In the Name of God
Unit 10: Rangeland Improvement

Specialized **grazing systems** were first conceptualized in the United States at the turn of the 20th century and became a major focus of range researchers and managers by the 1950's. In the Intermountain West, deferred-rotation received considerable attention during the 1950's, followed by **restrotation** during the 1970's. More recently, rangeland managers have used short duration grazing to more intensively control when and where **domestic animals** graze rangelands. When properly applied, grazing systems are powerful tools that can help rangeland and **livestock** managers achieve management objectives related to rangeland and livestock production (e.g., **forage** production, **average daily gain**), as well as those related to ecosystem structure (e.g., **wildlife habitat**) and function (e.g., erosion control, water quantity and quality). However, selection of the proper grazing system is contingent upon the uniqueness of the setting in which it is applied (e.g., topography, soils, vegetation types, climate, etc.).

The objectives of this article are to provide an overview of the major grazing systems that have been used on rangelands in the western U. S. and Canada, to summarize the conditions under which they may be applicable, and to highlight examples from the southwestern U. S. when relevant. Our discussion is largely a synopsis of Holechek et al's (1998) recent review of grazing systems, and of Vallentine's (1990) discussion of the same topic.

Continuous and Season-long Grazing

Continuous or season-long grazing are technically not grazing systems *per se* because there is no attempt to leave a portion of the range **ungrazed** by livestock for at least part of the growing season. Some have speculated that desirable plants, particularly grasses, will be grazed excessively under continuous or season-long grazing. However, research does not support this view when proper stocking is implemented. With continuous grazing, **stocking rate** must be very light during the **growing season** because adequate forage must be left to carry animals through the **dormant season**. Under light stocking, animals are allowed maximum dietary selectivity throughout the year. For example, **cattle and sheep** preferentially select **forbs** (i.e., broad-leaved plants) during certain times of the year, which can greatly reduce grazing pressure on grasses. **Rotation systems** that restrict livestock from part of the range during the growing season can waste much of the forb crop because some forb species complete their life cycle quickly and become **unpalatable** after **maturation**. Another advantage of continuous or season-long grazing over rotation systems is that livestock are not moved from one **pasture** to another. Moving livestock too frequently can reduce animal production (weight gains, calf crops, etc.). Continuous or season-long grazing work best on flat, well-watered areas (i.e., watering points no more than 2 miles apart) where precipitation occurs as several light rains throughout the summer, and where most plants have some grazing value (e.g., the **shortgrass prairie**, northern mixed prairies of the Great Plains). Continuous or season-long grazing have also worked well in the California annual grasslands where **annual plants** need only to set seed each year to maintain themselves, in contrast to **perennial grasses** that store carbohydrates for use during dormancy, and for use during the initiation of growth when dormancy breaks.

Deferred-rotation

Deferred-rotation grazing was first developed in 1895 and later implemented in the early 20th century by Arthur Sampson (the "father of range management") in the Blue Mountains of Oregon. Sampson's system involved dividing the range into 2 pastures with each pasture receiving **deferment** until seed set every other year. Several modifications of deferred-rotation have been used involving more than 2 pastures, however, its key feature is that each pasture periodically receives deferment (typically every 2 to 4 years, depending on the number of pastures). According to Holechek et al. (1998), ***plant response*** for deferred-rotation grazing was superior to continuous or season-long grazing on Palouse bunchgrass ranges, mountain **coniferous forest** ranges, **sagebrush bunchgrass** ranges, and **tallgrass** prairie ranges. ***Animal performance***, however, did not differ in studies comparing continuous, season-long, or deferred-rotation systems on Palouse bunchgrass or coniferous mountain ranges. In the tallgrass prairie, individual animal performance decreased with deferred-rotation compared to continuous grazing possibly due to lower forage quality (i.e., older, more mature forage) in the deferred pastures. However, grazing after seed set, when perennial grasses tend to be more tolerant to grazing may allow higher stocking rates and compensate for lower gain per animal without damaging rangeland resources. Deferred-rotation has been used as a tool to address seasonal preferences for riparian plant species exhibited by livestock. Seasonal deferment (and hence, seasonal grazing) in certain **wetland areas** can help sustain a balance of **riparian herbaceous** and **woody plants** by alternating grazing and **browsing pressure** in ways that inhibit one life form from gaining a competitive advantage over the other. For example, spring or early summer deferment has been used to reduce livestock use of riparian herbaceous plants such as grasses, sedges, and rushes, while summer and fall deferment has been used to reduce livestock use of riparian shrubs and trees. Thus, deferred-rotation, as described here, draws on our knowledge of animal **foraging behavior** to exclude livestock from riparian areas during the season(s) in which they are most likely to prefer herbaceous or woody plants. Riparian plant species are often cited as critical structural components of wildlife habitat for both game and non-game species (e.g., nesting and hiding cover, and as playing a functional role in capturing sediment and dissipating erosive energy in streams.

Rest-rotation

The **rest-rotation system** was designed by Gus Hormay of the U. S. Forest Service and was first implemented in the 1950s and 1960s. Although the original system was designed to rotate grazing and rest periods among 5 pastures using 1 to 3 herds over a 5-year cycle, other variations of rest-rotation have used 3 or 4 pastures in a 3 to 4 year cycle. Hence, under rest-rotation, 1 or 2 pastures are rested the entire year while the remaining pastures are grazed seasonally, depending on the number of pastures and herds. For example, 1 pasture in a 3-year, 3-pasture rest-rotation might be managed as follows during a 3-year cycle: 1) Graze the entire year or growing season, 2) Defer, then graze, and 3) Rest. This schedule rests about 1/3 of the range annually. Rest-rotation has shown superiority over continuous and season-long grazing on mountain ranges where cattle may heavily use riparian areas under all grazing strategies. Rest provides an opportunity for the vegetation around natural or developed water to recover and helps meet multiple use objectives (e.g., providing hiding cover for **birds** and **mammals**, leaving ungrazed areas for public viewing and enjoyment). Hence, rest-rotation provides many of the advantages for riparian habitats discussed under deferred-rotation. Additionally, rested pastures provide forage for emergency use during severe drought years, and provide opportunities to implement relatively long-term **rangeland improvement** practices (e.g., **burning**, **reseeding**, **brush control**) during scheduled rest periods. However, a disadvantage of all grazing systems that periodically exclude livestock is that **elk** or other wild **herbivores** may graze "rested" pastures, negating some of the benefit of rest or deferment from livestock grazing. Other disadvantages cited for rest-rotation are reduced individual animal performance due to forced animal movements from pasture to pasture, and increased **stocking density** in grazed pastures, which can reduce dietary selectivity. However, this criticism may emanate more from failure to properly adjust stocking rates to compensate for resting 20 to 40% of the total grazing area each year, rather than a definite failure of rest-rotation. For example, research on mountainous range in northeastern Oregon showed that cattle weight gains per hectare or per animal did not differ among rest-rotation, deferred-rotation, and season-long grazing systems when utilization averaged about 35% for each system over a 5-year period. The point to remember is that the benefits of a full year of rest can be nullified if previously rested pastures are overgrazed, particularly in arid regions where frequent drought conditions can impede rangeland recovery.

Santa Rita

The **Santa Rita grazing system** is basically a 1-herd, 3-pasture, 3-year, rest-rotation system that was modified for midsummer rainfall and concomitant forage production patterns that typically occur in the hot semidesert grasslands in southeastern Arizona. A three-year rotational schedule for 1 pasture is as follows: 1) Rest 12 months (November to October), 2) Graze 4 months (November to February), 3) Rest 12 months (March to February), and 4) Graze 8 months (March to October). Each pasture receives rest during both early spring and "summer-monsoon" growing periods for 2 out of every 3 years, but each year's forage production is also grazed (first year's growth is grazed in winter). A full year of rest before spring grazing allows residual vegetation to accumulate which helps protect new spring forage from heavy grazing. Target utilization levels in grazed pastures are 30-40%. Martin and Severson (1988) concluded that the Santa Rita system promoted recovery of ranges in poor condition, but had little advantage over moderate continuous grazing on ranges in good condition.

Seasonal Suitability

A common practice of **seasonal suitability grazing systems** is to partition and manage diverse vegetation types that differ due to elevation, ecological site, ecological condition, or precipitation, and to move animals based on seasonal forage production in the partitioned vegetation types. Disparate vegetation types are typically fenced, but livestock movements can also be controlled by turning on (or off) watering points, a technique most commonly employed in the Southwestern U. S. In Southwestern deserts, seasonal suitability systems use **creosote bush** (*Larrea tridentata*) and **mesquite** (*Prosopis* spp.) shrublands during winter and early spring, while **tobosa grass** (*Hilaria mutica*) and **alkali sacaton** (*Sporobolus airoides*) ranges are used during summer (or during spring with adequate moisture). Although creosote bush and mesquite dominated shrublands typically have little **perennial grass** understory, they may contain **nutritious plants** like 4-wing **saltbush** (*Atriplex canescens*), **winterfat** (*Ceratoides lanata*), and cool-season annual forbs, which are preferred by livestock when perennial grasses are dormant. Tobosa grass and alkali sacaton are comparatively less nutritious during dormancy, and more efficiently utilized by livestock when they are actively growing. Pastures dominated by **Lehmann lovegrass** (*Eragrostis lehmanniana*), a warmseason grass introduced from South Africa, can also be used in this system to relieve summer and early fall grazing pressure on native perennial grasses. **Seeded introduced grasses** may be an important component of other seasonal suitability systems because of their ability to provide forage both earlier and later than native range. For example, rotating livestock through native range in summer, **crested wheatgrass** (*Agropyron cristatum*) pastures in spring, and **Russian wildrye** (*Elymus junceus*) pastures in the fall more than doubled grazing capacity in Alberta. Seasonal suitability has also been used on mountain ranges in the northwestern U. S. where grassland (south-facing slopes), forest (north-facing slopes), and **meadow** (riparian) vegetation types provide late spring/early summer use, late summer/early fall use, and fall grazing, respectively. In Utah, seasonal suitability has been practiced where desert (winter use), foothill (spring use), and mountain ranges (summer use) are managed as separate, seasonal grazing units.

Best Pasture

Because summer rainfall in the Southwest U. S. usually comes in the form of intense but isolated thunderstorms, summer moisture patterns are typically spotty and unpredictable. It is not uncommon for areas of a ranch separated by only a few miles to vary greatly in the amount of precipitation received from a storm event. The best pasture grazing system, as originally proposed by Valentine (1967), attempts to match cattle movements with irregular precipitation patterns and associated forage production without regard to a rigid rotation schedule. For instance, when a local rain event causes a flush of annual forbs in a particular pasture, cattle are moved to that pasture, and then moved back to the previous pasture once acceptable utilization levels of the ephemeral forb resource have been achieved. On the other hand, if a pasture that is tentatively scheduled for grazing continues to miss localized rainstorms while another pasture continues to receive moisture, the rotation schedule for the two pastures could be flipflopped. Because livestock movements are not rigidly timed to a particular timetable, the best pasture system requires that land managers command a mindset of high flexibility. The best pasture system may also be timed to match seasonal forage quality changes across ecological sites, and thus, embraces some elements of the seasonal suitability system. For example, pastures containing **black grama** (*Bouteloua eriopoda*) as the primary forage species may be deferred until the dormant season when it is higher in protein compared to pastures dominated by **blue grama** (*Bouteloua gracilis*) or **hairy grama** (*Bouteloua hirsuta*). Because black grama is relatively less resistant to grazing than many other perennial grasses, winter grazing has less impact on this species than use during the growing season. This approach works best when some of the pastures in the “rotation” contain winter annuals and palatable shrubs. As with the seasonal suitability grazing system, the best pasture system may involve turning on (or shutting off) watering points in grazed (deferred or rested) pastures. Cattle learned within a year to follow active watering points on a 3,160-acre ranch in southeastern Arizona (Martin and Ward, 1970). Because localized heavy grazing around watering points was controlled during Martin and Ward’s 8-year study, perennial grass forage production nearly doubled with the best pasture system compared to continuous grazing.

Short Duration

Short duration grazing differs from other specialized systems in that a grazing area is typically divided into several small pastures (also called paddocks or cells), each of which may receive *more than one period* of nonuse *and* grazing during a single growing season. The number of nonuse and grazing periods depends on the rate and amount of forage produced within each pasture. Short duration grazing commonly uses 5 to 12 pasture units in which there are grazing periods lasting from 3-14 days. Pasture rotations may be conducted more frequently during periods of rapid growth and less frequently during periods of slower growth. A grazing period is followed by a variable nongrazing period of up to 60 days to allow for forage regrowth. The actual duration of each pasture's nongrazing period depends on growing conditions. Proponents of short duration grazing maintain this system benefits rangeland resources and domestic livestock production in several ways when properly implemented, including: improved soil water infiltration and increased mineral cycling due to animal impact (e.g., "hoof action"), increased photosynthesis that provides longer periods of available leafy forage to livestock, improved animal distribution and plant utilization, reduced percentage of ungrazed "wolf" plants, lower labor costs, better individual animal performance, and improved rangeland condition. The most attractive contention of short duration grazing to livestock producers is that higher stocking rates and stock densities can be used because of the "shorter duration" of grazing and more intensive management. Rangeland research indicates that managers should carefully consider several factors before investing in a short duration grazing system, particularly in arid regions. Arid areas typically have short growing seasons (less than 60 days) due to low precipitation levels, cold weather, or both; this minimizes the positive aspects of repeated periods of heavy defoliation followed by nonuse, especially when inadequate growing conditions (e.g., drought) can limit regrowth potential of heavily grazed plants. Concentrating a large number of animals in smaller pastures that have recently received high intensity storms can cause soil compaction and decrease infiltration rates. Increased trail density around water has been problematic in pastures that have been partitioned around a central watering point. Short duration grazing usually calls for extra labor for herding and large amounts of fencing to partition a large grazing area into smaller grazing areas because it is more costly to fence arid rangelands (less forage/unit area = more fence needed) than more productive areas (more forage/unit area = less fence needed). Frequent pasture rotations can take a toll on animal production measures and care must be taken to prevent mother-dam separations during livestock movements. Finally, there is simply less room for error in arid regions to decide when animals should be moved or destocked; failure to move animals at the correct time or to **destock** during drought can cause long-term damage to desert grasses. Holechek et al. (1998) asserted that short duration grazing works best on flat humid areas that have extended growing seasons (at least 3 months), greater than 20 inches of average annual precipitation, and an average annual forage production of greater than 2000 lbs/acre. However, the same authors identified 2 cases where short duration grazing might be successfully used in arid areas: 1) in flat, low-lying areas with deep, productive soils that collect water runoff from less productive upland areas, and 2) on exotic grass seedings (e.g., Lehmann lovegrass, crested wheatgrass) where grazing resistance and capacity may be higher than native rangeland.

Some Final Thoughts on Grazing Systems

• There is an infinite combination of climates, soils, topography, and vegetation types that occur across the western U. S. and Canada, which makes choosing the "correct" grazing system a challenge. No grazing system will work everywhere, or, as Dr. William Krueger from Oregon State University puts it, "every grazing system will fail somewhere." The system you choose must be tailor-made to your unique situation.

• Implementing a grazing system does not eliminate the need to heed basic principles of grazing management (stocking rates, season of use, frequency of use, kind or mix of animals, animal selectivity, etc.).

• Grazing systems require greater, rather than less management input, compared to continuous or season-long grazing. Increased attention to range and livestock *management* (see next point) may often be a primary reason for the success of a particular grazing system.
• Animal distribution tools such as riding, proper placement of nutrient blocks, selective culling based on animal behavior characteristics, range improvements (burning, reseeding, water developments), and control of access to watering locations should be implemented in ways that complement the intended management objectives of grazing systems.
• Flexibility is the hallmark of successful range management in arid regions. Strict adherence to animal numbers and livestock movement dates without regard to vagaries in precipitation and forage production can be counterproductive to both rangeland and livestock production. Adjust stocking rates and rotation dates so that livestock numbers are in balance with forage supply.
• Rangeland monitoring is critical to document both successes and failures of grazing systems and other management activities. Rangelands are extremely variable in the kind and amount of vegetation they are capable of producing. This variability is apparent across the land (space) and across the years (time) as anyone who has spent time on a ranch knows. Monitoring techniques are available to help you determine how much variability you can expect on your ranch across both space and time. Monitoring data are really the "proof of the pudding" as to whether your grazing system and management practices are accomplishing your goals and objectives.
• Evaluate a new grazing system over a period of 6- 12 years so that several weather cycles can be evaluated. This prevents erroneously assigning success or failure to a new grazing system when abnormally high or low precipitation years may be the primary cause.

Providing Water For Grazing Systems

Within any grazing system, water must be provided to livestock in adequate quantity and quality. Clean water and ample high quality forage are essential for improved livestock production. Inadequate livestock water developments in pasture areas can contribute to serious livestock losses, prevent efficient use of forages, encourage **overgrazing** near existing water supplies and **under-grazing** away from the water sources.

The following table (taken from the University of Wisconsin "Pastures for Profit") can be used as a general guideline for daily water requirements of grazing animals:

Animal	**Gallons Per Day**
Beef	8-10
Dairy Cows (in milk)	30
Sheep	1
Horses	8

Keep in mind that these are average figures. Water needs vary greatly with air temperature, relative humidity, animal size and percent moisture of the diet. For example, water needs are higher on hot, dry days or when grazing dry forage. Water needs decrease on cool, rainy days, or when livestock graze lush forage. Young, **lush forage** will have a moisture content of 70 to 90% and can account for a large percentage of an animal's water needs.

Does It Pay To Put Water In Each Paddock?

Providing adequate water to livestock is usually seen as one of the biggest obstacles to starting a rotational grazing plan. Many **graziers** use lanes to provide access to a central watering location, but the ideal situation is to have water available in every **paddock**. Economic analysis of grazing systems indicate that money spent to provide water to several central locations or to each paddock generates rapid repayment due to increased animal productivity and better utilization of pasture forage which decreases feed costs. Jim Gerrish and co-workers at the Forage Systems Research Center in Missouri have researched the distance beef cattle have to travel to water and how that affects grazing distribution and **pasture utilization**. In a study involving 160 acres, these researchers found that animal carrying capacity could be increased an additional 14% simply by keeping livestock within 800 feet of water. **Carrying capacity** was increased due to better pasture utilization, which permitted more forage to be harvested as compared to systems where livestock had to travel more than 800 feet to water. At the time of the study, that additional carrying capacity resulted in an additional $35 of gross income per acre annually.

Researchers in Wyoming have conducted similar studies under rangeland conditions. Results there showed that cattle did 77% of their grazing within 1,200 feet of the water source. Although approximately 65% of the pasture was more the 2,400 feet from the water source, it supported only 12% of the grazing usage.

The researchers at Missouri concluded that for the humid, temperate zone of the U.S., (like Ohio), water sources should be closer to livestock than under rangeland conditions. For optimal land use efficiency, water should be provided within 600 to 800 feet of all grazed areas.

Sources of Water Ponds

Water for livestock from a pond can best be developed by installing **floating inlets** and **piping** the water with gravity flow, or **pumping** to a tank or a series of tanks below the dam. Water located two feet below the surface has been found to be the highest quality water in a pond.

Springs

Springs will generally supply higher quality water than a **pond**. The water tank should be located where it can be accessible to the livestock, but away from the spring box and collection system. The overflow should be piped away. The water can be piped by gravity to one, or a series of tanks.

Streams

Many producers are fencing livestock out of streams or restricting their access to the stream for drinking only. Limiting the animals to small areas that have been protected from erosion allows them a watering site without disturbing the entire stream bank. Some producers are restricting all access and pumping the water from the stream into tanks for the livestock.

Wells

A few livestock producers are utilizing a well or public water and are pumping and piping the water to tanks or frost proof fountains.

Pumps

Pump alternatives where there is no electricity include the **pasture pump**, **ram pumps**, and **sling pumps**.

Pipes

If the water system is gravity flow, use a linear low density polyethylene (LLDPE) pipe. For pressurized systems, use a rolled high density polyethylene (HDPE). The size of the pipe needs to be matched to the demand placed on it. Gravity flow and siphon systems will typically require 1 1/4 inch pipe. One inch pipe should be sufficient for most pressurized systems. In situations where large numbers of livestock are running together, professional assistance will be useful in sizing tanks and water pipes for mains and laterals.

Hauling Water

"**Water wagons**" are low cost from a materials stand point but expensive from the extra labor that is required. However it does allow a producer to keep expenses to a minimum during the startup phase of a grazing operation. Water wagons can also be useful in severe droughts when normal water sources fail.

Installation

Portable piping systems seem to be a good alternative for most farms here in Ohio. These systems can either be above or below ground pipes with occasional risers. First of all, design with flexibility in mind especially when you are just starting your pasture system. It may be best to lay the pipe above ground until you have gained enough experience to know where the fences and water lines should be placed.

There will always be concern with black plastic pipe getting too hot in July and August. Water consumption in cattle is highest when the water is at room temperature (90-100 degrees F). That is not to say that the water will not get hotter than room temperature. Locate the pipe under a fence where shading from tall grass will keep it as cool as possible. Dumping the water tubs in mid-afternoon on hot days will allow cooler water to flow into the tank. Small tanks have an advantage in that near constant flow of water for a large group of livestock will maintain a more consistent temperature.

The area around all permanent tanks should be "raveled with egg sized stone or otherwise treated to provide all weather access. The large stones are uncomfortable to stand on and help to prevent boss cows from dominating a water source. Temporary or portable tanks are best when placed under an electric fence wire to help control the access and prevent tank damage or upset by the animals.

Livestock watering facilities such as tanks, pumps and pipe should be sized to meet the needs of all the livestock that will be using the system. If the water source yields less than what is needed for a watering period, but can provide the daily needs, a storage tank can be used. Buried pipe needs to be placed at least 30 inches deep for freeze protection during severe winters. If the pipeline is delivering gravity flow water, eliminate all the humps in the line where air could become trapped and stop the flow. Plastic or polypipe should not be laid in a straight line in the bottom of the trench. It should be curved back and forth to allow for contraction in the cold weather. A general rule is to "install 101 feet of pipe for every 100 feet of trench". Stones should be removed from the bottom of the trench so the pipe is not laying on or next to potential "line breakers". Most graziers feel the costs of water development was some the best money they have spent. Costs do need to be kept to a minimum and preferably less that $20 per acre.