in the planning process is critical to future success. To ensure participation, it is often necessary to reach out with personal invitations, phone calls, or face-to-face conversations.

Riparian issues often include multidisciplinary, science-intensive disputes. They affect multiple stakeholders who have different interests and levels of scientific understanding. As with most natural resource issues, they typically include a mix of both information- and value-based conflicts. **Information-based conflicts** are those in which people argue over information. There may be too little information or people may disagree about the assumptions or methods of others. Either way, scientific and technical information is a lynchpin for addressing the conflict. **Value-based conflicts**, on the other hand, cannot be resolved simply through better technical information because they address issues concerning economic, political, recreational, aesthetic, or spiritual values.

Agreed-upon resource decisions must be scientifically sound, as well as socially and economically acceptable. Because issues, groups, and options change, a collaborative planning process should be designed to foster ongoing deliberation among stakeholders and resource specialists (USDA 1999). To engage effectively in the deliberation and negotiation required for reaching common ground, individuals must feel safe in their social environment. Individuals must be able to examine, share, and broaden their perspectives in a nonthreatening and respectful manner. This requires attention to the physical and social setting within which group interactions take place (Smith 2002).

Once a group of diverse stakeholders and resource specialists has been organized, they must work to create a common vision for productive and sustainable ecosystems and communities. Studies demonstrate that individuals who have built relationships and trust within a group are able to develop and use their individual knowledge and skills more effectively (Coleman 1988). It is through relationship building and mutual learning that individuals build ownership and commitment to the planning process, other individuals, underlying information, and ultimately, final decisions. Once a certain social context has been established within a



Differences in feelings of power among individuals tend to be equalized when a group is seated in a circle versus when they are positioned in an auditorium-style seating arrangement where the "expert" is addressing an audience from a raised podium.

Individuals are more likely to develop relationships or connections to each other, as well as to a particular place, when they are working together in small groups to solve a problem on the ground.

Laura Van Riper,

National Riparian Service Team

group, individuals are more likely to understand and take collective action in response to information. Furthermore, adults learn best when they apply new knowledge to real-life situations, and most collaborative planning requires learning by all participants.

One of the most important factors in stream restoration is the commitment by the people involved to make it work. Given the inherent resiliency of riparian areas, almost any action that relieves an important stressor, or limiting factor, will result in improvement. The key is helping people understand that things can get better. This is not to say that science and technical information are not important attributes of successful management efforts but rather that such information can only be put to work if individuals are willing to change the beliefs and associated behaviors that caused the resource conditions.

Given the scientific complexity of natural resource issues, it is important to integrate science and technical information into a collaborative planning process. One of the most effective ways to meet this objective is to incorporate joint factfinding as part of the ongoing deliberation among resource specialists and stakeholders (Yaffee et al. 1997). When possible, it is best to go to the field together. Strangely, many people are prepared to decide whether a person is a good manager without ever looking at their land and are willing to decide whether the land is healthy without ever seeing it (Dagget 1998). However, to move forward on resolving conflict and improving the land, it is important to focus on what information the land provides.

Because riparian issues are interdisciplinary by nature, successful management relies upon resource specialists, representing multiple disciplines, who are able to read the land and effectively communicate what they see. By involving stakeholders in the joint factfinding process, research is enriched and studies become more relevant. The process helps resolve key areas of uncertainty and creates a common understanding (shared knowledge) about on-the-ground processes (ecosystem functions). Later, the group can discuss new management ideas with the understanding needed to overcome philosophical positions in pursuit of site-specific, interest-based solutions. Finally, joint factfinding strengthens personal relationships and builds trust among participants.

It is important to use a collaborative process through all planning phases (e.g., determining existing condition, identifying limiting factors, creating management objectives, and monitoring). Following the joint collection and consideration of preliminary information, group members must reach agreement on the existing situation (resource condition), problems (limiting factors), and opportunities. This information will then guide the creation of agreed-upon management objectives (practical and measurable), as well as a list of possible strategies and actions. The group should then review suggestions and identify those that are the most practical, workable, and likely to solve the problem. Once the action items have been narrowed, they should be listed in logical sequence that leads to the accomplishment of a particular management objective. For each item, a lead person and the estimated date of completion should be identified. The next step is to outline a monitoring system, indicating how progress toward each specific objective will be measured. This will serve as a feedback system for providing corrections and adjustments to the plan. As the group implements the plan, some will play more active roles than others. However, the whole group needs to periodically review

"Involving stakeholders in forums designed to share knowledge, build relationships, establish trust and encourage creative problem solving is more likely to produce socially acceptable decisions… Even when the decisions are the same, people need the opportunity to engage as partners in the decision-making process so they have ownership in the outcome."

Wondolleck and Yaffee (2000)

progress. Taking time to note what has been accomplished and the results helps to keep people committed to remaining tasks and necessary adjustments.

In the long term, successful collaborative management keeps people involved through adaptive management and through shared experiences that build relationships. As with any process, there are many downsides, and collaboration isn't always appropriate and doesn't always work. Success is dependent upon the commitment of all the involved parties.

APPENDIX C
ECOLOGICAL STATE AND TRANSITION MODEL EXAMPLES

Ecological site descriptions contain state and transition (S&T) models, which outline some of the various plant communities that can occur on a particular site. This outline provides a diagram of the functional relationships among the plant communities and disturbances that may cause them to shift or change. It depicts the potential results of current management or a planned action; thus, it helps managers avoid the possibility of crossing a threshold that would result in an irreversible consequence. Avoiding an irreversible consequence can be extremely important if the site has the potential to provide habitat for wildlife, fish, or plants of special concern. S&T models are based on processes, not on species lists. Plant communities are an expression of the reduction in ecological function occurring on the site. Primary processes include energy flow, nutrient cycling, and water storage. In riparian areas, the hydrology of the site is primary.

The community composition is an assemblage of plants that are **in dynamic equilibrium** with their surroundings and are able to shift in composition or production as a result of natural variables. There are many factors and processes involved in the changes from one plant community to another within a state. These variations in plant community are natural or management-induced and do not result in an irreversible consequence. Variations in climate, elevation, depth to water table, frequency and duration of flooding, soils, landform and geology, stream channel morphology, fire, and grazing all play a role in determining plant communities that will be expressed at a site.

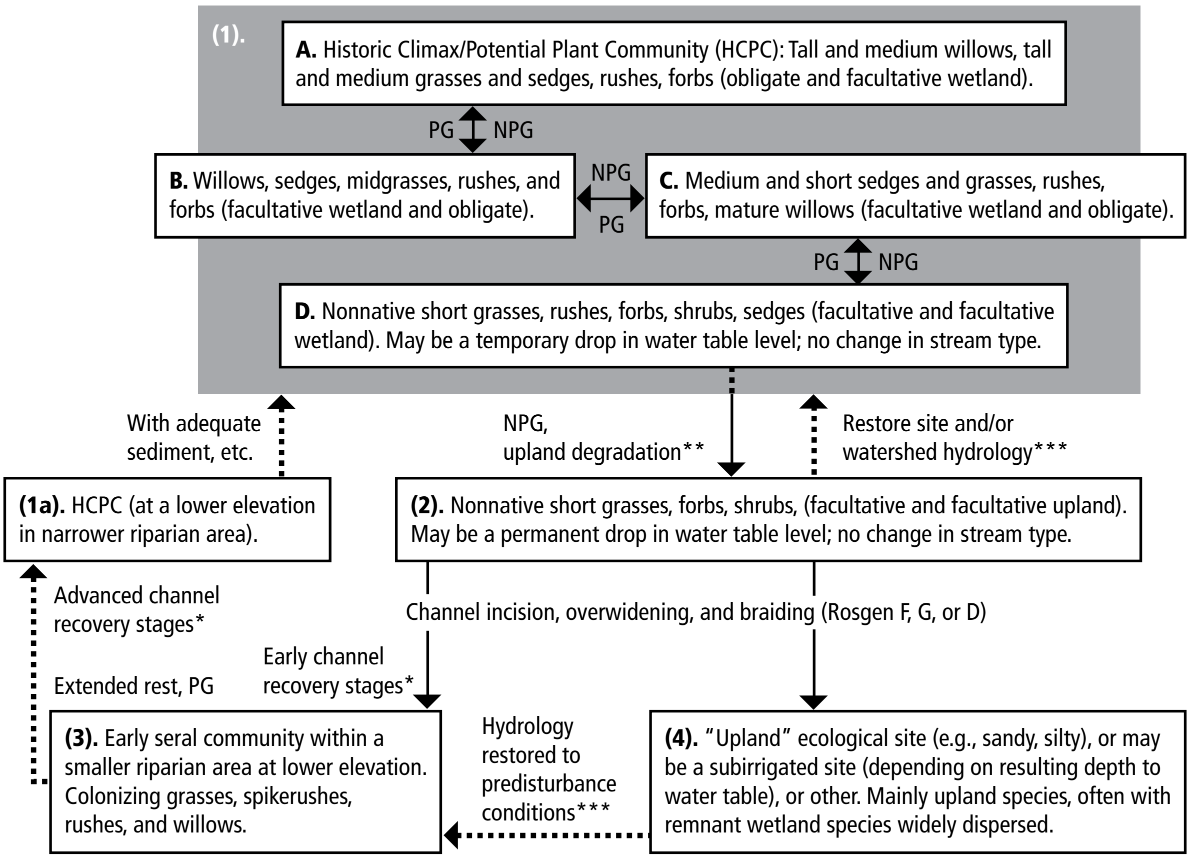
When the primary processes of an ecological state are altered past the point of self-repair, a **threshold** is crossed, resulting in a plant community that often has only a few remnant members of the original natural community. From a process perspective, it is appropriate to have a different suite of species as long as they fill the same functional role. However, if the ecological processes are compromised, resulting in a plant community that is functionally different, then a threshold has been crossed. Once established, these new communities (e.g., Kentucky bluegrass, reed canarygrass) can become very stable and will not return to one resembling the potential natural plant community through the use of grazing management or extended rest alone (Stringham et al. 2003). Significant inputs, along with extended rest, are generally required to restore a primary ecological process that has been lost and to return to a vegetative community that resembles the original. However, if a site recovers through just a minor change in grazing management or by restoring wildfire to the system, then it has not crossed a threshold. Once an ecological threshold has been crossed, management focus should be on restoring the damaged ecological processes, not on reestablishing a specific plant community (Stringham et al. 2003). Economic, social, or political thresholds or processes may also need to be dealt with in certain situations.

State and transition models for riparian plant community dynamics are still preliminary, and further investigation is warranted (Stringham pers. comm.). Disturbances that impact channel form and water table depth (incision, braiding, or overwidening) may alter the plant community to such a point that recovery to predisturbance conditions is not possible. Should the stream experience such significant degradation (i.e., incision), the channel itself usually must go through a recovery process (Schumm 1977, Jensen et al.1989) before the vegetative community can reestablish. In some cases, predisturbance stream morphology must be restored by physically altering or recontouring streambanks and floodplains in order to achieve these goals in a reasonable timeframe.

The following riparian subirrigated state and transition model for the north Rocky Mountain valleys in Montana is one example of a riparian model that is currently under development (Figure 66). A second component to the model has been added to provide a functional comparison of each state (Figure 67). Photos provide examples of several of the states found within different states within this description (Figure 68-72). Continued discussions of riparian ecological site descriptions are needed to incorporate the complexities inherent in dynamic riparian systems.

Figure 66. Riparian Subirrigated (RSb), North Rocky Mountain Valleys, Montana, 15- to 19-inch Precipitation Zone
Part 1 – State and Transition Pathway Model
(Typically occurs along riffle-pool streams, i.e., Rosgen C type).

Plant Communities and Transitional Pathways (State and Transition Model Diagram): Transitions in plant community composition occur along a gradient. Many processes, including climatic patterns, topography and landform, flood frequency and duration, elevation, soils, amounts and kinds of sediment available, fire pattern and history, and grazing are involved in the changes from one community to another. The following model outlines the various plant communities that may occur on this site and provides a diagram of the relationship between plant community and type of use or disturbance.



* Refer to the appropriate channel evolution/recovery model (e.g., Schumm 1977, Jensen et al. 1989) for details. This recovery may occur over many years.
** Upland degradation may occur from dewatering, lack of fire, conifer encroachment, or drought.
*** Restore hydrology by prescribed fire, timber harvest/thinning, irrigation system adjustments, or change in grazing management with accelerating (e.g., expensive stream restoration [Rosgen], range seeding) and/or facilitating (e.g., stock water, fencing) practices.

PG = Prescribed Grazing: A planned grazing strategy that balances animal forage demand with available forage resources. Timing, duration, and frequency of grazing are controlled, and a grazing rotation is applied to allow for plant recovery following grazing.

NPG = Nonprescribed Grazing: Grazing that does not control the factors listed above, or grazing that occurs when animal forage demand is higher than the available forage supply.

Smaller boxes within a large box indicate that these communities will normally shift among themselves with slight variations in depth to permanent water table, herbivory, and other factors. Moving outside the larger box indicates the community has crossed a threshold (heavier line) and will require intensive treatment to return to community A, B, C, or D. Dotted lines indicate a reduced probability for success without major inputs (e.g., accelerating practices).

(NRCS, Montana Draft 2005)

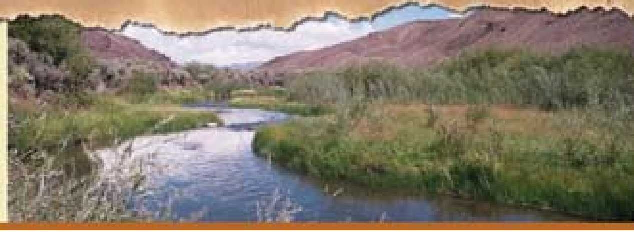
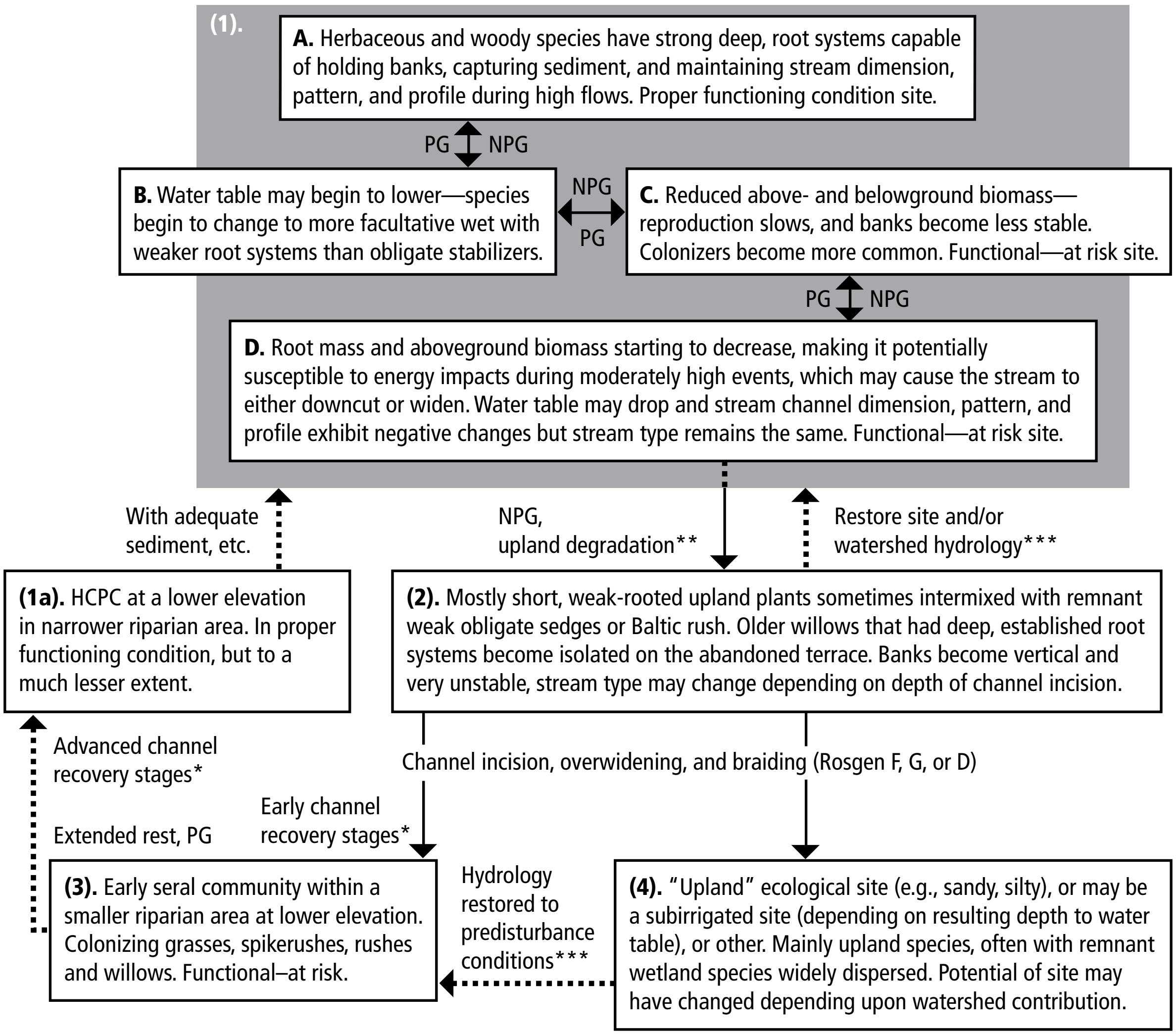


Figure 67. Riparian Subirrigated (RSb), North Rocky Mountain Valleys, Montana, 15- to 19-inch Precipitation Zone
Part 2 – Functional Comparison

(Typically occurs along riffle-pool streams, i.e., Rosgen C type).



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Smaller boxes within a larger box indicate that these communities will normally shift among themselves with slight variations in depth to permanent water table, herbivory, and other factors. Moving outside the larger box indicates the community has crossed a threshold (heavier line) and will require intensive treatment to return to community A, B, C, or D. Dotted lines indicate a reduced probability for success without major inputs (e.g., accelerating practices).

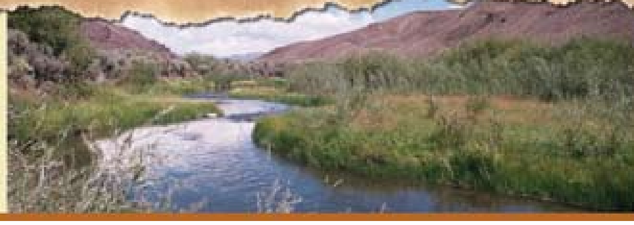
Figure 68. Overview of an example of a Rosgen C channel type.

Figure 69. Example of state 1B.

Figure 70. Example of state 1A.

Figure 71. Example of a state between 3 and 1A.

Figure 72. Braided Rosgen D channel type. Could become a state 3 or 4. (Photos this page by Bob Leinard, retired, NRCS.)



APPENDIX D
PROPER FUNCTIONING CONDITION OF RIPARIAN-WETLAND AREAS ASSESSMENT CHECKLIST (LOTIC)

Name of Riparian-Wetland Area: ____________________

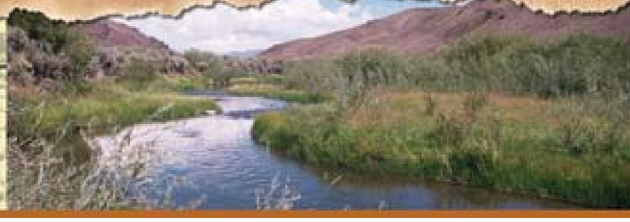
Date: __________ Segment/Reach ID: ____________________

Miles: __________ Acres: ____________________

ID Team Observers: ____________________

Yes	No	N/A	HYDROLOGY
			1) Floodplain above bankfull is inundated in "relatively frequent" events
			2) Where beaver dams are present are they active and stable
			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
			4) Riparian-wetland area is widening or has achieved potential extent
			5) Upland watershed is not contributing to riparian-wetland degradation
			VEGETATION
			6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
			7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)
			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events
			10) Riparian-wetland plants exhibit high vigor
			11) Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows
			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)
			EROSION/DEPOSITION
			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
			14) Point bars are revegetating with riparian-wetland vegetation
			15) Lateral stream movement is associated with natural sinuosity
			16) System is vertically stable
			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

(Revised 1998)



Remarks

Summary Determination

Functional Rating:

___ Proper Functioning Condition
___ Functional–At Risk
___ Nonfunctional
___ Unknown

Trend for Functional–At Risk:

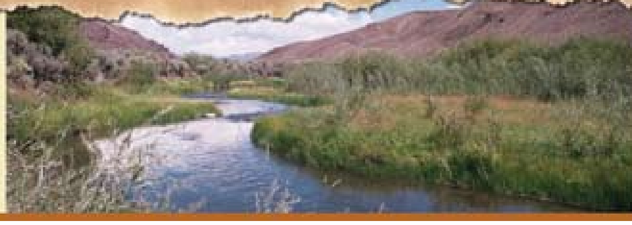
___ Upward
___ Downward
___ Not Apparent

Are factors contributing to unacceptable conditions outside the control of the manager?

___ Yes
___ No

If yes, what are those factors?

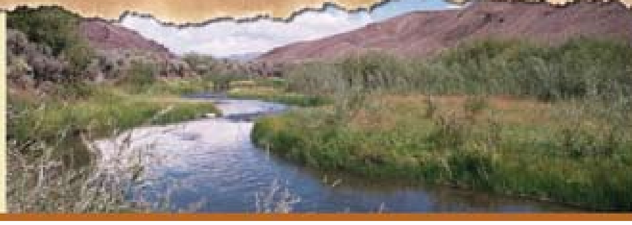
___ Flow regulations
___ Mining activities
___ Upstream channel conditions
___ Channelization
___ Road encroachment
___ Oil field water discharge
___ Augmented flows
___ Other (specify) ____



APPENDIX E
EXAMPLES OF GOOD OBJECTIVES

Objectives should be based on the **current** and **potential** condition of the site and allow for adjustments due to climatic conditions, monitoring methods, and **adaptive management** decisions. The PFC or other assessment methods, as well as other inventory data, should be used as guides to develop objectives.

1. Increase the length of cross-valley transects having any late seral riparian area community types (Winward 2000) on Rose Creek from 55 to 65 percent within 10 years (2015).
2. Facilitate willow establishment on the point bars of Fish Creek in the south pasture (DMA 2) so that by 2015 at least 65 percent of the greenline has a willow overstory or a willow plant within 1 meter of the greenline.
3. Increase bank stability along Sand Creek so that by 2010 stable streambanks within DMA 3 increase from 50 percent to 65 percent.
4. Allow aspen regeneration to escape at or near Rock Spring, resulting in an increase from 5 percent to 10 percent in sprout and seedling age classes by 2011.
5. Increase sprout and young willows along the 6-foot-wide, greenline-centered, belt transect at Greenline Monitoring Station 4 on Gravelly Creek so that there are more willows in sprout, young, and sapling than in dead age classes within 10 years after grazing plan has been implemented.
6. Decrease perennial pepperweed by 90 percent of the known population in the Elderberry Creek watershed by 2010.
7. Increase colonizing and stabilizing vegetation along the bottom of the now widened Gray Gulch Gully (DMA 4) so that the greenline to greenline width decreases from the approximate width of the gully to the width of a substantially narrower streambank along 80 percent of the reach within 5 years.



APPENDIX F
GRAZING RESPONSE INDEX
(Excerpt from USFS Rocky Mountain Region Rangeland Analysis and Management Guide)

Exhibit GRI: Grazing Response Index
R2 2200 GRI

General Discussion

The Grazing Response Index (GRI) is used to assess the effects of annual grazing pressures, and the effects of repetitive defoliation during the growing season. Understanding plant physiology and plant response to grazing is essential in the development of allotment management plans. Consequently, there is a need for a monitoring tool which adequately estimates rangeland use due to grazing. The tool must not only assess how much of the plant was grazed, but also when the plant was grazed and how many times it was defoliated during the growing season. GRI can be an effective tool to assess grazing systems or complications associated with situations such as early season big game use followed by livestock use.

The Grazing Response Index was developed to assess effects of use during the current year, and to aid in planning the grazing pattern for the following year. Consequently, GRI is based on general determinations of annual grazing use. GRI is not intended to be the only method for resolving major conflicts. *It should be used for situations where resource issues are considered low to mid level intensity,*

GRI considers three key concepts related to plant health: frequency, intensity, and opportunity.

Frequency

Frequency is the number of times forage plants are defoliated during the (actual or planned) grazing period. It is dependent on the length of time plants are exposed to the grazing animals. Approximately 7-10 days [are] required for a plant to grow enough to be grazed again during late spring or early summer when plants are experiencing rapid growth. Local knowledge of the area is needed to determine how fast the plants are growing.

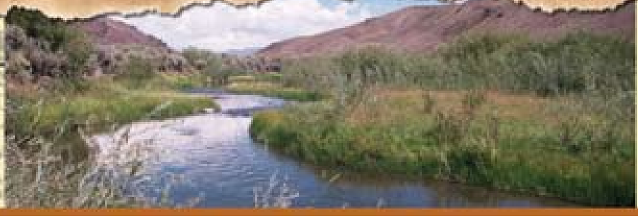
To obtain an estimate of how many times plants were (or will be) defoliated during a grazing period, divide the number of planned grazing days by 7 (or up to 10 if growth is slower). Using 7 is more conservative, because it will give the highest probable number of times the plants could be grazed. An index value of **+1 to -1** is assigned to as follows:

Number of Defoliations	Value
1	+1
2	0
3 or more	-1

Intensity

Intensity of defoliation is the amount of leaf material removed during the grazing period. The primary concern is *the amount of photosynthetically active leaf material remaining for the plant to recover from grazing*. This is not an estimate of percent utilization; generally, less than 40 percent defoliation will not inhibit plant growth. It is related to stocking rate. Intensity is described using three general levels of use.

Amount of Use	Percent	Value
Light	< 40 percent	+1
Moderate	40-55 percent	0
Heavy	> 55 percent	-1



Opportunity

Opportunity is the amount of time plants have to grow prior to grazing or regrow after grazing. This factor is related to time of use. Opportunity is the one factor most highly related to long term health and vigor of the vegetation. It [is] dependent on soil moisture, temperature, and leaf area. This factor is very important for sustaining healthy plants, thus the relative rankings for this attribute are doubled.

The index values for opportunity to grow or regrow forage are as follows:

Opportunity to Grow or Regrow	Value
Full season	+2
Most of season	+1
Some chance	0
Little chance	-1
No chance	-2

Determining opportunity is a judgment call based on appearance of vegetation at the end of the growing season. If the plants look like they were not grazed or just barely used, then a value of +2 is appropriate. If the plants look like they were used, but regrew fairly well, then use +1. Obviously, if the area has the appearance of being heavily used with no regrowth, assign a -2 value.

Even though opportunity is based upon appearance of the vegetation at the end of the growing season, there are some general guidelines that can help you make the determination. For example a pasture or allotment that is used season long can be expected to rate -2 (no chance). An allotment with 2 pastures will likely be in the 0 (some chance) or -1 (no chance) range. Allotments with multiple pastures that are used or rested at different times each year will usually receive the higher ratings of +2 or +1. These guidelines can help you get started, but the final rating should be based upon the appearance of the vegetation.

Overall Rating

The values for frequency, intensity, and opportunity are additive. The overall rating of the *expected response to grazing* is the sum of all three values. This result is a numerical value that is either positive, neutral, or negative. The index is a simple method to evaluate whether the grazing system has long term beneficial, neutral, or harmful effects to the rangeland forage. GRI gives a more comprehensive basis to plan future use that will maintain or improve plant health, structure, and vigor.

This index is based on grazing use that occurs during the growing season. This only marginally applies to grazing use when plants are dormant. Dormant season usually occurs after plants have had full opportunity to grow prior to use, hence an opportunity value of +2. Also, intensity is not as critical a parameter during the dormant season, because we are not concerned with producing regrowth.

Training

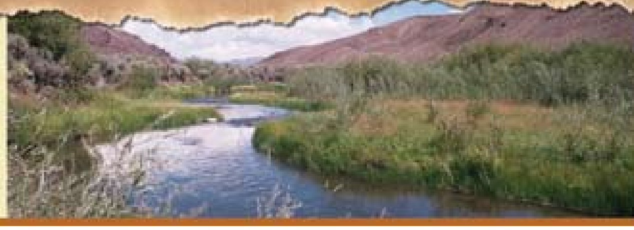
The GRI method does not require intensive training. Examiners can develop their eye for estimating light, moderate, or heavy use. This coupled with practical observations of timing and time of use will provide the information needed.

Personnel and Equipment

With a small amount of training, an individual can assess the amount of use and correlate that use to both time and timing of the grazing period. Form R2-2200-GRI is used to record data for each area of interest.

Sampling Procedure

Areas important to observe are: representative, special (critical or key areas), or treatment areas. The examiner should be familiar with the presence of these areas in the allotment or pasture to be rated. Also, it is important to have an idea of whether only one primary plant species, a group of species, or all forage plants in the area are to be monitored. The examiner should spend enough time to become familiar with grazing use patterns and levels of use across the area being rated. Rate the characteristics, record their ranking on the GRI form, and sum the rankings to obtain the GRI Index.



Grazing Response Index (R2-2200-GRI)

Forest	District	Spatial ID
Bighorn NF	Buffalo Rd	FS 02 12 10 373010830 0045 94
Allotment Name and Number	**Pasture**	
Table Mountain	Pat Park	
Kind/Class & Number of Animals	**Period of Use**	**Actual Use**
825 C/C	6/1 - 7/15	1238 Animal Months
Date	**Examiner(s)**	
07/21/94	J. Dawkins	

# of Defoliations	Value
1	+1
2	0
3	-1

Amount of Use	Percent	Value
Light	<40 percent	+1
Moderate	40-55 percent	0
Heavy	>55 percent	-1

Opportunity to Grow or Regrow	Value
Full season	+2
Most of season	+1
Some chance	0
Little chance	-1
No chance	-2

Pasture	Frequency	Intensity	Opportunity	Total GRI
1	+1	-1	+1	+1
2	0	0	-1	-1
3	0	0	+1	+1
4	-1	-1	-2	-4
5	+1	0	+2	+3
6	0	0	+1	+1
7	+1	+1	-1	+1
8	-1	0	-1	-2
9	0	+1	0	+1
10	0	-1	+1	0

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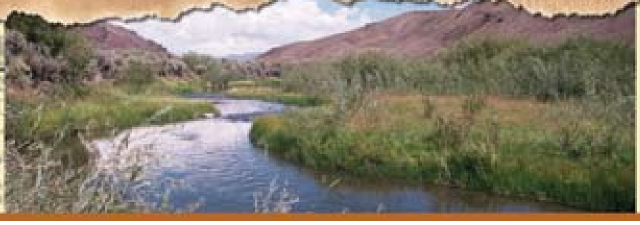


Grazing Response Index

Use this method to evaluate each pasture, or several sites within a pasture. Each row represents one GRI rating. **To determine the GRI, add all three values (frequency, intensity, and opportunity)** and record the sum in the Total column. Several sites within a pasture can be averaged to obtain an overall rating for the entire pasture. Complete the Site Information Form for each site or pasture.

Unit Name____________________________ Pasture Name___________________________________

Transect ID______________________ Date __________ Observer______________________________

Grazing System___________________________________ Season of Use __________ to ___________

# of Defoliations	Value
1	+1
2	0
3	-1

Amount of Use	Percent	Value
Light	<40 percent	+1
Moderate	40-55 percent	0
Heavy	>55 percent	-1

Opportunity to Grow or Regrow	Value
Full season	+2
Most of season	+1
Some chance	0
Little chance	-1
No chance	-2

Pasture Name	Site ID	Frequency	Intensity	Opportunity	GRI (Total)

APPENDIX G
LOW-STRESS STOCKMANSHIP

For a description of low-stress stockmanship, see section III.D.2.c.(7). Benefits of low-stress stockmanship include:

Riparian Benefits

- Avoiding sensitive areas is easier.
- The time of exposure to grazing and trampling is decreased.
- Enhanced monitoring by the livestock operator is possible.
- The area may be aesthetically more pleasing to some recreation users.
- Riparian conditions and trends improves.
- Bank stability improves.
- Water quality improves.

Rangeland Benefits

- Use of upland forages increases and use of riparian areas decreases.
- Increased control over livestock allows the use of prescribed grazing as an ecological management tool. Livestock may be used as a tool to influence plant community composition, age structure, etc.
- Rangeland conditions and function may be enhanced by improving the efficiency of the water, energy, and nutrient cycles.
- Cattle can be placed on the range, eliminating problems in riparian areas and other hot spots.
- Plant nutrition, palatability, and productivity increase.
- Herd effect is applied where it is appropriate or to achieve high density impacts to control brush, decrease fire hazard, and increase grass seed germination.
- The proportion of plants grazed at a low to moderate level of use increases.

Herd Health

Low-stress stockmanship allows for decrease of fly problems as the herd can be moved before flies hatch; decrease in diseases such as pink-eye, pneumonia, leptospirosis, and scours; decrease or elimination of death losses and injuries from stress; high-strung and low-condition stock gain better and are healthier; and overall improved herd health.

Economics and Sustainability of Ranching Operations

Bradford and Allen (1999), Smith (1998), and Cote (2004) as well as numerous testimonials from Cote, Westfall, and Leonard suggest that using low-stress stockmanship methods:

- Increases the pounds/acre of forage produced.
- Increases overall weight gains of animals, particularly on the range.
- Increases weight gains on weaned calves by reducing stress at weaning time. Animals go directly to feed and water.
- Allows use for the full grazing season even during periods of drought, because permittees can increase the ability to avoid riparian grazing triggers.
- Improves ease of handling and overall behavior in stock.
- Improves milk production.
- Improves the ease of sorting and shipping.
- Reduces expenditures by minimizing the need for fences and high-tech handling facilities.
- Reduces fencing needed as stock can be kept together or moved and placed in large pastures. Pasture units may be divided and grazed separately without the use of cross fences.
- Increases gains and improves health of previously high-strung and low-condition stock.
- Allows greater flexibility in pasture management.
- Increases carrying capacity on rangelands.
- Increase the number of head of livestock that can be handled efficiently by an individual.
- Saves time in gathering.
- Stops livestock from leaving the range and returning home before desired.

- Reduces dark cutters and bruising of meat caused by bumping, crowding, and shoving during sorting, loading, and routine handling.
- Reduces damage to facilities such as loosened gate posts, bent panels, etc.
- Improves the safety of livestock handlers.
- Achieves higher conception rates.
- Reduces pharmaceutical costs.
- Improves working relationships among ranchers, ranch employees, agency personnel, and other interested parties.

All results may not be achieved everywhere depending on past practices and performance.

GLOSSARY OF TERMS

Adaptive Management – an interdisciplinary planning and implementation process that identifies desired conditions, defines criteria for modifying management when progress toward achieving the desired conditions is not being made, and specifically defines the monitoring strategy and protocols.

Capability – the highest ecological status an area can attain given political, social, or economic constraints, which are often referred to as limiting factors.

Collaboration – the pooling of appreciations or tangible resources (e.g., information, money, or labor) by **two or more stakeholders** to solve a set of resource problems that no one party can solve individually. Also referred to as cooperation or coordination.

Decreasers – For a given plant community, those species that decrease in amount as a result of a specific abiotic/biotic influence or management practice (SRM 2004).

Dry Ravel – soil particles dislodging and rolling down a slope or bank under the influence of gravity. Ravel occurs most rapidly when a cohesionless soil on a steep slope dries out. Ravelling is dramatically increased when frost acts on the exposed soil. Ravel on some steep, bare cutbanks can quickly fill ditches and supply sediment that is then eroded and moved to nearby ditch relief culverts or streams by concentrated ditch flow (FishNet 4C et al. 2004).

Dynamic Equilibrium – the approximate balance between work done and imposed load, as the landscape is lowered by erosion and solution, then is uplifted, or as processes alter with changing climate, adjustments occur that maintain this approximate balance.

Eutrophication – designation of a body of water in which the increase of mineral and organic nutrients has reduced the dissolved oxygen, producing an environment that favors plant life over animal life.

Facultative – Plants that are equally likely to occur in wetlands or nonwetlands (34-66 percent).

Facultative Upland – Plants that usually occur in nonwetlands (67-99 percent) but are occasionally found in wetlands (1-33 percent).

Facultative Wetland – Plants that usually occur in wetlands (67-99 percent) but are occasionally found in nonwetlands.

Foci – center of interest or clarity.

Greenline – the first perennial vegetation that forms a lineal grouping of community types on or near the water's edge. Most often it occurs at or slightly below the bankfull stage.

Historic Climax Plant Community – the plant community considered to best typify the potential plant community of an ecological site prior to the advent of European settlers. It may no longer be one of the potential plant communities for the site (SRM 2004).

Increaser – For a given plant community, those species that increase in amount as a result of a specific abiotic/biotic influence or management practice (SRM 2004).

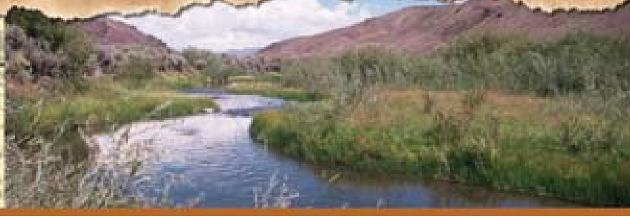
Intermittent or Seasonal – a stream that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow in mountainous areas.

In Utero – during growth and development before birth.

Low-Moisture Block – a free-choice nutritional supplement block for livestock containing not more than 5 percent moisture. Intake is controlled due to its hardness; it must be licked as it cannot be bitten or chewed. It may sometimes be referred to as a cooked block.

Morphological – relating to structure, shape, or form.

Obligate Upland – plants that may occur in wetlands in another region, but occur almost always (>99 percent) under natural conditions in nonwetlands in the region specified.



Obligate Wetland – plants that occur almost always (>99 percent) under natural conditions in wetlands.

Pathways – reversible changes in or among plant communities or phases within one state.

Phenological – relating to a plant's stage of growth.

Plant Association – used to group together all those stands of climax vegetation occurring in environments so similar that there is much floristic similarity throughout all layers of the vegetation.

Plant Community Type – a repeating classified and recognizable assemblage or grouping of plant species. Riparian community types represent the existing structure and composition of plant communities with no indication of successional status. They often occur as patches, stringers, or islands and are distinguished by floristic similarities in both their overstory and understory layers.

Potential – the highest ecological status a riparian-wetland area can attain given no political, social, or economic constraints. This status is often referred to as the potential natural community (PNC).

Proper Functioning Condition – a riparian-wetland area is considered to be in proper functioning condition 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 floodwater 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 the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses
- support greater biodiversity

Satiation – having had enough or more than enough so that all pleasure or desire is lost.

Senesce – mature

State – a recognizable soil and plant complex that resists change and usually self-repairs after disturbance. The state reflects a site's natural variability with a suite of plant communities specific to the functioning of the ecological processes.

Threshold – a "boundary" between two states that, once crossed, does not allow the community to "self-repair" to a former state because one or more ecological processes has become too degraded.

Transition – changes in vegetation or soil ecological processes (natural or management-induced) that will make one state change to another. Transitions can be reversed until a threshold has been crossed to another state.

Wolfy – plants containing accumulated standing dead material from previous growth. They often have a larger size due to selective use of nearby nonwolfy plants.

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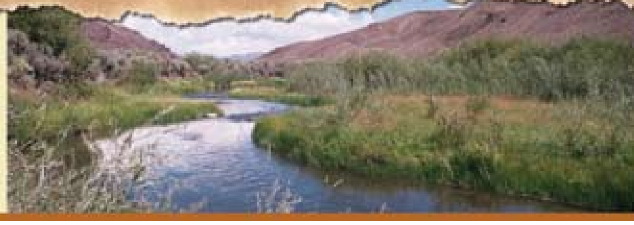

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