Grazing Management Principles and Practices

Jaimi Stokes

Colorado State University

Western Center for Integrated Resource Management

Professional Paper 2013

Introduction

Grazing is a complementary and natural process occurring in the ecosystem. It has occurred historically with wildlife use and has evolved as wildlife and land uses have changed to include managed grazing systems including wildlife and domestic individual and multi-specie animals. Grazing, when managed well, is a valuable disturbance that can be used to manipulate vegetation and maintain ecosystem health and balance.

We live in disturbance driven ecosystems. Disturbances that drive changes in these ecosystems are fire, insects, drought, flooding, early and late frosts, climate change, development and habitat fragmentation, logging, grazing, and recreation. As land managers, we have little control over most of these disturbances. However, we can use our resources to imitate natural disturbances to manage the vegetation and habitat in these ecosystems to improve rangeland health and productivity. Some tools that we use are prescribed fire, mechanical and chemical treatments for invasive species, reseeding, and prescribed grazing. In this paper, I will focus on the option of using grazing to manage rangeland systems.

History of Rangeland Grazing in the United States

The western range livestock industry came into prominence in the United States soon after the Civil War because capitalization costs were minimal. Cattlemen were drawn to graze on federal land which had low associated costs and a seemingly unlimited supply of free forage. In the late 1800's, as increasing numbers of cattle were grazed without management, the land became severely overused and depleted. Ranchers began to find other means to protect their use of what they considered their customary range. These means included using barbed wire fences to barricade their land, water sources, and cattle. In 1934, after these attempts caused repeated conflicts and failed to improve the range, the Taylor Grazing Act was enacted. This act was put into place to help regulate the use of public land for grazing purposes and allotted ranchers certain parcels of land. Additionally, “fees collected for grazing livestock on public lands was returned to the appropriate grazing district to be used for range improvements”. The Taylor Grazing Act helped to stabilize rancher’s operations and allow them to continue raising their livestock. In 1976, changing social values with respect to environmental protection and conservation of natural resources led to the Federal Land Policy and Management Act (FLPMA). The FLPMA considers livestock grazing a legitimate use of public lands; however, multiple uses such as recreation, wildlife habitat, riparian management, endangered species management, mining, hunting, and cultural resource protection are also acknowledged and protected. To graze livestock on federal lands now requires grazing permits, allotment management plans, payment for allotted AUMs, and following the federal recommended considerations for multiple uses of the land. (1)

Selecting the Grazing Species/Multi-Species Grazing

Selecting the best species to graze often depends on what animal resources you have available. However, when managing for vegetation improvement without animal resource limitations, species impact on grazing area recovery or improvement should be weighed and considered before deciding what animal species or if multiple species should be used to graze. The decision of what species to graze may also depend on the topographic features of the area. For instance, cattle tend to prefer areas that are less steep than goats. Therefore, goats may be a better option in steep terrain than cattle. Goats also have different diet selectivity than cattle.

Using multiple species grazing is a beneficial tool as grasses and browses have different cell walls, compounds, and growth dispersion. Grasses are single leafed plants that grow in uniform distribution, making it easier for an animal to graze. They provide a uniform and consistent food source with small amounts of nutritious material within each plant cell. Grasses also have thick cell walls containing high levels of cellulose, a carbohydrate produced by plants that requires lengthy fermentation to thoroughly digest. Browse are woody plants that grow in discrete, widely dispersed patches. Browse includes forbs (woody plants), tree and shrub leaves and stems. Browse grows in a branching manner where different plant parts vary in level of nutrition. Browse contains more cell contents, which are highly digestible. However, the thinner cell wall of browse is actually more difficult to digest because of the high levels of lignin, a compound found in some plants that is completely indigestible.(2) The table below outlines these characteristics between grasses and browse.

Characteristic	Grasses	Browses
Cell wall	• Thick • Greater proportion is cellulose/hemicellulose	• Thin • Greater proportion is lignin
Plant defense compounds	• Silica	• Phenolics – tannins • Terpenes • Alkaloids & other toxins
Plant architecture	• Fine-scaled heterogeneity in nutritional quality within a plant • New growth added at base • Low growth form • 3-dimensional volume	• Coarse-scaled heterogeneity in nutritional quality within a plant • New growth added at tips • Low to high growth form • Complex, diffuse, branching architecture
Dispersion	• Uniform	• Dispersed/discrete

Figure 1: A relative comparison of chemical and structural differences between grasses and browse. (3)

Animal species also have different digestive systems, chewing mechanisms and habitat selections due to nutritional needs. Ruminant grazers have a large rumen that can hold large quantities of food. Because of its large capacity, a grazer can keep food in the rumen longer for extensive digestion of cellulose. Browsers have smaller rumens and do not hold food in their rumens as long. To compensate for a short retention time, browsers have a higher intake rate of easily digested food that requires less fermentation. The size and shape of the mouth and teeth of ruminants also affects their feeding strategy. An example of a grazer is a cow. Cows have wider muzzles and a wider row of teeth that are suitable for clipping a continuous plot of grass, but make it very difficult to select specific plant parts. Browsers, such as sheep and goats, have narrower teeth and muzzles that allow for greater manipulation and selection of plant parts.. Overall body size also explains feeding behavior because fermentation rate in the rumen decreases with increasing body mass. (2) In other words, a large ruminant, like a cow, will hold forage in the rumen longer than a goat. Additional specific characteristics of grazers and browsers are outlined in the table below.

Characteristic	Grazers	Browsers
Foregut	• Large • Subdivided • Smaller opening between reticulum & omasum • Sparser, more uneven papillae	• Small • Simple • Larger opening between reticulum & omasum • Denser, more even papillae
True stomach (abomasum)	• Smaller	• Larger
Hindgut	• Smaller cecum and intestines	• Larger cecum and intestines
Salivary glands	• Smaller parotid salivary glands	• Larger parotid salivary glands
Liver	• Smaller	• Larger
Mouth	• Wider muzzle and incisor row • Lower incisors of similar size • Incisors project forward • Smaller mouth opening and stiffer lips	• Narrower muzzle and incisor row • Central incisors broader than outside ones • Incisors more upright • Wider mouth opening with longer tongue
Teeth	• Higher crowns in some species	• Lower crowns in some species

Figure 2: A relative comparison of digestive anatomy between grazers and browsers based on Hofmann (1989), Hoeck (1975), and Robbins et al. (1995). (3)

Cattle are primarily grazers; their diets typically consist of 70% grass. Goats are browsers; their diets consist of 60% browse. Sheep's diets consist of about 50% grass, 30% forbs, and 20% browse. Each species differ in the parts of the landscape they prefer to graze, therefore, managed multispecies grazing can effectively utilize and improve forage without competition. (4)

Grazing preferences have been shown to influence which plants dominate grazing lands, therefore, grazing more than one species over a landscape will improve botanical composition because they will select for different plants. Other benefits of multispecies grazing include; improved animal performance, reduction of parasites, and more animal production per unit of land. (4) Multi-species grazing has also been shown to be a powerful tool against weed invasion. The figure below shows the trend in cattle, sheep, and weeds in the 11 Western States. It illustrates that the decline in sheep numbers accounts for almost 90% of the variation in weed acreage increase.

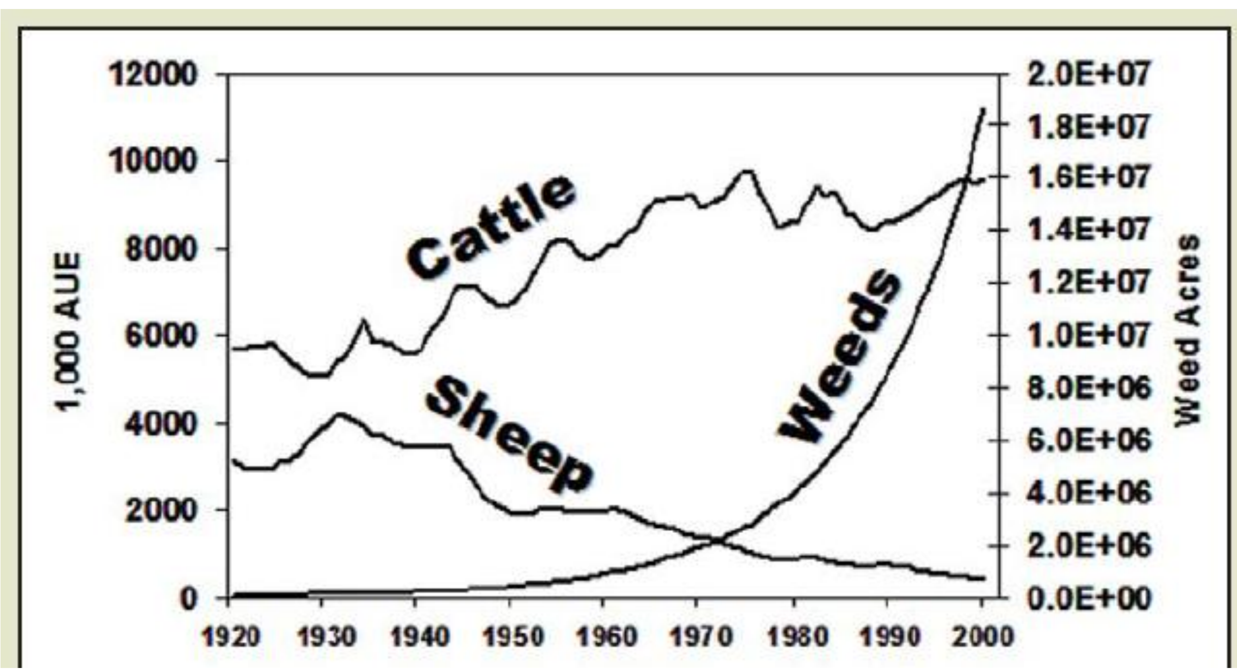


Figure 3: Trend in cattle, sheep, and weeds in the 11 Western States. The decline in sheep numbers accounts for almost 90% of the variation in weed acreage. (4)

Multi-species grazing is an important grazing consideration as it provides a viable method for improving biological and economic efficiency of rangelands utilization. (5)

Grazing Management Tools

Proper grazing management depends in part on determining correct livestock numbers per area of land, known as the stocking rate. Stocking rate is expressed as animal units per section or animal unit months (AUMs) per acre. An animal unit is defined as a mature (1,000 pound) cow or the equivalent, with an average consumption rate of 26 pounds of forage dry matter per day (6). That makes an AUM equal to about 800 pounds (31 days x 26 pounds per day) of forage. (25) Useable AUMs should be adjusted for utilization by wildlife and forage sustainability. Stocking rate has long been recognized as a fundamental variable determining the sustainability and profitability of grazed rangeland ecosystems. (7) Stocking rate has a high potential to modify the species composition of the vegetation. Plant production decreases with increasing stocking rate, as does individual animal performance. (8) Since high grazing intensities appear to minimize ecosystem function, stocking rates should be adjusted to balance the forage demand of grazing animals with that of the forage production over the annual forage production cycle. The graph below shows the complementary growth pattern of cool and warm season forages.

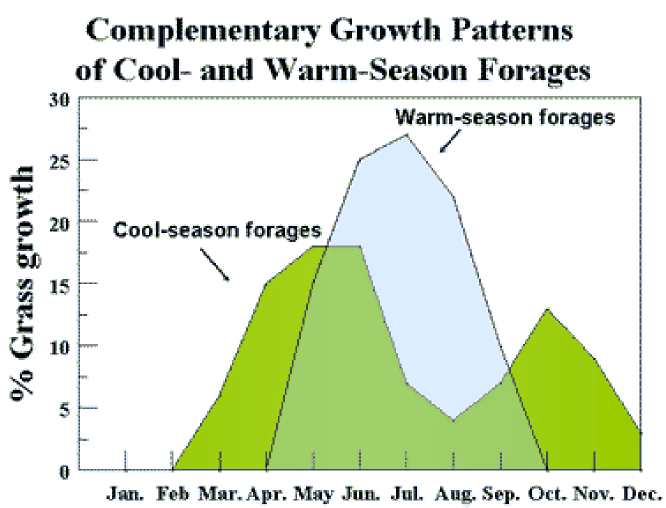


Figure 4: Growth Patterns of Cool and Warm Season Forages. (9)

Season of plant defoliation has unique and consistent effects on plant production. Individual plant production is greatly suppressed by defoliation during the middle of the growing season which coincides with culm elongation and the early boot stage of inflorescence development, especially in bunchgrasses. (10) Ideally, grazing should be matched to capitalize on livestock requirements and productivity while providing for plant development and recovery.

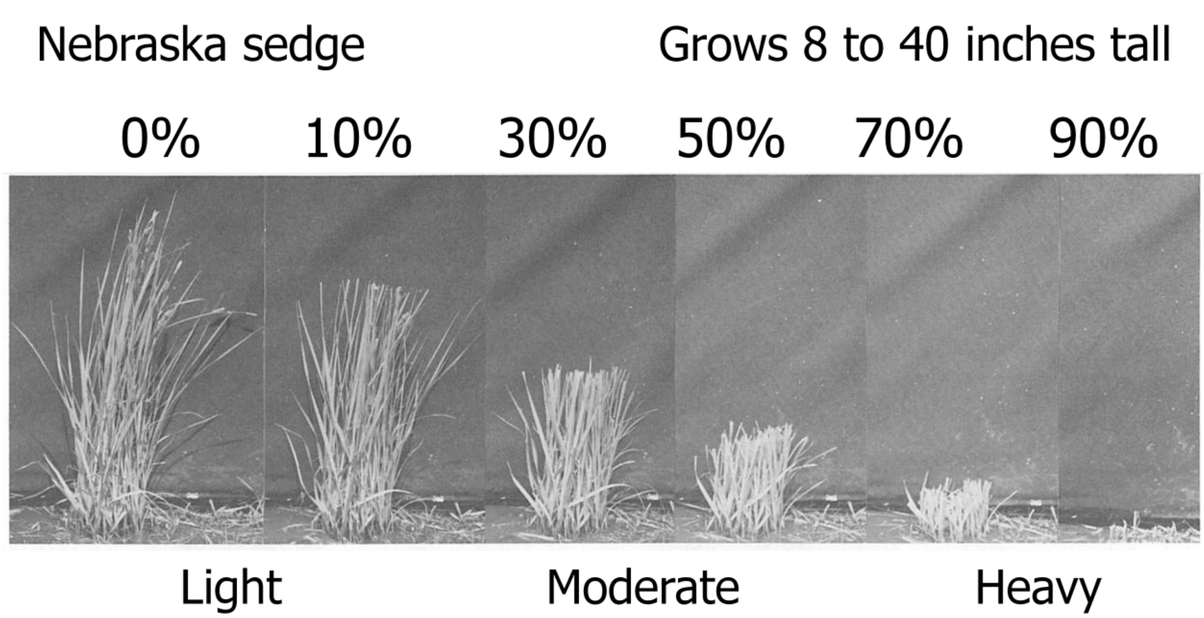
Often, the first action to correct a rangeland problem is to decrease stocking numbers or close that area to livestock grazing. When a problem occurs, it is not generally stocking rates that caused the problem, but rather a lack of management. (11) Closing an area to grazing or under grazing it leads to a condition termed over-rest. When an area is over-rested, the plant material from previous years does not decompose. The dead plant material insulates the soil causing a delayed initiation of plant growth. This dead plant material also prevents sunshine from reaching current year's leaves. This leads to long and slender leaves rather than broad leaves that capture more sunlight. (11) The result is less photosynthetic leaf area and a concurrent decline in production and plant vigor. Continued over-rest leads to an overall decline in habitat quality.

Conversely, an area may also suffer from the consequences of over-use. Over-use of an area will lead to a loss in plant vigor and production. Species can decrease and soils can become compacted. Over use may also disrupt the water cycle in an area and ultimately lead to loss or decline in habitat quality. The consequences seen with over-use and over-rest are similar. The challenge on rangelands is to find the balance between protection, proper use, and species use to improve ecosystem function as a whole.

Timing of grazing refers to the time of the season that grazing occurs. Grazing during the early growth, rapid growth, reproductive, and dormancy periods affect plants differently. Changing the time of the year that the range is grazed will change the impacts that grazing has on rangeland plants. Duration of grazing refers to the length of time a plant is exposed to grazing. Duration affects the intensity of grazing or the utilization rate of the pasture. Frequency or how often a plant is grazed during the growing season also should be factored into this puzzle as plants need time to rest and recover. Livestock grazing based on timing and duration provides more flexible turn outs, with the emphasis being on forage production and plant recovery. (12)

Utilization refers to the amount or percentage of use for each pasture. This percentage is dependent on the goals and objectives of each plan. It is generally classified as light, moderate, or heavy use. Below is a figure showing these levels of use for Nebraska Sedge. (13)

A Photographic Utilization Guide for Key Riparian Gramanoids, by John Kinney and Warren Clary, June 1994



Utilization rates have direct consequences on plant vigor and regrowth. In general, the rule to take half and leave half is ideal (this is demonstrated in the table below). However, in situations such as invasive species removal or monoculture plant communities, using a higher utilization goal will suppress growth of these species which will allow others to establish. (11) Another factor to consider is wildlife utilization. For example, if we take half of the vegetation with cattle grazing in an area that was already 40% utilized by elk, we have left only 30% of photosynthetic plant material for regrowth. This will stop root growth and degrade the landscape.

A plant's ability to recover depends on its capacity to re-establish leaves for photosynthesis. If we don't leave enough of the above ground production in the form of leaves, then the below ground production suffers. The table below shows how grazing affects root-growth. (11)

How Grazing Affects Root Growth	
Percent leaf volume removed	**Percent root growth stoppage**
10%	0%
20%	0%
30%	0%
40%	0%
50%	2-4%
60%	50%
70%	78%
80%	100%
90%	100%

When the below ground root system suffers, the plant has reduced water and mineral uptake, less aboveground growth, loss in plant vigor, less litter on the soil surface, and increased water runoff. The plant also will store less water and have lower forage production when root mass decreases. In areas where roots have been decreased, there is a reduced density of grasses and a greater potential for invasion of non-desirable plants. Drought can exacerbate root loss effects. When managing grazing, we are managing vegetation productivity (i.e., leaf area). This includes planning to utilize areas for grazing benefits while leaving adequate leaf area and root mass for plant growth and vigor.

Types of Grazing Systems:

Common types of grazing systems are continuous or season long, deferred and rest rotation, seasonal suitability, and short duration or management intensive grazing. Riparian systems are managed on a site by site basis and should be a part of the overall grazing plan. Selection of proper grazing systems depends on the objective of the particular system and the limitations of the land and water resources. A table comparing the systems discussed, distinguishing features, and where they are most applicable is shown below. (7)

<table>
<tr><th>Type of Grazing System</th><th>Distinguishing Features</th><th>When or Where Applicable</th></tr>
<tr><td>Continuous or Season Long</td><td>Continuously graze an area the entire year or through the entire growing season.</td><td>This works well in the shortgrass prairie. It is most successful when uniform precipitation is received and plants have a similar grazing palatability.</td></tr>
<tr><td>Deferred Rotation</td><td>Periodically defers each pasture in the rotation one grazing rotation. Animals are rotated through other pastures on a seasonal basis.</td><td rowspan="2">Applicable where distribution problems occur in overused areas such as riparian and multiple use areas.</td></tr>
<tr><td>Rest Rotation</td><td>Periodically rests each pasture in the rotation for 12 months. Animals are rotated through the other pastures on a seasonal basis.</td></tr>
<tr><td>Seasonal Suitability</td><td>Diverse vegetation types are portioned and grazing rotation is managed based on seasonal changes in forage production.</td><td>Applicable in areas where diverse vegetation types can be portioned and managed as separate units based on seasonal differences in plant phenology, forage quality and quantity.</td></tr>
<tr><td>Short Duration or Management Intensive</td><td>This system uses higher stocking densities in a frequent rotation of a single herd through multiple, smaller pastures for short grazing periods. Periods of grazing and non-grazing are based upon plant growth characteristics. This system attempts to increase production or utilization per unit</td><td>Similar criteria to continuous and seasonal grazing systems although these systems typically require higher capital investments and labor.</td></tr>
</table>

	area or production per animal. (6)	
Grazing Systems for Riparian Zones	Special considerations due to this critical area of the landscape. Rotational grazing systems work well. Riparian areas should be avoided in July and August to prevent overuse in the hot months.	Applicable in riparian areas (springs, creeks, ponds, low water table areas, wetlands) or any areas with riparian vegetation.

Continuous or season-long grazing is when animals are allowed free access to range throughout the growing season following natural rotations according to forage availability. (14) As continuous grazing allows livestock access to a single unit throughout the entire grazing season, it is generally assumed that it will lead to degradation of rangelands. This is not always true. For instance, in areas where there are not large differences in palatability of plants and no shortage of preferred locations, continuous grazing can be successful. Continuous grazing under high stocking rates can be detrimental to ecosystems when the animals focus on easy to use areas, water sources, and palatable plants rather than being distributed over larger areas. (10) Cattle that are continuously grazed can be managed through herding, or rotated throughout allotments using supplement or salt placement, and available water sources.

Prescribed grazing is defined as, "the manipulation of animal grazing in pursuit of a defined objective." (6) The objective of prescribed grazing is to improve ecosystem health. Properly applied and managed grazing systems will improve ecosystem health and quality over time. Improvements such as increased species diversity and vigor, maintenance of quality and quantity of forage, maintenance and improvement of wildlife habitat, and management of fuel loads are seen under prescribed grazing systems. (10) Not managing grazing can lead to habitat deterioration and overuse of preferred areas. Implementing a prescribed grazing system does not change basic rangeland management practices such as proper stocking rates and season and frequency of use. It requires additional management input and labor, and increased monitoring along with grazing plan re-evaluations. Prescribed grazing systems require more work when compared to continuous or season-long grazing practices.

Multi-pasture rotational grazing can offer greater flexibility and provide opportunities for plant growth that season-long grazing cannot. However, no significant differences have been measured in seasonal utilization between continuous and rotational grazing. (10)

Rotational grazing is where large pastures are subdivided into smaller units. The size and number of units is determined by the need to balance the length of the grazing period with the length of the rest period to achieve grazing and plant management goals. The animals are then rotated through these units, generally moving as one herd. Ideally, the period of occupancy in each unit is short enough to facilitate plants only being grazed once per grazing period. Each unit will have a period or periods of rest that is long enough for the vegetation to recover after grazing and can grow at its maximum rate. The goal of rotational grazing is to divide into enough units to increase stocking density which will result in fairly uniform utilization of a high proportion of plants.

Deferred rotation provides for a systematic deferment of the units. Typically, certain units are deferred for a particular reason such as wildlife use or to avoid a growth or reproductive stage of a particular plant species. An example of a deferred rotation system would be deferring cattle use of larkspur pastures during periods of plant toxicity and grazing those areas during other times of the year. Rest rotation is a rotational grazing system that provides for systematic rest among the units. The rest period is usually for 1 year or a full growing season. Reasons for using rest rotation are to improve plant growth and achieve habitat objectives. Deferred and rest rotation are useful in areas where there are differences in palatability or problems with over use in critical areas such as riparian zones or heavily used meadows. (10, 11)

Short duration or management intensive grazing is a high intensity, low frequency, short duration, rapid rotation system. It is characterized by grazing more pastures at higher stocking densities for relatively short periods. Short duration grazing still must manage forage supply with livestock demand and does not necessarily mean stocking rates will increase although the density, or the number of animals per unit of land at an instant in time, will. Management intensive grazing requires considerable time to accomplish. It provides a manager with the opportunity to reduce the animal's selectively of forage and change the distribution of animals across the landscape which has been said to improve animal performance as it utilizes grass while it is still in the vegetative stage and nutrient levels are high. (10, 11)

Strategies to aid in grazing system function include; improving water sources, salt and supplementation use/placement, managing the livestock as one herd, low stress livestock handling, and observation. Installing stock tanks away from riparian areas through development of water sources provides cattle with a clean source of water while protecting critical areas. This improves ecosystem and livestock performance. Using salt and/or supplement to move and distribute animals evenly across the landscape is also an effective tool for improvement of the vegetation. Splitting the salt blocks and moving them to low preference or under-utilized areas creates additional labor for management. However this practice is important because it achieves a more even distribution of use across a pasture while avoiding habitat degradation in preferential areas. Moving the salt and/or supplement may also be used to move animals from pasture to pasture without herding as the animals will follow it. Using low stress livestock handling techniques and good stock dogs are other ways to improve livestock distribution.

Riders may also bed cow-calf pairs away from preferred riparian areas in the evening in an effort to keep use of the riparian area low in those pastures. Through monitoring and observing cattle, riders can select cattle with undesirable bottom dwelling traits for culling. Managing the livestock as one herd helps riders to identify the leaders, main body, and stragglers in a herd. It also allows for an animal density that is easier to evaluate and results in less work for the producer. (11)

Riparian Grazing

Most pastures or allotments include some riparian areas, and managing livestock in those areas is one of the most contentious issues facing rangeland managers. Although riparian areas constitute only a fraction of total land area on western rangelands, they generally support greater overall plant and animal species diversity, richness and productivity than adjacent uplands. (10) These areas are often harder to manage because the acreage may be under partial private control or intermingled with other ownerships. The area may be the only water source for grazing animals or may have other uses, such as wildlife, fisheries, and recreation. (15) Many of these areas are already over used or depleted, and have been fenced off or restricted from use in an effort to stop further degradation. Wayne Elmore, a retired BLM Riparian Ecologist, said, "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." (15) Excluding riparian areas through fencing or exclusion from the grazing system prescribed for the landscape is not the best solution as it is not managing for the complete ecosystem.

Grazing in riparian areas is controversial, but when properly managed, it provides positive effects; however, when mismanaged, it can be detrimental. The table below shows the evaluations of grazing strategies for stream-riparian-fisheries values based on the observations of Platts. (10)

Evaluation & Rating of Grazing Strategies for Stream-Riparian Related Fisheries The rating Scale based on 1 (poorly compatible) to 10 (highly compatible) with fishery needs.							
Strategy	**Use**	**Distribution**	**Stream bank stability**	**Brushy species condition**	**Seasonal plant regrowth**	**Stream-riparian rehabilitative potential**	**Rating**
Continuous or Season Long	Heavy	Poor	Poor	Poor	Poor	Poor	1
Deferred Rotation	Moderate to Heavy	Good	Fair	Fair	Fair	Fair	4
Rest Rotation	Heavy to Moderate	Good	Fair to Good	Fair	Fair to Good	Fair	5
Seasonal Suitability	Moderate to Light	Good	Good	Good	Fair	Fair	6
Short Duration or Management Intensive	Heavy	Excellent	Poor	Poor	Poor	Poor	1
Riparian Pasture	As Prescribed	Good	Good	Good	Good	Good	8

The results from Platts' study show the highest rating for prescribed or individualized riparian plans. Successful riparian grazing strategies are developed by considering site-specific resource vegetation capabilities, water quality requirements, and livestock and wildlife needs. (15) While no single grazing system will maintain riparian areas or consistently help recover degraded areas, combinations of strategies can be used to customize an approach for each site. (16,18) The grazing system selected may not be that important as long as there is management of livestock distribution and timing. In Montana studies, riparian area conditions improved if the operator or manager was seriously committed and constantly involved. (17) 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 achievable. (18)

Wildlife Habitat and Grazing Systems

Previously grazed patches support forage of higher nutritional quality, including crude protein, and digestibility than areas that were not grazed. (10) Nutritional quality of forages is improved by grazing in 2 ways: directly, by spring defoliation which initiates regrowth of higher quality when compared with ungrazed mature vegetation; and indirectly, by removing standing litter and increasing the availability of fall regrowth or new, spring growth. (19) For example, controlled sheep grazing on forest plantations resulted in the initiation of spring growth earlier than on ungrazed areas, thereby providing high-quality forage for deer and elk. (20) Because livestock have preferences for vegetation, cover, topography, and proximity to water, rangelands are non-uniformly grazed. Livestock may cause simple structural changes that benefit wildlife habitat. For example, grazing may also create structural diversity (patchiness) of the herb layer that creates a desired edge effect for birds. (21)

One consideration before implementing a grazing system is that it may change vegetation composition, therefore, changing wildlife use of the habitat if the system is implemented in areas that were previously ungrazed or only grazed during specific time periods. Grazing systems can be used to alter composition of the vegetation, influence livestock and wildlife behavior, increase productivity of selected species, increase the nutritive quality and palatability of forage, and increase diversity of the habitat by altering its vegetative structure. (22) In a landscape grazed by herbivores that prefer one class of forage (grass, forb, or shrub), that preferred forage will, through defoliation, be less competitive than those species that are not grazed. (19) These altered plant communities provide opportunities for wildlife habitat. For example, in mule deer winter range, bitterbrush has often declined because of prolonged fall, winter, and early spring use by deer whereas perennial grass has increased (22) which has benefited grazing species.

Special considerations for threatened or endangered animals and plants in conjunction with state and federal regulations under which they are governed are to be taken into consideration when designing a grazing management strategy such as not grazing a pasture during sage grouse leking in areas where birds are present. Managing for threatened and endangered species is often a two edged sword. It is beneficial in preserving habitat and wildlife species from extinction. However, managing an area for one species is impractical and does not fit into the sustainable concept of managing an area for all species and the success of the complete ecosystem.

Preference for browses or grasses also plays a role in effective range management. Often foraging by wildlife, which tend to be browsers or intermediate feeders, has only minimal influence on production of domestic livestock, which tend to be grazers. (3) However, foraging by intermediate or mixed feeders, such as elk, can occasionally reduce production of cattle. (23) Elk and cattle compete for forage because they are both grazers and prefer grasses over other types of vegetation. Elk are also termed as intermediate feeders because they have a simpler digestive system than a cow, therefore, an elk, which has a smaller overall body size than a cow, is considered equivalent to 0.8 AUMs. Elk prefer to graze areas already grazed by cattle, but are still competing with cattle due to their dietary overlap. Mule deer are considered concentrate feeders as they have a smaller, simple rumen with a faster passage rate. Pronghorn species are also considered intermediate feeders. Both deer and pronghorn are browsers preferring to eat shrubs. Because of this dietary preference, they compete less with livestock for forage. However, in studies, mule deer have been shown to select habitats that were previously grazed by cattle in the winter (24) which could lead to over use of pastures.

Monitoring

Implementing grazing plans is about more than just moving cows, checking troughs, and distributing blocks of salt. It involves an active role in observation of the cattle and ecosystem. When conditions change or disturbance occurs, it may be necessary to modify the original grazing plan. Constantly monitoring the forage supply and demand also provides opportunity to adjust stocking rates to prevent over or under use.

Collecting monitoring data protects landowners, governmental agencies, and permittees against environmental lawsuits and provides them with official documentation of their results. These results also serve as a baseline when seeking to improve vegetative conditions in following years.

Monitoring should follow a set protocol such as photo points or vegetation transects and may consist of long and/or short term data collection. Points should be taken in representative areas, critical areas, and treatment areas. The Grazing Response Index is also an effective method used to annually assess the effects of grazing under the criteria of frequency, intensity, and opportunity for plant regrowth following grazing. (11) Pastures should be monitored for documented evidence of changes in vegetation dynamics, wildlife use, forage condition, and introduced or invasive species.

Conclusion

Managed grazing is a process that can improve rangeland, wildlife, and livestock productivity. Management tools to aid specialists in preparing grazing plans are the AUM system of estimating forage and livestock use, stocking rate, duration, utilization, and timing of use. Grazers and browsers utilize different vegetation and can be grazed together for higher efficiency of the ecosystem. Types of grazing systems used are continuous, season long, rest rotational, deferred rotational, short duration, management intensive, and riparian plans. Grazing should be matched to capitalize on plant nutrient availability to meet livestock requirements while considering timing and plant recovery. The take half, leave half principle is a good practice to implement with regards to plant recovery on rangelands. There is no perfect solution to any aspect of planning grazing systems and the answers are often site-specific and dependent upon individual circumstances. Annual monitoring results protect and provide future information for grazing on an area. The best managers are flexible, proactive, and observant.

Productive grazing management takes into consideration all uses of the land. The use of grazing improves the nutritional quality of forages and stimulates re-growth of plants. This process improves habitat for wildlife and provides a natural re-start of the ecosystem. Managing the riparian zone in pastures is necessary for overall landscape health and productivity. Planning for the entire ecosystem and multiple uses optimizes rangeland conditions thereby maximizing profitability of the livestock enterprises dependent upon them.

References

1. Department of the Interior: Bureau of Land Management. History of Public Livestock Grazing (2009)URL: http://www.blm.gov/nv/st/en/prog/grazing/history_of_public.html

2. Johnstone-Yellin, T. Are mule deer grazers or browsers? Behavioral Education for Human, Animal, Vegetation & Ecosystem Management. URL: http://www.webpages.uidaho.edu/range556/appl_behave/projects/deer_browsers.html

3. Shipley, L. (1999) "Grazers and browsers: How digestive morphology affects diet selection." Grazing Behavior of Livestock and Wildlife 20-27.

4. Launchbaugh, K. and Walker, J. (2006) "Targeted grazing—A new paradigm for livestock management." Targeted grazing: A natural approach to vegetation management and landscape enhancement. Centennial, CO, USA: American Sheep Industry Association 2-8.

5. Glimp, H.A. (Dec., 1988) "Multi-Species Grazing and Marketing Rangelands" Vol. 10, No. 6 pp. 275-278 Published by: Allen Press and Society for Range Management Article Stable URL: http://www.jstor.org/stable/4000299

6. Society for Range Management. (1998) Glossary of terms used in range management, 4th Edition.

7. Briske, D. et al. (2011) "An evidence-based assessment of prescribed grazing practices." Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps. Washington, DC, USA: USDA-NRCS 21-74.

8. Holechek, J. et al. (1999) "Grazing studies: What we've learned." Rangelands 12-16.

9. University of Arkansas Division of Agriculture Research and Extension (2013) URL: http://www.aragriculture.org/forage_pasture/Management_Guides/Forages_Self_Help_Guide1.htm

10. Briske, D. (2011) Conservation benefits of rangeland practices: Assessment, recommendations, and knowledge gaps. US Department of Agriculture, Natural Resources Conservation Service

11. Bradford, F. and Reed, D. (2013) Grazing School, Colorado State University Western Center for Integrated Resource Management., Fort Collins, CO

12. Department of Agriculture: Forest Service (1996)USFA Rocky Mountain Rangeland Analysis and Management Training Guide

13. Kinney J. and Clary W (1994)A Photographic Utilization Guide for Key Riparian Graminoids. United States Department of Agriculture. URL: http://www.fs.fed.us/rm/pubs_int/int_gtr308.pdf

14. Howery, L., Sprinkle, J., and Bowns, J. (2000) "A summary of livestock grazing systems used on rangelands in the Western United States and Canada."

15. Department of the Interior: Bureau of Land Management(2006) Grazing Management Processes and Strategies for Riparian-Wetland Area BLM Riparian Area Management TL 1737-20.

16. Lucas, R.W., Baker, T.T., Wood, M.K., Allison, C.D., and Vanleeuwen, D.M. (2004) Riparian vegetation response to different intensities and seasons of grazing. J of Range Manage 57(5):466-474.

17. Ehrhart, R.C. and P.L. Hansen (1997) Effective cattle management in riparian zones: a field survey and literature review. Riparian Technical Bulletin No. 3. U.S. Department of the Interior, Bureau of Land Management, Montana State Office, and Riparian and Wetland Research Program, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula, MT. 92 pp.

18. Leonard, S., Kinch, G., Elsbernd, V., Borman, M., and Swanson, S.. (1997) Riparian area management: Grazing management for riparian areas. TR 1737-14. U.S. Department of the Interior, Bureau of Land Management, Service Center, Denver, CO. 63 pp.

19. Vavra, M. (2005)"Livestock grazing and wildlife: developing compatibilities." Rangeland Ecology & Management 58.2: 128-134.

20. Rhodes, R.D. and Sharrow, S.H. (1990) Effect of Grazing by Sheep on Quantity and Quality of Forage Available to Big Game on Oregon’s Coast Range. J of Range Management 43(3):235-237.

21. Payne, N.F and Bryant, F.(1994) Techniques for Wildlife Habitat Management of Uplands. McGraw-Hill , New York, New York.

22. Severson, K.E. and Urness, P.J. (1994) Livestock Grazing: A Tool to Improve Wildlife Habitat. . in Ecological Implications of Livestock Herbivory in the West, M. Vavra, W. A. Laycock, and R. D. Pieper, Eds., Society of Range Management, Denver, CO, 232-249.

23. Hobbs, N.T. et al (1996) “Modification of Ecosystems by Ungulates” Journal of Wildlife Management. 60:2397-2402.

24. Yeo, J.J. et al. (1993) "Influence of rest-rotation cattle grazing on mule deer and elk habitat use in east-central Idaho." Journal of Range Management 245-250.

25. Ruyle, G. and Ogden, P. (1993) "What is an AUM?." Arizona Ranchers’ Management Guide, Arizona Cooperative Extension. University of Arizona