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Grazing Principles for Profitable and Regenerative Resource Management Series:

V. ESSENTIAL CONCEPTS NECESSARY FOR ADAPTIVE MULTI-PADDOCK GRAZING MANAGEMENT TO ACHIEVE DESIRED LIVESTOCK AND LANDSCAPE GOALS

Tim Steffens* and Morgan Treadwell**

This is the fifth in a series of Texas A&M AgriLife Extension publications to help readers better understand the ecology of grazed lands, the way plants grow, develop, and react to **defoliation** by **herbivores**, how to manage forage quality and quantity, management of stocking rate to improve grazing profitability, essential concepts related to proper grazing management, and how to apply these concepts successfully using adaptive grazing management strategies. We suggest you read these in order, but each can be read separately if you already have a firm background in these topics. A complete glossary of technical terms used throughout all of the publications can be found at the back of each publication. Several of these terms were supplied by the Society for Range Management, and their definitions are placed in quotes.[1] When needed, additional clarification is provided. When a technical term is used for the first time in each publication, it is shown in boldface type.

Other Titles in the Principles of Regenerative Grazing Management Series

I. **Ecological Concepts in an Economic Context**

II. **Grazing Management and Its Effects on Plant Competition at Different Scales**

III. **Factors Affecting the Magnitude of Grazing Effects on Plant Responses and Forage Quality**

IV. **Stocking Rate: The Essential Concept for Profitable and Regenerative Grazing Management**

VI. **Using Essential Grazing Concepts to Properly Implement Successful Adaptive, Multi-paddock Grazing Strategies**

*Assistant Professor and Extension Rangeland

**Associate Professor and Extension Range Specialist

INTRODUCTION

In the fourth publication in this series, *Stocking Rate: The Essential Concept for Profitable and Regenerative Grazing Management*, we discussed stocking rate, its effects on individual and total productivity for a ranch, how it relates to economic performance, and factors that affect optimum stocking rate. We also discussed the financial and production cues that will tell managers that stocking rates need to be adjusted, how they should be adjusted, as well as how optimum stocking rate is unrelated to overhead costs.

However, stocking rate, while critical to the success of any grazing management strategy, is only one among several key concepts that must be understood for profitable grazing enterprises that can also improve the resource on which they rely. This publication is a discussion of key concepts required to understand plant-animal interactions and how both plants and animals can be managed profitably to conserve soils, increase water yield or quality, enhance plant species composition and other ecological processes, enhance forage and diet quality for livestock and wildlife, and provide desired wildlife habitat structure. Management effects on plant structure, cover, patchiness of habitat, and watershed function vary with the scale at which they are measured and the space that animals are allowed to use over different time intervals.

ESSENTIAL CONCEPTS

Overgrazing versus overstocking. At this point, the difference between overgrazing and overstocking should be clarified. Overgrazing happens to individual plants and occurs as a result of *repeated*, intense defoliation with insufficient **recovery** periods between defoliations that do not allow plants to maintain vigor. If continued, it will result in the plant's death. Therefore,

[1](Society for Range Management, 2005)

overgrazing can occur even in lightly stocked situations because of poor animal distribution, poor timing, or high frequencies of defoliation, which will almost invariably happen to plants in some areas of pastures or **paddocks** when grazing periods occur over long periods of time during the growing season.

Figure 1. This photograph, taken near a water point located to the right, shows that even when plants are grazed severely, as in the mid-ground of the picture, they can maintain a high degree of vigor if given enough time to regrow between defoliations as in the foreground. In the background is a paddock that has begun to regrow but has not yet fully recovered. Unless grazing periods are very short with movable water troughs, these areas of severe use will likely occur. However, if they are not grazed again before they have fully recovered, they will not be overgrazed, even though they have been severely grazed. If severely grazed areas comprise a large portion of the grazing unit, it is an indication of overstocking, and livestock performance will suffer. *Photo courtesy of Tim Steffens.*

Stocking rate is a financial decision with ecological consequences. As discussed in the fourth publication in this series, the availability of plants with different levels of quality relative to animal requirements determines animal performance, and consequently, profitability. Overstocking usually, but not invariably, causes overgrazing because plants may recover adequately after heavy levels of defoliation, if given a sufficiently long period of recovery. However, overstocking will always cause some degree of livestock nutritional stress or require higher levels of additional feed. It will also cause plant productivity to decrease in the short term, and if continued chronically, a long-term decrease in soil stability and profitability.

Recovery. One of the most critical factors to maintain healthy grass stands, even when defoliated heavily, is to provide enough time for grazed plants to recover vigor and reproduce, either **vegetatively** or from seed, between grazing events. At a given level of defoliation, the optimum recovery period depends on

Figure 2. Patchy, severe grazing (a "grazing lawn") in the foreground caused by a high degree of selection allowed over an extended period of time. If allowed to continue without allowing the grazed plants to reestablish a full array of leaves, this area may become a focal point of deterioration as a result of overgrazing, even if the pasture is stocked moderately. *Photo courtesy of Tim Steffens.*

Figure 3. The moderately defoliated little bluestem plant in the foreground (an ungrazed little bluestem plant is behind it for comparison) still has enough leaf area to begin regrowth rapidly so that its frequency on the landscape can be maintained or improved once cattle are moved to another paddock. This South Texas paddock was grazed continuously for many years but was about 1 year into a grazing strategy to provide moderate levels of use during short grazing periods followed by extended periods of nonuse to allow plants to recover from defoliation. Rainfall had been about average for the past year when this photo was taken. Note the high proportion of bare ground from previous continuous grazing and the many seedlings beginning to establish in the spaces between established bunchgrasses. *Photo courtesy of Tim Steffens.*

the growth rate, which is a product of temperature and available moisture. Desirable plants can be favored in the community by deferring grazing on the area when the growing conditions favor those plants (e.g., warm- versus cool-season plants). During periods of rapid growth, recovery periods should be shorter to prevent plants from becoming overly mature. When growth slows, recovery periods must be increased because it will take longer to achieve the rapid growth phase (phase II as discussed in the third publication of this series). During slow growth, phase II may also last longer. See the third publication in this series, *Factors Affecting the Magnitude of Grazing Effects on Plant Responses and Forage Quality*, for more information regarding how plants grow and the importance of the rapid growth phase for determining proper recovery periods.

A good rule of thumb to monitor when grasses are again ready to be grazed without being overly mature (lower quality) is to allow *grazed* plants to have had 30 to 45 days of rapid growth (during optimum growing conditions). In many drier regions, it may take a full growing season to accumulate this many days of optimum growth conditions, even in average rainfall years because of short, sporadic periods of rapid growth. Likewise, when plants are grazed near the end of their normal growing season, it may take many months before they have any significant growth. During severe drought, more than a full year of recovery may be required for plants to adequately recover. Remember that in a system where the number of pastures or paddocks is set, when the recovery period increases, the grazing period must also increase.

While the previous paragraph provides some way to *monitor* if enough recovery has occurred, it is also important to *plan* for enough recovery when developing a grazing management plan. Another rule of thumb to plan for adequate recovery of grazed plants in operations where animals are grazed all year is to have no more than one grazing of plants for every 10 inches of precipitation in a year. For instance, in an area where you receive roughly 20 inches of rain per year, you could have one grazing period in the growing season and one in the dormant season. With only 15 inches, you would only be able to graze part of the paddocks the second time through.

It is also important to consider the timing of precipitation. If the majority of rain comes in the growing season, grazing and recovery periods could likely be more rapid than if the rainfall is more evenly dispersed in a year or dominated by dormant season precipitation. Also, if plant preferences change through the season or year, so that a second grazing period in the growing season targets different plants than a previous one, the plants that were defoliated in the previous grazing period, but not in the following one, would still be able to recover, enabling more grazing periods in a year than might be expected. This type of situation is often seen where a mix of cool- and warm-season plants are found. Careful observation of the plants that animals select at different times of the year can help to make better decisions regarding the length of grazing and recovery periods needed at different times of the year.

It is also important to remember that "rest" is not the same as recovery. The Society for Range Management defines rest as "To leave an area of grazing land ungrazed or unharvested for a specific time, such as a year, a growing season or a specified period required within a particular management practice."[1] However, recovery requires enough regrowth for the plant to maintain its ability to compete for resources with its neighbors. "Resting" a paddock during the dormant season, when no growth is occurring, does not allow recovery of the plants. Removing the animals during an extended drought when little or no growth is occurring also does not allow for adequate recovery, though it may prevent damage to crowns and maintain cover and watershed function. Plants should regrow a full array of leaves (at least four fully formed leaves per stem) before full recovery has occurred.

To this point, recovery has been discussed from the standpoint of maintaining the vigor and competitive ability of existing **perennial** plants, since most reproduction results from **stolons**, **rhizomes**, or increased numbers of tillers that increase the size of the crown. If you need more plants, and those new plants must come from seedlings (e.g., bunchgrasses), you will need to allow desired plants to make seed, at least occasionally, so that there is a viable seed bank when conditions are right for germination. Then, should you get conditions for germination, the seedlings will need to remain ungrazed long enough to establish an adequate root system before being grazed. Limb et al. found that little bluestem seedlings defoliated once in the first 16 weeks after germination, when grown under optimum conditions, had significantly lower survival rates than undefoliated seedlings.[2] When defoliated twice during that period, the seedlings had almost no chance of survival.

Without adequate recovery, no reliable improvement in the forage resource should be expected, whether many or few paddocks per herd are utilized. It is *critical* to remember that the length of recovery period is a management decision based on the factors discussed in this section. The length of grazing periods should be

[2](Limb et al., 2011)

determined based on the recovery needed for grazed plants, the number of paddocks that are recovering at any particular time, and the relative carrying capacity of that paddock. It should *not* be derived from a desired grazing period per paddock.

Figure 4. Sand bluestem (white arrow) growing out of sand sagebrush, where it has been protected from excessive defoliation by grazing livestock. Note the severe use on surrounding grasses. If grazing is routinely deferred long enough between grazing periods for the plants that were grazed to reestablish a full array of leaves between grazing periods, and for any seedlings that might germinate to put down roots and establish, desirable and productive plants like sand bluestem will begin to be found outside these protected areas. Without adequate recovery, no reliable improvement in the forage resource should be expected, whether many or few paddocks per herd are utilized.
Photo courtesy of Tim Steffens.

Area Allowance or Stocking Density. Stocking density should not be confused with stocking rate. Whereas stocking rate is a measure of animals per unit area *over a period of time*, stocking density is a measure of animals per unit area at a given *point in time*. Stocking density is measured in units of animals/area with no measure of time. Because of this confusion, we prefer to use the term "area allowance" rather than stocking density. Area allowance is the reciprocal of stocking density and measured in units of area/animal with no measure of time. **Area allowance** is decreased (therefore, stocking density is increased) at a given stocking rate by concentrating animals on smaller areas.

In the United States, area allowance is usually decreased by combining herds or subdividing paddocks. However, in the same way that the distances traveled by two drivers moving at different speeds depend on how long each of them travels relative to their speed, the intensity of grazing that a paddock receives is dependent on the length of the grazing period compared to the area allowance. By concentrating animals on relatively small areas for short periods of time, we may have low area allowances with low, moderate, or high average intensities of defoliation. Even though the rate of forage disappearance is faster at high densities, consumption can be stopped at any time. Conversely, if animals are spread over fairly large areas for extended periods, area allowance will often be high, even with high stocking rates, which would cause high average levels of forage utilization with a high likelihood of multiple defoliations on palatable plants.

Area allowance is important primarily because of its effects on livestock distribution, the animal's ability to select a high-quality diet, the efficiency with which forage is harvested, and the frequency and intensity of defoliation. As area allowance decreases with adaptive, multi-paddock (AMP) grazing, livestock distribution may become more uniform on the area the animals are using for the grazing period, but the animal is less able to select a high-quality diet at any given point in time. However, it may or may not allow more selectivity over an *extended period* of time.

If animals see more high-quality plants because animal distribution on the landscape is more equitable, and plant maturity and diversity are managed to provide higher diet quality, they will have a greater ability to select a high-quality diet over an extended period of time. *Assuming the same desired recovery period* and the same number of animals in each case, decreasing area allowance as a result of more but smaller paddocks on the same land area results in a lower average stocking intensity in each paddock and a lighter degree of average forage utilization than on the same resource with higher area allowance. Under that type of strategy, the grazing period decreases to a greater extent than the area allowance does. The livestock will also see more acres over a set time period than animals using fewer paddocks on the same management unit, since the shorter grazing periods also shorten the **cycle length** (time from entry of a paddock until it is entered again).

More paddocks and shorter grazing periods with adequate intervening plant recovery should decrease the risk that a plant will be defoliated more than once before it has recovered enough leaf area to maintain itself. Such a strategy, in turn, should increase forage production, particularly on heavily utilized parts of the landscape, if there has been adequate quantity, timing, and distribution of precipitation over the course of the intervening recovery period. More frequent rotations to fresh forage may or may not allow greater selectivity over time, decrease average levels of defoliation for the plants in a paddock, and increase diet quality. The relationship between stocking intensity and area allowance when using the correct and incorrect management strategies is explained further in the next publication in this series, *Using Essential Grazing Concepts to Properly Implement Successful Adaptive, Multi-paddock Grazing Strategies.*

Harvest Efficiency. Harvest efficiency is the proportion of total forage that is consumed by the animals we manage. When moderately stocked on diverse rangeland, harvest efficiency usually ranges between about 20 and 40 percent, with lower figures generally seen with extensive, low-intensity grazing management, long grazing periods, high area allowances, and often, irregular livestock distribution. Higher values are usually associated with more intensive management using higher stocking densities, more equitable distribution, and shorter grazing periods.

Figure 5. Animals will always graze preferred plants on preferred areas of the landscape. At higher densities, they *may* use the landscape more uniformly but will not stop grazing selectively, though the degree of selectivity they can express may change. Without a period of regrowth sufficient for the grazed plants to maintain their competitive ability for resources with their neighbors, they will weaken and can eventually die. *Photo courtesy of Tim Steffens.*

These values may seem low until you consider that some plant parts are too low or high in the canopy to be easily grazed or are on areas that are underutilized because of brush cover, steepness, exposed rock, etc. Some plants are unpalatable or poisonous. Much of the production, even of palatable species, is composed of stems and other lowly palatable parts. Some plants are fouled by dung, mud, urine, etc. Some herbage is trampled or dropped from the mouth. Weather and consumption by other **herbivores** also account for some losses. Additionally, some material needs to remain to protect soils, promote optimum water cycles, and facilitate rapid regrowth following grazing. While increased productivity of the vegetation is the way to increase stocking rate in the long term, the only way to increase stocking rate without resource degradation in the short term is to improve harvest efficiency and animal distribution.

Herbage Allowance. Herbage allowance compares the amount of forage on offer to the amount animals can consume. It may be measured in units of forage weight available per animal per day. However, these measures are often hard to determine accurately, and

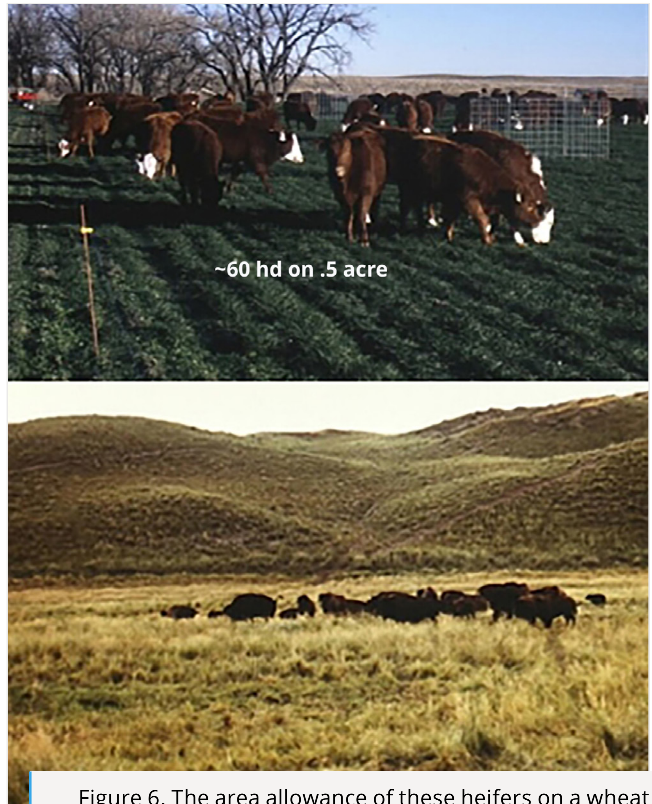

Figure 6. The area allowance of these heifers on a wheat pasture research project with very sandy soils is quite high. How much forage is available to meet nutritional requirements and their effects on the forage resource depend on how long they stay and how long they are gone. Note the high vigor, continuous cover, and lack of trails, indicating stable soils when moved multiple times per day with extended recovery periods. The bison are using a similarly sized area at the moment, despite continuous access to several thousand acres. Note deep trailing in the background and grazing lawns forming in the foreground in very sandy soils that can lead to instability over time. *Photos courtesy of Tim Steffens.*

area allowance (the area available per animal per day) is often used in areas with similar vegetative structure and species composition to estimate availability instead. Herbage allowance affects the quality of the diet that the animal is able to select, since the animal must select its diet from a variety of different plants and plant parts of varying quality.

Figure 7 shows a hypothetical example of the amount of material in a paddock composed of plants with different forage quality during the dormant season. The dotted vertical line shows the requirement for an animal at a desired level of production. The animal must mix plants with higher quality than its requirements with plants of lower quality in an effort to meet its nutritional needs. You can see that there is more low-quality forage that does not meet the animal's requirements than high-quality forage. As the proportion of forage lower than the animals' requirements increases, the herbage allowance must increase if the animal is to meet its requirements. Eating too much of the lower-quality forage will decrease the animals' diet quality enough that they cannot meet performance goals. Increasing herbage allowance can be accomplished by lowering stocking rate, increasing area allowance for a given grazing period, or shortening the grazing period more, proportionally, than area allowance decreases.

In Figure 7A, where all of the forage consumed happens during a single grazing bout or day, a higher proportion of the total herbage on offer will still meet an animal's requirements than if grazing periods occur over a longer period of time. When grazing periods are longer, the selectivity of the animals causes a higher proportion of the higher-quality components to be eaten early in the grazing period (the tan portion under the curve in Figure 7B). Fewer high-quality plants are available

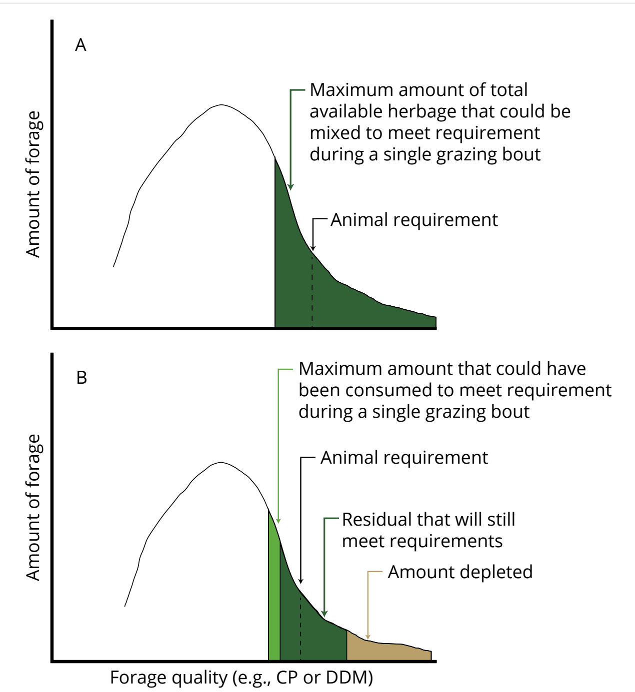

Figure 7. The relationship of the availability of forages of different quality versus nutrient requirements and the proportion of the standing quality that can be consumed to achieve the desired performance. (A) If consumed in a single day, all of the forage represented by the dark-green shaded area could be consumed and still meet the animals' requirements, maximizing harvest efficiency for the desired level of nutrient intake. (B) As a longer grazing period progresses, higher-quality components are selectively removed (tan area), decreasing the proportion of high-quality plants remaining and decreasing the amount still available for the rest of the grazing period that will meet the animals' requirements (dark-green area). The light-green area represents the additional available forage that is no longer useable, because there is insufficient higher quality remaining with which to mix it that will still meet requirements. *Figure is derived from Rittenhouse and Bailey.*[3]

in later parts of the grazing period that can be mixed with lower-quality herbage to provide adequate diet quality, resulting in decreased carrying capacity, more supplementation, or decreased performance.

MANAGEMENT SIGNIFICANCE

Adequate recovery between grazing periods is necessary for desired plants to maintain their competitive position in the **plant community**. To provide regular and adequate recovery, some method of periodically removing the possibility of grazing is required. By using multiple paddocks per herd in succession, this recovery can be provided to allow plants to regrow and reproduce between grazing periods. However, at some level of paddock subdivision, additional fencing and water development costs will not be covered by additional plant productivity, quality, or animal performance. The optimum number of paddocks will be lower in drier climates and depend on fencing costs, the improvement in livestock distribution, management, and husbandry achieved, the amount of labor that can be decreased with animals concentrated in smaller areas, and the degree to which the resource can be improved. Other means of changing distribution that can be used include access to water points, patch burning, herding, and changing the timing when animals have access to an area.

Animals typically mix plants of varying quality—some higher than their dietary requirements and some lower—in order to meet their nutrient needs each day. Multiple paddocks per herd result in lower area allowance, causing higher-quality components of the forage resource to disappear at a faster rate. However, if the animals can select a mixture of plants with different qualities that meets their requirements over the length of the grazing period, they will perform adequately. By doing so over shorter and shorter periods of time, as would happen when using more paddocks per herd on a management unit of a fixed size, diet quality will vary less within a grazing period and from one grazing period to the next. The highest diet quality may not be as high, but the lowest diet quality will not be as low as they would be when grazing periods are longer. Herbage allowance and harvest efficiency can be used to plan for these changing rates of disappearance so that animal performance is maintained. However, to do so reliably, understanding how to manage grazing periods to provide enough herbage allowance while still providing adequate recovery is critical. That is the focus of the sixth and final publication in this series, *Using Essential Grazing Concepts to Properly Implement Successful Adaptive, Multi-paddock Grazing Strategies.*

[3](Rittenhouse and Bailey, 1996)

GLOSSARY

Aggregate A cluster of soil particles held together in a single group such as a clod or crumb. The more stable and rounder in appearance, the more desirable the aggregate **structure**.

Animal Unit Day (AUD) "The forage demand (amount of forage) on an oven-dry basis required by one animal unit for a period of one day."[1]

Animal Unit Month (AUM) "The amount of oven-dry forage (forage demand) required by one animal unit for a standardized period of 30 animal-unit-days."[1]

Animal Unit Year-long (AUY) "Equal to 12 AUMs."[1]

Area Allowance A measure of area/animal at a given point in time. It is measured in units of area/animal with no measure of time. It is the inverse of stocking density and changes linearly with increasing paddock numbers on the same land area with animal numbers remaining constant.

Biomass The amount of living material.

Browse The part of shrubs, woody vines, and trees available for animal consumption composed of leaves and small, soft twigs of palatable shrubs.[1]

Bulk Density The mass per unit of volume (e.g., pounds/cubic foot) of undisturbed soil, including air space. Within a particular soil type, lower bulk density will allow more rapid moisture infiltration and movement through the profile.

Capital Assets In the context of a business, capital assets are things with a useful life longer than a year that are used to make the products of the business. They are not intended for sale in the regular course of business operations such as machinery, buildings, or the real property where the business is located. In the case of the range resource, they would be things like seedbanks, soil organic matter, perennial plants, and water resources.

Carnivore An animal that eats other animals.

Carrying Capacity "The average number of livestock and/or wildlife that may be sustained on a management unit compatible with management objectives for the unit. In addition to site characteristics, it is a function of management goals and management intensity."[1]

Climax "The final or stable biotic community in a successional series; it is self-perpetuating and in equilibrium with the physical habitat."[1] Stress or disturbance as a result of excessive levels of grazing or other factors would cause the community to revert to a lower **successional state**. With removal of the stressor, the community would then progress through the same stages back to the stable climax community. This view of **successional** processes, however, has been unsuccessful in explaining **plant community** changes in some circumstances, particularly those where "naturalized" alien species have become an important part of the plant community, on areas where extreme degradation of the soil has occurred, or where other environmental influences like pollution or species extinction have changed the productive potential of the site.

Cycle Length The length of time required to graze all paddocks in a unit, i.e., the recovery period plus the grazing period.

Deferment "The delay of grazing to achieve a specific management objective. A strategy aimed at providing time for plant reproduction, establishment of new plants, restoration of plant vigor, a return to environmental conditions appropriate for grazing, or the accumulation of forage for later use."[1]

Defoliation "The removal of plant leaves, i.e., by grazing or browsing, cutting, chemical defoliant, or natural phenomena such as hail, fire, or frost."[1]

Disturbance A change in conditions, processes, or a stress that causes some plants to die in an area. Examples include fire, drought, excessive grazing, floods, etc.

Dormancy The period when the plant is no longer growing, usually after frost, but may also be due to drought.

Ecological Site "A kind of land with specific physical characteristics which differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation and in its response to management."[1]

Ecological Threshold A threshold of soil or other degradation that, once crossed, changes the potential plant community for a site irreversibly on management-level time scales without high levels of management input or extended periods of time.

Ecosystem "Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space."[1] I.e., the plants, animals, soils, climate, and other living and non-living things that affect each other through a series of chemical and physical feedbacks.

Forb A broadleaf herbaceous plant (not a grass, sedge, or rush); often referred to as a weed.

Herbaceous Plant Plants that are not woody.

Herbage Allowance The amount of forage on offer compared to the amount that the animals can consume.

Herbivore "An animal that subsists principally or entirely on plants or plant materials."[1]

Litter "The uppermost layer of organic debris on the soil surface; essentially the freshly fallen or slightly decomposed vegetal material."[1]

Meristem A region of plant tissue—found chiefly at the growing tips of roots and shoots, at the nodes, and in grasses, at the collar of leaves and at the base of the plant—consisting of actively dividing cells forming new tissue. The growth points of the plant.

Omnivore An animal that eats both plants and animals.

Organism Any living thing.

Overgrazing "Continued heavy grazing which exceeds the recovery capacity of the plant and creates a deteriorated range."[1] It happens to individual plants and is caused by inadequate opportunity for regrowth following defoliation that weakens, and if continued, can kill that plant. Overgrazing can occur even with low stocking rates.

Overhead cost The costs, usually associated with land, facilities, or labor, that do not increase directly with the number of animals.

Overstocking "Placing a number of animals on a given area that will result in overuse if continued to the end of the planned grazing period."[1] That is, forage demand in excess of that which will meet animal production and resource goals. Overstocking will always cause one or more of the following: 1) overgrazing; 2) increased variable costs; 3) decreased animal performance; 4) lower profitability.

Paddock "A grazing area that is a subdivision of a grazing management unit and is enclosed and separated from other areas by a fence or barrier."[1] The term "pasture" is also used in the United States. However, "paddock" is used in this case because it is most often used in conjunction with controlled grazing management, whereas pasture is a term more commonly used in areas where season-long or year-long grazing is common.

Perennial A plant that has a life span of 3 or more years that regrows each year from existing crowns, stems, or roots.[1]

Photosynthesis The chemical reaction carried on by green plants in which they change carbon dioxide from the air and water absorbed from its roots to form simple compounds used for energy using the light from the sun.

Plant Community "An assemblage of plants occurring together at any point in time, thus denoting no particular successional status."[1]

Recovery Regrowth following **defoliation** sufficient for a plant to fully regain its vigor so that it can retain its competitive ability in relation to neighboring plants. With regard to a plant community, recovery may also require additional time for plants to produce reproductive parts and then germinate and establish new plants, if more desirable plants are wanted. In order to ensure recovery, a period of grazing **deferment** is usually required.

Revenue The total amount of money received as a result of doing business.

Rhizome A horizontal underground stem, usually sending out roots and aboveground shoots from the nodes that is responsible for vegetative reproduction in some plants like Johnsongrass and Tobosa.[1]

Ruminant "Even-toed, hoofed mammals that chew the cud and have a 4-chamber stomach."[1] These animals also have a dental pad in the upper jaw instead of incisor teeth, such as a cow, sheep, goat, or deer, but not a horse.

Seral "Refers to species or communities that are eventually replaced by other species or communities within a sere."[1] It is sometimes used to refer to the **successional state** of a community growing on an **ecological site.** A high seral community would have a high proportion of species that are long-lived, use resources efficiently (e.g., conserve them with little waste), and are adapted to lower levels of disturbance. Low or mid-seral communities would have a higher proportion of plants that were shorter-lived, more opportunistic, and possibly less efficient in their resource use. High, mid-, and low seral may also refer to plants characteristically found in these respective communities.

Seral Community "The relatively transitory communities that develop under plant succession. Syn. seral stage"[1]

Stocking Density "The relationship between number of animals and the specific unit of land being grazed at any one point in time. May be expressed in animal units per unit of land area (animal units at a specific time/area of land)."[1] It is the inverse of area allowance and changes asymptotically with increasing paddock numbers on the same land area when animal numbers remain constant.

Stocking Intensity The total forage demand per unit area in a paddock for a grazing period.

Stocking Rate "The relationship between the number of animals and the grazing management unit utilized over a specified time period."[1] This will be expressed in terms of animal units of forage demand over a described time period per unit of land area such as acres/cow/year, acres/animal unit × month, animal unit × days/acre, etc.[1] Therefore, it is an indirect measure of forage demand on a management unit for a grazing season or year. With continuous grazing, stocking rate and stocking intensity will be the same.

Stolon "A horizontal stem which grows along the surface of the soil and roots at the nodes."[1] These are the "runners" commonly seen in species like Buffalograss, Curly mesquite, and Bermudagrass.

Structure The characteristic size and shape of the soil aggregates.

Succession "The progressive replacement of plant communities on a site which leads to the potential natural plant community."[1]

Successional State "The present state of vegetation and soil protection of an ecological site in relation to the potential natural community for the site. Successional status is the expression of the relative degree to which kinds, proportions, and amounts of plants in a community resemble that of the potential natural community."[1] Generally, in higher seral communities, species are usually longer-lived, reproduce less often, and are generally better adapted to conditions where competition is high for limited resources and the plants are generally assumed to be better adapted to moister conditions and are more productive, though there is often much of the energy lost to respiration, such that net productivity approaches respiration.

Transpiration The loss of moisture through the leaves of plants.

Turnover The number of units produced from a given area over a period of time.

Variable costs Those costs that increase with each additional unit of production. In livestock production, usually associated with feed, veterinary costs, shearing, interest, depreciation on the livestock, etc.

Vegetative "Non-reproductive plant parts (i.e., leaf and stem) in contrast to reproductive plant parts (i.e., flower and seed) in developmental stages of plant growth. Also, the non-reproductive stage in plant development."[1] This term also may be used for classes of plants that are not woody—that is, not shrubs or trees.

Vegetative Reproduction "Production of new plants by any asexual method,"[1] e.g., from **stolons** or **rhizomes**.

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