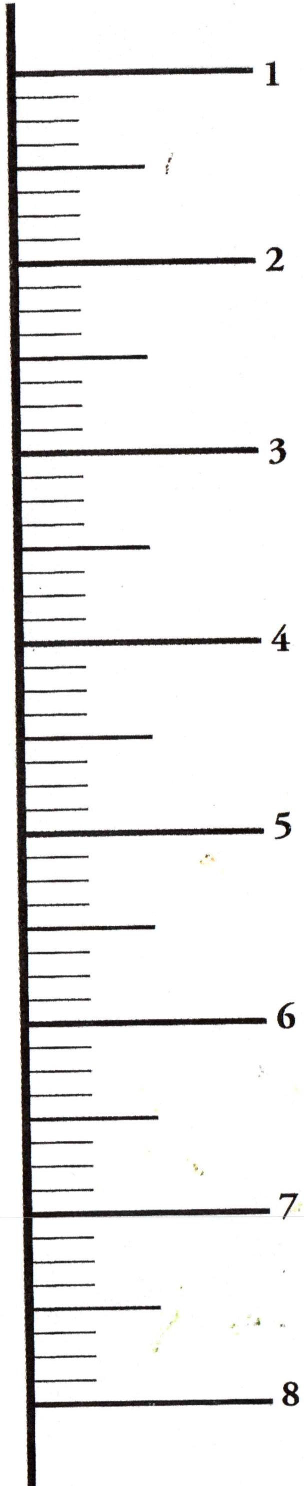

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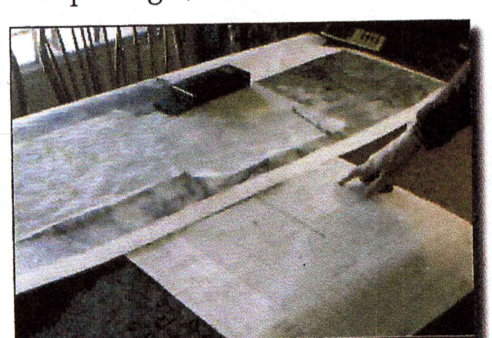

Rangeland Health & Planned Grazing Field Guide

by
Kirk Gadzia & Nathan Sayre

The Quivira Coalition, Earth Works Institute & The New Ranch Network

April 2009
Fourth Edition

Over the past 400 years, grazing has been one of the major land use activities in the Southwest and continues to remain and important use. Often grazing has been poorly managed and has led to large-scale soil loss. Currently, many rangelands show signs of either over-resting or over-grazing. Both conditions lead to reduced vegetation cover and water absorption in the soil. This in turn, leads to accelerated sheet, rill, and gully formation while polluting arroyos and creeks with sedimentary stream-bottom deposits.

Grazing management in the form of planned grazing for land rehabilitation and future grazing use can contribute to a ***reduction*** of erosion and sedimentation of watershed streams.

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Introduction to Grazing

This field guide is an introduction to grazing management designed to help landowners, stock handlers, and agency personnel make better decisions concerning rangeland management. Improved management decisions will increase vegetative cover, control erosion, help curb the spread of invasive species and improve animal production.

Arid and semiarid rangelands (receiving less than 10 or 20 inches of rain per year, on average, respectively) defy some of the central assumptions of conventional rangeland management. They are highly variable over time and space, making fixed measurements of carrying capacity or "the right" stocking rate questionable. Which plants grow, and how much they grow, depends not only on how much rain falls but when and how quickly it falls, and on the weather that follows it.

Plants must be able to withstand drought and take advantage of rain when it finally arrives. Different kinds of plants will grow depending on whether the rain arrives in summer or winter, in large quantities or small. Over thousands of years of evolution, the vegetation of these areas has adapted to reflect these circumstances. In recent decades, scientists have begun to develop models to explain and explore these complex dynamics. This field guide presents some updated tools and concepts of rangeland management that reflect the improved scientific understanding of rangeland dynamics.

Central to an understanding of rangeland dynamics is the concept of "disturbance." Droughts and wildfires are natural disturbances in arid and semi-arid rangeland ecosystems. Grazing is also a type of natural disturbance to which many rangeland plants are adapted. The effects of grazing depend—like those of other disturbances—on ***timing*** (when they happen), ***intensity*** (how severe they are), and ***frequency*** (how often they recur), and grazing can be managed in these terms (see page 8). Vegeta-

Fence line contrast: The pasture on the left is 100 acres in size and carried 275 head of livestock for one week. The pasture on the right is 1,500 acres; it supported the same herd for four weeks. Grazing pressure was 3.5 times greater in the left pasture. The difference is timing: the left pasture has had a growing season to recover, while the right pasture has not.

tion is highly sensitive to variations in available water and nutrients, both of which cycle through the ecosystem in ways that can be indirectly influenced by management. Management tailored to these processes, and attuned to variability, can conserve rangeland resources and help restore areas that have been degraded in the past—while simultaneously producing greater returns for the ranch.

Ranching as Sustainable Agriculture

To be sustainable, ranching must convert natural forage into livestock in such a way that perennial forage plants retain vitality year after year. This is possible because grasses (and many other plants) are resilient to grazing—they can recover from it provided that the disturbance is not too great. However, grazing is not limited to the plants that are eaten. There are other factors to consider: water, soils, nutrients, other plants, wildlife and a host of organisms that inter-relate with all of them. Livestock are only one piece of a much larger puzzle that must fit together if ranching is to remain sustainable.

At its simplest, "biodiversity" is the richness or number of species (kinds of organisms) in a community. When the community is rich, the landscape is more resilient to disturbance. Therefore, it is necessary to maintain resources other than just grass, soil, and cattle. As one rancher put it: "My goal is to manage for diversity and complexity of life on the ranch: biodiversity. Each plant species has different growing seasons, different root zones, and different leaf capacity. Each provides a different pathway for conversion of solar energy to life. By maximizing the pathways of solar energy conversion, I maximize production. I have learned that biodiversity extends beyond a mixture of grass. Each animal, fish, and insect species expresses something important about the health of the land."

Grazing as a Natural Process

Grazing is a natural process which has been occurring for millions of years. From the fossil record it has been determined that grasses and grazers evolved together some 45 million years ago. Having co-evolved, grazers and grasses are adapted to each other.

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%

Table 1.

Imagine a perennial bunch-grass plant over the course of a year. Whenever conditions for growth are insufficient, the plant is dormant. Grazing during the dormant season is unlikely to cause damage, because the leaves are not living tissue at this time (i.e., they are not photosynthesizing and not exchanging minerals, nutrients, and fluids with the plant's roots). When moisture and temperature conditions reach favorable levels, the plant enters a period of growth. Below ground, the plant's roots begin to grow, drawing minerals and nutrients from the soil. Above ground, leaves begin to "green-up" as new buds grow from the base of the plant, which is known as the crown.

Throughout the growing season, the plant responds to changing conditions of moisture and sunlight. If conditions permit, the plant continues photosynthesis through the growing season until temperatures drop again in the fall. It produces enough food to support growth in the roots and the leaves, as well as to develop tillers and/or seed stalks. It stores up energy for the upcoming dormant season. It flowers and sets seed. Eventually the plant returns to dormancy, its leaves and stems again turning brown. The health or vigor of the plant depends on its ability to produce enough food during the growing season to survive through the dormant season and resume growth when conditions are again favorable.

In commencing to grow in the spring, the plant utilizes stored energy in the root crown area to produce new above ground growth. It thus takes a risk, so to speak, that the new leaves will be able to produce enough additional energy to replenish its supplies. At this early stage of growth, then, the plant is more vulnerable to

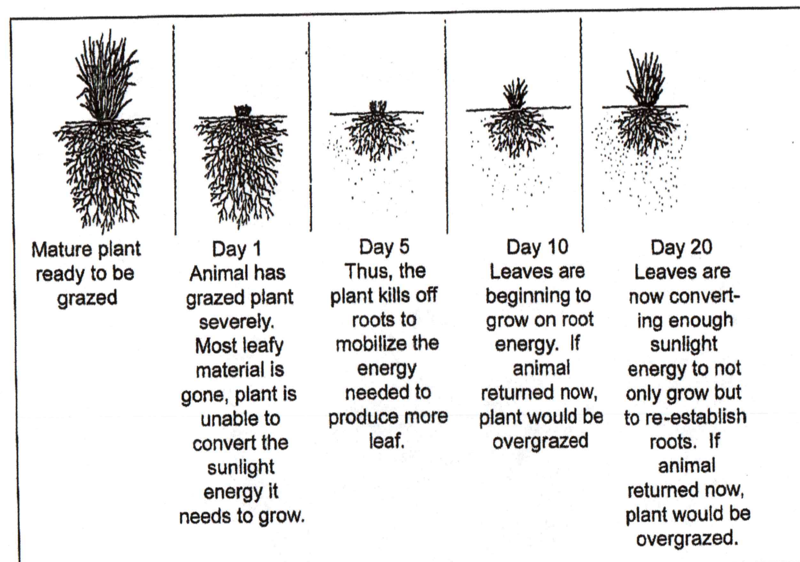


Figure 1. Effects of grazing on growth cycle of grass plant.

leaf loss than it is later in the growing season.

Grazing disturbs the plant by removing leaf tissue. This can be good, bad, or indifferent for the plant as a whole. If very little leaf is removed, the effects of grazing may be negligible. A more severe, single grazing may slow or even halt root growth (Table 1, page 2), and/or accelerate the growth of leaves, but recovery is likely if grazing does not recur until roots and leaves regrow sufficiently. Repeated defoliations in the same growing season, however, can set the plant back for many years to come (Figure 1, page 3).

Grasses have several traits that enable them to tolerate grazing, and in some circumstances to benefit from it. Most importantly, they produce more leaf area than is necessary for optimal photosynthesis, meaning that some leaf area can be removed without damage. Younger leaves photosynthesize more efficiently than older ones, and defoliation of older leaves can expose new growth to greater sunlight. ***Overgrazing*** occurs when a plant bitten severely in the growing season gets bitten severely again while using energy it has taken from its crown, stem bases, or roots to reestablish leaf—something perennial grasses routinely do (Figure 1, page 3). Ovegrazing can happen:

- when the plant is exposed to the animals for too many days and they are around to re-graze it as it tries to re-grow;
- when animals move away but return too soon; or
- when grazing is allowed too soon after dormancy when the plant is growing new leaf from stored energy.

Overgrazed plant.

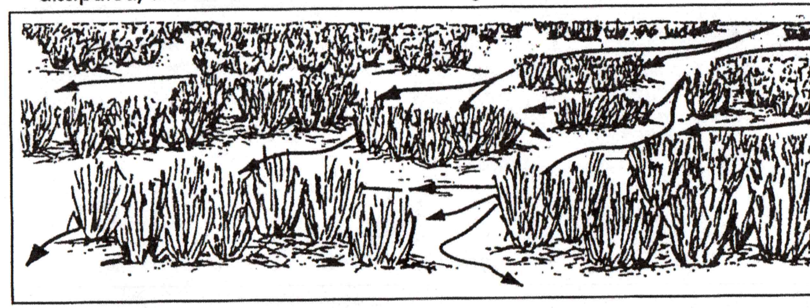
The Distribution of Water and Nutrients

How plants respond to grazing also depends on larger conditions in the area: the other plants present, topography and soils, or whether it's a dry year or a wet one.

Two ecological processes strongly determine the vigor and composition of vegetation, especially in arid and semiarid rangelands: the flow or cycling of water and nutrients. Put simply, the plants on a rangeland—what they are and how well they are growing—are a reflection of these underlying ecological processes. The goal is to develop means of managing grazing for improved water and nutrient availability.

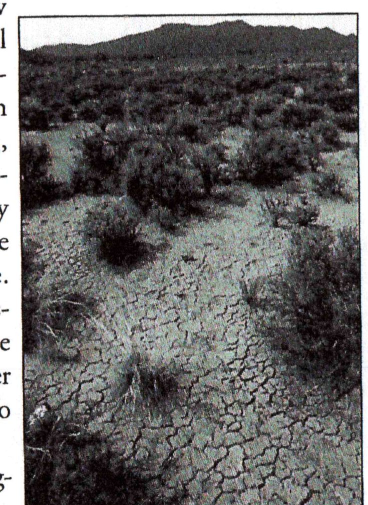
Plants require water and nutrients for growth. These are not static quantities: they increase and decrease, sometimes rapidly, and they move around. The issue is not simply how

Figure 2. Where vegetation is dense, water flows are tortuous. Erosive energy is dissipated, and more water absorbs into the ground as it moves across the land.



much moisture or nutrients there are, but whether they are available to plants when they need them. In arid and semiarid regions, small changes in the availability of water and nutrients can have dramatic effects on vegetation. Therefore, we have to manage rangelands in a way that effectively uses available water and diligently recycles the nutrients in the soil and plant matter.

Effective Use of Water. Moisture is scarce in arid and semiarid areas and precipitation is highly variable. The key issue is how much of the total precipitation is retained in the system and for how long, because this determines how effectively the plants use the available moisture. A second, related issue is erosion: where erosion is high, water retention tends to be low.



Soil Surface Crusting

Vegetation strongly affects the distribution of water in space and time. In the absence of vegetation, water hits the ground surface at a high rate of speed. The impact dislodges fine soil particles, which then clog the pores of the soil. This greatly reduces infiltration and accelerates erosion. Soil particles are also transported downhill in runoff. This reduces the quality of the soil that remains. Where bare ground exists, a thin sealed surface ("crusting") develops which encourages runoff and prevents plant establishment, resulting in more bare ground.

If a raindrop hits plants or litter, on the other hand, the impact on the soil is greatly diminished. Even a thin cover of litter will protect soil from crusting and reduce erosion. Live plants intercept water both from the sky and running off from higher ground. By slowing its progress, the plants diminish the water's erosive power (Figure 2.)

Studies indicate that small increases in the basal cover of plants (i.e., the number of stems per square foot) can dramatically increase the infiltration of water into the soil. The leaves of grass plants catch water and deliver it to the base of the plant, where it is unlikely to disrupt the soil upon impact. Roots open pores in the ground and support communities of insects, fungi, and bacteria that create cavities and tunnels for water to pass through. The difference is especially pronounced when rainfall is torrential, as in Southwestern U.S. summer monsoons.

The more water that is retained in the soil, the more resilient the system will be to extremes of rainfall or drought. The goal can be expressed simply: capture as much of the rain that falls as possible, retain that water in the soil, so that it can be safely released to plants and downstream areas over time. Given that drought is almost "normal" in the Southwest, this is an important goal.

Cycling Nutrients. The nutrient cycle consists of the movement of nitrogen, phosphorus, and other minerals from the soil, through plants, and eventually back into the soil. The more effectively the nutrient cycle functions, the more nutrients are available to support plant growth (figure 3).

Decomposers—especially insects—are a key link in both the water and nutrient cycles. For example, termites can dramatically increase water infiltration rates by opening pores in the soil. Without plants to feed on, termites disappear and the soil becomes more compact and impermeable. Termites actually consume the majority of dead plant matter in Southwestern deserts. Without their activity, much of the nutrients in dead plants would remain trapped in standing matter, unavailable to other plants.

Disturbances like grazing and fire also play a role in the nutrient cycle by reducing the standing crop of old plant material and bringing it into contact with the ground, either as manure, ash, or by trampling.

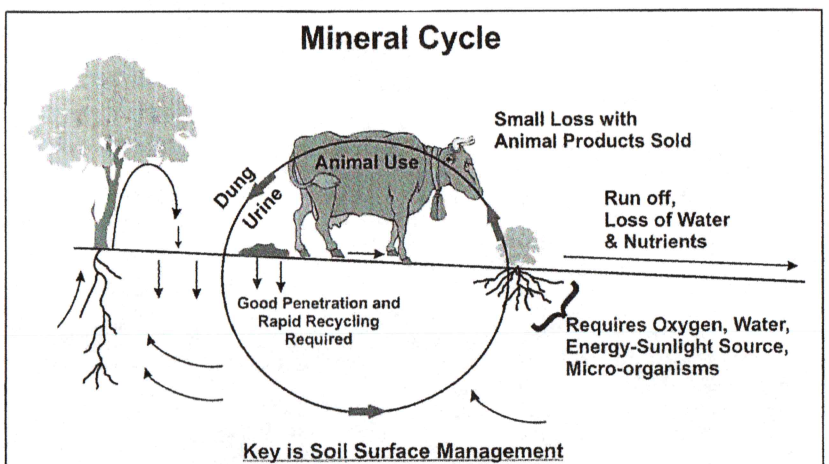


Figure 3.

The nutrient cycle is strongly affected by the water cycle, for better and for worse. Plants are the mechanism that enables the two cycles to reinforce each other. An area with good plant cover will retain more water and cycle more nutrients, allowing the plants to survive droughts better and to produce still more vegetation in good years. If the soil is hard and bare, on the other hand, less moisture penetrates into the ground, which dries out more quickly and makes plant growth more difficult, which in turn diminishes the amount of nutrients being cycled in the area. Plants and litter also have a strong effect on ground surface temperatures and evaporation rates. Bare ground is hotter, drier, more subject to temperature extremes, and less likely to permit germination of new plants. It is also poor habitat for microorganisms and insects that enhance nutrient cycling.

The processes that determine water and nutrient availability come together at the surface of the ground. If the soil is well-covered with plants and stable under the surface because of roots, litter, and biological activity, the watershed is functioning properly and the potential for long-term sustainable production of forage is good. Chances are that the rangeland will be able to recover from disturbances like drought and grazing. However, if there is poor vegetation cover, limited root mass, and minimal biological activity in the soil, and if the watershed drains precipitation too quickly via rills and gullies, soil loss by wind and water will be higher and will weaken the resilience of the system, making it more vulnerable to disturbances. Productivity will gradually diminish, usually for a long time.

Monitoring

The water and nutrient cycles, and their effects on plants, are difficult to observe or measure directly. Most of a perennial grass plant is below the ground, in the root system. Nutrients like nitrogen and phosphorus are invisible to the eye. **Monitoring** is a way of measuring ecological processes indirectly. The processes themselves cannot be observed, but indicators of the processes can be observed and measured. Litter cover, for example, is an indicator of the cycling of nutrients, because litter is organic material (with captured nutrients) that is returned to the soil for decomposition (release of nutrients).

Monitoring must be: 1) consistent; 2) practicable—that is, not too time-consuming or difficult; and 3) related to management goals and activities. The point of monitoring is simple: it provides feedback that is timely and objective. Monitoring data can reveal the effects of management decisions well before they are apparent to the naked eye, greatly increasing one's ability to avoid lasting damage and to encourage rangeland improvement. Every manager learns from experience, but good monitoring allows that learning to happen more quickly and systematically. Lessons learned from monitoring also help rangeland managers to adapt and update their management plans. (See pages 13-15 for a description of rangeland health indicators that can be used for monitoring.)

Planning & Managing Livestock Grazing

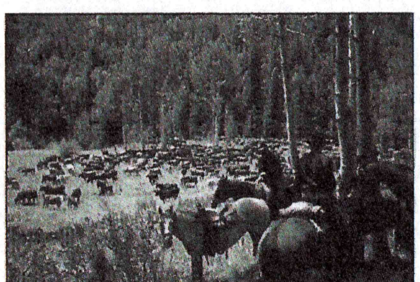
Two primary tools for the management of grazing are available: disturbance and rest. Some disturbances can be manipulated, like grazing and (to some degree) fire. Others, like drought and flood, are largely beyond the manager's control. In this field guide, we introduce the central principles of New Ranch management: to use the tools skillfully and to plan for the disturbances that cannot be controlled.

For purposes of brevity, this field guide will only discuss the skillful use of the tools of grazing and rest. The main tool, controlled grazing (or planned grazing), is a disturbance that can be managed through three different parameters: **intensity, timing, and density.**

Intensity. Intensity refers to how much biomass is removed from a plant by livestock. It measures the percentage of net primary production that is channeled into herbivores rather than consumed by fire, oxidation, or decomposers. Intensity is a function of three variables: the number of animal units in a pasture, the length of time they are there, and the size of the pasture. To manage intensity, therefore, requires a tool with three components: one for animals, one for time, and one for area.

Animal-days per acre, or ADAs, contains all three components necessary to measure and manage intensity. Adjustment must be made for the class of livestock being grazed (cattle, sheep, goats, horses, etc.). Once this adjustment is made, animal-days per acre is exactly what it says: animal units, multiplied by days in the pasture, divided by the size of the pasture in acres (pages 11-12).

Timing. During the growing season, the challenge is to control the impact of grazing in such a way that the grasses have time to recover. It's impossible to know when it will rain, how much, or how long the growing season will last. So there's no telling exactly how long it will take for grasses to recover from grazing. But the principles of growing



Herding in the West Elks, CO.

season grazing management are fairly simple: 1) the more leaf area that's grazed off, the longer recovery will take, and 2) a plant that is grazed again before recovering will store less energy in its tissues and will weaken over time. Finally, grazing should not happen at the same time of year every year in any given pasture. If it does, the palatable species that are young and green at that time will bear a disproportionate share of the impact and will eventually decline relative to other species.

Control over grazing boils down to control over the distribution of livestock across the rangeland and over time. The most common way to do this is with fencing, but there are other ways to control the distribution of livestock, as well. Mineral blocks have been used this way for decades. Where water can be turned on and off, can also be used to control the location of grazing pressure. Herding is an ancient technique that is being reborn in a few areas. Riders and dogs move and control the herd. New techniques such as GPS based "virtual fencing" are also being developed.

Density. Perhaps the most controversial issue in livestock distribution concerns density. Should livestock graze together in a herd, or should they be spread out across the rangeland? For decades, ranchers and rangeland conservationists have worked to spread cattle out in order to utilize forage more evenly across large pastures. New Ranchers have chosen instead to amalgamate their herds and work them as a single unit or, in certain circumstances, as two herds. The benefits they attribute to this are several. A single herd is more easily monitored. This decreases labor and other costs associated with routine care. Cattle in a herd are also better able to fend off predators than if they were spread out, just as wild ungulates are. In addition, manure trampling and grazing are more evenly distributed within each pasture.

Developing a Grazing Plan

Planning is critical to sustainable grazing and to avoid overgrazing. Not only does good planning improve management, it also provides a greater sense of control over one's livelihood, which can be an important boost to morale in a business characterized by uncertainty and risk. Grazing plans should be adaptable to annually changing circumstances and always be ready for the worst.

The central task of planning is to allocate grazing pressure and recovery periods. This includes when the grazing will occur, at what intensity, and for how long. But planning is not complete until provision is made to monitor the effects of management actions and thereby learn from them. Without monitoring, mistakes may go unnoticed until it is too late to minimize the consequences, while successes may be misinterpreted.

Table 2. Planned Grazing Example: Will I Overgraze?

# LAND DIVISIONS	AVG. GRAZE PERIOD (GP)	RCVRY PERIOD GIVEN (RP)	PLANT GROWTH RATES: SLOW GROWTH: GP TOO LONG	SLOW GROWTH: RP TOO SHORT	FAST GROWTH: GP TOO LONG	FAST GROWTH: RP TOO SHORT
8	4	30	NO	YES (1)	NO	NO
	13	90	NO	NO	YES (2)	NO
31	1	30	NO	YES !!!!!!	NO	NO
	3	90	NO	NO	NO	NO

GP = Grazing Period (days) and
RP = Recovery Period (days)

This is an example only. This example assumes:
1) **Slow growth** requires **90** days of recovery; **Fast Growth** requires **30** days.
2) Pastures are equal in size and quality of forage [seldom true in the real world].
3) There are many other factors not considered in this example diagram.
Note the "Yeses" in the diagram. They indicate overgrazing:
Yes #1. During **slow growth,** the recovery period is too short. A 90 day recovery period is needed, but only 30 are given.
Yes #2. During **fast growth,** the grazing period is too long. Animals stay in the pasture too long and re-graze plants that have already been bitten and have re-grown from energy derived from the roots.
YES!!!! During **slow growth,** the recovery period is too short. A 90 day recovery period is needed, but only 30 are given. **This is the worse scenario: Animals will overgraze a higher percentage of plants because 31 land divisions would have a smaller pasture size than with 8 land divisions, thus a higher proportion of plants will be re-bitten too soon.**

With low pasture numbers, the only way to avoid overgrazing, when vegetation growth rate is fast, is to move the animals quickly. The only way to avoid overgrazing when vegetation growth rate is slow is to move the animals slowly.

With high pasture numbers (> 30), the animals can be moved slowly, without overgrazing, but there can be negative effects on animal nutrition.

Therefore, a Grazing Plan should:

1. Take into account the **ecology** of the area, including:
   - the disturbance and utilization needs of each pasture,
   - the grazing season: dormant or growing,
   - other elements such as wildlife, water, riparian management etc.
2. Ensure that areas that are impacted by grazing receive an adequate **recovery period (rest).**
3. Serve as a **guideline** that helps the land manager make specific adjustments that will lead to a more successful plan.

4. Be treated with **flexibility,** since few plans will predict actual periods of fast or slow growth.
5. Change with changing weather conditions, knowledge, and experience.
6. Have a **monitoring** and **follow-up** component which are keys to successful implementation of a grazing plan.

Figuring Animal Days per Acre

Think of Animal-Days simply as a unit of forage volume. The higher the animal numbers or the longer the days, the greater the volume of forage removed. Animal Days per Acre can be understood as the *volume* of forage that will be removed from each acre. The following is a partial list of some of the uses for ADAs:

- Assessing pasture qualities relative to one another.
- Determining if a paddock can supply the necessary forage for a future grazing.
- Dormant season planning.
- Reassessing pasture quality following grazing.
- Emergency re-planning in case of drought, fire, etc.
- Determining the area required to supply the daily forage requirement for one animal unit.
- Weighing different possible policies for future management.
- Accounting for wildlife needs in dormant season planning.
- Setting stocking rates.

As illustrated in Figures 4a and 4b (page 12), to estimate ADAs, one begins with the amount of forage one animal consumes in one day. In weight, this is generally about 2-3% of the animal's weight in dry matter.

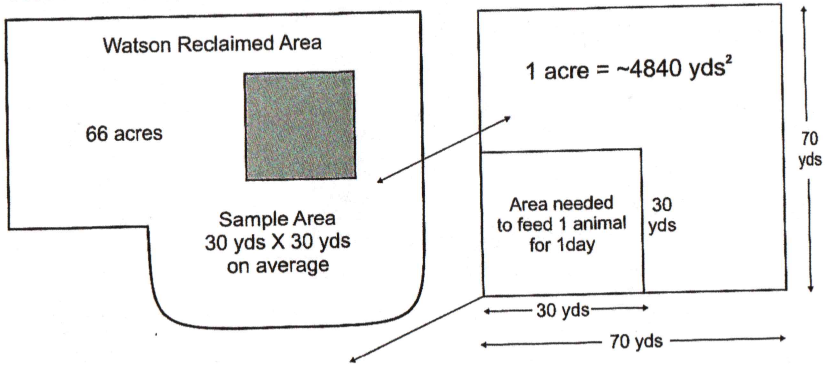
There are approximately 4840 square yards per acre. Pace or measure off a square required to feed one animal for one day that you feel will leave the amount of leaf area you want for recovery and for wildlife. Divide the number of square yards per acre, 4840, by the resulting square yards to feed one animal. This will give you the number of Animal Days Per Acre.

Do several of these calculations per pasture and then find an average for the pasture. You know the number of acres in a pasture and the number of animals in your herd, which allows you to calculate the probable days of grass available. ADA calculations are best used for dormant season or drought conditions.

$$\frac{4840 \text{ yds}^2}{\text{Square yards paced off}} = \text{Animal Days per Acre}$$

Figure 4a. Animal Days per Acre (ADAs) Example 1

Used to calculate the duration to graze a specific number of animal units on a pasture.



A. 30 yd X 30 yd = 900 yd² sample area to feed 1 animal unit for 1 day

B. $\frac{4840 \text{ yd}^2}{900 \text{ yd}^2 \text{ / animal unit / day}}$ = 5.38 animal days/acre (ADAs)

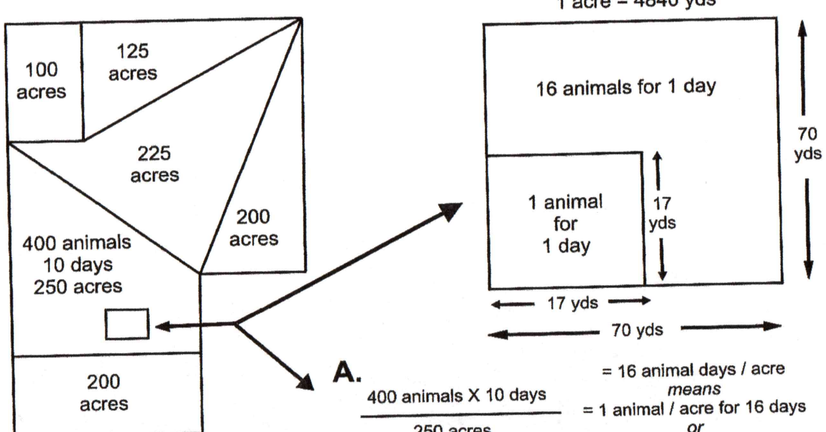
C. 1 acre will feed 1 animal unit for approximately 5 days or 1 acre will feed 5 animal units for 1 day

D. 66 acres X 5.38 ADAs = 355 animal days grazing

E. $\frac{355 \text{ animal days}}{60 \text{ animal units}}$ = 5.9 days grazing for 60 animals units

Figure 4b. Animal Days per Acre (ADAs) Example 2

Used to calculate whether a plan to graze a herd on a pasture for a given number of days is realistic.



A. $\frac{400 \text{ animals X 10 days}}{250 \text{ acres}}$ = 16 animal days / acre *means* = 1 animal / acre for 16 days *or* = 16 animals/ acre for 1 day

B. $\frac{4840 \text{ yds}^2 \text{ / acre}}{16 \text{ animal days / acre}}$ = 302.5 yd² / animal day

C. The square root of $\sqrt{302.5 \text{ yds}^2}$ = 17.4 yds on a side to measure (round to 17 yds)

D. Question: Will the 17 X 17 yard area feed 1 animal for 1 day?

Is the Land Healthy? Definitions of Rangeland Health Indicators

In 1994, a committee of the National Academy of Sciences published Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands. They concluded that rangeland health can and should be defined and measured in terms of three desired conditions:

1. **Degree of soil stability and watershed function.** Rangelands should not be eroding, and they should capture and retain water rather than shed it as run-off.

2. **Integrity of nutrient cycles and energy flows.** Rangelands should support plants that capture energy from the sun and cycle nutrients from the soil.

3. **Presence of functioning recovery mechanisms.** Rangelands should be resistant to disturbances and resilient to change—that is, they should be capable of recovering from ordinary disturbances, such as fire, drought, or grazing.

Below are some definitions of certain indicators of rangeland health for each condition:

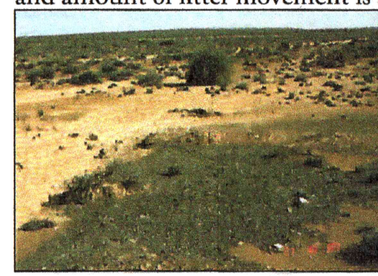
1. Soil Stability:

Bare Ground: Bare ground is exposed mineral or organic soil that is susceptible to raindrop splash erosion, the initial form of most water-related erosion.

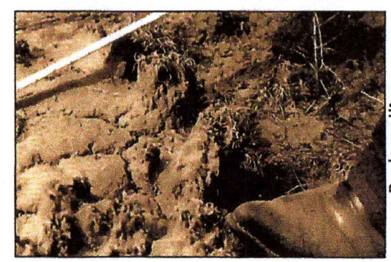

Gully.

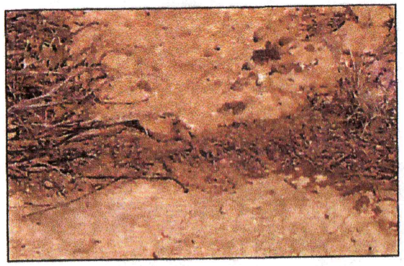
Gullies: A gully is a channel that has been cut into the soil by moving water. Gullies generally follow the natural drainages and are caused by accelerated water flow and the resulting down-cutting of soil.

Litter Movement: The degree and amount of litter movement is an indicator of the degree of wind and/or water erosion.


Litter movement.

Pedestals and/or Terracettes: Pedestals are rocks or plants that ap-


Pedestalling.


Terracette.

pear elevated as a result of soil loss by wind or water erosion. *Terracettes* are benches of soil deposition behind obstacles caused by water movement (not wind).

Plant Community Composition and Distribution Relative to Infiltration and Runoff: Changes in plant community composition and the distribution of species can influence (positively or negatively) the ability of a site to capture and store precipitation.

Rills: Rills are small erosional rivulets that are generally linear and do not necessarily follow the microtopography as flow patterns do.

Soil Surface Loss or Degradation: The loss or degradation of part or all of the soil surface layer or horizon is an indicator of a loss in site potential. As erosion increases, the potential for loss of soil surface organic matter increases, resulting in further degradation of soil structure.

Soil Surface Resistance to Erosion: Resistance depends on soil stability, microtopography, and on the spatial variability in soil stability relative to vegetation and microtopographic features.

Water Flow Patterns: Flow patterns are the path that water takes (i.e., accumulates) as it moves across the soil surface during overland flow. Overland flow will occur during rainstorms or snowmelt when a surface


Water flow pattern.

crust impedes water infiltration, or the infiltration capacity is exceeded.

Wind-Scoured, Blowouts, and/or Deposition Areas: Accelerated wind erosion on an otherwise stable


Wind scouring.

soil increases as the surface crust is worn by disturbance or abrasion.

2. Nutrient Cycle:

Annual Production: Above ground biomass is an indicator of the energy captured by plants and its availability for consumption given current weather conditions.

Compaction Layer: A compaction layer is a near surface layer of dense soil caused by the repeated impact on or disturbance of the soil surface. Compaction becomes a


Litter.

problem when it begins to limit plant growth, water infiltration, or nutrient cycling processes.

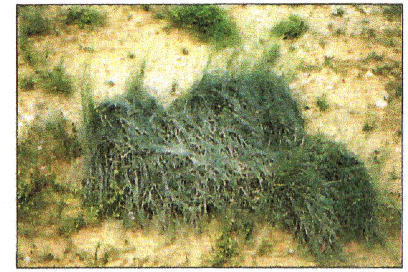
Litter Amount: Litter is any dead plant material that is in contact with the soil surface.

3. Recovery Mechanisms:

Invasive Plants: This indicator deals with plants that are invasive to the area of interest. These plants may or may not be noxious and may or may not be exotic.


Invasive plants.

Plant Mortality/Decadence: The proportion of dead or decadent to young or mature plants in the community relative to that expected for the site, under normal disturbance regimes, is an indicator of the population dynamics of the stand.


Dead plant.

(Definitions derived from ***Interpreting Indicators of Rangeland Health,*** Version 3, Technical Reference 1734-6, USGS, USDA, and the NRCS.)

Cool Season Grasses: These grasses grow best during the coolness of spring and fall. When the temperatures get warm, they grow slowly or become dormant. As temperatures cool in the fall, they will grow again if there is sufficient moisture. Common cool season grasses include: brome grass, orchard grass, blue grass, mutton grass, needle and thread, wheat grass, and fescues.

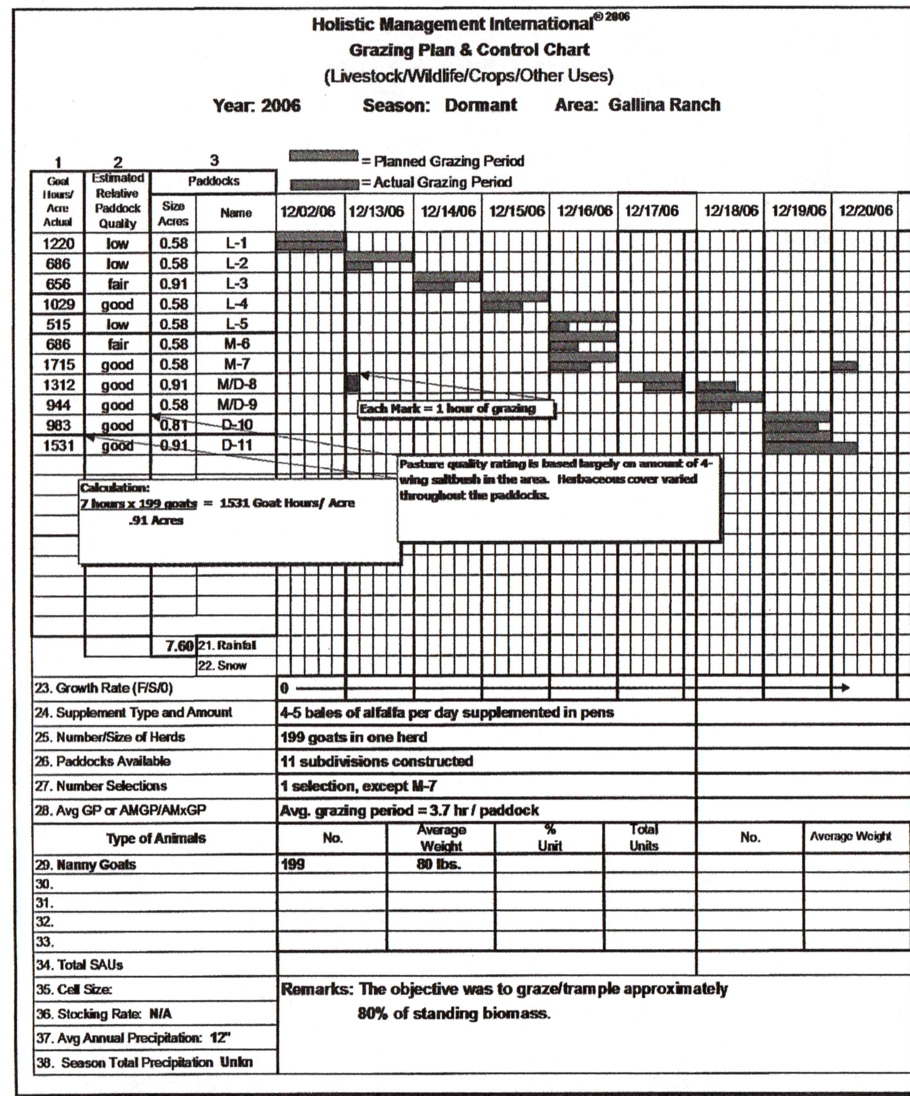

Kentucky Blue Grass

Warm Season Grasses: These grasses start growing in the summer when temperatures warm up. Growth slows down in late summer and fall. Common warm season grasses include: blue and black grama, galleta, big and little blue stem, switchgrass, and buffalo grass.


Black Grama.

Suggested Readings and Plant Identification Guides

- Allred, Kelly W., ***A Field Guide to the Grasses of New Mexico***, 3rd Edition; Agricultural Experiment Station, New Mexico State University, Las Cruces; 2005.
- DeWitt Ivey, Robert, ***Flowering Plants of New Mexico***, 4th Edition; 2003.
- Dietz, Harland E., Special report: ***Grass: The Stockman's Crop—How to Harvest More of It***, Sunshine Unlimited, Inc.; 1989 (P.O. Box 471, Lindsborg, Kansas 67456).
- Gadzia, Kirk and Todd Graham. ***Bullseye: Targeting Your Rangeland Health Objectives***, The Quivira Coalition; 2009 2nd edition, www.quiviracoalition.org.
- Hitchcock, A.S., ***Manual of the Grasses of the United States (Vol. 1 & 2)***, 2nd Edition (revised by Agnes Chase); Dover Publications, Inc., New York; 1971.
- Savory, Allan, ***Aide Memoire for Holistic Management Grazing Planning.***
- Butterfield, Jody, Bigham, Sam and Allan Savory. ***Holistic Management Handbook: Healthy Lands. Healthy Profits***, Holistic Management International, 2006.
- Savory, Allan with Jody Butterfield, ***Holistic Management: A New Framework for Decision Making***, 2nd Edition, Island Press, Washington D.C., 1999. *The three books above can be obtained at: www.holisticmanagement.org.*
- Sayre, Nathan F., ***The New Ranch Handbook: A Guide to Restoring Western Rangelandlands***, The Quivira Coalition; 2001, www.quiviracoalition.org.
- The National Research Council, ***Rangeland Health, New Methods to Classify, Inventory, and Monitor Rangelands***, National Academy Press, Washington, D.C., 1994.
- USGS, USDA, and the NRCS, ***Interpreting Indicators of Rangeland Health*** Version 3, Technical Reference 1734-6. Entire document available online at: http://www.blm.gov/nstc/library/pdf/1734-6.pdf.
- Whitson, Tom D. (Editor), ***Weeds of the West***, 9th Edition (ISBN 0-941570-13-14); The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities Cooperative Extension Services; 2002.



Grazing Plan Example