4E: Grazing Management

Grazing Management Measure

Manage rangeland, pasture, and other grazing lands to protect water quality and aquatic and riparian habitat by:

1. improving or maintaining the health and vigor of selected plant(s) and maintaining a stable and desired plant community while, at the same time, maintaining or improving water quality and quantity, reducing accelerated soil erosion, and maintaining or improving soil condition for sustainability of the resource. These objectives should be met through the use of one or more of the following practices:
   a. maintain enough vegetative cover to prevent accelerated soil erosion due to wind and water;
   b. manipulate the intensity, frequency, duration and season of grazing in such a manner that the impacts to vegetative and water quality will be positive;
   c. ensure optimum water infiltration by managing to minimize soil compaction or other detrimental effects;
   d. maintain or improve riparian and upland area vegetation;
   e. protect streambanks from erosion;
   f. manage for deposition of fecal material away from water bodies and to enhance nutrient cycling by better manure distribution and increased rate of decomposition; and,
   g. promote ecological and stable plant communities on both upland and bottom land sites.
2. excluding livestock, where appropriate, and/or controlling livestock access to and use of sensitive areas, such as streambanks, wetlands, estuaries, ponds, lake shores, soils prone to erosion, and riparian zones, through the use of one or more of the following practices:
   a. use of improved grazing management systems (e.g., herding) to reduce physical disturbance of soil and vegetation and minimize direct loading of animal waste and sediment to sensitive areas;
   b. installation of alternative drinking water sources;
   c. installation of hardened access points for drinking water consumption where alternatives are not feasible;
   d. placement of salt and additional shade, including artificial shelters, at locations and distances adequate to protect sensitive areas;
   e. provide stream crossings, where necessary, in areas selected to minimize the impacts of the crossings on water quality and habitat; and,
   f. use of exclusionary practices, such as fencing (conventional and electric), hedgerows, moats and other practices as appropriate

   and

The restoration or protection of designated water uses (e.g. fisheries) is the goal of BMP systems designed to minimize the water quality impact of grazing and browsing activities on pasture and range lands.

3. achieving either of the following on all rangeland, pasture, and other grazing lands not addressed above:

    a. apply the planning approach of the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) to implement the grazing land components in accordance with one or more of the following from NRCS: a Grazing Land Resource Management System (RMS) ; National Range and Pasture Handbook (USDA-NRCS, 1997b); and NRCS Field Office Technical Guide, including NRCS Prescribed Grazing 528A;

    b. maintain or improve grazing lands in accordance with activity plans or grazing permit requirements established by the Bureau of Land Management, the National Park Service, or the Bureau of Indian Affairs of the U.S. Department of Interior, or the USDA Forest Service; or other federal land manager.

Management Measure for Grazing: Description

The management measure is intended to be applied to activities on rangeland, irrigated and non-irrigated pasture, and other grazing lands used by domestic livestock. This management measure applies to both public and private range and pasture lands. A grazing management plan/system should be used to plan and achieve implementation of this management measure.

The goals of this management measure are to protect water quality and quantity and sensitive areas. The grazing management plan/system is the primary mechanism through which these goals are achieved. A grazing management plan/system may include management strategies and practices such as herding, alternative water sources, livestock exclusion, and conservation of range, pasture, and other grazing lands. Grazing management systems are intended to achieve specified objectives and ensure “proper use.” Proper use can be defined as grazing managed so that the total vegetation available is grazed at a time and intensity that does not degrade the existing-riverine/aquatic-riparian-upland systems or in the case of degraded rangelands, inhibit system response to a more desirable state (adapted from Platts, 1990). As such, a clear understanding of plants and their ecology are key to good grazing management.

It is recognized that livestock exclusion is more practicable on pasture than rangeland in many cases, but livestock exclusion can be used for the protection of water quality in key sensitive areas on rangelands. In grazing systems, major environmental improvements can be achieved by minimizing livestock access to streambanks and riparian areas during periods of streambank instability and regrowth of key riparian vegetation.

To meet the objectives of the management measure, a comprehensive management system should be employed to manage the entire grazing area. This grazing area may include uplands, riparian areas, and wetlands. Special attention should be given to grazing management in riparian and wetland areas due to their sensitivity to disturbance and the tendency of many grazing animals to favor these areas for foraging and loafing. *Riparian areas* are defined by Mitsch and Gosselink (1986) and Lowrance et al. (1988) as:

> vegetated ecosystems along a water body through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent water body.

Riparian area and wetland protection strategies should be integrated with upland management strategies. The health of the riparian and wetland ecosystems, receiving waterbody quality, and stream base flow levels are often dependent on the use, management and condition of adjacent uplands. Proper management of uplands can reduce grazing pressure on riparian areas and also increase forage productivity due to increased water table height and stream base flow. Increased forage productivity and overall upland health can result in increased economic benefits to the landowner or grazing management entity.

This management measure also contains recommendations under 3a and 3b that USDA/NRCS methodologies and guidance and/or other federal agency requirements should be employed in addition to the management elements listed in 1a-g and 2a-f to provide the requisite level of natural resource protection. Resource management systems (RMS) include any combination of conservation practices and management that achieves a level of treatment of the five natural resources (i.e., soil, water, air, plants, and animals) that satisfies criteria contained in the Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG). The rangeland and pasture components of a RMS address erosion control, proper grazing, adequate pasture stand density, and rangeland condition. National (minimum) criteria pertaining to rangeland and pasture under an RMS are applied to achieve environmental objectives, conserve natural resources, and prevent soil degradation.

Recommendations for Grazing Management in Riparian Areas

- ❒ Tailor the grazing approach to the specific riparian area under consideration.
- ❒ Incorporate management of riparian areas into the overall management plan for the whole operation.
- ❒ Select a season or seasons of use so grazing occurs, as often as possible, during periods compatible with animal behavior and conditions in the riparian area.
- ❒ Control the distribution of livestock within the targeted pasture.
- ❒ Ensure adequate residual vegetative cover.
- ❒ Provide adequate regrowth time and rest for plants
- ❒ Be prepared to play an active role in managing riparian areas.

Source: *Best Management Practices for Grazing Montana,* Montana Watershed Coordination Council's Grazing Practices Work Group, 1999.

Grazing and Pasturing: An Overview

In addressing nonpoint source pollution concerns, producers must balance production and water quality objectives. This section explores some of the production-oriented resources management decisions confronting livestock producers.

Livestock can obtain their needed nutrients through feed supplied to them in a confined livestock facility, through forage, or through a combination of forage and feed supplements. Forage systems can be pasture-based or rangeland-based.

It is important for the reader to be aware of the difference between rangeland and pasture. *Rangeland* refers to those lands on which the native or introduced vegetation (climax or natural potential plant community) is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. Rangeland includes natural grassland, savannas, many wetlands, some deserts, tundra, and certain forb and shrub communities. *Pastures* are those improved lands that have been seeded, irrigated, and fertilized and are primarily used for the production of adapted, domesticated forage plants for livestock. Other grazing lands include grazable forests, native pastures, and crop lands producing forage.

The major differences between rangeland and pasture are the kind of vegetation and level of management that each land area receives. In most cases, range supports native vegetation that is extensively managed through the control of livestock rather than by agronomy practices, such as fertilization, mowing, or irrigation. Rangeland also includes areas that have been seeded to introduced species (e.g., clover or crested wheatgrass) but are managed with the same methods as native range. For both rangeland and pasture, the key to good grazing practice is vegetative management, i.e., timing of grazing should be managed to ensure adequate vegetative regrowth and soil stability.

Pastures are represented by those lands that have been seeded, usually to introduced species (e.g., legumes or tall fescue) or in some cases to native plants (e.g., switchgrass or needle grass), and which are intensively managed using agronomy practices and control of livestock. Permanent pastures are typically based on perennial warm-season (e.g., bermudagrass) or cool-season (e.g., tall fescue) grasses and legumes (e.g., warm-season alfalfa, cool-season red clover), while temporary pastures are generally plowed and seeded each year with annual legumes (e.g., warm-season lespedezas, cool-season crimson clover) and grasses such as warm-season pearl millet and cool-season rye (Johnson et al., 1997). Plant selection for pastures should be based upon consideration of climate, soil type, soil condition, drainage, livestock type and expected forage intake rates, and the type of pasture management to be used. Management of pH and soil fertility is essential to both the establishment and maintenance of pastures (Johnson et al., 1997). In some climates (e.g., Georgia), overseeding of summer perennials with winter annuals is done to provide adequate forage for the period from mid-winter to the following summer.

Factors Affecting Animal Performance on Grazed Lands

The manager of a forage system must be concerned with care and management of the livestock, control of noxious plants, and the quality of forage (McGinty, 1996). Both forage quality and forage intake must be managed to ensure the performance, or quality, of livestock on pasture and grazing lands.

Forage quality

Forage quality is generally measured in terms of its nutritional value and digestibility. Nutritional value can be assessed based on the amount of protein, phosphorus, and energy the plants contain (Ruyle, 1993). The nutritional value of rangeland forage varies with season (e.g., higher in spring and summer), and differs among forage types. For example, protein availability from grasses decreases rapidly as the grasses mature, while shrubs are good sources of protein even at full maturity. The protein content of forbs (e.g., weeds, wildflowers) falls between that of grasses and shrubs. Grasses are generally considered to be good sources of energy, shrubs are good energy sources before fruit development, and the value of forbs is intermediate between that of grasses and shrubs for livestock.

Rangeland condition also affects the nutritive value of forage plants, with better rangeland condition yielding more digestible plants (Ruyle, 1993). Other factors affecting the quality of forage include the plant parts eaten (e.g., leaves versus stem), the presence of secondary compounds (e.g., lignin, tannins, terpenes) in the plants (Lyons et al., 1996b), and pests (Johnson et al., 1997). The stocking rate and the type of grazing system can affect grazing animal nutrition as well. Over-stocking will cause a shift toward less productive and less palatable forage plants, resulting in decreased forage intake due to less total forage and less desirable forage (Lyons et al., 1996b). The preservation of some of the forage on grazed lands is necessary to protect the resource, but forage quality may suffer if too much old growth is maintained. Closely-grazed forage is generally good for animal performance since it results in younger forage that is higher in nutrient value and more digestible (Johnson et al., 1997). The quality of regrowth in pastures is improved with intensive grazing, but the rate of regrowth, and therefore the yield, is reduced (Cannon et al., 1993). Grazing management decisions should allow for plant vigor and regrowth and maintenance of soil stability. Growing season factors should be considered when evaluating the potential for plant regrowth.

Many practitioners currently use forage utilization or stubble height as a management tool to gauge the acceptable level of grazing. Stubble height measurements can be used successfully as one component of a comprehensive grazing management strategy. Stubble height measurements are a good tool to help practitioners begin to focus on stream ecology and forage availability for animal production. However, the exclusive and continuing use of stubble height as the only or primary indicator of riparian health can be problematic. As a result stubble height measurements are sometimes improperly used. Stubble height measurements often are conducted at the wrong time or intervals, in the wrong places, and based on measurements of the wrong plant species. To properly use stubble height as an effective grazing management tool, stubble height must be measured frequently during the grazing period to ensure that adequate vegetative cover and soil stability are maintained at the end of both the growing season and grazing period. The proper use of stubble height measurements can benefit animal production and help ensure the stability of the riparian area, however, the practicality and expense of frequent stubble height measurements may be burdensome, and, as a result, this technique may be improperly applied.

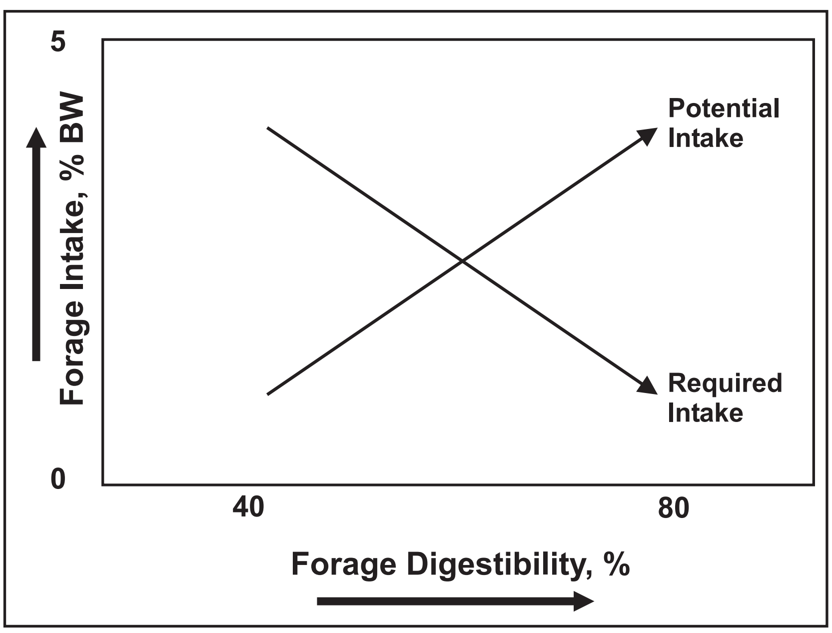
In Oregon, it is recommended that pastures be grazed from about 2,400 to 2,800 pounds of dry matter growth per acre down to about 1,500-1,600 pounds of dry matter growth per acre, maintaining a height of 2-6 inches for clover and grasses (Cannon et al., 1993). Guidelines for Texas ranchers recommend minimum stubble height and plant residue as follows: 1.5 inches and 300-550 pounds per acre for short grass; 4-6 inches and 750-1,000 pounds per acre for mid-grass; and 8-10 inches and 1,200-1,500 pounds per acre for tall grass (McGinty, 1996). However, these stubble height strategies may oversimplify the complexity and site specificity of herbage dynamics under grazing, and it has been argued that these assessments are qualitative, subjective, and not truly quantitative (Scarnecchia, 1999).

The Montana Watershed Coordination Council's Grazing Practices Work Group publication, *Best Management Practices for Grazing Montana* (1999) recommends that rangeland managers set target levels for grazing use based on animals' nutritional needs balanced against the need to maintain a healthy plant community. This approach is based on setting target levels for key species and evaluating on a site level basis rangeland condition and trends. As a general rule of thumb, the Council advises that the planned grazing target should be to use no more than 50-60% of the key species.

Forage intake

Forage intake generally increases as forage quality increases (Lyons et al., 1995). As illustrated in Figure 4e-1, forage intake increases with digestibility since digestion creates room for additional forage. Livestock do not generally stop eating once their nutrient requirements are met. Because of this, ranchers cannot assume that higher quality forage alone will result in adequate resource protection. Grazing management systems will still be needed to protect the

Figure 4e-1. Relationship between forage digestibility, the amount of forage ruminants can eat, and the amount of forage needed to meet nutrient requirements as a percentage of body weight (BW) (Lyons et al., 1995).



resource from improper grazing. With low-quality forage, more forage is needed to meet nutrient needs, but the lower digestibility makes it much more difficult for the livestock to meet their nutrient needs since the forage does not pass through the rumen as quickly.

Forage intake is also affected by herbivore species and size, foraging behavior (e.g., preference for certain forage types, preference for specific areas), physiological status, animal production potential, supplemental feed, forage availability, and environmental factors (Lyons et al., 1995). Smaller herbivore species (e.g., sheep) have greater intake rates when measured as a percentage of live weight than do larger species (e.g., beef cattle). Sheep and goats tend to be more selective of the plants they graze than are cattle, and tend to have higher forage intake rates due to their consumption of a readily digestible mixture of grass, forbs, and browse (young twigs, leaves, and tender shoots of plants or shrubs suitable for animal consumption). Horses may consume up to 70 percent more forage than a cow of similar size due mostly to the rapid passage rate of horses.

The forage selected by herbivore species varies, and is determined largely by their mouth parts and the anatomy of their digestive systems (Lyons et al., 1996a). For example, horses eat more grass than cattle, sheep, and goats as a percentage of their annual diet, while goats eat the most browse, and sheep eat the greatest share of forbs. Diet also varies across season within a given species. Browse constitutes 34 percent of the diet of Texas-raised goats in spring and 53 percent in fall and winter, while forbs account for 6 percent of the diet of cattle in fall and 25 percent in spring. Management strategies should control animal distribution and plant harvest timing to counter the effects of preference (Platts, 1990).

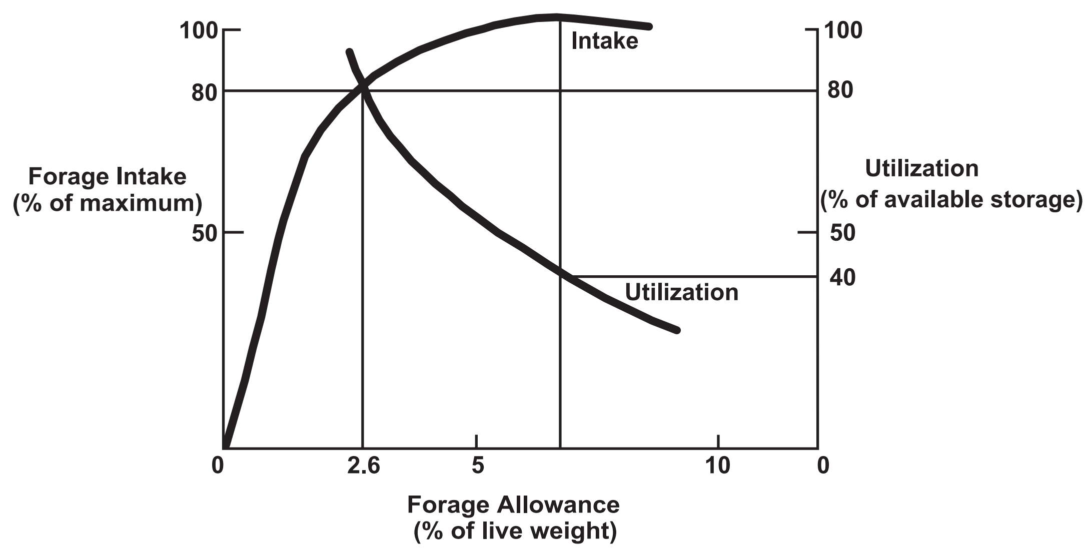
The importance of physiological status is evidenced by the fact that lactating animals generally have a higher nutrient demand and greater forage intake rate than animals that are dry, open, or pregnant (Lyons et al., 1995). In fact, an animal can eat 35 to 50 percent more when lactating than when dry, open, or pregnant. Highly productive cows early in lactation require the highest quality feed to maintain production (Cannon et al., 1993). Thus, the good farm manager gives high priority to the provision of adequate forage to lactating dairy herds in order to avoid a drop in milk production.

Producers may need to provide feed nutrient supplements to ensure suitable livestock production on rangeland (Ruyle, 1993) and other grazing lands. Protein supplements are often given to livestock grazing on low-protein forage, and the quantity and timing of the supplemental feeding can affect forage intake (Lyons et al., 1995). For example, supplemental protein can increase forage intake to a point, beyond which forage intake is reduced with increasing supplemental protein.

Forage availability is often measured in terms of stocking rates, or the number of animals that use a unit of land for a specified period of time (White, 1995; Sedivec, 1992). Forage growth and production can vary greatly over any given land area, as seasons change, and as a function of weather conditions, so matching stocking rates with forage availability is dependent upon assumptions regarding forage production. Further, since forage intake is dependent upon forage quality, it becomes necessary to carefully monitor forage quality and quantity to determine if stocking rates need to be adjusted. A general rule-of-thumb for grazing is to allow livestock to use 50 percent of the forage (Sedivec, 1992). USDA encourages development of a feed, forage, livestock balance sheet to assist in management of grazing lands, and provides procedures and worksheets to assist managers (USDA-NRCS, 1997b).

An alternative approach to addressing forage availability in management decisions is based on the concept of a forage allowance, which is the weight of forage allocated per unit of animal demand at any instance (Cropper, 1998). Forage allowance is expressed as a percentage of live body weight or as pounds of forage per animal per day, and generally averages 2.5-3% for beef and sheep, 2% for horses, and 3-4% for lactating cows (Cropper, 1998). Research has shown that forage intake increases with forage allowance, reaching a maximum level at a forage allowance of about 6.5% of herd live weight (Figure 4e-2). Forage utilization rate, however, decreases as forage allowance is increased, meaning that more forage is potentially wasted since it is not consumed by livestock. With knowledge of the number of animals on the pasture, the percentage of forage intake derived from the pasture, forage intake per animal, and the desired forage utilization rate, one can manage forage and livestock to achieve desired animal performance without wasting or degrading pasture (Cropper, 1998).

Figure 4e-2. Relationship of forage allowance to forage intake and utilization (after Cropper, 1998). (Lyons et al., 1995).



Environmental factors, including air temperature, soil moisture, and snowcover, also affect forage intake. Each species of herbivore has a temperature-based comfort zone, the thermoneutral zone, within which forage intake is not affected (Lyons et al., 1995). Above and below the thermoneutral zone, however, intake may increase or decrease depending upon outside conditions.

There is also a need to assess and compensate for wildlife forage utilization when managing livestock to protect water quality. In many areas, wildlife consumes a significant portion of available forage and wildlife ungulates (i.e., mammals with hooves) may have a major impact on riparian areas and woody vegetation. Land managers should take these impacts into account when planning and managing grazing management programs and setting grazing use levels for each grazing unit.

Because of the many sources of variability in forage quality, forage availability, and forage intake, the rancher faces a significant challenge in providing an appropriate mix of forage to ensure that livestock receive adequate nutrition throughout the year.

Water

Water is essential to the survival, growth, and productivity of livestock. Insufficient water supply will result in reductions in feed intake, production, and profits (Faries et al., 1998). High salinity, high nitrate and nitrite levels, bacterial contamination, excessive growth of blue-green algae, and spills of petroleum, pesticides, and fertilizers are the water quality problems that most affect livestock production.

Research in Missouri has shown that water consumption of pastured beef cow-calf pairs increased almost linearly as the temperature increased from 50 degrees to 95 degrees Fahrenheit (Gerrish, 1998). At 50 degrees F, water consumption was approximately 6 gallons per day, increasing to about 24 gallons per day at 95 degrees F. Cattle in Texas drink from 7 to 16 gallons per day, while horses (8-12 gallons per day) and sheep and goats (1-4 gallons per day) drink less (McGinty, 1996). Dry cows drink 8-10 gallons of water per day, while cows in their last three months of pregnancy need up to 15 gallons of water per day (Faries et al., 1998). The frequency with which livestock seek water varies, ranging from 3-5 times per day for beef cows in the Midwest, to less frequent visits in drier climates (Gerrish, 1998). A recent study showed that distance from water supply had a large effect on water consumption, as cows within 800 feet of water drank 15 percent more water than cows further than 800 feet from water (Gerrish, 1998). The maximum distance that livestock will travel to water in Texas ranges from 0.5 miles in rough terrain to 2.0 miles in smooth, flat terrain (McGinty, 1996).

Minerals

Sodium, chloride, and other minerals are essential to the bodily functions of animals, and livestock on the rangeland should consume about 20 pounds of salt per year (Schwennesen, 1994). Well managed vegetation can provide the needed minerals for healthy animals, but mineral supplements can benefit animals if they are developed to meet local deficiencies. Livestock are attracted to salt and other mineral supplements, and will remain with it as long as it remains, making mineral supplements a very useful grazing land management tool. By placing measured quantities of minerals at various locations throughout the year, livestock operators can manage the location of livestock to control grazing, help manage the grazing land condition, and keep livestock away from sensitive areas.

Weed and Brush Management

Weeds can reduce forage production and lower forage quality (Johnson et al., 1997). Well-managed pastures present fewer weed problems as grasses can outcompete most weeds. Weed management on rangeland may involve prescribed burning or the use of herbicides (McGinty, 1996). The grazing of cattle, sheep, and goats can also be used as a weed management tool.

Grazing Systems

There is a wide range of grazing systems for rangeland and pastures that managers may select from (Table 4e-1). Specific terms and definitions used may vary considerably across the nation. In all cases, however, the key management parameters are:

- ❒ grazing frequency
- ❒ livestock stocking rates
- ❒ livestock distribution
- ❒ timing and duration of each rest and grazing period
- ❒ livestock kind and class
- ❒ forage use allocation for livestock and wildlife.

Factors to consider in determining the appropriate grazing system for any individual farm or ranch include the availability of water in each pasture, the type of livestock operation, the kind and type of forage available, the relative location of pastures, the terrain, the number and size of different pasture units available (Sedivec, 1992), and producer objectives.

While many systems may be derived from combinations of the key management parameters, the basic choice is between continuous and rotational grazing. Under continuous grazing, the livestock remain on the same grazing unit for extended periods, while rotational grazing involves moving the livestock from unit to unit during the growing season (Johnson et al., 1997). A prescribed grazing schedule for rangeland is a system in which two or more grazing units are alternately deferred or rested and grazed in a planned sequence over a period of years (USDA-NRCS, 1997b). Rest periods are generally non-grazing periods of a full year or longer, while deferment typically involves a non-grazing period of less than twelve months.

Continuous, season-long grazing is typically done on larger pastures, with less fencing and less livestock management than required for rotational grazing (Johnson et al., 1997). A central problem with this approach is the difficulty of matching the stocking rate with the changing forage growth rate during the grazing season. For example, forages may grow at a rate of 90 pounds per acre per day in spring, followed by summer growth rates of as little as 5 pounds per acre per day, resulting in a mismatch of supply and demand if the stocking rate is kept constant (Cropper, 1998).

Rotational grazing generally involves smaller pastures or paddocks, more fencing, and more livestock management than required for continuous grazing (Johnson et al., 1997). If forage growth exceeds forage intake, forage from some paddocks may be harvested and stored for winter grazing. Rotational grazing provides opportunities to better manage the available forage to meet livestock needs (Johnson et al., 1997). In some cases, the additional costs for fencing and supplying water in each paddock may be prohibitive. Options exist, however, for designing paddocks such that drinking water sources can be shared by more than one paddock, thus eliminating the need for additional water development (Drake and Oltjen, 1994). In addition, affordable, portable fencing is often used in management-intensive grazing systems (SARE, 1997).

Table 4e-1. Some commonly used grazing systems (Sedivec, 1992; McGinty, 1996; Frost and Ruyle, 1993; USDA-NRCS, 1997b).1995).

Grazing System	Description	Comments
Continuous	Unrestricted livestock access to any part of the range during the entire grazing season. No rotation or resting.	Difficult to match stocking rate to forage growth rate. Severe overgrazing occurs where cattle congregate. Other areas underutilized. Long-term productivity depends upon moderate levels of stocking. Can be year-long or seasonal continuous grazing. Less fence and labor than for rotation.
Rotation	Intensive grazing followed by resting. Livestock are rotated among 2 or more pastures during grazing season.	Each pasture may be alternately grazed and rested several times during a grazing season. Cattle are moved to different grazing area after desired stubble height or forage allowance is reached.
Switchback	Livestock are rotated back and forth between 2 pastures.	Every 2-3 weeks in ND. In TX, graze 3 months on pasture 1, 3 months on pasture 2, then 6 months on pasture 1, etc.
Rest-rotation	One pasture rested for an entire grazing year or longer. Others grazed on rotation. Multiple pastures with multiple or single herd.	In ND, 4 pastures used with 1 rested, one each grazed in spring, summer, and fall. Rest periods are generally longer than grazing periods.
Deferred rotation	Grazing discontinued on different parts of range in succeeding years to allow resting and re-growth. Generally involves multiple herds and pastures.	Length of grazing period is generally longer than the deferment period.
Twice-over rotation	Variation of deferred rotation, with faster rotation. Uses 3-5 pastures.	Long period of rest between rotations. Sequence alternates from year to year.
Short-duration grazing	Grazing for 14 days or less. Large herd, many small pastures (4-8 cells), high stocking density.	Rest period is 30-90 days. Allows 4-5 grazing cycles. Requires a high level of grass and herd management skills. Similar to high intensity-low frequency, but length of grazing and rest periods are both shorter for short-duration grazing.
High intensity-low frequency	Heavy, short duration grazing of all animals on one pasture at a time. Rotate to another pasture after forage use goal is met. Multiple pastures with single herds.	Grazing period is shorter than rest period, and grazing periods for each pasture change each year. In TX, grazing period is more than 14 days, and resting period is more than 90 days. TX typically has single herd on 4 or more pastures.
Merrill	Each of 4 pastures grazed 12 months and rested 4 months.	Three herds.
Season-long Grazing	No specific number of herds or pastures.	No set movement pattern.

A number of different stocking methods are used to manage pastures, including allocation stocking methods (continuous set stocking, continuous variable stocking, set rotational stocking, variable rotational stocking), nutrition optimization stocking methods (creep grazing, strip grazing, frontal grazing), and seasonal stocking methods (deferred stocking, sequence stocking) (USDA-NRCS, 1997b). Rotational stocking, or top grazing, is an adaptation of rotational grazing that improves the efficiency with which forage is used. This approach is based upon the fact that cattle select the highest quality forage available before grazing lower quality forage (Johnson et al., 1997). In rotational stocking, for example, a lactating dairy herd might be rotated to a paddock where it can obtain

100 percent of its forage intake needs at a low forage utilization rate (see Figure 4e-2). Forage allowances for high-producing, lactating diary cattle need to be generous to maintain milk production, resulting in utilization rates of 50 percent or less (Cannon et al., 1993). Dry cows and heifers might be rotated to the same paddock after the lactating dairy herd is removed to increase the forage utilization rate (Cropper, 1998).

Potential Environmental Impacts of Grazing

The focus of the grazing management measure is on the protection of water quality and aquatic and riparian habitat. Riparian areas may need special attention to achieve water quality and habitat related goals. The entire watershed should be evaluated to determine the sources and causes of nonpoint source pollution problems and to develop solutions to those problems. Application of this management measure will reduce the physical disturbance to sensitive areas and reduce the discharge of sediment, animal waste, nutrients, pathogens, and chemicals to surface waters.

More than half the commercial operators with beef cattle herds in the West graze federal lands. According to a report by the Council for Agricultural Science and Technology (CAST) (Laycock, 1996), a leading consortium of 33 professional scientific societies, individuals are becoming increasingly concerned about the ecological effects of improper grazing on federal lands. Major concerns include diminished biodiversity, deteriorating rangeland, watershed, and streambank conditions; soil erosion and desertification; decreased wildlife population and habitat; and lost recreational opportunities.

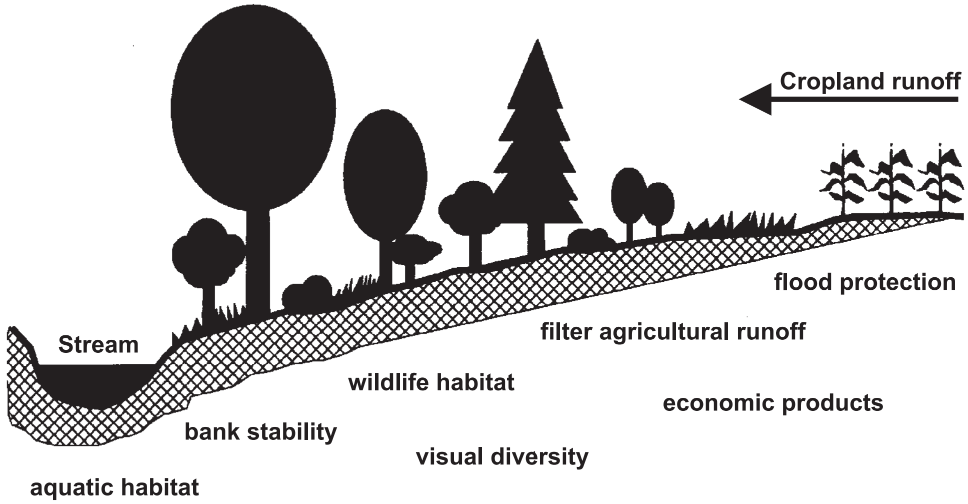
Riparian areas constitute important sources of livestock grazing. One acre of riparian meadow has the potential grazing capacity equal to 10 to 15 acres of surrounding forested rangeland. In the Pacific Northwest, riparian meadows often cover only 1 to 2% of the summer rangeland area, but provide about 20% of the summer forage.

The loss of streambank stability, riparian vegetation, stream habitat, and modification of hydrologic regime due to poor grazing practices has a devastating effect on stream life.

Streambank stability is directly related to the species composition of the riparian vegetation and the distribution and density of these species (Figure 4e-3). During high water, riparian vegetation protects the banks from erosion, reducing water velocity along the stream edge, and causing sediments to settle out. Platts (1991) has summarized the importance of riparian vegetation in providing cover and maintaining streambank stability. Trees provide shade and streambank stability because of their large and massive root systems. Trees that fall into or across streams create high quality pools and contribute to channel stability. Brush protects the streambank from water erosion, and its low overhanging height adds cover that is used by fish. Grasses form the vegetative mats and sod banks that reduce surface erosion and erosion of streambanks. As well-sodden banks gradually erode, they create the undercuts important to salmonids as hiding cover. Root systems of grasses and other plants trap sediment to help rebuild damaged banks.

When animals repeatedly graze directly on erodible streambanks, bank structure may be weakened causing soil to move directly into the stream. Excessive grazing on riparian vegetation can result in changes in plant community composition and density and can negatively impact bank stability and the filtering capacity of the vegetation. Within the federal government, the Bureau of Land Management (BLM) and the USDA have experience in and tools for assessing riparian system function and erodibility.

Figure 4e-3. Benefits that a riparian buffer can provide. Dosskey, 1997).



The loss of riparian vegetation together with collapsed streambanks increases stream width and decreases depth, which has the potential to alter stream temperature. With the loss of riparian vegetation, the stream is exposed to greater temperature fluctuations, resulting in potentially higher temperatures during the day and cooler temperatures at night. Riparian vegetation moderates stream temperatures by absorbing short-wave radiation during the day and insulating the stream from loss of long-wave radiation at night. Other reports indicate that keeping the water in the ground longer is also a major contributing factor to cooler water temperatures (Baschita, 1997).

Compaction and vegetation loss due to improper grazing can increase runoff, erosion, and sediment delivery to streams.

Improper grazing management can contribute to the removal of most vegetative cover, soil compaction, exposure of soil, degradation of soil structure, and loss of infiltration capacity. These impacts can result in soil susceptible to wind and water erosion. Due to the steep slopes, highly erodible soils, and storm events, the sediment delivery ratio from rangeland can be very high (Carpenter et al., 1994). Improper management can also alter the plant species composition by creating a shift from desirable perennial species to undesirable annual species.

Livestock also generate microorganisms in waste deposits as they graze on pasture and rangelands. Animal wastes contain fecal coliform and fecal streptococci in numbers on the order of 10^5 – 10^8 organisms per gram of waste, or 10^9 – 10^{10} excreted per animal per day (Moore et al., 1988). In addition to such indicator organisms, livestock can serve as an important reservoir of pathogens such as *E. coli* O157:H7 (Wang et al., 1996; Pell, 1997). The extent of manure and microorganism deposition on grazing land typically depends on livestock density or stocking rate (Carpenter et al., 1994; Fraser et al., 1998; Edwards et al., 2000).

Pathogen impacts on waterways are a grazing land use issue.

Release of microbes from manure deposited on grazing land is influenced by time, temperature, moisture, and other variables. Enhanced survival of microorganisms in fecal deposits on grazing land has been documented elsewhere; the bacterial pollution potential of fecal deposits on grazing land is significant (Thelin and Gifford, 1983; Kress and Gifford, 1984). Bohn and Buckhouse (1985) reported that fecal coliforms may survive in soil only 13 days in summer and 20 days in winter, but that cow fecal deposits provide a protective medium that permit microorganisms to survive for more than a year.

Runoff from grazed land can contain high numbers of indicator microorganisms. Crane et al. (1983) cited fecal coliform counts of 10^3 – 10^5 organisms/100 ml in pasture runoff. Edwards et al. (2000) reported that FC levels in runoff from simulated grazing plots were always higher (2.4 x 10^5 – 1.8 x 10^6 FC/100 ml) than counts from the ungrazed control plots (1.5 x 10^3 FC/100 ml). Microorganism counts in runoff from grazing land are, however, typically several orders of magnitude lower than numbers from land where manure is deliberately applied.

It should be noted that, because all warm-blooded animals excrete indicator bacteria in their feces, wildlife inhabiting agricultural land are likely to contribute to the pool of microorganisms available in a watershed, including both indicator organisms (Kunkle, 1970; Niemi and Niemi, 1991; Valiela et al., 1991) and pathogens such as *Giardia* (Ongerth et al., 1995).

Nutrient inputs from grazing lands to surface water come mainly in the form of nitrogen and phosphorus from manure and decaying vegetation (Carpenter et al., 1994). Nutrient impacts on water quality vary considerably in study results, and are dependent on specific site conditions such as precipitation, runoff, vegetation cover, grazing density, proximity to the stream, and period of use. The risk of nutrient enrichment is low in arid rangelands where animal wastes are distributed and runoff is comparatively light. Studies by the ARS and BLM found little evidence of nutrient enrichment from unconfined livestock grazing in Reynolds Creek, an arid watershed in southern Idaho (USDA–ARS, 1983). This risk can also be low in humid climates if grazing lands are managed correctly. In a humid site in east-central Ohio (Owens et al., 1989), nutrient concentrations did not increase significantly with summer grazing of the unimproved pasture, and were also low when continuously grazed. In another study, Schepers and Francis (1982) found increases in nutrients in a cow-calf pasture in Nebraska. Nutrient levels were correlated primarily with grazing density.

Grazing Management Practices and their Effectiveness

The Grazing Management Measure was selected based on an evaluation of available information that documents the beneficial effects of improved grazing management. Specifically, the available information shows that

- ❐ Riparian habitat conditions are improved with proper livestock management;
- ❐ The amount of time livestock spend drinking and loafing in the riparian zone is dramatically reduced through the provision of supplemental water and fencing; and
- ❐ Nutrient and sediment delivery is reduced through the proper use of vegetation, streambank protection, planned grazing systems, and livestock management.

For any grazing management measure to work, it must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, and particular operation involved.

For both pasture and rangeland, areas should be provided for livestock watering, supplemental minerals, and shade that are located away from streambanks and

Five Steps to a Successful Prescribed Grazing Management Plan

1. Inventory existing resources and range/pasture conditions
2. Determine management goals and objectives
3. Map out two or more grazing management units
4. Develop a grazing schedule to implement
5. Develop a monitoring and evaluation strategy

Source: *Best Management Practices for Grazing Montana,* Montana Watershed Coordination Council's Grazing Practices Work Group, 1999.

riparian zones where necessary and practical. This will be accomplished by managing livestock grazing and providing facilities for water, minerals, and shade as needed.

Contact your county Cooperative Extension agent, USDA–NRCS district conservationist, or the local Soil and Water Conservation District.

The rancher may seek technical assistance from Cooperative Extension, NRCS, Soil and Water Conservation Districts, or other agencies to help identify water quality problems, develop management measures (statements of water quality goals or objectives), and select management practices. The amount or extent to which a practice is applied must be consistent with national, state, and basin water quality goals and should reflect the relative contribution of that type of land use activity toward water quality problems within the basin. This technical assistance will result in a plan, typically known as a ranch plan or conservation plan.

Additional information on grazing management can be found in the NRCS National Range and Pasture Handbook (USDA-NRCS, 1997b), as well as the Bureau of Land Management's (BLM) Technical Reference Series on Grazing.[1]

The Management Practices set forth below have been found by the U.S. Environmental Protection Agency (EPA) to be representative of the types of practices that can be applied successfully to achieve the management measure for grazing. The NRCS management practice number and definition are provided for each management practice, where available. Other practices may be appropriate due to site specific factors. State and local requirements may apply.

Grazing Management Practices

Appropriate grazing management systems ensure proper grazing use by adjusting grazing intensity and duration to reflect the availability of forage and feed designated for livestock uses, and by controlling animal movement through the operat-

[1] Four key references within the BLM's Technical Reference Series on Grazing include *Grazing Management for Riparian-Wetland Areas* (Leonard et al., 1997), *Process for Assessing Proper Functioning Condition* (Prichard et al., 1993), *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas* (USDOI-BLM, USDA-Forest Service, and USDA-NRCS, 1998), and *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas* (USDOI-BLM, USDA-Forest Service, and USDA-NRCS, 1999). Other references of similar interest include *Successful Strategies for Grazing Cattle in Riparian Zones*, Riparian Tech Bulletin #4, USDOI, Montana BLM, January 1998; and *Effective Cattle Management in Riparian Zones: A Field Survey and Literature Review*, Riparian Tech Bulletin #3, USDOI, Montana BLM, November 1997.

ing unit of grazing land. Grazing used as a tool for promoting vegetative vigor can help maintain live vegetation and litter cover from actively growing grasses and forbs and help reduce the soil erosion rates below the natural erosion rates for the soil type and pre-existing vegetative cover. The use of grazing management systems can help maintain riparian and other resource objectives and can help meet the specific management objectives of the desired quality, quantity, and age distribution of vegetation. Practices that accomplish this are:

- ❒ **Grazing Management Plan:** A strategy or system designed to manage the timing, intensity, frequency, and duration of grazing to protect and/or enhance environmental values while maintaining or increasing the economic viability of the grazing operation. This applies to both upland and riparian management.
- ❒ **Pasture and Hay Planting (512):** Establishing native or introduced forage species.
- ❒ **Rangeland planting (550):** Establishment of adapted perennial vegetation such as grasses, forbs, legumes, shrubs, and trees.
- ❒ **Forage Harvest Management (511):** The timely cutting and removal of forages from the field as hay, greenchop, or ensilage.
- ❒ **Prescribed Grazing (528A):** The controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve a specified objective.
- ❒ **Use Exclusion (472):** Exclusion of animals, people, or vehicles from an area to protect, maintain, or improve the quantity and quality of the plant, animal, soil, air, water, and aesthetic resources and human health safety.
- ❒ **Nutrient Management (590):** Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.

Alternate Water Supply Practices

Providing water and mineral supplement facilities away from streams will help keep livestock away from streambanks and riparian zones. The establishment of alternate water supplies for livestock is an essential component of this measure when problems related to the distribution of livestock occur in a grazing unit. In most western states, securing water rights may be necessary. Access to a developed or natural water supply that is protective of streambank and riparian zones can be provided by using the stream crossing (interim) technology to build a watering site. In some locations, artificial shade may be constructed to encourage use of upland sites for shading and loafing. Providing water can be accomplished through the following NRCS practices and the stream crossing (interim) practice of the following section. Practices include:

Practices have been developed for grazing management, alternative water supply, riparian grazing, and land stabilization.

- ❒ **Irrigation Water Management (449):** Irrigation water management is the process of determining and controlling the volume, frequency, and application rate of irrigation water in a planned, efficient manner.
- ❒ **Pipeline (516):** Pipeline installed for conveying water for livestock or for recreation.
- ❒ **Pond (378):** A water impoundment made by constructing a dam or an embankment or by excavation of a pit or dugout.

- ❒ **Trough or Tank (614):** A trough or tank, with needed devices for water control and waste water disposal, installed to provide drinking water for livestock.
- ❒ **Well (642):** A well constructed or improved to provide water for irrigation, livestock, wildlife, or recreation.
- ❒ **Spring Development (574):** Improving springs and seeps by excavating, cleaning, capping, or providing collection and storage facilities.

Riparian Grazing Practices

When implementing a grazing management system (see table 4e-1) within a riparian area, it may at times be necessary to minimize livestock access to riparian zones, ponds or lake shores, wetlands, and streambanks to protect these areas from physical disturbance. The use of management practices for limiting access should be linked in the overall management plan to proper grazing use and other water quality goals. Practices include:

- ❒ **Fence (382):** A constructed barrier to livestock, wildlife, or people.
- ❒ **Animal Trails and Walkways (575):** A travel facility for livestock and/or wildlife to provide movement through difficult or ecologically sensitive terrain.
- ❒ **Stream Crossing (Interim):** A stabilized area to provide controlled access across a stream for livestock and farm machinery.

Land and Streambank Stabilization Practices

It may be necessary to improve or reestablish the vegetative cover on rangeland and pastures or on streambanks to reduce erosion rates. The following practices can be used to reestablish vegetation:

- ❒ **Nutrient Management (590):** Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.
- ❒ **Channel Vegetation (322):** Establishing and maintaining adequate plants on channel banks, berms, spoil, and associated areas.
- ❒ **Pasture and Hay Planting (512):** Establishing native or introduced forage species.
- ❒ **Rangeland Planting (550):** Establishment of adapted perennial vegetation such as grasses, forbs, legumes, shrubs, and trees.
- ❒ **Critical Area Planting (342):** Planting vegetation, such as trees, shrubs, vines, grasses, or legumes, on highly erodible or critically eroding areas. (Does not include tree planting mainly for wood products.)
- ❒ **Brush Management (314):** Removal, reduction, or manipulation of non-herbaceous plants.
- ❒ **Grazing Land Mechanical Treatment (548):** Modifying physical soil and/or plant conditions with mechanical tools by treatments such as; pitting, contour furrowing, and ripping or subsoiling.
- ❒ **Grade Stabilization Structure (410):** A structure used to stabilize the grade and control erosion in natural or artificial channels, to prevent the

formation and advance of gullies, and to enhance environmental quality and reduce pollution hazards.

- ❒ **Prescribed Burning (338):** Applying controlled fire to predetermined area.
- ❒ **Stream Corridor Improvement (interim):** Restoration of a modified or damaged stream to a more natural state using bioengineering techniques to protect the banks and reestablish the riparian vegetation.
- ❒ **Land Reclamation Landslide Treatment (453):** Treating inplace materials, mine spoil, mine waste, or overburden to reduce downslope movement.
- ❒ **Sediment Basin (350):** A basin constructed to collect and store debris or sediment. Stock water ponds often act as sediment basins.
- ❒ **Wetland Wildlife Habitat Management (644):** Retaining, creating or managing habitat for wetland wildlife. The construction or restoration of wetlands.
- ❒ **Stream Channel Stabilization (584):** Using vegetation and structures to stabilize and prevent scouring and erosion of stream channels.
- ❒ **Wetland Restoration (657):** A rehabilitation of a drained or degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to the natural condition to the extent practicable.
- ❒ **Streambank and Shoreline Protection (580):** Using vegetation or structures to stabilize and protect banks of streams, lakes, or estuaries, against scour and erosion.
- ❒ **Riparian Forest Buffer/Herbaceous Cover (391A/390):** Establish an area of trees, shrubs, grasses, or forbs adjacent to and up-gradient from water bodies.

Monitoring Grazing Land Condition

Monitoring is essential to determining whether grazing management objectives are being achieved (Chaney et al., 1993). An integrated approach to monitoring will evaluate nutrient cycling, soil and water quality, and plant community dynamics. To evaluate and adjust management strategies, monitoring should be conducted on both a site specific or allotment level and at the watershed or subwatershed level to determine rangeland condition status and trends. A wide array of monitoring options exist, including the use of photo points, vegetation sampling, soil assessments, water quality and quantity analyses and assessments of watershed, riparian and stream condition. A number of methods are available for monitoring vegetation and for measuring forage utilization and residuals to determine the effects of grazing and browsing on rangelands (Interagency Technical Team, 1996 a, 1996 b; Ruyle and Forst, 1993). To assess vegetative consumption and assist in the nutritional management of livestock and wildlife, other methods, such as clipping procedures, have been developed (Brence and Sheley, 1997).

Numerous publications aid the rangeland manager in determining the status and trends of rangeland resources. Recommended publications on rangeland monitoring include:

- Monitoring the Vegetation Resources in Riparian Areas (Winward, 2000).
- Interpreting Indicators of Rangeland Health (USDOI-BLM and USGS, and USDA-NRCS and ARS, 2000).
- Monitoring Rangelands: Interpreting What You See (Rasmussen et al., 2001)
- Repeat Photography, Monitoring Made Easy (Rasmussen and Voth, 2001)

See page 143 for additional references on rangeland management.

Decisions regarding changes to stocking rates and preservation of an adequate amount of forage to ensure good rangeland health and minimize water quality impacts are dependent upon good information. Grazing land should be checked frequently to ensure that the plants and animals are meeting management objectives, depending on the management techniques being used.

Spreadsheet applications are available to make tracking and management of grazing cells much easier (Gum and Ruyle, 1993). These spreadsheets address both growing and dormant seasons, and incorporate such factors as the number and size of paddocks, the number of days each paddock is to be rested, and the relative quality of forage in each paddock. Some studies also recommend monitoring plan implementation (i.e., how well the grazing management plan is followed) and effectiveness (i.e., have objectives for vegetation condition been met) (Clary and Leininger, 2000).

Recognizing that the pattern of grazing use varies across an enclosed grazing area, or management unit, USDA recommends the identification of key grazing areas and key plant species to aid in grazing land management (USDA-NRCS, 1997b). By protecting and monitoring the key grazing areas and key plant species, it is believed that the management unit as a whole will be protected.

Practice Effectiveness

Eckert and Spencer (1987) studied the effects of a three-pasture, rest-rotation management plan on the growth and reproduction of heavily grazed native bunch grasses in Wyoming. The results indicated that rangeland improvement under this otherwise appropriate rotation grazing system is hindered by heavy grazing. Stocking rates on the study plots exceeded the carrying capacity of the land and would decrease native grasses and increase potential erosion and sedimentation.

Van Poollen and Lacey (1979) showed that herbage production was greater for managed grazing versus continuous grazing, greater for moderate versus heavy intensity grazing, and greater for light- versus moderate-intensity grazing.

Tiedemann et al. (1988) studied the effects of four grazing strategies on bacteria levels in 13 Oregon watersheds in the summer of 1984. Although wildlife were believed to be significant sources of bacteria in each of the study watersheds, results indicate that lower fecal coliform levels can be achieved at stocking rates of about 20 ac/AUM (acres per animal unit month) if management for livestock distribution, fencing, and water developments are used (Table 4e-2). The study also indicates that, even with various management practices, the highest fecal coliform levels were associated with the higher stocking rates (6.9 ac/AUM) employed in strategy D.

Owens et al. (1982) measured nitrogen losses from an Ohio pasture under a medium-fertility, 12-month pasture program from 1974 to 1979. The results included no measurable soil loss from three watersheds under summer grazing only, and increased average TN concentrations and total soluble N loads from watersheds under summer grazing and winter feeding versus watersheds under summer grazing only (Table 4e-3).

Data from a comparison of the expected effectiveness of various grazing and streambank practices in controlling sedimentation in the Molar Flats Pilot Study Area in Fresno County, California indicate that planned grazing systems are the most effective single practice for reducing sheet and rill erosion (Fresno Field Office, 1979).

By switching grazing allotments from continuous, season-long grazing to a three-pasture, rest-rotation system, the U.S. Forest Service was able to achieve

Table 4e-2. Bacterial water quality responses to four grazing strategies (Tiedemann et al., 1988).

Practice		Geometric Mean Fecal Coliform Count
Strategy A:	Ungrazed	40/L
Strategy B:	Grazing without management for livestock distribution; 20.3 ac/AUM.	150/L
Strategy C:	Grazing with management for livestock distribution: fencing and water developments; 19.0 ac/AUM.	90/L
Strategy D:	Intensive grazing management, including practices to attain uniform livestock distribution and improve forage production with cultural practices such as seeding, fertilizing, and forest thinning; 6.9 ac/AUM.	920/L

Table 4e-3. Nitrogen losses from medium-fertility, 12-month pasture program (Owens et al., 1982).

Practice	Soil Loss (kg/ha)	Total Sediment N Transport (kg/ha)	Total N Concentration (mg/l[a])	Total Soluble N Transport (kg/ha)[a]
Summer Grazing Only				
Growing season	—	—	3.7	0.4
Dormant season	—	—	1.8	0.1
Year	—	—	3.0	0.5
Summer Grazing – Winter Feeding				
Growing season	251	1.4	4.9	2.5
Dormant season	1,104	6.6	14.6	11.3
Year	1,355	8.0	10.7	13.8

[a]Five-year average (1974-1979)

major improvements in the vegetation in the Tonto National Forest in Arizona (Chaney et al., 1990). For example, cottonwood populations increased from 20 per 100 acres to more than 2,000 per 100 acres in six years, while at the same time the amount of livestock forage grazed increased by 27 percent. Similar improvements from improved grazing management were documented through case studies in Idaho, Nevada, Oregon, South Dakota, Texas, Utah, and Wyoming.

Hubert et al. (1985) showed in plot studies in Wyoming that livestock exclusion and reductions in stocking rates can result in improved habitat conditions for brook trout. In this study, the primary vegetation was willows, Pete Creek stocking density was 7.88 ac/AUM (acres per animal unit month), and Cherry Creek stocking density was 10 cows per acre (Table 4e-4).

Platts and Nelson (1989) used plot studies in Utah to evaluate the effects of livestock exclusion on riparian plant communities and streambanks. Several streambank characteristics that are related to the quality of fish habitat were measured, including bank stability, stream shore depth, streambank angle, undercut, overhang, and streambank alteration. The results clearly show better fish habitat in the areas where livestock were excluded (Table 4e-5).

Kauffman et al. (1983a) showed that fall cattle grazing decreases the standing crop of some riparian plant communities by as much as 21% versus areas where cattle are excluded, while causing increases for other plant communities. This study, conducted in Oregon from 1978 to 1980, incorporated stocking rates of 3.2 to 4.2 ac/AUM.

Buckhouse (1993) did an extensive review of livestock impacts on riparian systems. Researchers documented many factors interrelated with grazing effects, primarily dealing with instream ecology, terrestrial wildlife, and riparian vegeta-

Table 4e-4. Grazing management influences on two brook trout streams in Wyoming (Hubert et al., 1985).

	Pete Creek (n=3)		Cherry Creek (n=4)	
Stream Parameter	**Heavily Grazed (mean)**	**Lightly Grazed (mean)**	**Outside Exclosure (mean)**	**Inside Exclosure (mean)**
Width	2.9	2.2[a]	2.9	2.5[a]
Depth	0.07	0.11[a]	0.08	0.09[a]
Width/depth ratio	43	21	37	28[a]
Coefficient of variation in depth	47.3	66.6[a]	57	71
Percent greater than 22 cm deep	9.0	22.3[b]	6.7	21.0[a]
Percent overhanging bank cover	2.7	30.0[a]	24.0	15.3
Percent overhanging vegetation	0	11.7[a]	8.5	18.0
Percent shaded area	0.7	18.3[a]	23.5	28.0
Percent silt substrate	35	52	22	13[a]
Percent bare soil along banks	19.7	13.3	22.8	12.3[a]
Percent litter along banks	7.0	6.0	10.0	6.8[a]

[a] Indicates statistical significance at p<=0.05.
[b] Indicates statistical significance at p<=0.1.

Table 4e-5. Streambank characteristics for grazed versus rested riparian areas (Platts and Nelson, 1989).

Streambank Characteristic (unit)	Grazed	Rested
Extent (m)	4.1	2.5
Bank stability (%)	32.0	88.5
Stream-short depth (cm)	6.4	14.9
Bank angle (°)	127.0	81.0
Undercut (cm)	6.4	16.5
Overhang (cm)	1.8	18.3
Streambank alteration (%)	72.0	19.0

Grazing management research indicates that local practices designed for area soils, vegetation, and stocking rates are more likely to succeed than applying one system of BMPs across the entire region.

tion. Permanent removal of grazing will not guarantee maximum herbaceous plant production. Researches found that a protected Kentucky bluegrass meadow reached peak production in six years and then declined until production was similar to the adjacent area grazed season-long. The accumulation of litter over a period of years seems to retard forage production in wetlands. Thus, some grazing of riparian areas could have beneficial effects. Stoltzfus and Lanyon (1992) also identified that fencing a riparian zone protects herd health from infectious bacteria, hoof diseases, poor quality drinking water, and provides a wildlife habitat.

The effect of grazing on streambanks depends on site conditions, management practices, timing, and other factors. Kauffman et al. (1983b) found that late-season grazing increased bank erosion relative to ungrazed areas in Oregon. If late season grazing is permitted, adequate time for regrowth should be allowed prior to the next major runoff event. Hallock (1996) found that delaying grazing in riparian pastures until the soil dries in the late spring did not degrade the streambanks or change stream morphology significantly in a Coastal California Watershed.

Lugbill (1990) estimates that stream protection in the Potomac River Basin will reduce total nitrogen (TN) and total phosphorus (TP) loads by 15%, while grazing land protection and permanent vegetation improvement will reduce TN and TP loads by 60%.

Nutrient loss is minimal where the riparian pasture remains in good condition. Vegetation buffers the stream from direct waste input and assimilates the nutrients into plant tissue. Gary et al. (1983) evaluated the effects on a small stream in central Colorado of spring cattle grazing on pastures. Nitrate nitrogen did not increase significantly and ammonia increased significantly only once.

Meals (2001) reported significant water quality improvements in Vermont streams following livestock exclusion and riparian restoration on dairy pastureland. Mean total phosphorus concentrations were reduced by 15%, and total P load was reduced by 49% over a three-year period following riparian restoration. Indicator bacteria counts in treated streams fell by 29% - 46%.

Photos have been used to document improvements in riparian condition due to such practices as rest rotations and exclusion (Chaney et al., 1993). The authors emphasize the importance, however, of looking beyond the vegetation and examining whether water quality benefits also accrue. Vegetative response usually happens in one to five years, however, stream channel changes may take decades.

Miner et al. (1991) showed that the provision of supplemental water facilities reduced the time each cow spent in the stream within 4 hours of feeding from 14.5 minutes to 0.17 minutes (8-day average). This pasture study in Oregon showed that the 90 cows without supplemental water spent a daily average of 25.6 minutes per cow in the stream. For the 60 cows that were provided a supplemental water tank, the average daily time in the stream was 1.6 minutes per cow, while 11.6 minutes were spent at the water tank. Based on this study, the authors expect that a 90% decrease in time spent in the stream will substantially decrease bacterial loading from the cows.

Plant species production management is central to effective grazing BMPs. Consider ecosystem productivity, harvest rates by stock and wildlife, and regenerative capacity.

McDougald et al. (1989) tested the effects of moving supplemental feeding locations on riparian areas of hardwood rangeland in California. With stocking rates of approximately 1 ac/AUM, they found that moving supplemental feeding locations away from water sources into areas with high amounts of forage greatly reduces the impacts of cattle on riparian areas (Table 4e-6).

Table 4e-6. The effects of supplemental feeding location on riparian area vegetation (McDougald et al., 1989).

	Percentage of riparian area with the following levels of residual dry matter in early October		
Practice	**Low**	**Moderate**	**High**
Supplemental feeding located close to riparian areas:			
1982-85 Range Unit 1	48	38	13
1982-85 Range Unit 8	59	29	12
1986-87 Range Unit 8	54	33	13
Supplemental feeding moved away from riparian area:			
1986-87 Range Unit 1	1	27	72

Factors in the Selection of Management Practices

The selection of grazing management practices for this measure should be based on an evaluation of current conditions, problems identified, quality criteria, and management goals. Successful resource management on grazing lands includes appropriate application of a combination of practices that will meet the needs of the rangeland and pasture ecosystem (i.e., the soil, water, air, plant, and animal (including fish and shellfish) resources) and the objectives of the land user.

For a sound grazing land management system to function properly and to provide for a sustained level of productivity, the following should be considered:

- ❒ Know the key factors of plant species management, their growth habits, and their response to different seasons and degrees of use by various kinds and classes of livestock.
- ❒ Know the demand for, and seasons of use of, forage and browse by wildlife species.
- ❒ Know the amount of plant residue or grazing height that should be left to protect grazing land soils from wind and water erosion, provide for plant health and regrowth, and provide the riparian vegetation height desired to trap sediment or other pollutants.
- ❒ Know the ecological site production capabilities for rangeland and the forage suitability group capabilities for pasture so an initial stocking rate can be established.
- ❒ Know how to use livestock as a tool (i.e., control timing and duration of grazing) in the management of the rangeland ecosystems and pastures to ensure the health and vigor of the plants, soil tilth, proper nutrient cycling, erosion control, and riparian area management, while at the same time meeting livestock nutritional requirements.
- ❒ Establish grazing unit sizes, watering, shade (where possible) and mineral locations, etc. to secure optimum livestock distribution and proper vegetation use.
- ❒ Provide for livestock herding, as needed, to protect sensitive areas from excessive use at critical times.
- ❒ Work with state game management agencies to agree on proper stocking numbers prior to wildlife harvest. Encourage proper wildlife harvesting to ensure proper population densities and forage balances.
- ❒ Know the livestock diet requirements in terms of quantity and quality to ensure that there are enough grazing units to provide adequate livestock nutrition for the season and the kind and classes of animals on the farm/ ranch.
- ❒ Maintain a flexible grazing system to adjust for unexpected environmentally and economically generated problems.
- ❒ Follow special requirements to protect threatened or endangered species.

To speed up the rehabilitation process of riparian zones, seeding can be used as a proper management practice. This strategy, however, can be very expensive and risky. Riparian zones can be rehabilitated positively and at a lower cost through improving livestock distribution, better watering systems, fencing, or reducing stock rates. In areas where the desirable native perennial forage plants are nearly extinct, seeding is essential. Such areas will have a poor to very poor rating of forage condition and are difficult to restore.

Cost of Practices

Costs

Much of the cost associated with implementing grazing management practices is due to fencing installation, water development, and seeding. Costs vary according to region and type of practice. Generally, the more components or structures a practice requires, the more expensive it is. However, cost-share is usually available from the USDA and other federal agencies for most of these practices.

The principal direct costs of providing grazing practices vary from relatively low variable costs of dispersed salt blocks to higher capital and maintenance costs of supplementary water supply improvements. Improving the distribution of grazing pressure by developing a planned grazing system or strategically locating water troughs, salt, or feeding areas to draw cattle away from riparian zones can result in improved utilization of existing forage, better water quality, and improved riparian habitat.

Principal direct costs of excluding livestock from the riparian zone for a period of time are the capital and maintenance costs for fencing to restrict access to streamside areas and/or the cost of herders to achieve the same results. In addition, there may be an indirect cost of the forage that is removed from grazing by the exclusion.

Principal direct costs of improving or reestablishing grazing land include the costs of seed, fertilizer, and herbicides needed to establish the new forage stand and the labor and machinery costs required for preparation, planting, cultivation, and weed control (Table 4e-7). An indirect cost may be the forage that is removed from grazing during the reestablishment work and rest for seeding establishment.

Table 4e-7. Cost of forage improvement/reestablishment for grazing management (EPA, 1993a).

					Constant Dollar[a]	
Location	Year	Type	Unit	Reported Capital Costs $/Unit	Capital Costs 1991 $/Unit	Annualized Costs 1991 $/Unit
Alabama[b]	1990	planting (seed, lime & fertilizer)	acre	84 - 197	83 - 195	12.37 - 29.00
Nebraska[c]	1991	establishment	acre	47	47	7.00
		seeding	acre	45	45	6.71
Oregon[d]	1991	establishment	acre	27	27	4.02

[a] Reported costs inflated to 1991 constant dollars by the ratio of indices of prices paid by farmers for seed, 1997=100. Capital costs are annualized at 8% interest for 10 years.
[b] Alabama Soil Conservation Service, 1990.
[c] Hermsmeyer, 1991.
[d] USDA–ASCS, 1991b.

Water Development

The availability and feasibility of supplementary water development varies considerably between arid western areas and humid eastern areas, but costs for water development, including spring development and pipeline watering, are similar (Table 4e-8).

Table 4e-8. Cost of water development for grazing management (EPA, 1993a).

Location	Year	Type	Unit	Reported Capital Costs $/Unit	Constant Dollar[a] Capital Costs 1991 $/Unit	Constant Dollar[a] Annualized Costs 1991 $/Unit
California[b]	1979	pipeline	foot	0.28	0.35	0.05
Kansas[c]	1989	spring	each	1,239.00	1,282.94	191.20
		spring	each	1,389.00	1,438.26	214.34
Maine[d]	1988	pipeline	each	831.00	879.17	131.02
Alabama[e]	1990	spring	each	1,500.00	1,520.83	226.65
		pipeline	foot	1.60	1.62	0.24
		trough	each	1,000.00	1,013.89	151.10
Nebraska[f]	1991	pipeline	foot	1.31	1.31	0.20
		tank	each	370.00	370.00	55.14
Utah[g]	1968	spring	each	200.00	389.33	58.02
Oregon[h]	1991	pipeline	foot	0.20	0.20	0.03
		tank	each	183.00	183.00	27.27

[a] Reported costs inflated to 1991 constant dollars by the ratio of indices of prices paid by farmers for building and fencing, 1977=100. Capital costs are annualized at 8% interest for 10 years.
[b] Fresno Field Office, 1979.
[c] Northup et al., 1989.
[d] Cumberland County Soil and Water Conservation District, undated.
[e] Alabama Soil Conservation Service, 1990.
[f] Hermsmeyer, 1991.
[g] Workman and Hooper, 1968.
[h] USDA–ASCS, 1991b.

Use Exclusion

There is considerable difference between multistrand barbed wire, chiefly used for perimeter fencing and permanent stream exclusion and diversions, and single- or double-strand smoothwire electrified fencing used for stream exclusion and temporary divisions within permanent pastures. The latter may be all that is needed to accomplish most livestock exclusion in a smaller, managed, riparian pasture (Table 4e-9). In some cases, exclusion of livestock from waterways and riparian areas can be accomplished through the use of hedgerows, intensive herding/grazing management, or provision of feed, water, and shade at alternative sites.

Overall Costs of the Grazing Management Measure

Since the combination of practices needed to implement the management measure depends on site-specific conditions that are highly variable, the overall cost of the measure is best estimated from similar combinations of practices applied under the Agricultural Conservation Program (ACP), Rural Clean Water Program (RCWP), and similar activities.

Table 4e-9. Cost of livestock exclusion for grazing management (EPA, 1993a).

Location	Year	Type	Unit	Reported Capital Costs $/Unit	Constant Dollar[a] Capital Costs 1991 $/Unit	Constant Dollar[a] Annualized Costs 1991 $/Unit
California[b]	1979	permanent	mile	2,000	2,474.58	368.78
Alabama[c]	1990	permanent	mile	3,960	4,015.00	598.35
		net wire	mile	5,808	5,888.67	877.58
		electric	mile	2,640	2,676.67	398.90
Nebraska[d]	1991	permanent	mile	2,478	2,478.00	369.30
Great Lakes[e]	1989	permanent	mile	2,100 - 2,400	2,174.47 - 2,485.11	324.06 - 370.35
Oregon[1]	1991	permanent	mile	2,640	2,640.00	393.44

[a] Reported costs inflated to 1991 constant dollars by the ratio of indices of prices paid by farmers for building and fencing, 1977=100. Capital costs are annualized at 8% interest for 10 years.

[b] Fresno Field Office, 1979.

[c] Alabama Soil Conservation Service, 1990.

[d] Hermsmeyer, 1991.

[e] DPRA, 1989.

[1] USDA–ASCS, 1991b.