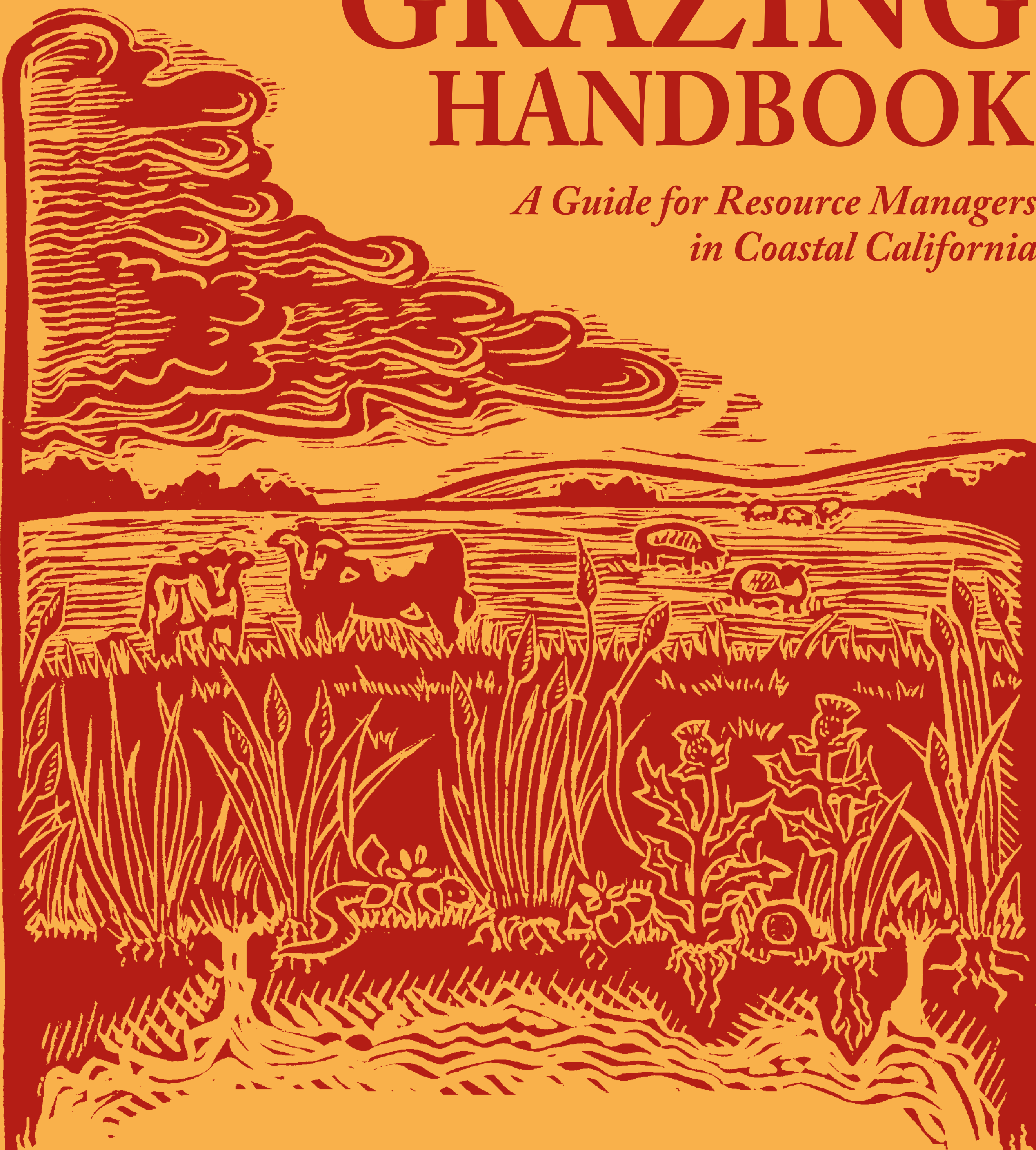
GRAZING HANDBOOK

A Guide for Resource Managers in Coastal California



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Background

This handbook is for public agency personnel and private landowners who may be interested in exploring the use of livestock grazing to further their resource management goals. It has been prepared for smaller agencies and private landowning organizations that do not have grazing specialists on staff. We hope that the information contained in this handbook will broaden the understanding of the potential applications of livestock grazing in various grassland vegetation types and will help guide decision-making about grazing programs.

While livestock grazing may not be a management tool that all grassland owners or managers will use, better understanding and access to information about grazing will help landowners and managers make informed decisions.

Geographical Context

This handbook addresses grazing management on three important rangeland types within the Sotoyome Resource Conservation District (SRCD). These include coastal grasslands, vernal pool grasslands, and riparian areas. However, most of the information contained in this handbook is widely applicable to similar areas elsewhere in coastal central California and beyond.

Socio-economic Considerations

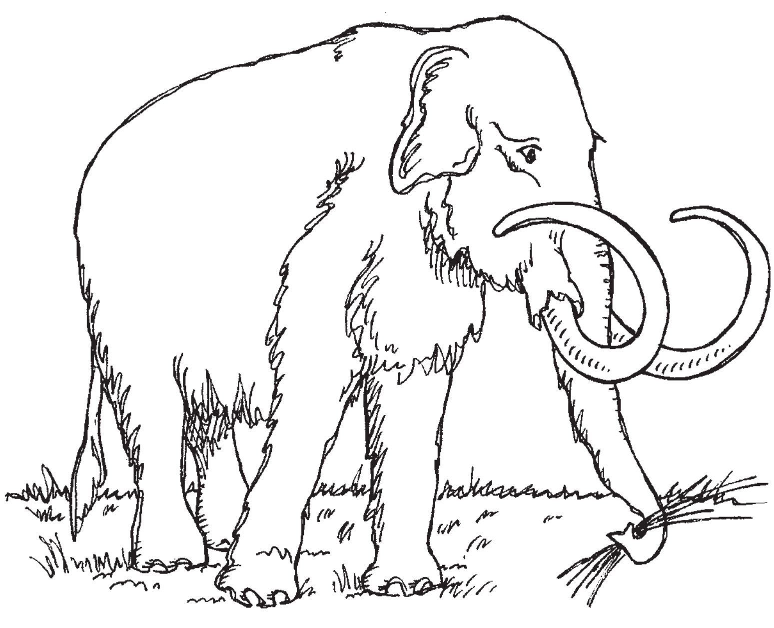
Protecting the unspoiled parts of California is important to both residents and visitors. Much of the character of rural areas comes from working landscapes. Historically, this was based largely on an agricultural way of life where residents made their livings from the land. Despite the fact that the economics of farming and ranching no longer make that possible for many people, ongoing integration of ranching in rural communities still plays a very strong role in preserving their identities. Without ranching, private open lands may be subdivided where zoning allows and converted to other uses, most likely increasing the residential density at the expense of open views and the area's agrarian lifestyle.

As with any business that depends on local infrastructure and services, the regional survival of livestock ranching is threatened with each ranch that decreases in size or goes out of business. Every livestock rancher depends on local services and supplies including veterinary care, feed sales and delivery, farm and ranch supplies, cattle buyers, and processing facilities. As land is taken out of ranching, all of these services are incrementally affected. Eventually, some support businesses may cease to operate, increasing the burden for ranchers who choose to keep ranching. Because profit margins in the livestock business are slim, increased travel to access services or supplies, or increased shipping costs to markets, can mean the end of a family's livestock business, and that in turn, affects others. Making appropriate public and private conservation lands available to livestock producers encourages continued productive economic use of those lands, to support communities while providing potentially beneficial land management services to the public.

To Graze or Not to Graze: That is the Question

The topic of livestock grazing on public lands has for decades stirred emotionally charged and often bitter controversy between those in favor and those opposed. The "anti-grazing" side has cited degradation of public trust resources while the "pro-grazing" side has held up the tradition of ranching in the West as reason enough to continue this practice.

Beyond the emotional arguments, however, is a complex web of scientific information, ecosystem processes, and practical issues related to grazing that must be carefully considered before judging whether grazing is "good" or "bad" or might be "right" or "wrong" for any given situation. In most cases the question is not black and white, but rather a matter of weighing the expected effects of grazing against the objectives for a particular site. Grazing is sometimes referred to as a "management tool," so in many cases it should be evaluated as such. "Will grazing help achieve land management goals for this site?" is a more appropriate question to consider than "is grazing good or bad?"



Livestock grazing is a complex phenomenon. It has many facets, from social to ecological to economic. Each of these, along with the impacts of the grazing animals themselves – including trampling, defecating, and urinating – must be carefully considered in deciding whether or not grazing may be favorable or detrimental for a given site. Beyond the question of "to graze or not to graze," there are a multitude of qualitative and quantitative variables that must be considered. Species of animal, stocking rate, season of use, and length of grazing periods are just a few of the things that affect the outcome of a grazing program.

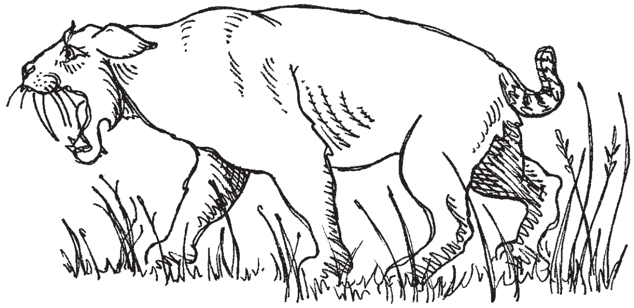
Some wilderness advocates and preservationists point out that livestock grazing is not a part of California's native ecosystems, and thus believe that it doesn't belong in parks and other public lands. While it is true that modern day grazing by European and Asian livestock breeds does not necessarily replicate the impacts of large herds of native ungulates that once roamed the state, the only large grazing animals currently found in most of California are domesticated livestock.

The grazing ecology of California's grasslands extends back millions of years into the Tertiary Period. Present day relationships between grassland plants and grazing animals are strongly linked to these prehistoric associations.[1] There is strong evidence that many of California's present-day genera of native perennial grasses evolved over millions of years with the extensive megafauna, large animals that once populated California. Although massive megafauna extinctions occurred near the time of the last ice age, during the prior two million years in the late Pleistocene Epoch, elephant-like mastodon, mammoth, camel, llama, bison, elk, pronghorn, horses, and numerous other large herbivores roamed over what is now California.[2] These animals, which browsed on brush and trees and grazed on herbaceous vegetation, impacted the landscape through their feeding habits as well as through trampling that resulted from herding behavior. Over the10,000 years since the last ice age, the only large grazers present in California have been elk, which have now been extirpated from most of the state.

Plant residue found in fossilized teeth and dung links some present-day plants with prehistoric grazers and demonstrates the importance of grazing, browsing, and trampling by large ungulates in late Pleistocene California. Contemporary grass genera that have been found in fossil remains include wheatgrass (*Agropyron*) and oatgrass (*Danthonia*). Observing California oatgrass (*Danthonia californica*) in the field shows clearly its adaptation to close grazing. It is a short-statured native bunchgrass often found in areas that are compacted, such as along human or cattle trails, and in areas where other short grasses prevail. It can be found in extensive closely-cropped patches, unrecognizable unless closely examined.

California, as we know it, has been shaped by human management practices for thousands of years. Burning was conducted repeatedly by California Indians to improve hunting of game, improve grass seed production, and for many other other uses.[3] Anderson[4] documents that "…land management systems have been in place here for at least twelve thousand years – ample time to affect the evolutionary course of plant species and plant communities. These systems extend beyond the manipulation of plant populations for food. Traditional management systems have influenced the size, extent, pattern, structure, and composition of the flora and fauna within a multitude of vegetation types throughout the state. When the first Europeans visited California, therefore, they did not find a pristine wilderness but rather a carefully tended garden that was the result of thousands of years of selective harvesting, tilling, burning, pruning, sowing, weeding, and transplanting."

Many questions about the pre-European condition and composition of California's landscapes and flora will always remain unanswered. So, we must consider, given the highly altered ecosystem that we live in today, if grazing can play a constructive role in preserving landscape patterns, native plants and animals, managing fire fuels, or otherwise help achieve resource management goals.



What are Rangelands?

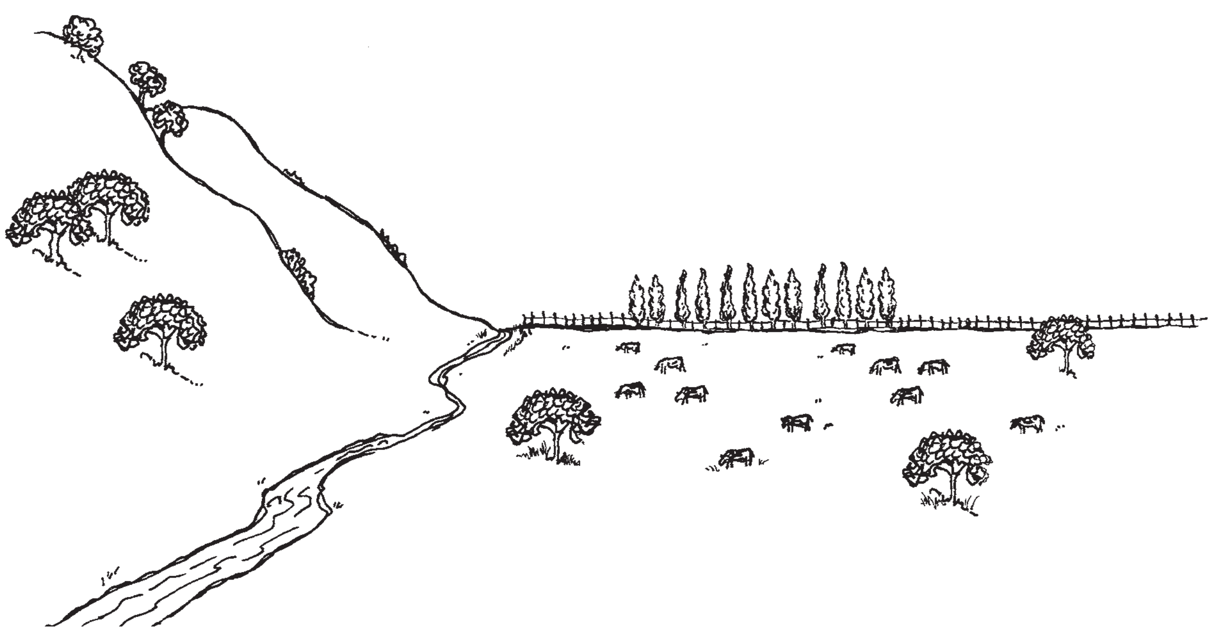
Rangelands include grasslands, savannas, and shrublands. When grazed by livestock, these lands are called range. The unifying characteristic of rangelands is that primary productivity per hectare is typically lower than croplands or forest lands.[5] Rangelands provide essential biological, scenic, economic, and recreational values locally and throughout the world. They are threatened in many areas by development, conversion to other intensive land uses, and alteration of management regimes.

Why is Grassland Management Important?

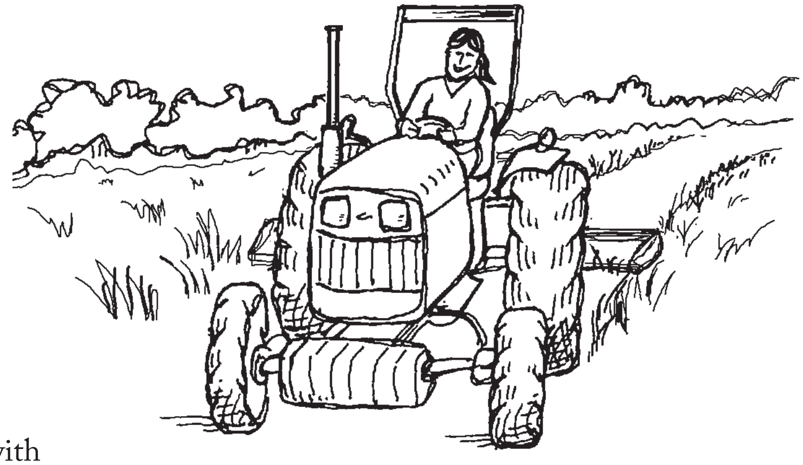
Grasslands cover roughly nine percent of California[6] and support about 25% of the State's sensitive plant species.[7] Grasslands cover 22 to 23 percent of Sonoma County,[8] and are threatened in many areas by development, conversion to other intensive land uses, and alteration of management regimes. Within the SRCD, the vernal pool grasslands of the Santa Rosa Plain exemplify this threat. Many of these subtle depressions in the earth that seasonally fill with water have been lost or are threatened due to various types of development, mismanagement, or simple neglect. Management actions such as removing livestock grazing from vernal pool grasslands without providing alternative methods for management of exotic annual grasses have likely contributed to the decline of numerous Santa Rosa Plain vernal pools.

California's grasslands are dynamic ecosystems that respond to seasonal changes in our Mediterranean climate. Generally, annual grasses and forbs, many of which are non-native, germinate with the first fall rains, and grow slowly through the cool winter. Perennial species begin their growth at this time, after surviving the dry summer in a dormant state. In spring, with warmer temperatures and adequate moisture, grassland plants grow rapidly, with biomass production peaking from late April to late May in most of the SRCD. In drier parts of the state, growth can end earlier; along the coast, green growth can continue well into June or July. By mid- to late spring, the biomass in ungrazed or very lightly grazed grasslands can be so tall and dense that small-statured species cannot get enough sunlight or moisture to properly develop and are essentially smothered. In late spring and early summer, standing vegetation dries and begins to decompose. Some species decompose fairly quickly while others are more resistant, remaining intact as dried straw-like thatch. Thatch from species that are especially high in silica, such as the exotic weed medusahead (*Taeniatherum caput-medusae*) can pile up year after year, so that the ground is covered in a dense layer of dried plant material, preventing sunlight penetration and germination and growth of species that are poorly adapted to these conditions. Disturbance or removal of this biomass is essential for germination and growth of some native species including popcornflowers (*Plagiobothrys* spp.), clovers (*Trifolium* spp.), owl's-clovers (*Castilleja* spp.), cream cups (*Platystemon californicus*), red maids (*Calandrinia ciliata*), water chickweed (*Montia fontana*), and many vernal pool forbs such as downingia (*Downingia* spp.).[9] Unmanaged biomass can also adversely affect habitat for certain animal species. For example, shore birds are less likely to occupy grassland habitat where standing biomass is over six inches tall.[10]

In grasslands that aren't grazed or otherwise managed to keep them open, especially where they abut or intergrade with shrublands, shrub invasion can convert grasslands to coastal scrub. As well as increasing fire hazards, this conversion results in loss of coastal grasslands and thus, loss of the species that occupy them. As noted by Ford and Hayes,[11] Northern Coastal Scrub,



a shrubland type, and Coastal Prairie, a grassland type, are both increasingly rare and endangered. Remaining areas of Northern Coastal Scrub mature to dense tall stands and often encroach into coastal prairie and annual grassland after termination of periodic disturbances, such as fire and grazing, which prevented such encroachment. Cessation of periodic burning and livestock grazing has occurred where sprawl has fragmented the landscape, and where changed ownerships or cultural values now favor preservation with little or no deliberate vegetation management. As a result, remnant patches of Northern Coastal Scrub are expanding in unmanaged areas at the wildland-urban interface.[12] Coyote brush is typically the first invader, and may eventually become the sole community member of such stands until other member species can establish themselves.[13]



Other Grassland Management Options

Controlling brush encroachment and preserving open grassland habitat requires the mimicking or substitution of disturbance processes that maintained open grasslands in the past. In many cases, available management options have been neither feasible nor acceptable to the public or management agencies. Meanwhile fire hazards, reduced habitat, and reduced aesthetic values are increasing problems.

Grazing is not the only method available for managing grasslands, but frequently, especially on a large scale, it can be the most economical, reliable, and practical. Mowing and prescribed burning are other grassland management tools that have been used successfully and may be preferred treatments where animal use is impractical or where objectives warrant.

However, while similar to grazing in some ways, the effects of these treatments are distinct from those of grazing. All grassland management methods have unique benefits and limitations, and the tool chosen will depend on many factors including the objectives for the site, current vegetation composition, and funding availability. In many cases, with careful planning and monitoring, two or more of these treatments can be used in conjunction to great effect.

Mowing

Mowing can be used on level-to-gently rolling sites where the soil surface is fairly even. On very small areas where livestock management is not practical, mowing may be the best way of managing grassland biomass. However, it is a fairly labor intensive method and must be repeated throughout the year for consistent management of grassland canopy height. Because mowing does not usually involve removal of biomass from the site, it often fails to address the problem of thatch accumulation.

Prescribed Burning

As with grazing, some of the primary effects of fire are mulch removal, increased light and water penetration to the soil, nutrient cycling, and control of grassland weeds. Fire has been used effectively in establishing and managing native grasses. Burns conducted at the Jepson Prairie in Solano County, for example, doubled average native species richness and increased frequencies of several uncommon native plant species while greatly reducing the cover of medusahead.[14] However, there are some important distinctions between grazing and burning, and factors such as timing, intensity, and frequency of burns must be carefully considered for each site and will vary depending on objectives and site characteristics.

Prescribed burning carries with it greater liability than grazing, and acquiring permits to burn is increasingly difficult because of air quality concerns. While less expensive than some other management tools, fire is more costly than grazing. In many cases, so much biomass has accumulated due to years of excluding fire and grazing, that burning is simply too hazardous to be easily initiated. Appropriate burn prescriptions and good relationships with fire agencies can sometimes alleviate these issues, but grazing will likely continue to be the more-favored tool for managing extensive grasslands.

Understanding Grazing Basics

Impacts of Grazers

Grazing animals affect plant communities in several interrelated ways.[15] They defoliate plants, remove and/or redistribute nutrients, and cause mechanical impacts on soil and plants through trampling. Each of these affects is complex and may have desirable or undesirable consequences for individual species, plant guilds, or grassland ecosystems. Keeping in mind the potential impacts of these three primary influences should help managers predict how grazing might impact a site and its resources.

Herbivory and Defoliation

Herbivores are animals that feed on plants; to defoliate means to remove leaves or "foliage" from a plant. Aside from browsing and grazing ungulates, other animals such as insects and rodents and other natural processes such as fire and hail can defoliate plants. Herbicides, some of which are referred to as "defoliants," and mechanical methods such as mowing and pruning also cause defoliation. Defoliation affects the entire plant. Reduction in leaf area of an individual plant reduces the photosynthetic capacity of that plant which, in turn, affects its roots, and can also affect its reproductive capacity.

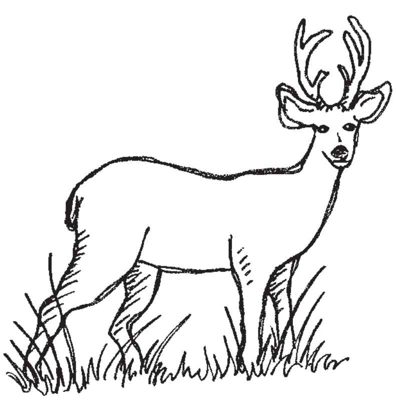
Some plants are more or less resistant to grazing due to morphological characteristics.[16] For example, plants with growing points (meristematic tissue) that are low or close to the ground tend to resist the effects of herbivory more than tall plants with high growing points.[17] Grasses and forbs of different species, life forms (i.e. annual versus perennial), and growth habits (i.e. bunchgrasses versus sod forming grasses) differ in their responses to defoliation. Additionally, some plants have mechanisms that reduce the chances of being grazed, such as production of toxic compounds or physical deterrents such as spines or especially hairy foliage.

Selective herbivory influences the structure and function of plant communities. Grazing alters competitive interactions among species by removing various amounts of leaf area and establishing the potential for differential growth rates.[18] Species composition is altered when a particular intensity, frequency, and/or seasonality of grazing shifts the competitive advantage from one group of species to another. Grazing by livestock or other herbivores affects different plant communities in different ways.[19] In general, moister communities that evolved under grazing, such as most grassland communities, may be rather resistant to deterioration caused by grazing. In fact, as discussed above, many such communities depend upon grazing or similar disturbance for their persistence over time.

Intensity, seasonality, frequency, and duration of defoliation all affect plants and their ability to resist and/or recover from herbivory. In other words, how much leaf area is removed, when is it removed, how often, and for how long affect plant responses to grazing. Responses to defoliation also depend on: availability of meristematic tissue and the developmental stage of new tiller buds; carbon reserves and carbon balance; remaining leaf area; light interception; time of year and physiological growth stage; root area and root growth factors; and the physical effects of grazing animals on plants and soils.[20] Recovery from grazing involves both the re-establishment of photosynthetic tissues and the ability to retain a competitive position in the plant community. Excessive defoliation reduces both root system activity and leaf area and may limit the plant's capacity to compete for and utilize soil moisture and nutrients. This information can be applied to undesirable plants in an effort to reduce their presence in a plant community managed with grazing.

Trampling

While clipping or mowing can also be used to remove above-ground plant biomass, the effects are different from grazing which also results in the pulling up and discarding of unpalatable plant parts and, more significantly, trampling. Trampling can be detrimental, causing soil compaction and worsening some types of erosion. It can also have beneficial effects such as breaking up dead grass residue, which aids in germination and growth of small-statured wildflowers. Trampling can help mix manure and other organic matter into the soil surface, as well as acting to plant seed. Positive effects of trampling include changes in surface soil bulk density that favor desirable species over undesirable species. An example is the tendency of poison hemlock (*Conium maculatum*) to quickly dominate sites under little or no grazing pressure, where soils are light and very crumbly.[21] Livestock trampling on such sites can be used to rapidly convert such sites to more desirable species cover. The negative effects of trampling can be minimized by controlling trampling intensity in accordance with soil texture, soil moisture and management objectives.



Nutrients

Grazing affects nutrient cycling in plant communities in a variety of ways. Compounds that can easily volatilize, such as readily degradable carbon and some forms of nitrogen, tend to be conserved in cattle feces, which contributes to accelerated rates of humus formation. As a particularly durable form of soil organic matter, humus also increases both the water- and nutrient-holding capacity of soils. It increases biological activity and other beneficial soil processes, improving soil aeration and accelerating soil development. By increasing soil organic matter, humus also improvs water and nutrient-holding capacity of soils. Grazing tends to increase the proportion of clovers and other nitrogen-fixing plants in the pea family by reducing competition from taller grasses. These legumes glean nitrogen from the air, which is fixed in the soil by symbiotic rhizobia. Trampling and the physical mixing of dead and decaying plant material with manure, urine, and soil hastens vegetation decomposition and makes the nutrients bound in it available for use by the soil and plant community. Of course, all of these processes may be interrupted or reversed if grazing is not properly managed to meet these objectives.

Kind and Class of Animal

Selecting Type of Livestock

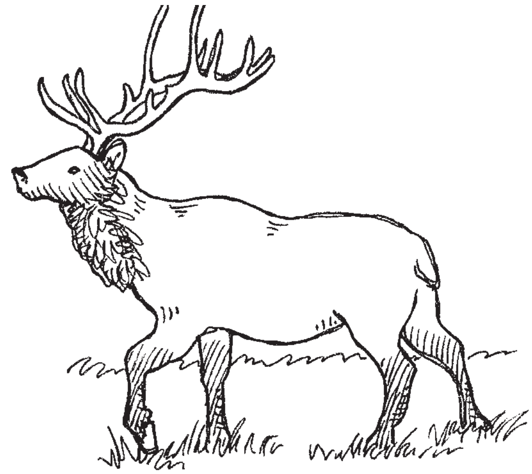
Different species and classes of animals have particular foraging habits, behaviors, and other characteristics that may make one preferable to another for meeting site-specific management goals. Predator problems and site topography are also important considerations. Local availability of livestock types also may restrict choices.

Different species of animals prefer different topographic positions. Steepness of slope significantly influences distribution of cattle,[22] while smaller animals, such as sheep and goats, are more able to traverse steep hillsides. Larger animals including cattle and horses prefer to graze level-to-gently rolling land. In areas with steep terrain, cattle generally congregate on more level areas, which can lead to heavy use of flat land unless infrastructure or attractants are used to improve distribution.

Foraging Differences

Grazing animals are divided into groups based on their vegetation preferences and primary foraging methods. These groups include the grazers (cattle and horses), which have a diet dominated by grasses and grasslike plants, the browsers (goats), which consume primarily shrubs and forbs, and the intermediate feeders (sheep), which have no particular preference for grasses, forbs, or shrubs.[23] Browsers commonly consume large amounts of green grass during rapid growth stages but avoid dry, mature grass and often experience digestive upsets if forced to consume too much mature grass.[24]

Body size and reticulo-rumen capacity, anatomical differences in teeth, lips, and mouth structure, grazing ability, and differences in digestive systems account for some of the differences in foraging behavior. Mouth size directly affects the degree of selectivity that is physically possible; ruminants with small mouth parts such as goats, deer, and pronghorn, in contrast to cattle, horses, and



elk, can more effectively utilize shrubs while selecting against woody material.

In addition to physiological influences on diet selection, animal behavior can strongly affect what livestock choose to eat. Young animals learn foraging behaviors from their mothers and peers and can be taught to eat or avoid certain plants.

TABLE 1. ANIMAL UNIT EQUIVALENTS[25]

Animal Kind and Class	Animal Unit Equivalent	Monthly Forage Consumption in Lbs.
Cow, dry	.92	727
Cow, with calf	1.00	790
Bull, mature	1.35	1,067
Cattle, one-year-old	.60	474
Cattle, two-year-old	.80	632
Horse, mature	1.25	988
Sheep, mature	.20	158
Lamb, one-year-old	.15	118
Goat, mature	.15	118
Kid, one-year-old	.10	79
Elk, mature	.60	474

TABLE 2. GENERALIZED DIETARY AND TOPOGRAPHIC SITE PREFERENCE CHARACTERISTICS BY GRAZING ANIMAL SPECIES[26]

Species	Diet Preferences	Topographic Position Preferences
Horse	Grazer: Mostly grasses, minor forbs, and browse	Widely adapted to plains
Cattle	Grazer: Mostly grasses, some seasonal use of forbs and browse	Prefers level to rolling land; capable but often unwilling to graze steep or rocky areas
Domestic sheep	Intermediate feeder: high use of forbs, but also use large volumes of grass and browse	Better adapted to steep lands and rough terrain than cattle
Domestic goat	Browser to intermediate feeder: high forb use, but can utilize large amounts of browse and grass; highly versatile	Adapted to a wide variety of terrain and vegetation types
Elk	Grazer to intermediate feeder: also considerable forbs and browse; highly versatile	Prefer meadows, parks, bottoms, and lower slopes; grazing often concentrated

The amount of forage consumed is affected by many factors, including breed and age of animal. Although many other factors can influence forage consumption, animal unit equivalents (AUEs) can be useful in estimating stocking rates and comparing forage demand of different ages and species of animals. Animal unit equivalents vary by source, actual weight of animal, and individual animal.[27] Table 1 gives AUEs for common domestic livestock which can be calculated as follows:

3 mature bulls=4 animal units (3 x 1.35)
48 two-year-old cattle=38 animal units (48 x .8)

Tule Elk and Other Native Species

Tule elk (*Cervus elaphus nannodes*), which are native grazers/intermediate feeders, roamed California until the late 1880s. Tule elk are classified as game animals and as such, their management in California is governed by the California Department of Fish and Game (CDFG). CDFG oversees several sites where tule elk have been reintroduced, all of which are extensive in size, providing adequate acreage to support planned populations. CDFG personnel have stated that no new introductions of tule elk will be made in California in areas where they cannot be hunted, because without hunting, there is no viable means of population control.[28]

Grazing Intensity

Intensity of use strongly affects a site's response to grazing. Grazing intensity is often described as "light," "moderate," or "heavy," labels that are slightly more descriptive than simply "grazed" or "ungrazed," but still reveal very little about a grazing regime. Two variables – stocking rate and length of grazing period(s) – are the principal controls that can be prescribed to achieve the grazing intensity desired for a site.

Stocking Rate and Grazing Capacity

The terms stocking rate and grazing capacity are interrelated. Grazing capacity quantifies the amount of available forage for grazing animals on a given site while stocking rate is the number of animals grazing that forage for a given period of time.

Initial stocking rates must be established when grazing is newly introduced to a site. Monitoring newly grazed sites over a several year period should reveal whether or not stocking rates are suitable.

Grazing capacity can be estimated and stocking rates can be set based on site data and simple mathematical formulas. However, annual fluctuations in forage production mean that setting and adjusting stocking rates should be viewed as a process rather than an exercise in determining a precise number of animals that a site can carry. For example, the grazing season generally begins in California in the fall when annual grasses germinate and start to grow in response to the first rains. By late fall and winter, when cold weather sets in, forage growth slows though feed intake requirements of livestock do not. Warm spring weather accelerates forage growth, with peak production occurring in April and May. During the summer, fall, and winter forage deficits can occur; forage growth can exceed forage demand in late spring. Supplemental feeding of hay is often necessary during forage deficits, especially to meet the nutritional needs of pregnant or lactating livestock. Forage production and grazing capacity also vary between years, depending on amount and distribution of rainfall and other climatic factors.

In severe drought years or in years of above-average forage production, stocking rates may need to be adjusted downward or upward during the grazing season to achieve management objectives. This process can be tricky, as it requires the livestock operator to be flexible and to respond quickly to unpredictable weather conditions that affect forage production. A livestock producer who must decrease stocking rates in response to a spring drought may suffer financially. In a good forage year, adding animals may be difficult unless the operator has a large herd with the ability to move animals from other sites. Stocking rate can be adjusted down in poor feed years by weaning calves or lambs early, or culling more heavily than usual. In good forage years, culling animals lightly or retaining more replacement animals can be used to increase stocking rates. A process for adjusting stocking rates should be identified in grazing agreements.

Grazing capacity can be estimated by several different methods including: use of forage production estimates for range sites identified in the USDA Soil Surveys; direct measurement methods that involve clipping and weighing of vegetation; knowledge of present or historical stocking rates on the site,

Grazing capacity is expressed in pounds or tons of forage produced, often described in animal unit months (AUMs). In intensively managed rotational grazing systems, where animals are moved frequently, animal unit days (AUDs) may be used to describe forage availability or consumption.

Stocking rate is expressed as animal units (AUs) per time period.

Available forage is the forage produced minus the amount of residual dry matter or RDM desired.

Grazing capacity and stocking rate example: On a 100-acre site that produces 1,500 pounds per acre of available forage per year, the total available forage production, or grazing capacity, would be 1,500 lbs./acre × 100 acres = 150,000 lbs. of forage or 150 AUMs (150,000 / 1,000 lbs./AUM).

Appropriate stocking rates for this site would include 30 AUs for 5 months (30 x 5 = 150 AUMs) or 40 AUs for 3.75 months (40 × 3.75 = 150 AUMs).

or on a similar nearby site; and a scorecard method based on climate zone, topography, and tree canopy cover.[29]

USDA Soil Survey Range Site Values

The USDA Soil Surveys provide estimates of forage production for range sites and/or soil map units for "favorable," "normal," and "less favorable" years. These values can be used as rough guidelines.

Direct Measurement

Samples of current season's biomass should be taken from one-square-foot quadrats located within representative areas of the site, thoroughly dried, then weighed with a gram scale. Weight in grams x 96 = lbs./acre of forage. Depending how carefully sampling is done, this can be a useful method, although many samples may need to be taken for accuracy, especially on sites where forage production is highly variable.

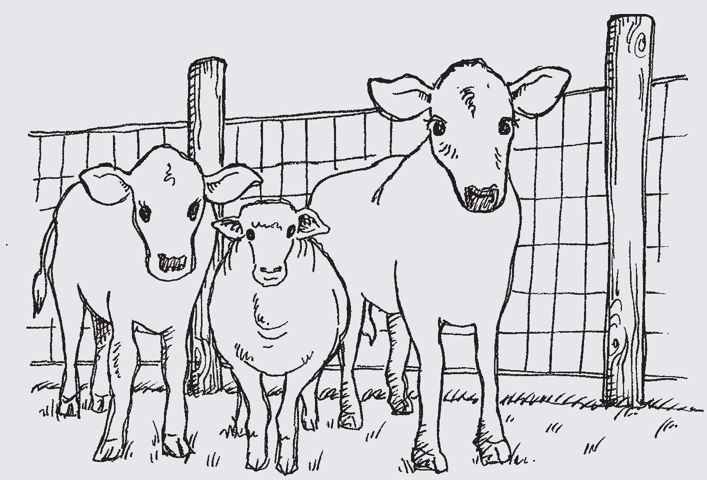
Known Stocking Rates

Knowledge of current or historic stocking rates and resultant site conditions provide excellent estimates of forage production. Depending on how well end-of-season site conditions compare with desired conditions, stocking rates can be adjusted to increase or decrease the amount of grassland biomass remaining at the end of the growing season.

Mixed Species Grazing

Grazing by two or more species (separately or together) on the same pasture in a single growing season is known as common use, dual use, or mixed species grazing. Where animal and economic gain is the goal, or management objectives are advanced by grazing more than one species, common use can be advantageous. The primary advantage to mixed species grazing is that forage use can be more efficient. Two different species, cattle and sheep, for example, will differentially graze, with the result that more diverse forage resources are utilized. As grazing use intensifies, available forage decreases and the different animal species reduce their selectivity to maintain adequate forage intake. This results in an increase in dietary overlap. Other advantages include improved animal distribution, complementary food habits, diversification of income, and parasite and disease management. Disadvantages include increased costs due to loss of feeds, reduced efficiency within each species, and need for increased management.[30]

Common use may be an appropriate technique, but management goals for a specific site may require a careful choice of animal species due to species-specific foraging habits or other animal characteristics. Availability of interested livestock producers can also dictate the type of animals available. Sheep ranching, for example, has decreased dramatically on California's North Coast over the past few decades, due primarily to an increase in predation by coyotes and, to a lesser extent, mountain lions. Now, sheep ranchers must use a combination of predator deterrents including electric fencing, guard animals, and where predation is extreme, night-time housing for animals.



Scorecard Estimates

University of California researchers developed a simple "scorecard" that can be used to estimate grazing capacity on annual-dominated rangelands based on desired RDM levels and general site characteristics.[31] This method provides rough estimates based on rainfall, canopy cover, and slope, and is most applicable to large tracts of land dominated by annual grasses and forbs.

Grazing Periods and Grazing Systems

A grazing period is the length of time that animals occupy a specific land area, which can range from less than one day to one year. The term "grazing system" is sometimes used to describe the way in which grazing and nongrazing periods are arranged within the maximum feasible grazing season (in coastal central California, the grazing season is year-round), either within or between years. Grazing systems often have descriptive names such as: continuous or yearlong grazing; short-duration grazing; deferred grazing; and rest-rotation grazing. Continuous grazing is the simplest grazing system and is very common in low-elevation California. Short-duration grazing involves short periods (hours or days) of grazing alternated with non-grazing periods that are based upon plant growth characteristics.

Grazing Season

Grazing can also occur seasonally within a year. Different time periods for grazing might be prescribed based on:

- type of livestock operation; for example, a cow-calf beef operation requires pasture all year to support the mother cows
- species targeted for enhancement or control; for example, deferment of grazing until after seed sets is sometimes used if seed reproduction of a particular species is critical; in other cases certain weed species are grazed at critical times in their development to weaken or kill them or prevent reproduction
- saturated soils; grazing may need to be deferred on sites with fragile soils.
- minimizing competition; late winter and early spring grazing may be important for reducing undesirable species competition with native grasses[32]
- fire hazard control; where grass fires are a concern, grazing should continue long enough into the spring or summer to adequately reduce standing fuels prior to the fire season

Grazing as a Management Tool

Beyond the obvious benefits of livestock grazing such as food production, grazing can benefit individual plant and animal species, can help manage fire hazards, and, in the absence of natural disturbance regimes, help maintain California's landscape structure. A land manager's use of grazing can be viewed as application of a tool for keeping weed or shrub invasion at bay, enhancing wildflower displays, or maintaining a low grassland canopy height to allow visibility, foraging, and movement of small mammals such as voles and ground squirrels.

As our highly altered environment becomes more and more affected by development, industrial pollution, and global climate change, these impacts pose new threats to native ecosystems, making livestock an increasingly important management tool. For example deposition of atmospheric nitrogen from air pollution has dramatically altered the chemistry of serpentine grassland soils at Coyote Ridge near San Jose, seriously threatening the Bay checkerspot butterfly (*Euphydryas editha bayensis*). Excess nitrogen has resulted in an extensive non-native grass invasion, primarily by Italian ryegrass (*Lolium multiflorum*), which has eliminated many acres of dwarf plantain (*Plantago erecta*), one of the primary food plants of the butterfly. Grazing is being used to manage the Italian ryegrass invasion and butterfly numbers have rebounded. Properly managed grazing can enhance carbon sequestration in rangeland soils, helping to slow the rate of increase in atmospheric CO_2.[33] On the other hand, poorly managed grazing can have undesirable effects, such as unwanted changes in plant species composition, negative effects on wildlife species, and acceleration or exacerbation of erosion.

Grazing at Audubon Canyon Ranch's Bouverie Preserve

"We want to favor native annual wildflowers and perennial grasses. We're trying to reduce competition and create some openings in the grass canopy. This will also ultimately reduce thatch."

—Daniel Gluesenkamp, Ph.D., Habitat Protection and Restoration Specialist

Sonoma County Agricultural Preservation and Open Space District

"One of the reasons that the District has grazing on its land is to support local agricultural producers – to make land available to them. It's a perfect partnership."

—Kathleen Marsh, Stewardship Planner

Beneficial Uses of Grazing

Fire Hazard Management

The influence of livestock on fire hazard is two fold. First, grazing at moderate levels has been shown to change wildfire behavior, by slowing its spread, shortening flame length, and reducing fire intensity, although it does *not* significantly reduce the risk of fire ignition.[34]

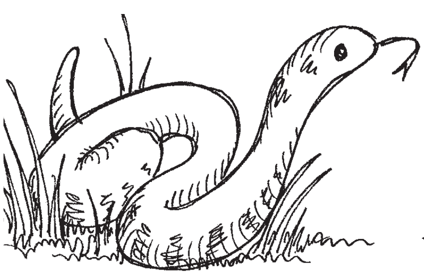
Second, and most important for long-term fire safety, especially near urbanized areas, grazing can prevent or minimize expansion of shrublands which have much greater fuel loading and pose greater fire hazard than grasslands. High-density shrub cover can be seen throughout the San Francisco Bay Area where fires have been suppressed for long periods and grazing has been reduced or removed. In particular, coyote brush (*Baccharis pilularis*), occurs over large areas of ungrazed properties. McBride[35] found that 51 years after grazing was removed from the Berkeley hills, coyote brush density had increased dramatically. Grasslands in the Berkeley hills that are grazed are relatively free of coyote brush and other shrub species, while ungrazed grasslands in this area have been, or are rapidly being, invaded by coyote brush.

> *"Without modifications to our current management strategies fire hazard will likely continue to increase."*
> —Russell and McBride[38]

Biswell[36] also described his observations of shrub invasion on a site in Berkeley that had been burned frequently from the 1920s to the 1950s. When annual burning was stopped in about 1960, he observed that "…changes began to show in the plant cover. Ripgut brome and coyote brush increased, and by 1984, no purple stipa (*Nassella pulchra*) could be found."

Although this observation relates to cessation of a different disturbance regime, controlled burning, it illustrates the fact that shrub invasion of coastal grasslands is likely to occur in the absence of a regular disturbance regime.

In a study of seven San Francisco Bay Area open space sites, Russell and McBride[37] found that increases in shrub-dominated communities and decreases in grassland since the 1940s and 1950s have increased the probability of high intensity fires. During this time, fire has been generally excluded, and grazing pressure has been reduced. Using aerial photographs, their study measured the relative frequency of vegetation types including grassland, shrubland, and forest and woodland over time, and found that in most cases, shrub cover had increased significantly over this period. The heightened fire hazard is caused by the great increase of surface biomass in shrublands as compared with grasslands and oak woodlands, with a surface biomass in the *Baccharis* shrublands more than 10 times greater than grasslands and more than five times greater than oak woodlands. As well as greater fuel loading, results indicated the greatest average flame length and fire-line intensity for shrublands and the lowest for oak woodlands. The authors state that these changes suggest "a general increase in fire hazard within the open spaces of the San Francisco Bay Area" and that "the succession from grasslands to *Baccharis* shrublands indicates dramatic increase in fire hazard for those areas" and "In the context of the landscape matrix as a whole this increased hazard indicates a greater possibility of fire being spread into adjacent forested areas and residential communities."



Weed Management

Livestock can be a useful tool in weed management programs when the following conditions are met: 1) target plants are acceptable as forage, 2) grazing can be timed to inflict damage at vulnerable periods in the weed's life cycle, 3) water is available for livestock; and 4) livestock are controlled to minimize damage to non-target species and other ecosystem components. A land manager can manipulate various factors in a grazing/weed management program: these include pasture or paddock size, location, and configuration; stocking rates; timing and frequency of grazing; and class of animal.[39] Use of portable electric fencing to facilitate short-duration, intensive grazing in small paddocks is a component of most grazing-based weed management programs because animals must be forced to trample or eat plants that they would avoid given a choice in a larger pasture.

Grazing has been shown to be effective in managing some species of noxious weeds that occur within the SRCD. Yellow star-thistle (*Centaurea solstichialis*) and medusahead (*Taeniatherum caput-medusae*) have both been effectively managed through intensive grazing.

Yellow star-thistle. Properly timed grazing can reduce yellow star-thistle seed production as demonstrated by controlled experiments conducted over a three-year period with cattle, sheep, and goats at two heavily infested sites in northern California by Thomsen et al.[40] They used an intensive grazing management approach, i.e., high stocking rates with short grazing periods that were timed according to plant phenology and regrowth responses. Grazing during rosette stages (spring-grazed) led to an increase in yellow star-thistle's seed output and reduced competition from associated plants, giving yellow star-thistle greater access to light, water, and nutrients. Intensive grazing using large numbers of animals for short duration timed to yellow star-thistle's bolting, pre-spiny stages (late-May and June), was effective in decreasing yellow star-thistle flower head densities, plant height, and canopy size.[41] Timing of grazing is critical because viable seed is produced by yellow star-thistle after only a few percent of the flower heads have bloomed.[42]

Horses, which can develop "chewing mouth disease," a fatal nervous disorder, from consumption of large quantities of yellow star-thistle, should never be used for its management,[43] although it is an acceptable forage for ruminants.[44] Sheep, goats, and cattle eat yellow star-thistle before spines form on the plant. Goats will eat star-thistle even in the spiny stage. It is a nutritious plant, especially when in the rosette stage with crude protein ranging from 28% in this stage down to 11% at the bud stage. Grazing should not be as intensive as for medusahead control because remaining grass helps to shade out yellow star-thistle. No more than half of the grass should be removed.[46]

> *"One common objective of livestock grazing on preserves is to reduce the amount of RDM. This allows sunlight to reach the soil surface and stimulate germination of the seeds of native species."*
>
> — J. W. Bartolome[45]

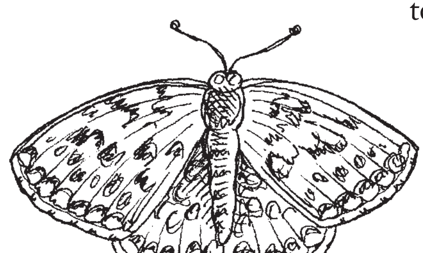
Medusahead. Grazing for control of medusahead is experimental, but it has been effective in research plots in Yolo County.[47] Based on this research, essential components of a grazing program for medusahead control are: 1) critical timing; 2) high stocking density; 3) use of portable electric fencing; and 4) a portable water supply. Research has been conducted with sheep, although goats and cattle may also be effective.

Grazing should occur in late spring, as soon as the flag leaf – the last leaf to emerge before the flower head – thickens and the stem engorges. (The flag leaf emerges only days to a week before the flower head emerges, at which point the plants become completely unpalatable.) Heavy grazing at this time ensures that the medusahead plants will not flower and will not re-sprout, greatly decreasing seed output. The window of opportunity for this late-spring grazing is very short, which means that careful monitoring and the ability to move an adequate number of livestock onto the property in a timely fashion is essential. If grazing occurs too early, the plants will re-sprout and if it occurs too late, the livestock will not graze the flower heads. The timing of this optimal phenological stage will vary depending on weather conditions, but usually occurs in late April.

The intensity of late-spring grazing should be heavy, which may result in a higher proportion of bare ground than would normally be considered acceptable. Grazing episodes may need to be followed with fall seeding or other erosion control methods, especially on slopes. Experimental stocking densities for late-spring grazing have been on the order of 5 AUs per acre, or as needed to graze herbage down to a height of about two inches.

Grazing Responses of Select Species

Scientists and practitioners have documented the grazing responses of numerous individual plant and animal species. On sites where legally protected special-status species are found, grazing is increasingly used to enhance their habitat. Animals whose habitat requirements can be promoted by grazing include insects, amphibians, mammals, birds, and reptiles. With its inherent complexity across the landscape, grazing can promote habitat heterogeneity by creating a matrix of plant species with varying structure for a wide variety of wildlife. For example, in some parts of California, areas grazed to lower RDM levels may be suitable for small mammals such as kangaroo rats (*Dipodomys* spp.) that prefer open habitats for ease of movement and foraging. Other small mammals, such as the locally occurring California meadow mouse (*Microtus caifornicus*) prefer more lightly grazed areas with substantial standing vegetation that provides nesting sites and protective cover. Similar patterns of use across a range of grazing levels occur with birds. Some ground nesters and birds that dart across the ground, such as endangered mountain plovers (*Charadrius montanus*), prefer very open uplands that may have been grazed intensively while the locally common western meadowlark *(Sturnella neglecta)* spends more time in denser grasslands. Other birds, such towhees (*Pipilo* spp.), prefer to forage and nest in relatively dense brush.



Various native wildflower species may also respond well to grazing. To determine whether or not grazing might benefit individual species, it's important to first describe the various habitat elements that they require, then analyze how and when livestock could impact them, positively or negatively.

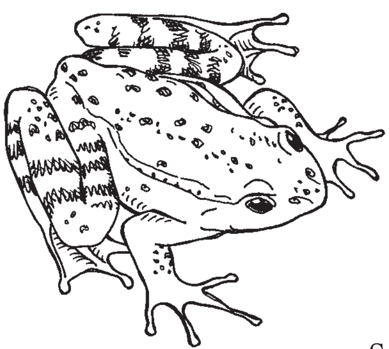
Carefully thought out, site-specific goals and objectives for grazing should be used to identify target RDM levels or other desired habitat conditions.

Below are examples of locally represented taxa that appear to benefit from appropriate grazing regimes.

Myrtle's Silverspot Butterfly (*Speyeria zerene myrtleae*) is a federally-listed endangered species that inhabits coastal dunes, coastal prairie, and coastal scrub. Critical to its survival is the larval host plant dog violet (*Viola adunca*) and nectar plants for adults to feed on. Nectar plants include a variety of native and non-native species including the non-native bull thistle (*Cirsium vulgare*). This butterfly occurs locally at the Point Reyes National Seashore and on private lands in Sonoma and Marin Counties. Until 1990, when populations on private lands were discovered, the Point Reyes population was believed to be the only one that was thriving. Despite the wide range of potential habitat and the large area over which the butterfly was observed at Point Reyes, the butterfly population densities were found to be relatively low.[48] By comparison, a similarly sized population was found on a private site roughly one-tenth of the size of the butterfly's observed Point Reyes territory. The private site, which has been grazed commercially for more than a hundred years, apparently supports a much greater density of Myrtle's silverspot butterflies than the Point Reyes sites.

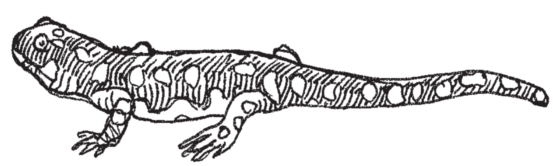
Murphy and Launer[49] concluded that the areas on the private site found to have the highest concentrations of adult Myrtle's silverspot butterflies, probably are also the areas likely to support butterfly larvae, which are dependant on higher concentrations of dog violet host plants. Data collected in paired grazed and ungrazed plots at three locations within PRNS show dog violet to occur more frequently in grazed plots.[50]

California Red-legged Frog (*Rana aurora draytonii*), a federally-listed threatened species, occurs throughout the SRCD and other parts of California in grassland, oak woodland, oak savanna, riparian scrub, and riparian woodland.[51] As documented in the Recovery Plan for the Red-legged Frog,[52] in many cases they co-exist with managed livestock grazing. High numbers are found in grazed areas including Point Reyes National Seashore, East Bay Regional Parks, and private land holdings where stock ponds and cattle are prevalent. The Recovery Plan states, "In many of these areas, California red-legged frogs may be present only because livestock operators have artificially created ponds for livestock water where there were none before and therefore, created frog habitats. In such ponded habitat, grazing may help maintain habitat suitability by keeping ponds clear where they might otherwise fill in with cattails, bulrushes, and other emergent vegetation." The Recovery Plan also points out that cattle may cause negative impacts to California red-legged frogs by crushing eggs and/or disturbing egg masses, negatively affecting riparian habitat, marshes, and ponds and can have other detrimental effects.



Red legged-frogs reside in or near streams, marshes, and stock ponds, preferring pools or slow water with dense overhanging vegetation. They attach their eggs to emergent vegetation and use upland grassland habitats and rodent burrow or woody litter refuges up to one mile from breeding areas during November to March (movements prior to breeding) and July to October (post metamorphic juvenile dispersal). During periods of movement, the frogs are vulnerable to trampling by livestock, but on the other hand, excess upland grass height can hinder movement during these times. Excessive damage by livestock to emergent aquatic plants or plants that provide breeding or sheltering habitat at the water's edge could have negative effects. East Bay Municipal Utilities District[53] classifies red-legged frogs as moderately vulnerable to livestock impacts, citing such negative effects as damage to emergent aquatic and riparian vegetation. Since the Recovery plan implies that livestock can help keep emergent vegetation from becoming too dense, allowing periodic livestock access to ponds can be used to manage emergent vegetation without overuse.

California Tiger Salamander (*Ambystoma californiense*) inhabits grassland and oak savanna with rodent burrows used for summer retreats, and ponds used for breeding. They emerge from their subterranean refuges with the first rains and migrate to seasonal wetlands such as vernal pools, stock ponds, or slow streams that hold water through May. Breeding occurs from December to early February with larvae transforming in water by late spring or early summer. Juveniles disperse from breeding sites in late spring to early summer. Very little information is available regarding the effects of livestock grazing on the salamander. Like other small animals, they are vulnerable to trampling during migration periods, and are also sensitive to excess herbaceous vegetation height[54] which can hinder their movement from November to March (adults) and March to August (juveniles). Conditions that could lead to premature drawdown of pools, such as excessive spring evapotranspiration from annual grasses, could degrade breeding habitat. According to Huntsinger and Ford[55] the salamander requires access across



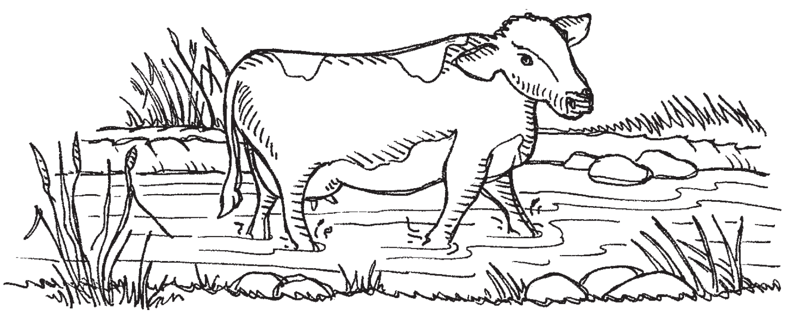
open grasslands, thus insufficient grazing and associated grass height and shrub encroachment would reduce habitat quality.

Disadvantages of Grazing as a Management Tool

While grazing can be beneficial for some species and in some habitats when appropriately prescribed, poorly managed grazing or grazing of unsuitable sites can cause serious environmental damage. As with most management methods, even when well managed, grazing carries some risks to natural resources, wildlife, and occasionally to human health and safety. With thoughtful planning, serious grazing-related issues can be avoided.

Undesirable Vegetation Changes

As discussed throughout this Handbook, grazing can strongly affect vegetation. Stocking rates that are too high and inappropriate seasons of use, especially over long periods of time, can result in serious negative consequences. Browsing of woody plants by livestock can negatively affect plant communities. For example, livestock grazing when oaks are in leaf can damage or kill seedlings and saplings unless they are protected by livestock exclosures. Poorly timed or heavy grazing in riparian areas can lead to loss of woody riparian canopy, which can degrade habitat for many wildlife species.



Repeated, prolonged heavy grazing can exacerbate infestations of some weed species that thrive in highly disturbed environments. Purple star-thistle (*Centaurea calcitrapa*) and woolly distaff thistle (*Carthamnus lanatus*) are more prevalent in areas that are heavily grazed or trampled. Livestock avoid grazing these spiny plants but eat the forbs and grasses around them, reducing competition with thistle seedlings. Unfortunately, the same conditions that encourage the germination and growth of native forbs – reduction of annual grass canopy height and density – can also promote establishment of weed populations.

Erosion and Water Quality Impacts

Erosion and water quality impacts are common concerns on grazed lands. Some types of erosion can be exacerbated or accelerated by livestock and can cause degradation of upland soils and/or sedimentation of waterways. Sediment, nutrients, and pathogenic organisms can degrade water quality for fish, wildlife, and human uses.

Sediment that is mobilized and reaches stream channels can damage anadromous fish habitat by filling in gravel beds, making them unsuitable for spawning or smothering developing fish eggs in the gravel. Sediment can also fill in deep pools that remain cool in the summer and provide habitat for young fish.

Streambank erosion, which can be caused or exacerbated by livestock that have free access to riparian areas, results in eroded soil being deposited directly into affected waterways. Upland erosional processes, on the other hand, also move sediment but, depending on specific geomorphic processes and site conditions, this sediment may or may not be transported into a stream.

Sheet and rill erosion commonly occur on unpaved ranch roads, and can also occur on bare ground in animal confinement areas. This type of erosion is less likely to occur on grazed pastures, unless grazing intensity is excessive. Concentrated flows on hillslopes, from activities such as road building, livestock trailing, and gopher or other animal burrowing can cause gully initiation. Minimizing animal trailing that is parallel with slopes, and maintaining adequate vegetation cover can guard against concentrated runoff and, thus, the chances of livestock-induced gullying.

Terracettes, or grazing terraces, are geomorphic features that can be caused by livestock trailing on steep hills. They can increase infiltration into slopes, which can increase the potential for landsliding if other site conditions favor this type of hillslope erosion. They may also serve as conduits for concentrated flows of water, and may lead to gully formation.

Nutrient and pathogen pollution of surface waters from animal waste can result from rangeland grazing, but most often occurs when livestock are confined and animal wastes are concentrated. Minimizing or preventing livestock access to perennial streams and avoiding excessive concentration of livestock should minimize this possibility.

Ammonia from livestock wastes can cause acute toxicity to aquatic species. Pathogens are a less common but potentially serious source of water quality degradation. Since pathogens are transmitted through animal wastes, the same conditions that cause nutrient pollution can cause pathogen pollution. Many of the pathogens that are carried by livestock can cause illnesses in humans and wildlife.

Pathogenic organisms include bacteria, viruses, and cysts. More than 150 pathogenic organisms can be transmitted through livestock waste. Some of the most common include *Giardia*, *Leptospira*, *Brucellas*, *Salmonella*, and *Cryptosporidia*. Pathogens can also be carried by wildlife; for example, the presence of botulism in stagnant water can devastate waterfowl populations. Livestock grazing in watersheds that provide domestic water for urban areas has raised concerns about some cattle-borne pathogens, especially *Cryptosporidium parvum*. This pathogen poses a danger to persons with compromised immune systems. Generally, calves up to three or four months of age shed more *Cryptosporidia* on a per weight basis than older or heavier animals.[56]

Negative Impacts to Wildlife

Although grazing can provide habitat heterogeneity for many bird species, birds that nest in the lower strata of riparian vegetation, such as yellow warbler (*Dendroica petechia*), Wilson's warbler (*Wilsonia pusilla*), warbling vireo (*Vireo gilvus*), and song sparrow (*Melospiza melodia*); or on the ground, such as dark-eyed junco (*Junco hyemalis*), California quail (*Callipepla californica*), and spotted towhee (*Pipilo maculatus*) can be adversely affected by grazing. Grazing in riparian areas during the nesting season can destroy nests and expose nests to predators through removal of cover. The brown-headed cowbird (*Molothrus ater*), which increases when cattle are present, parasitizes the nests of other birds, laying her eggs for other species to incubate. The young cowbirds are often larger and more competitive than other songbirds and have a serious impact on other species' reproductive success.[57]

Heavy grazing can also cause shifts in rodent populations, affecting predatory birds populations. As with plant species, impacts to wildlife species should be carefully considered in any grazing plan or program.

Recreational User Conflicts

Conflicts between livestock and recreational users can occur on public lands that are grazed. Although reports of injury are rare, complaints about livestock and potential liability are cause for concern. The few incidents of aggression by cattle toward visitors at Point Reyes National Seashore have occurred when unleashed dogs have approached mother cows with young calves or when people have come between the cow and her calf.[58]

Bulls can also be aggressive and can cause serious injury. In most cases, bulls should not be in areas with public access. On public recreational land or private land that will allow recreation or visitation, caution should be used in determining what kind and class of livestock will be on site. In some cases, it may be best to have access closed on all or part of a property during certain times of year, such as calving season. Recreational users may regard livestock as a nuisance due to their impacts on trails, manure and flies, and perceptions about damage to natural resources. Concerns such as these may be best addressed through public education, including signage.

For livestock producers, conflicts and concerns caused by recreational users include gates left open and aggression towards livestock by unleashed dogs.

Planning a Grazing Program

Planning for grazing is a process that can culminate in a product – a grazing plan – but it should begin even before land is acquired by an agency or organization. For example, certain physical improvements such as water and truck and trailer access are necessary to facilitate grazing on any given site. In the case of partial acquisitions, when properties are divided and sold in pieces, these important improvements are sometimes retained by the original owner or otherwise separated from the acquired parcel. If establishing a grazing program is later desired, it may be impossible due to the absence of this infrastructure.

In the case of publicly-owned or private conservation lands, having a written plan for grazing is important because:

- many public agencies or private land conservation organizations lack expertise in grazing management, and a professionally prepared grazing plans provide essential information and instruction
- by law in California, range management planning on "forested landscapes" requires a state license except when conducted by an individual private landowner or on federal land
- along with monitoring data, a plan provides a record of management activities against which the effects of grazing can be evaluated; if land management goals aren't achieved after the grazing plan is implemented, the original plan can be modified

Adapting a Grazing Plan

Once a grazing plan has been written, it should be reviewed periodically and updated as new information becomes available or management objectives change. Information gathered through monitoring should be used to evaluate goals and implementation methods, and to modify the plan to improve future results. This common sense approach is the origin of the term "adaptive management," which was coined in the early 1970s. Adaptive management is the process whereby management is initiated, evaluated, and refined.[59] The concept of "adaptive management" complements the notion of "Best Management Practices," by explicitly

Why is Planning Important?

"Planning for grazing is important for the same reasons that it's important for anything else – it gives direction. It also provides a strategy for implementation and a basis for monitoring which allows you to adapt your actions to continue improving management."

— Sheila Barry, Natural Resources and Livestock Advisor, University of California Cooperative Extension, Bay Area

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"You need to know that you're working toward your goals. With a grazing plan you know where you're heading and it allows you to move step-by-step in the right direction. It also helps you know if you've achieved your goals."

— Stephanie Larson, Livestock and Range Management Advisor, University of California Cooperative Extension, Sonoma and Marin Counties

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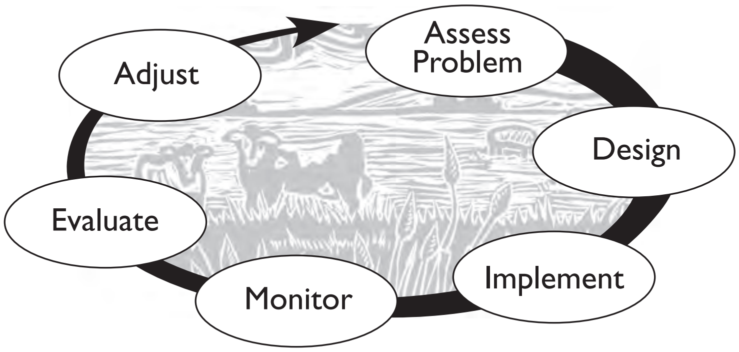
"The District needs to show how they're spending taxpayer's money and to have a plan for taking care of the resources…and for grasslands, that's always going to include grazing. The land has always been grazed – first by native ungulates, then by livestock. Grazing enhances biodiversity and keeps fire danger down."

— Kathleen Marsh, Stewardship Planner, Sonoma County Agricultural Preservation and Open Space District recognizing that what is thought to be "best" now may change as new information about a site becomes available. It differs from traditional management approaches by recognizing and preparing for the uncertainty that underlies resource management decisions.



The formal adaptive management process, as shown in the following diagram, consists of a six-step cycle that is a useful framework for grazing planning where the "design" step equates with preparation of a written plan. A less structured approach is to continually fine-tune grazing plans as monitoring reveals useful information and/or conditions change. Unfortunately, although adaptive management is held up as an ideal management model and its use is sometimes required by regulatory agencies, the expense of detailed monitoring and assessment mean that it is seldom put into use.

> *"Effective goals should be well defined with time frames and clear, measurable objectives. For a public agency, well-defined goals create accountability."*
>
> — Sheila Barry, Natural Resources and Livestock Advisor, University of California Cooperative Extension, Bay Area

Setting Goals and Objectives

Regardless of the planning model used, setting goals and objectives is the most important step in developing a grazing plan. Goals are the foundation upon which specific prescriptions should be made within regulatory parameters. Goal setting is especially important when numerous entities (agencies or people) have a stake in management of a site. The process of setting goals and objectives helps identify each stakeholder's needs and desires and paves the way for a positive working relationship among all the stakeholders.

The concerns of potential livestock operators must be considered in setting goals because without the cooperation of a suitable implementation partner, even well-planned grazing programs can fail. Ideally, the landowner and livestock operator would share common goals. However, these two parties often have different fundamental reasons for being involved with grazing. While land managers may have ecological goals driving their decision to have livestock grazing on a site, the livestock operator's primary goal is usually economic. Potential lessees should be included in the planning process along with other stakeholders whenever possible to get their input and buy-in.

With clear goals and objectives, many of the possible affects of grazing can be individually evaluated in relation to desired outcomes. As the favorable effects of livestock grazing become more widely recognized, some land managers are eager to try to accomplish many of their goals through grazing. For example, fire fuel control, weed management, enhancement of grassland biodiversity, and improvement of wildlife habitat all can be positively affected by livestock grazing. These may be reasonable goals for a grazing program but they must be examined in detail and on a site-specific basis to determine if they can be met through grazing.

There are many approaches to goal setting but several rules always apply. Goals must be:

- consistent with agency and/or land management policies
- consistent with local, state, and federal laws and regulations
- attainable
- measurable (through objectives)

Experience is the Best Teacher

A Lesson in Goal Setting

The Marin County Open Space District's Mount Burdell Open Space Preserve provides a scenic backdrop to the City of Novato and an important recreational site for hikers, joggers, and equestrians. Its 1,560 acres of grassland and oak woodland also support many plant and wildlife species, including several special-status species. Entities that have a stake in its management include District staff, recreational users, nature lovers, adjacent residents, and, because of its forage resources, the local ranching community. Additionally, fire management agencies have an interest in vegetation management as it relates to fire hazard. The site has been grazed by livestock for over a century, with a formal grazing program put in place in 1989, about 15 years after it was purchased by the District. Grazing use was initially retained after the District's acquisition to provide fire fuel management and because neighbors wished to retain their views of the pastoral landscape.[60]

Initial grazing program goals were:

- to preserve and enhance the native plant and wildlife habitat for the enjoyment and use of Marin County and regional residents
- to preserve the soil and water resources and productivity of the Open Space
- to manage the fuel loads so as not to endanger the homes adjoining the Open Space and
- to maintain the pastoral values associated with the important dairy industry in Marin County

A grazing program has been operated on the site for 15 years based on these goals. Complaints about grazing impacts from local residents and recognition that some of the goals were not being met led the District to reevaluate its grazing program.

This reevaluation process identified potential incompatibilities between and within these goals, and recommended that they be carefully evaluated and prioritized with management directed at achieving one or more of the highest priority goals.

For example, goals addressing "fire fuel management" and "preserving soil and water resources" may have inherent conflicts – while soil and water resources would be best protected by lighter grazing for a shorter time period, fire fuel reduction would require a more aggressive grazing program with less biomass retained at the end of the season.

Preserving and enhancing "the native plant and wildlife habitat" would require identification of target species and their habitat requirements. Which native plants should be favored and what are the most important wildlife species? Different guilds of plants (i.e. grass versus forbs and annuals versus perennials) may react differently to a given grazing regime. High levels of grassland biomass can hinder some wildlife species while benefitting others.

Attempting to meet all of these goals would be a complicated task requiring establishment of specific objectives. Clear, realistic management goals must be established and prioritized before the existing grazing program can be evaluated to determine its effectiveness. The District is in the process of evaluating and simplifying its goals, and making appropriate adjustments to its grazing program.

What are Goals and Objectives?

Because goals, which represent a future desired state or condition, are often general or idealistic, they should be paired with specific and practical objectives. Goals are *what* you want to have accomplished while objectives set out *how* they will be accomplished.[61] Goals don't have to be lofty – they can be simple statements, such as "maintain the beauty of wildflower fields."

> *"The most important thing is really being clear on your goals first, because everything comes out of that."*
>
> —Bob Neale, Sonoma Land Trust Stewardship Director

Goals should be practical and clearly stated, avoiding jargon. If "enhancing native biodiversity" is a goal, include an explanation of what this means. Are there particular native species on site that might be favored by grazing? Are there protected species that, by law, require special consideration?

Goal statements should begin with an action verb like "increase," "reduce," or "provide".[62] For example, 1) "to increase native forb diversity," 2) "to reduce cover of noxious weeds," or 3) "to provide a forage base for local ranchers" could all be goals.

Complimentary objectives could be 1) "decrease annual grass biomass by 50% during March, April, and May, to reduce competition with native forbs for sunlight and moisture," 2) "intensively graze medusahead in spring as soon as the flag leaf (the last leaf to emerge before the flower head) thickens and the stem engorges to reduce seed output," and 3) "lease the property to an established, local rancher by a specific date."

Lastly, goals may need to be prioritized. Some goals may conflict with others and it may be necessary to select one or more at the expense of another.

Contents of a Grazing Plan

There is no single best way to write a grazing plan, but there are certain elements that should generally be addressed. These include:

Site Description and Resource Inventories. These are sometimes referred to as "Existing Conditions" and should contain text, maps (topographic and aerial photography), and other graphics as needed to thoroughly document a site's physical properties and resources, including:

- property boundaries
- vegetation, including special-status species and important forage and weed species
- wildlife, including special-status species
- soils, as described and mapped in USDA Soil Surveys; soils information can help predict forage production and erosion potential that can be affected by grazing
- topographic and hydrologic features including wetlands and streams, especially those that are fish bearing; for larger properties, USGS quadrangle maps may be adequate; more detailed information may be available in local watershed plans or resource studies
- information on other sensitive resources; archaeological sites or other cultural resources that could be adversely affected by grazing should be identified
- grazing infrastructure inventory and condition, including water sources and livestock watering locations, roads, fencing, gates and vehicular access locations, corrals and loading chutes, and barns

Land Use Information

- historic use records, Natural Resources Conservation Service (NRCS) conservation plans, and farming or ranching records can reveal information that helps explain current conditions; for example, evidence of prior cultivation, irrigation, or fertilization may explain degraded populations of native plant species
- current and planned future uses should be identified in as much detail as possible, especially on lands used for public recreation; certain types of recreation may be incompatible with grazing

Goals and Objectives

- general goals
- specific, measurable objectives

Grazing Recommendations/Prescriptions

- grazing capacity of site
- initial stocking rate and methods for adjustment
- recommended kind and class of animal
- grazing units and pastures
- timing of grazing
- methods for animal distribution
- infrastructure improvements and maintenance
- grazing effects on special-status species (if applicable)

Related Management Recommendations

- weed control, especially if grazing animals will be used for this purpose
- protection of sensitive resources such as riparian areas or oak seedlings

Monitoring and Evaluation

- compliance monitoring (i. e. actual use records if applicable)
- effectiveness monitoring
- evaluation of monitoring results
- management feedback

Implementation Schedule

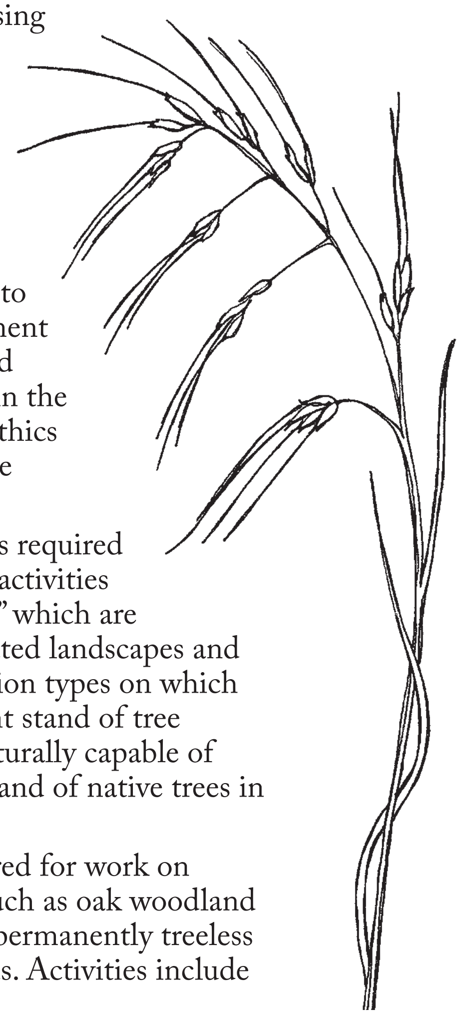
Appendices

Who Can Help You Develop a Grazing Plan?

Non-federal landowners who are not individuals (i.e. agencies, corporations, non-profits etc.) are required to engage a state-licensed Certified Rangeland Manager (CRM) to prepare grazing plans and make related recommendations under certain circumstances. In situations where CRM laws don't apply (see below), ecologists, botanists, wildlife biologists, livestock producers, and other practitioners or professionals who have related experience and academic background may be able to help. University of California Cooperative Extension (UCCE) Range Management Advisors and NRCS are two excellent sources of assistance.

Certified Rangeland Managers

Since 1995, The State Board of Forestry has been licensing qualified individuals as Certified Rangeland Managers. The intent of the program is to provide evidence of professional competency, to protect the public interest, and to ensure proper management of California's rangeland resources as embodied in the Code of Professional Ethics of the Society for Range Management.



The state license is required for range management activities on "forested landscapes" which are defined as "tree dominated landscapes and their associated vegetation types on which are growing a significant stand of tree species or which are naturally capable of growing a significant stand of native trees in perpetuity."[63]

A license is required for work on hardwood rangeland, such as oak woodland or savanna, but not on permanently treeless shrublands or grasslands. Activities include making management recommendations, developing conservation plans, grazing plans and management plans, and other associated endeavors.

Scientists and Academics

California's rangelands have been the subject of study and description since the 1940s.[64] In addition, published research on the effects of livestock grazing,[65] native herbivores,[66] exotic plant invasions[67] and defoliation effects on native perennial grasses,[68] to name just a few topics, provides a bounty of information that can be used to help predict grazing effects on grasslands and their component species.

> *"One of the most important reasons to have a grazing plan is that it becomes an essential reference document to guide and adapt the planning process into the future."*
>
> —Larry Ford, Ph.D. CRM # 70

Because every site and set of circumstances under which grazing occurs is unique, predicting the exact effects of grazing on a given site is difficult at best, but drawing from the many research projects and scientific studies that are available in university libraries or on the internet may provide useful background information for a grazing plan. Additionally, familiarization with local preserves or organizations with scientists on staff may be another way to access scientific information. The Nature Conservancy (TNC) produces "Element Stewardship Abstracts" which include management information on numerous invasive species and are available over the internet.

Livestock Producers

Most livestock producers have spent a good deal of time observing the land where they graze, and its response to changes in management. Ranchers may have historic knowledge of a particular site and although they may use different terminology or plant names, they can often describe changes in landscape appearance and plant populations.

Implementing a Grazing Program

Infrastructure

Certain physical improvements are needed for managing livestock grazing. Water, fencing, site access, and corrals for working and loading animals are the basic necessities. Buildings such as hay storage barns may be useful or necessary in some cases.

Infrastructure should be evaluated soon after, or even before, a new property that may be grazed is acquired. Land trusts and public agencies can end up owning small parcels that have been divided from larger ones, and it's important to ensure that any site planned for grazing has, at a minimum, a viable water source and good access for a livestock truck. Fencing can be constructed, but without water and access, a property may be ungrazable.

Fencing

Boundary fencing is essential for keeping livestock on site; cross fencing is important for distributing and managing livestock; enclosure or exclosure fencing is used to protect resources that might be damaged by grazing or to establish controls for monitoring purposes.

Fencing can be constructed from a variety of materials including different types of wire. The type used should be appropriate for the kind and class of livestock and site considerations. High tensile smooth-wire, barbed wire, woven wire, and electrified wire are a few of the typical types of livestock fencing. With smooth or barbed wire, strands should be spaced so that cattle cannot push their heads through, as this will cause undue pressure on the fence, shortening its life. Five or six strands of wire should be used to prevent this.

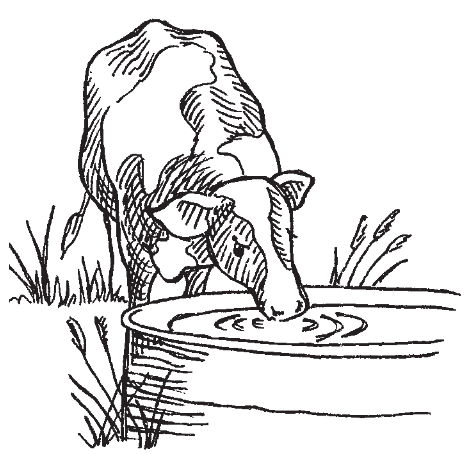
Woven wire or "field fencing" is commonly used for sheep and goats as it is more effective with small animals than barbed wire. High tensile smooth wire fencing is usually electrified, and is best used on long straight runs on flat-to-gently-rolling land where few posts are needed to maximize its economy.

Wildlife biologists and conservationists promote the concept of "wildlife friendly" fencing that minimizes interference with wildlife movement patterns. Smooth bottom wires, adequate distance from the ground to the bottom wire for small animal movement under the fence, and other characteristics that allow animal movement through the fencing are used. Such fencing, especially on property boundaries, should be carefully designed to ensure that it is truly effective in controlling livestock, as young calves, lambs, and small mature livestock also may be able to pass through. Boundary fencing must also be designed to meet California Food and Agricultural Code "lawful" fence requirements. Local fencing companies, fence material suppliers, and NRCS staff can provide help with fence design.

California Food and Agriculture Code[69] requires that livestock be kept from public roads by the person who owns or controls them:

"16902. Permitting livestock on highway. A person that owns or controls the possession of any livestock shall not willfully or negligently permit any of the livestock to stray upon, or remain unaccompanied by a person in charge or control of the livestock upon, a public highway, if both sides of the highway are adjoined by property which is separated from the highway by a fence, wall, hedge, sidewalk, curb, lawn, or building."

A livestock fence is considered "lawful" according to Chapter 7 of this same code as follows: "17121. 'Lawful fence'; Wire fence; Good and substantial fence; Cattle guards. A lawful fence is any fence which is good, strong, substantial, and sufficient to prevent the ingress and egress of livestock. No wire fence is a good and substantial fence within the meaning of this article unless it has three tightly stretched barbed wires securely fastened to posts of reasonable strength, firmly set in the ground not more than one rod apart, one of which wires shall be at least four feet above the surface of the ground. Any kind of wire or other fence of height, strength and capacity equal to or greater than the wire fence herein described is a good and substantial fence within the meaning of this article. The term 'lawful fence' includes cattle guards of such width, depth, rail spacing, and construction as will effectively turn livestock." Regulations pertaining to electrified fencing is included in Chapter 8 of the code.



Water

A livestock watering system includes the source, the distribution system, and watering locations. Water should be good quality to ensure animal health. While livestock will drink stagnant water if forced to, poor quality water can lead to health problems and can decrease water intake.

The source must produce enough water, and the delivery system must be able to supply the daily needs of a herd within an hour or two because most of the animals in a pasture will seek water at the same time. Insufficient water can cause herd panic, where all livestock run to a water source at the same time for fear of not having any water left to drink. Their fears are proven out if the water source and delivery system cannot refill the trough quickly enough. With troughs that stay full all the time, animals learn to drink a few at a time, avoiding panic and the resultant quick draw down.

Livestock drinking water requirements vary with size and species of animal, and throughout the year based on air temperature and water content of forage. Heady and Child[70] report that European cattle breeds need more water than other ungulates and that Hereford cattle require 6.42 liters/100kg/day (7.7 gallons/1,000 pounds/day). They suggest that a reasonable rule is to supply 10–12 gallons per day for a cow and calf, 12–15 gallons per day for a horse, and 1–1.5 gallons per day for a ewe and lamb.

In many cases, water must be delivered from a source to troughs or other drinking facilities. Although some livestock will travel over a mile for water,[71] more closely spaced watering locations encourage better livestock distribution. Even on small sites, more than one water source may be needed to encourage even grazing. Use of specific areas can be discouraged by turning water sources off and similarly, use of other areas can be encouraged by providing water. Off-stream water should always be provided in riparian pastures to discourage heavy use of streams. Depending on location and type of source (well, spring, or pond) water may be gravity-fed or may require pumping through pipes to troughs. Portable water systems can be used if permanent water sources are not available on a site, although they require much more labor to set up and move, and they must be vigilantly monitored to ensure a consistent water supply. In emergency situations, water can be trucked in, although transportation costs may be prohibitive.

Factors to consider in determining the number of watering locations that should be developed include size and shape of the property, number of pastures or paddocks (each pasture or paddock must include access to water), herd size, topography, and yield of water source. Heady and Childs[72] suggest that watering locations should not be farther than 1.3 miles apart, though Vallentine[73] states that .5 to 1 mile apart is the preferred range in steep, rough country and that they can be up to 2 miles apart on level or gently rolling sites. Theoretically then, based on a 1-mile distance between watering locations, a square-shaped 2,500-acre site could be served by one central watering location if it could supply adequate water for the whole herd within an hour or two. However, far corners of the site would likely be underutilized and areas close to the watering location would be overutilized. NRCS staff, UCCE advisors, contractors who specialize in rural water systems, and ranch materials and equipment suppliers can be consulted for help in designing and installing livestock watering systems.

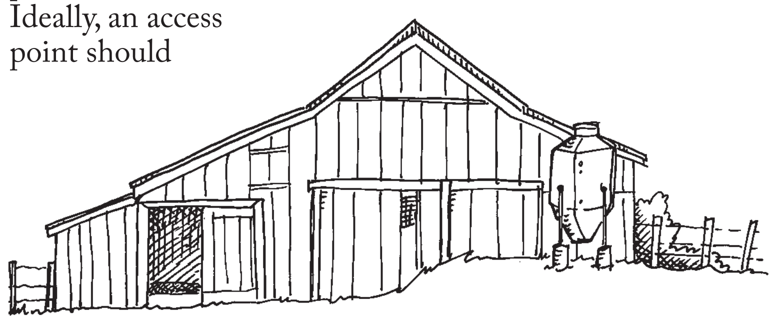
Corrals and Chutes

Corrals and chutes are often necessary for gathering and working livestock. Loading on a truck, branding, and veterinary work all require gathering animals into a small area where they can be funneled for loading or individual handling. Temporary corrals can be set up, but where grazing is an ongoing practice, permanent facilities should be considered. The livestock operator should be consulted about location and design of handling facilities.

Roads and Access

Maintaining access into and within a grazed site is important for bringing animals on site, supplemental feeding, and, especially on large properties, to allow the livestock operator to check his or her animals. Development and repair of water sources, fencing, and other improvements also requires vehicular access.

If livestock are trucked in, an entrance that allows a truck and trailer to safely pull off public roads is needed. Ideally, an access point should allow a truck and trailer to drive onto a site and turn around without impeding traffic. A minimum 12-foot-wide (preferably 16-foot-wide) gate and gravel turn-around area near corrals and buildings should be provided.



Existing ranch roads should be maintained to keep them clear and serviceable and prevent erosion. Areas that are not accessible by truck may need to be served by 4-wheeled, off-road vehicles.

Barns

Barns can be useful for hay storage, especially for livestock operations where animals are fed alfalfa or other supplemental feed. For example, cow-calf operators provide supplemental feed to pregnant and lactating mother cows during fall and winter when forage does not provide adequate nutrition. Barns are also useful for storage of tools and equipment. The type of livestock operation, distance to off-site storage, if any, and other variables determine how important on-site storage is.

Fostering the Landowner/Livestock Producer Relationship

Livestock producers are an essential component of grazing programs. Without the people who raise livestock commercially, this important vegetation management tool would not be available. Ranchers face many constraints in today's culture and marketplace. From conflicts with adjacent urban neighbors, to marginal profits, to more stringent regulations, ranching is an increasingly difficult business.

A good relationship between a landowner and livestock producer may be the most important factor in determining the success of a grazing program and meeting the goals and expectations of each party. This relationship begins with the first communication between the producer and the landowner. When properties are purchased with a livestock operation on-site, continuing the existing grazing agreement is often the best option. If existing grazing management is not compatible with a new landowner's goals and objectives, an attempt to work out differences should be made before seeking a new operator. Losing grazing land can seriously impact a livestock producer's operation, and it may be difficult to find another compatible producer. If finding the right livestock producer seems to be an ongoing problem, this may indicate that grazing requirements are impractical, that landowner expectations are unreasonable, or that grazing fees are too high.

The manner in which a livestock producer is selected has a strong bearing on the future relationship with the landowner. Requesting bids for grazing agreements can have disastrous results. High bidders may be inexperienced and may offer to pay more than they can really afford, tempting them to overstock a site or cut corners on maintenance. A more successful relationship is likely to develop if the landowner sets grazing fees and solicits proposals, including references. Grazing fees should be based on a survey of local rates, and qualified operators can be found through advertising in local ranching publications. References should be checked and visits to applicants' other grazing lands can be part of the selection process. During this process, the landowner should clearly describe goals and desired grazing parameters to the producer, and the producer should, in turn, make his or her operational needs known to the landowner. Private landowners may wish to simply select a local rancher whom they know and trust.

The bottom line for a livestock producer is that he or she must make a profit – or at least break even – in order to stay in business. The landowner needs to have ecological, fuel management, or other types of goals furthered, or he or she may not continue the grazing program. The producer should be allowed as much flexibility as possible, as long as reasonable parameters are met. Likewise, a producer must honor the landowner's needs and should make it clear during the grazing agreement negotiation process if there are requirements that will be difficult to meet. In cases where grazing program parameters are so restrictive that they create substantial additional work for the livestock producer, grazing fees should be discounted. In cases where the landowner requires a highly complex or inconvenient grazing program, actual payment to the livestock producer for providing a vegetation management service may be in order. Clear and immediate communication between the landowner and the producer is essential in the event that management problems arise.

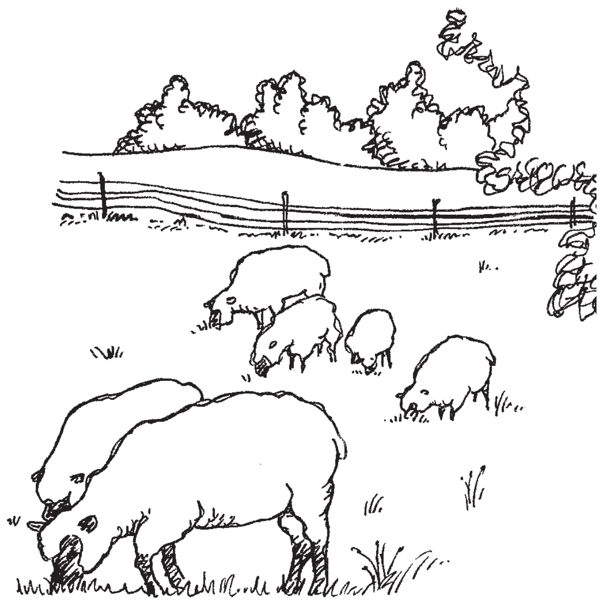
Developing a Grazing Agreement

A grazing agreement may be as simple or complex as needed to fit a given situation. Different types of agreements can be used, including leases, licenses, or permits. The landowner's attorney should select the type of agreement best suited to the landowning entity (individual, corporation, public or other). At a minimum, the grazing agreement should include: the names of the parties involved; a description of the site location; starting and ending dates; and appropriate legal terms. If fees are charged, these should be stated in the agreement, along with the method of payment. Agreements should also spell out the obligations and rights of both producer and landowner, grazing guidelines/requirements, whether or not supplemental feeding of hay will be allowed, and other pertinent information. Attorneys, who may not be familiar with grazing terminology and livestock management, sometimes draft grazing agreements. Therefore, it's important for land managers who interact with the producer and are familiar with livestock grazing to provide input to the attorney. Specifics about the grazing program should be integrated into the body of the lease with more detail specified in an exhibit or addendum.

Grazing agreements should clearly describe management practices and/or performance-based desired outcomes. Descriptions can be in the body of the agreement or in exhibits, but in either case should be clear and easy to understand. Clauses that include terms such as "proper use," "good range management practices," or "best management practices" are sometimes used in agreements when the drafter does not have specific information about the grazing program. Such phrases should be avoided as they are subject to broad interpretation and are so non-specific that they can be meaningless.

Grazing Fees

Rental rates are determined by forces of supply and demand and are influenced by the relative profitability of the livestock industry, the supply and cost of alternative feed sources, the productivity (feed producing capacity) of the parcel in question, and conditions of the lease.[74] Grazing fees are most commonly structured so that payment is by the acre per year or month, or by the AUM, based on the number of AUs grazing for an established period of time. Both of these methods have



advantages and disadvantages. Regardless of how fees are structured, performance standards that describe desired conditions during and at the end of the grazing season should be specified in the lease.

Other methods for charging lease fees include payment per whole tract, payment per head, share of gain, and variable leases. Payment per whole tract and payment per head are self-explanatory terms. With share of gain, the landowner is paid based on animal gain. Variable leases include a base payment rate (this could be per AUM or acre, see below) and a variable rate that is modified each year by the livestock price index. The East Bay Regional Park District (EBRPD) uses this system, adjusting grazing fees based on annual variation in livestock prices.

Payment per Animal Unit Month (AUM)

Payment on an AUM basis offers several advantages over a per-acre payment structure: adjustments to the lease for changing livestock numbers are easy to make; and temptation to maximize stocking at the expense of the land is removed as the lessee is paying for what he or she uses. The downside of AUM-based leases is that the actual use must be monitored to ensure that fees accurately reflect usage.

Some Relative Terms

What is "normal" maintenance?
Normal maintenance is the level of annual maintenance necessary to keep fencing, water developments, and other improvements necessary for grazing in working order. Replacement of fences, gates, water troughs and related improvements should not be expected as part of normal maintenance.

What is a short-term grazing agreement and what is a long-term grazing agreement? A 1–5-year agreement is considered short-term. Five–10-year agreements can be considered medium-term, and many livestock producers may prefer longer-term agreements of 10–20 years or more.

What is "good quality" forage? Generally speaking, good quality forage is highly palatable and has adequate nutrients required by livestock. Forage quality is determined by species, phenological stage of forage plants, and by seasonal changes due to weather. In order for forage to be utilized, it must be palatable to the livestock species, so palatability is a criterion. If a plant is palatable enough to be ingested, then nutritional content is important. Legumes are relatively high in protein throughout their life cycle, including in the seed stage. Nutritional value of grasses varies with stage of development, with the best nutrition typically in the early leaf stages before flowering.[75]

What is "productive" land? Land productivity, and thus forage production, is highly variable between sites with deep, valley bottom soils and sites with steep, exposed hillslopes. Generally, flat ground has deeper soils and produces more forage than hillsides or ridges that have a thin covering of soil over rocky parent material. Land may be productive, but if the species produced aren't palatable, it may not be desirable for grazing. For example, the non-native invasive annual grass medusa head produces a lot of biomass, but it is highly unpalatable and thus unproductive from a livestock forage perspective.

Payment per Acre

Payment on a per-acre basis does not require monitoring of animal numbers to ensure compliance but does require that land condition is carefully checked to ensure that land isn't overstocked to maximize the producer's return on the dollar. However, if grazing fee rates are appropriate for the site – in terms of pasture productivity and producer obligations – this should not be a problem. The number and type of livestock and season of use should be established in the grazing agreement with allowances for adjusting stocking rates based on forage production fluctuations. Otherwise, the lessee assumes the risk of fluctuations in annual forage production.[76]

Exchange of In-kind Services in Lieu of Grazing Fees

As interest in using livestock as a management tool has increased, so has the incidence of grazing agreements where the producer does not pay a grazing fee. This is especially true on small properties where it might not be financially worthwhile for a producer to move a small number of animals to the site, or in situations where "nuisance factors" such as complicated or especially restrictive grazing prescriptions create additional work or hardship for the producer.

The practice of trading services for grazing fees is also used by agencies or organizations that cannot or do not want to receive income. A value for the grazing rights is established, and a value for labor and/or services provided by the producer is also determined. An exchange is then made. For example, within the San Luis National Wildlife Refuge Complex, owned by the United States Department of Fish and Wildlife (USFWS), "cooperative land management agreements" are used in lieu of grazing fees. A total of 16,580 acres on three refuges within the complex are grazed under this type of agreement. The USFWS keeps track of the number of animals and length of grazing period (AUMs) for each livestock operator and a set rate per AUM is "charged" to the operator. At the end of the grazing season, the livestock operator has accrued a deficit based on the number of AUMs times the fee charged per AUM. In exchange, the livestock operator purchases supplies for the refuge complex, or provides labor toward on-the-ground projects. Labor rates are arrived at through negotiation.[77]

If infrastructure is in need of maintenance beyond what can be considered "normal," a partial exchange can be used to upgrade or make major repairs, if the livestock operator is willing and able to do so. Generally, the longer the grazing agreement, the more a producer is willing to invest in management of a property. It is unreasonable to expect a producer to invest in major infrastructure repairs on a property with a short-term lease. The amount of work and/or money invested should be balanced with the length of time needed to absorb associated costs.

Welfare Exemption for Nonprofit Landowners

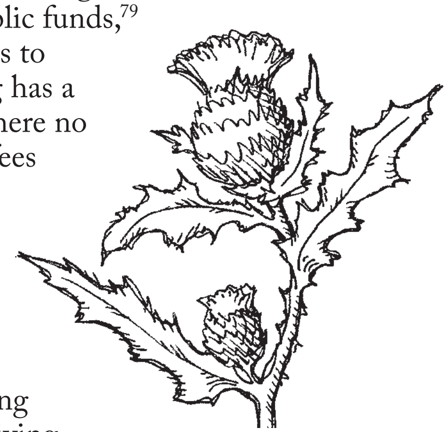
Nonprofit landowners can apply for welfare exemptions to property taxes through the County Assessor's office. The State Board of Equalization (SBE) and the County Assessor jointly administer the Welfare Organization Exemptions. The SBE determines whether the nonprofit organization is eligible to receive the exemption and, if so, issues an Organizational Clearance Certificate for the landowner to include with claim forms filed in any of the 58 counties of California.[78]

If a Welfare Exemption is granted, the ability to earn income from the property is terminated, which can impact the nonprofit landowner's capacity to enter into a grazing agreement with a livestock producer. Interpretation of State regulations vary by County, and in some cases, receiving in-kind compensation from a livestock producer is prohibited. Even when the non-profit landowner does not receive any compensation, the sale of livestock that have been grazed on Welfare Exempt land by a "non-qualified entity" (the livestock producer), may be considered a violation of the exemption. Before setting up a grazing agreement, nonprofit landowners who take a Welfare Exemption should contact their County Assessor's office to discuss the Assessor's position regarding livestock grazing. If allowed, in-kind service exchanges should be carefully described in the grazing agreement.

Muir Heritage Land Trust in Contra Costa County uses an in-kind services exchange system with livestock operators. As with USFWS staff at the San Luis National Wildlife Refuge Complex, lease rates are established and ranch livestock operators complete maintenance or habitat enhancement projects in exchange. Exchanges involve both labor and materials.

No Gifts of Public Funds

Article 16, Section 6 of the California Constitution prohibits public agencies from making gifts of public funds,[79] obligating public agencies to demonstrate that grazing has a public benefit in cases where no fee or less-than-market fees are charged. Agency personnel should first be confident that a public benefit purpose will be fulfilled through grazing if the agency is considering not charging, or not receiving in-kind compensation, for grazing.



Fee-for-Service-Grazing

In some cases, where especially labor-intensive grazing plans are to be implemented, payment for the livestock operator's services is warranted. Companies that provide goat herds for brush control, for example, charge a per-acre fee for importing and managing goats that eat undesirable woody plants. These fees are necessary to offset the costs of transporting animals, providing a herder to protect and manage animals, and setting up and moving electric fencing, all practices that are essential for effectively managing goats.

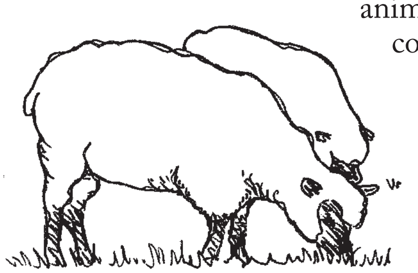
An example of fee-for-service grazing occurs at The Sea Ranch in northern Sonoma County. The Sea Ranch is a residential subdivision built on approximately 2,000 acres of former agricultural land. Beginning in the 1960s, grazing was gradually phased out over a 20-year period as development progressed. By the early 1990s, worry over increasing fire fuel loading and other concerns prompted managers of The Sea Ranch Association (TSRA) to consider methods for managing the buildup of biomass in this complex of forest, coastal scrub, and grassland.

Long-term landscape character was also a concern as shrubs and trees began invading open grasslands in the absence of grazing. Community members did not want to lose the pastoral landscape that had attracted them to this beautiful coastal site. Additionally, Bill Wiemeyer, TSRA Director of Design Review and Environmental Management, was concerned about loss of grassland diversity.

Different biomass management options, including burning, mowing, and grazing were considered. Mowing was ruled out as a significant vegetation management tool due to expense and the fact that many areas were not accessible to equipment. Prescribed burns were planned in thirteen areas of the property but just a few of these burns were ever executed due to logistical problems and reluctance on the part of the California Department of Forestry and Fire Protection (CDFFP). TSRA's target burn season was fall, when wildfires are common throughout the state and CDFFP personnel are fully occupied.

Eventually, livestock grazing was settled on as the only reliable tool for biomass management, and a grazing program was initiated. Sheep were the chosen livestock species, primarily because grazing would take place within the subdivision and smaller animals were considered to be most appropriate in this setting. From a production standpoint, there were many aspects of the site and the proposed grazing program that presented production difficulties. It was decided that payment by TSRA would be necessary to secure an appropriate rancher. Issues for the sheep rancher included:

- low forage quality due to many years without grazing
- grazing required labor-intensive management including frequent movement of small paddocks constructed of electric fencing
- high frequency of predators including coyotes, mountain lions, and ravens.



Several ranchers were considered for the grazing program and a young, local producer was selected. Issues unique to grazing within a subdivision occasionally crop up, such as some residents wanting to see grass blowing in the wind during the spring, so timing the grazing to meet the needs of both the residents and the landscape pose special challenges. Overall, though, Bill Wiemeyer reports that the program is working well, although the herd size is not yet adequate to manage the growth. TSRA Board of Directors is considering doubling the program. The sheep rancher is paid per head per month, based on records and monthly reports that he submits.[80]

How to Determine Grazing Fees

To establish grazing fees, local market rates should be determined, then adjusted upward or downward based on relative land productivity, forage quality, "nuisance" factors, and other pertinent information. Market rates can be determined by contacting local agencies or private landowners that rent land out for grazing. Park and/or open space districts, water districts, state and federal agencies, and conservation landowners should be able to provide estimates of grazing fees. Rates may vary widely, so information about site conditions and how rates were established should also be sought.

Role of Resource Conservation Districts

Resource Conservation Districts (RCDs) are legal subdivisions of the State, formed under Division 9 of the Public Resource Code to provide local leadership in the conservation of our soil, water, and related natural resources. RCDs were originally developed in the 1930s as the local non-regulatory mechanism for delivery of conservation practices to farmers dealing with soil conservation issues brought to Congressional attention during the Dust Bowl era. Conservation Districts exist in all 50 states; there are 103 Conservation Districts in California.

RCDs can help facilitate grazing on public lands because they have greater contracting flexibility than certain government agencies. For example, the Alameda County and the Sotoyome RCDs are both working through Cooperative Agreements with CDFG to implement grazing programs on CDFG preserve lands. In both cases, the RCD has contracted with Certified Rangeland Managers to have grazing plans prepared. The Alameda RCD also has developed a lease with a livestock producer and is managing a grazing program on CDFG's Byron Conservation Bank property for CDFG. The grazing program is designed to maintain habitat for several sensitive animal species including California tiger salamander, California red-legged frog, San Joaquin kit fox (*Vulpes macrotis mutica*), western pond turtle (*Clemmys marmorata*), and burrowing owl (*Athena cunicularia*).

Monitoring Grazing Use

What is Monitoring?

Monitoring is a process that includes collection, evaluation, and interpretation of data. Because these components can require different sets of skills, monitoring may require the expertise of more than one person. Depending on the grazing program goals and objectives, the type of monitoring being carried out, and other variables, monitoring may require scientific expertise and statistical analysis. In some cases, simple photographic monitoring may be adequate and qualitative evaluation of the photos may be an effective way to interpret the data.

Why is Monitoring Important?

Monitoring a grazing program is the only way to determine if grazing is effectively meeting established goals and objectives. Monitoring provides the feedback to evaluate progress toward goals and objectives in the planning cycle. Once monitoring has revealed trends linked to management practices, results should be used to adjust the grazing plan and program as appropriate

Monitoring Approaches

There are many ways to monitor grazed sites. Methods and approaches depend on goals and objectives, available funding, and other factors. Monitoring can be very simple to very complex, although complicated monitoring plans that aren't backed by adequate resources will probably not be carried out. Simpler monitoring programs that are well matched with a budget are more likely to be implemented. It's much better to carry out a simple monitoring program than to have none at all.

Monitoring should be properly designed to yield the type of information desired; there is no single right way to monitor grazing use, although there are several techniques that are commonly used. Monitoring for management purposes is usually less rigorous than monitoring for experimental purposes. Most landowners lack the expertise or staff time required to set up and execute true experiments involving replicated trials and statistical analysis of results. However, in some instances, university faculty or students may be interested in helping with monitoring if it offers research opportunities. Private groups, such as California Native Plant Society (CNPS) also may be a resource for monitoring assistance. For example, CNPS chapters often have dedicated volunteers who monitor rare plant populations.

Compliance Versus Effectiveness Monitoring

Two general reasons to monitor are: 1) to discover if an action complies with expectations or regulations (compliance monitoring); and 2) to determine if grazing treatments are effective in achieving desired results (effectiveness monitoring). Compliance monitoring can be viewed as a simple question – did what was supposed to be done get done? For example, compliance monitoring would be used to determine if a grazing lessee is following lease terms. Effectiveness monitoring is done to determine if management actions, such as a specific grazing prescription, are effective in meeting goals and objectives. In other words, is the prescription working? An example of how these two categories of monitoring interact is given below:

Step 1. Goals and objectives are developed

Goal – Increase habitat for aquatic invertebrates in vernal pools.

Objective – Increase by two the number of species of aquatic invertebrates in specific vernal pools by extending the inundation periods of vernal pools from 60 to 100 days

Step 2. A grazing plan is developed to achieve this goal and objective: the plan prescribes cattle grazing during the green forage season to consume exotic annual plants that dry vernal pools up through evapotranspiration

Step 3. The prescription is implemented: cattle graze the site at the recommended stocking rate during the green forage season

Step 4. Compliance monitoring is performed to determine if the livestock operator or other responsible party implemented the grazing prescription as specified

Step 5. Effectiveness monitoring is performed to determine if the vernal pool inundation period was extended from 60 to 100, and if two additional species of aquatic invertebrates occupied the pool as described in the objective

Step 6. Monitoring results are validated: the pools' inundation period may have been extended, but the aquatic invertebrates might not have occupied the pool

Step 7. Feedback is incorporated into the grazing plan/program

If the prescription was successful in that the two invertebrate species occupied the pool, then the prescription should be continued

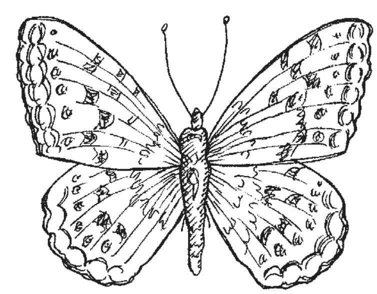
If the pool inundation period was extended but the two species of invertebrates didn't occupy the pool, then the shortfalls of the prescription should be diagnosed, the prescription should be changed and reapplied, and monitoring should be repeated until the prescription is determined to be effective

Conducting Compliance Monitoring

Compliance monitoring can be used to verify compliance with a grazing lease, mitigation agreement conditions, or other regulatory requirements. Monitoring methods depend on the type of information needed to determine compliance.

Monitoring for compliance with grazing agreement conditions could include:

- degree of utilization or other performance-based measure such as RDM; these types of monitoring can be used to determine if a producer is meeting stocking rate and season-of-use requirements.
- animal counts/AUM verification; this involves monitoring the number of animals on a site and could be necessary when payment is by AUM or to confirm that agreed upon stocking rates are appropriate for meeting goals and objectives
- season-of-use verification; for grazing programs that are not year around, and where the grazing agreement specifies a particular season of use, this would be done to determine when animals are brought onto the site and when they're removed



Monitoring for mitigation compliance could include:

- checking to make sure that a grazing prescription designed to enhance specific species or habitat conditions for plants or animals was implemented; it could include

TABLE 3. SAMPLE VEGETATION MONITORING VARIABLES FOR SPECIFIC PURPOSES

Purpose	Variable	Data Collection Methods
Detect shrub invasion into grasslands	Cover	Measure shrub cover coverage on historic and recent aerial photographs
Detect population change (negative or positive) in an annual wildflower species	Frequency	Frequency measures percentage of a species present in a sample unit and is usually estimated by plots, points, or lines
Determine amount of RDM remaining at the end of the grazing season such	Biomass (weight per unit area)	Clip and weigh sample quadrats; visually estimate; map by weight categories as low, medium, and high
Determine if the "coefficient of beauty" in grasslands is being maintaineds	Subjective evaluation of beauty – possibly colorful wildflower display	Observation and photography

TABLE 4. SAMPLE WILDLIFE AND HABITAT MONITORING VARIABLES FOR SPECIFIC PURPOSES

Purpose	Variable	Data Collection Methods
Determine when grazing has optimally affected shorebird habitat	Vegetation Height	Measure or estimate height of stubble in representative or critical areas
Determine quality of Myrtle's silverspot butterfly habitat	Density (number per unit area)	Count and/or estimate the number of adult nectar plants and larval host plants within populated area
Determine population size of Callippe silverspot butterfly	Density (number per unit area)	Count and/or estimate the number of adult and larval butterflies within populated area
Determine if grazing is beneficially affecting numbers and/or diversity of vernal pool aquatic invertebrates	Density for numbers; diversity can be measured with several different indices such as density, cover, or biomass	Force the bottom edge of a dip net along the pool bottom for a fixed period, with each dip representing a single sample that must be replicated to characterize populations or communities at a particular site[81]

TABLE 5. SAMPLE RANGELAND WATER QUALITY AND HYDROLOGIC MONITORING VARIABLES

Purpose	Variable	Data Collection Methods
Determine if livestock urine and/or manure are entering a stream and causing elevated ammonia levels	Parts per million of un-ionized ammonia	Collect water samples from above and below livestock-affected area and run ammonia tests
Determine if livestock are causing or exacerbating streambank erosion and resultant sedimentation	Observation, volumetric measurements, turbidity	Visit site and record observations; several kinds of turbidity sensors and meters are available; transparency can be measured by the Secchi disk method
Determine if livestock grazing is affecting the length of vernal pool inundation periods	Pool depth	Measure pool depth in grazed and ungrazed control plots with staff gauge at regular intervals in spring

monitoring use records, determining if prescribed fencing was installed, or confirming any other aspect of a grazing program prescribed as mitigation

Conducting Effectiveness Monitoring

Many different variables related to vegetation, wildlife, hydrology, soils, or other ecosystem components can be monitored to determine grazing prescription effectiveness. Changes in vegetation composition, cover, frequency, dispersion, biomass, stubble height, and other characteristics can all be measured and evaluated through monitoring. Some vegetation changes, such as species composition in perennial grasslands, may occur slowly, requiring many years of careful monitoring. On the other hand, changes in populations of some annual wildflowers take place more quickly, providing short-term monitoring feedback.

In laying out a monitoring program, care should be taken to balance financial and staffing resources with monitoring design. If monitoring native perennial grassland composition changes is planned, will the resources to follow such a long-term project be available in the long-term?

A few examples of vegetation variables that might be monitored for specific purposes and appropriate general data collection methods are shown in Table 3.

Monitoring for wildlife commonly includes vegetation measurements (see Table 4). Habitat conditions are often evaluated, rather than – or in addition to – the animal itself. Habitat monitoring for wildlife species also requires confirmation that the target species is occupying the habitat.

Trampling, deposition of nutrients or pathogens from animal waste, and sedimentation from upland erosion sources related to grazing can affect water bodies. Often these affects are negative, but recent research by Marty[82] demonstrates that cattle grazing can beneficially affect vernal pools. Water quality or hydrologic monitoring variables and methods are dependent on the type of information desired (see Table 5). Because many natural and human- (or livestock-) induced processes affect water quality, it's important to carefully separate livestock from other affects. If livestock impacts on water quality variables such as ammonia or pathogen levels are being monitored in a stream, water samples should always be taken above and below a suspected source of contamination. This way, it can be determined if the contaminants entered the stream before they came in contact with the livestock operation in question.

Erosion, which can be caused or exacerbated by livestock, is related to water quality monitoring because sediment is a common and serious non-point source pollutant on grazed lands. Beyond simply using careful observation, common sense, and knowledge of erosional processes, monitoring erosion rates or determining exact causes is difficult and very technical and, therefore, not addressed here.

Common Types of Grazing Monitoring – RDM, Stubble Height, and Percent Utilization

Several types of monitoring are commonly used on grazed lands to determine if grazing complies with generally accepted levels of use. RDM standards were developed specifically for use in California, while percent utilization and stubble height standards have been more commonly used in other states.

The basic differences in these three approaches to monitoring grazing use are:

1. RDM monitoring evaluates the amount of *dry* biomass remaining in the fall, at the end of the grazing season; standards are not necessarily linked to total forage production
2. stubble height is based on height of biomass remaining after grazing, though it does not necessarily need to be dry; like RDM, stubble height standards are not based on the total forage crop, but represent a desired condition

Predicting Fall RDM Levels

RDM monitoring is done in the fall prior to the rainy season. While the timing of fall germinating rain is a moving target, the amount of RDM at that time can be critical for soil protection and a favorable micro-environment for the coming years' herbaceous plant community. If RDM is measured earlier, an adjustment must to made to correct for losses due to decomposition. Research has demonstrated that the amount of RDM, by weight, will average a decrease of 7% per 30-day period from the time of peak standing crop of annual herbaceous species to occurrence of the germinating rain in the fall.[83] This rate can be used to calculate backward from the desired RDM amount in October-November to an amount that must be present earlier in the summer. RDM disappearance at individual locations has been shown to range from a high of 13% per 30 day period to a low of no disappearance over the dry summer months in any one year. In situations where conservative use and a higher RDM standard is appropriate or desired, rangeland managers could utilize the higher observed rate of RDM disappearance, 13% per 30-day-period to determine the amount to leave at an earlier date.[84]

The Development of RDM Monitoring

Since Clawson and McDougald[85] coined the term "residual dry matter" more than 20 years ago, it has been prescribed widely for monitoring on grazed lands in California. RDM monitoring has many valuable uses, both for livestock producers and for conservation-oriented land managers. A look at how this concept was developed gives some interesting insights into its potential applications.

Harold Heady, professor emeritus of Range Management at the University of California at Berkeley, recognized that although many range managers and scientists acknowledged the importance of maintaining mulch (the dead plant materials above the soil surface – also referred to as RDM, litter, or plant residue) in grassland management, critical variables such as distribution, thickness, and occasionally the amount of mulch, had not been examined quantitatively. In the early 1950s, he conducted an experiment at the Hopland Field Station in Mendocino County to examine the relationships of mulch levels to subsequent years' forage production and species composition in 64 adjacent plots. The results of this experiment were reported in a paper titled "Changes in a California Annual Plant Community Induced by manipulation of Natural Mulch" that was published in *Ecology*.[86]

Heady recognized the resource protection values of mulch as well as the advantages to livestock producers and California's agricultural economy. Among the questions that this experiment attempted to answer was: "What is the optimum amount which will promote maximum yearly and year-long production of forage?" Another objective was to determine the cumulative effects of mulch on botanical composition. Study site vegetation was composed primarily of annuals with scattered broad-leaved perennials and occasional individuals of purple needle grass (*Nassella pulchra*). It's important to note that, although he supposed the importance of mulch in protecting soil from erosion, his experiment did not quantitatively evaluate this aspect.

The experiment involved manually manipulating mulch levels within plots by hand clipping to various levels. Over the four years of the experiment, Heady found that:

- increasing amounts of mulch on the soil immediately before the fall rains led to an increase in herbage production the following spring
- biomass production increased with increased weight of mulch between 1,200 and 2,400 pounds
- some species responded to mulch treatments, and some didn't
- mulch has a direct effect on composition, and some species were favored when all mulch was removed, others were favored when none was removed, and a third group reached maximum composition with intermediate mulch levels; for example, California goldfields (then *Baeria chrysostoma,* now *Lasthenia californica*) were very abundant with no mulch and were absent where mulch was heaviest; conversely, soft chess (then *Bromus mollis,* now *B. hordeaceus*) was the only plant that increased significantly in percent composition with the heaviest mulch treatments; legumes were most abundant at intermediate mulch levels
- although he observed evidence of erosion on the plots where all mulch was removed, there was no evidence of erosion on other plots; the erosion evidence disappeared on the bare plots three to four weeks after the first rains

In the late 1970s, Heady and four graduate students, Jim Bartolome, Michael Stroud, Glenn Savelle, and Mike Pitt conducted another important RDM experiment. This experiment, which again involved manipulation of mulch levels, took place on nine sites throughout California. The purpose was to demonstrate how the mulch layer can be managed to significantly influence the subsequent year's forage production. Findings included:

- perennial grass sites with annual precipitation over 40 inches should probably be managed as perennial grasslands with attention paid to plant vigor, season of grazing use, and maintenance of at least 1,000 pounds per acre (the RDM standard for high rainfall areas has been adjusted upward in recent years) of mulch, preferably more, at the end of the grazing season
- in mid-rainfall annual ranges, mulch levels are the most important factor
- on drier sites, maintenance of sufficient (this was not quantified) mulch to prevent soil loss is most important

W. James Clawson and Neil McDougald presented numeric RDM standards for the first time in 1982,[87] in the proceedings of the Western Section, American Society of Animal Science. As a Range Specialist with Agronomy and Range Science Extension (Clawson) and Madera County Farm Advisor (McDougald), their work focused on livestock production on annual rangeland, which contributes 80 percent of the range forage for California's livestock industry.

They coined the term "residual dry matter" and suggested guidelines for minimum or lower threshold RDM levels for California. These ranged from about 270 pounds per acre to 1,070 pounds per acre, depending on annual precipitation. They acknowledged that the amount of RDM required for a given site can be quite variable and encouraged managers to test minimum guidelines and develop their own levels to meet the requirements of specific site conditions. They stated, "Too much residual dry material or a dense mulch results in a thatch which inhibits early response of new forage growth. Maintenance of seeded annual legumes and filaree (*Erodium* spp.) abundance requires adequate but lower amounts of residual dry material." This paper also linked the idea of using broad categories to describe grazing impact on landscape appearance and stubble height: light grazing leaves three or more inches; moderate grazing leaves two inches; and heavy grazing leaves less than two inches with areas of bare soil visible from 20 feet away.

That same year, University of California Cooperative Extension Leaflet 21327, titled "Guidelines for Residue Management on Annual Range" was authored by Clawson, McDougald, and Don Duncan, a US Forest Service Range Specialist. This publication included similar information, but suggested minimum guidelines (again, to be tested site-specifically) ranging from 200 – 1,250 pounds per acre.

RDM guidelines recently have been reviewed and updated by the University of California Division of Agriculture and Natural Resources in Rangeland Monitoring Series Publication 8092[88] with more consideration given to the perennial-rich coastal prairie. RDM guidelines for open coastal prairie (with no tree cover) now range from 1,200 – 2,100 pounds per acre, depending on slope.

RDM monitoring techniques include:

- **Comparison to Photographs.** This is a simple and quick method that involves visual comparison of field conditions to photographs of known RDM levels
- **Clipping Plots.** RDM is clipped within one-square-foot quadrats, weighed, and converted to pounds-per-acre
- **Visual Estimating.** This is usually done in combination with clipping, which is used to calibrate the monitor's eye; once the monitor is able to accurately make visual estimations, clipping is no longer necessary
- **Mapping.** Mapping the pattern of RDM levels on a site has been used to graphically depict livestock-use patterns so that managers can improve animal distribution;[89] visual estimating is used to mark RDM categories – low, medium, or high RDM – or weight ranges, on a map

See Appendix for sources of information on RDM monitoring.

> **Warning:**
> **Be Aware of Monitoring Limitations**
>
> Detecting long-term change is difficult because of the high degree of interannual variation in grasslands that tends to override longer-term patterns of change. Due to the high degree of annual variability, an adequate baseline or record of characteristics takes longer than one year to build in grasslands.

3. percent utilization requires knowledge of the total forage crop, with a certain percentage *allowed for removal* by livestock

RDM and stubble height monitoring have useful applications for conservation-based grazing as either type of monitoring can be customized to correspond to desired landscape conditions. For example, if a particular native wildflower species is known to thrive with very low RDM levels, then site-specific standards can be developed to represent conditions required for that species.

"Stubble" or grass height standards can be used similarly. Suitably low grass height is important for maintaining habitat for a number of wildlife species including burrowing owls. Plumpton[90] found that in Colorado, burrowing owls nested in black tailed prairie dog (*Cynomys ludovicianus*) burrows that were farther than expected from the nearest perch; grass height was shorter at nest sites than at non-nest sites.

Utilization measurements were originally developed in midwestern tall-grass prairies, and there is little evidence to support its application in arid and semi-arid areas.[91] Measurements are based on the idea that if grazing is in excess of a certain critical amount, desired plants will lose vigor, produce less herbage, and eventually die.[92] The term "proper utilization" is used to describe the level of defoliation that can occur while still maintaining range productivity or improving range conditions. Identifying key plant species and their associated "proper use factor" is an essential part of meaningful utilization measurements. This technique is sometimes employed to measure browsing use on woody riparian plants where RDM and stubble height measurements don't apply.

An example of how these standards are applied is provided in the Bureau of Land Management's (BLM) "Northwestern California Standards for Rangeland Health and Guidelines for Livestock Grazing Management".[93] In this document, BLM prescribes:

- **Stubble height.** A four-to-six inch minimum stubble height should remain at the end of the grazing season in most riparian areas.
- **Percent utilization.** No more than 20 percent of key riparian tree and shrub species should be utilizedin those areas where the presence of woody riparian species is necessary to meet standards.
- **RDM.** Specific RDM levels should be maintained on upland slopes; levels vary from 400–2,000 pounds per acre depending on rainfall and slopes.

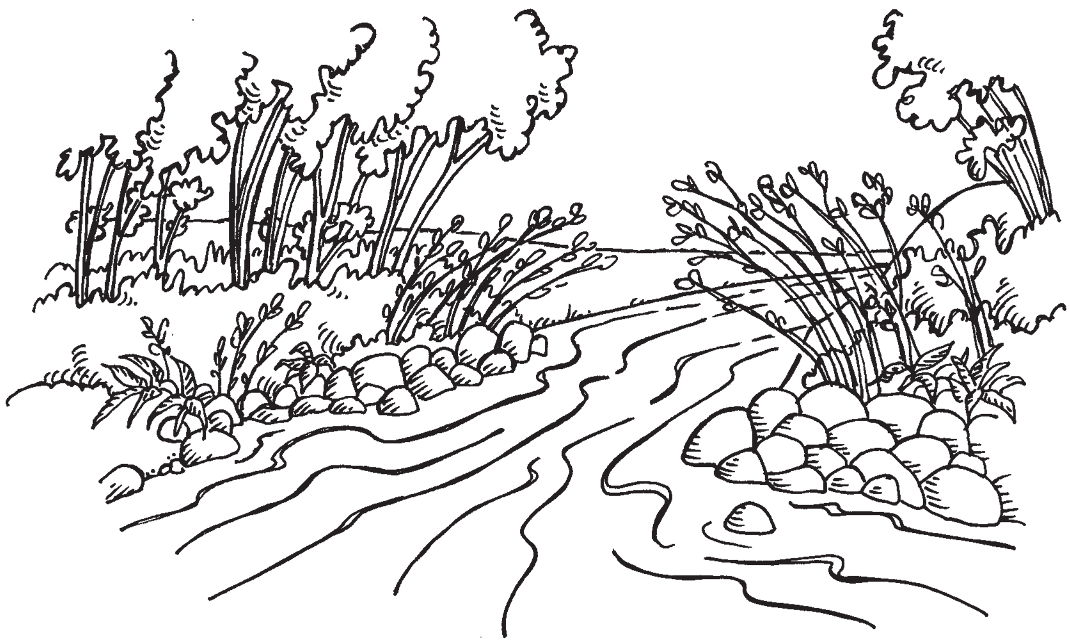
Minimal Monitoring Approaches

If staffing or financial constraints are obstacles to carrying out a structured monitoring program, very rudimentary monitoring is better than none. At a minimum, visiting the site, recording observations, and adjusting management based on these observations is preferable to not conducting any monitoring. Photographic monitoring, especially if photographs are taken in the same location over a period of time, is a good way to document changes in landscape appearance. Videos or movies taken with a digital camera also can be used.

Photographic monitoring

Photographic monitoring can be done in a variety of ways but it should, at a minimum, incorporate the following:

- **Permanent photo points.** Permanent photographic monitoring locations should be established to ensure that photographs can be successfully compared over time.



Monitoring Riparian Grazing

Riparian grazing programs can be evaluated on the basis of whether they improve degraded riparian areas or maintain riparian areas in good-to-excellent condition. Where target species are involved, whether plant, animal or both, monitoring the status of those species within the riparian area will be critical in evaluating the success of a particular riparian grazing program. Managers must be prepared to change key indicator species or forage utilization guidelines as needed to meet defined objectives. For example, a grazing prescription developed to protect sedge reproduction in a given stream reach may not adequately allow willow recruitment. If establishing willows becomes a management priority on this reach, a change in season of use, or a period of livestock exclusion, may be necessary. Some species, anadromous fishes, for example, may not respond to local riparian improvement when larger landscape processes or population dynamics override local conditions. At the same time, improvement in local conditions on multiple sites throughout a watershed can lead to system-level improvement in patterns and processes.

Adding to the complexity of managing and monitoring the response of riparian pastures is the fact that watersheds are dynamic, and may change quite independently of grazing treatments. Managers of riparian pastures need to keep this clearly in mind as they implement and adapt their management plans through years of drought, flood and average rainfall. Documentation of successful – and unsuccessful – riparian grazing strategies is an important contribution that riparian graziers can make to land management in the region.[94]

Photo points can be set using a global positioning system (GPS), a naturally occurring monument such as a large rock, or a man-made marker.

- **Recorded data.** Information should be recorded to ensure that the exact photograph can be reproduced in the future. The location should be carefully recorded, preferably on an aerial photograph and/or on a monitoring form, even if using a GPS. Camera focal length should also be noted as well as camera distance from the focal point of the photograph.
- **Identify the photographs.** Each photograph should include the subject, date, photograph location number or other reference. This can be done by writing this information on a small chalkboard or whiteboard that is propped up in the foreground of the photo.
- **Include landscape features.** If possible, photographs should include landscape features that can be identified for exact relocation in the future. A photograph of a hillside with a tree in it is much easier to duplicate than one of a generic, grassy hillside. If possible, include the horizon line to facilitate relocating the photopoint within the landscape.
- **Identify scale.** A short pole or board with the halfway mark identified (this can be done by painting half of the stake a different color or with tape) should be set in the foreground of the photograph to provide a scale reference. This is especially important if vegetation height is being recorded.

Woody vegetation change and other landscape features can be monitored over time through aerial photograph interpretation. Aerial photos of the same scale can be compared, or actual point sampling of photos using a dot grid can be used. Guidelines for photographic monitoring are widely available on the internet.

Select Habitat Types

Vernal Pool Grasslands

Vernal pools are unique seasonal wetlands that support diverse and often rare and endangered native plant and animal species.[95] They fill with water during the rainy season and dry up in the spring as rainfall ends. They are threatened and are disappearing rapidly in California.[96]

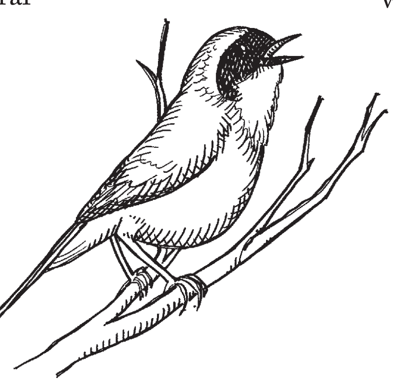
Within the SRCD, vernal pools occur throughout the Santa Rosa Plain in areas where clay soils and a hardpan layer restrict water percolation. They also occur in scattered locations on the mountains that surround the Plain. Most vernal pools occur on flat and nearly flat ground, so many of the natural vernal pools in this area have been destroyed by urban development and crop farming. In recent years, artificial vernal pools have been constructed within the Santa Rosa Plain to mitigate for the loss of natural pools by development.

In the past, preserve managers have tended to remove livestock from vernal pool preserves to protect them from damage. Cattle grazing has been implicated as a major contributing factor to the decline of four vernal pool crustaceans listed under the U.S. Endangered Species Act but with little supporting scientific data.[97] However, scientists and conservationists have observed endemic vernal pool species disappear after grazing removal in numerous Bay Area locations.[98]

Results of a recent study on grazing of vernal pool grasslands in Central California indicate that cattle grazing can have dramatic beneficial effects on vernal pool flora, fauna, and hydrological regimes. This study was performed on The Nature Conservancy's (TNC) Cosumnes River Preserve by TNC Project Ecologist Jaymee Marty. Marty's study compared timing of grazing in vernal pool grasslands to determine its effects on native plant and aquatic faunal diversity. The study involved vernal pools across two different soil types and a wide range of pool sizes and depths on a site where cattle had grazed for the past 100 years. Marty removed cattle either completely or seasonally from groups of pools and compared the response of plant species cover and diversity, pool hydroperiod – the time period that pools are filled with water – soil compaction, and aquatic invertebrate diversity to pools grazed at historic levels. The entire site was grazed from October to June at a stocking rate of 1 AU/6 acres. Treatments were: ungrazed; dry-season-grazed (October/November and mid-April–June); wet-season-grazed (December–mid-April); and continuously-grazed (October–June).

After three years of treatment, pools in areas where grazing was removed had 88% higher cover of exotic annual grasses and 47% lower relative cover of native species than pools grazed at historic levels (October through June at a rate of 1 AU/6 acres). Marty found that in pools that were released from grazing, pool inundation periods were reduced by 50–80%, making it difficult for some vernal pool species to complete their life cycles.

She also found that continuously-grazed pools had the highest relative cover of native species across all three years of the experiment. Relative cover in the pool zone was not affected, but relative cover of native species in the edge zone was 80% higher than in ungrazed pools and 160% higher than in the ungrazed pools in the upland zone. Exotic grass cover increased dramatically in the pools where grazing was removed during



the experiment. A strong increase in cover of grasses relative to cover of forbs was measured in the ungrazed treatments.

Native plant species richness either increased or remained the same over the three years of the experiment in the continuously-grazed, wet-season-grazed, and dry-season-grazed treatments, but it declined in the ungrazed treatment. This represented a loss of 25% of the average native species richness in the edge and upland zones over the three years of the experiment.

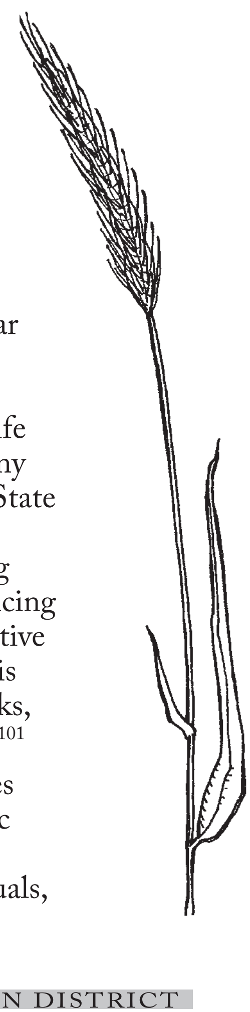
Marty's field experiments indicate that when cattle are removed from grazed vernal pool grasslands, diversity can decline and non-native species abundance can increase. Marty believes that "decline in native plant cover and diversity in the ungrazed treatments was most likely caused by the significant increase in grass cover" through competition for soil moisture and light resources. Increased evapotranspiration rates due to high annual grass cover may be the cause of dramatic decrease in pool inundation period, though Marty also theorized that decreased soil compaction in the absence of livestock could have negatively influenced pool hydroperiod. Invertebrate taxa richness also declined in pools that were ungrazed or had shorter grazing periods, most likely due to altered pool hydrology, especially an increase in the number of times that pools dried up.

Her results also show that prolonged inundation in the absence of grazing is not enough to keep exotic species out of the pools. Edge and upland zones (compared with pool bottoms) were the most negatively affected by grazing removal with marked declines in native species richness and relative cover of natives.

Coast Range Grasslands

Grasslands that occur near California's coast often include a higher proportion of perennial grasses than drier, inland sites and have thus been termed "Coastal Prairie." California's grasslands have been described as being composed of three major types:[99] the Valley Grassland; the California Annual Grassland; and the Coastal Prairie, which is dominated by native perennial grass species that vary from north to south and with distance from the coast. This division of grassland types into classifications that imply a sharp division between inland and coastal areas, as well as dominance by perennial versus annual species ignores the vast acreage of transitional grasslands within the SRCD and other areas of near-coastal California. They imply a distinct separation when, in fact, the gradient of maritime influence is often gradual.

Jackson and Bartolome[100] have recently proposed adding a third grassland subtype, the Coast Range Grassland, which is transitional between inland (Valley) and coastal (Prairie) grassland types. This term may be the best label for near-coastal grasslands within the SRCD, which typically include a varied mixture of native and non-native, perennial and annual species.



Management for Native Perennial Grasses

Goal-driven grazing management relinquishes the need to describe grassland vegetation according to particular terms or classifications. Instead, it can address certain species or guilds of plants, particular wildlife species, landscape function, or any number of other elements. The State Coastal Conservancy and many resource managers share a strong interest in preserving and enhancing native grasses. Restoration of native species in California grasslands is a conservation goal in many parks, reserves, and other public lands.[101]

Generally, perennial grasses benefit from seasonal or periodic grazing rather than continuous year-round grazing. Unlike annuals, which rely on copious seed production and germination of many new plants each season, perennials can live for many years. They normally produce less seed that annuals and are slower to germinate and grow as young plants, so the health and longevity of individual plants is much more important. When their leaf area is temporarily decreased through grazing, the plant's ability to photosynthesize and make carbohydrates is reduced, which results in root dieback. Severe, repeated grazing can weaken or kill some perennial grasses but complete absence of grazing can diminish their overall health because grazing stimulates vigorous new growth that actively photosynthesizes.

Perennial grass species vary in their responses to grazing. Low-growing species and those that spread by rhizomes or stolons, tend to be more resistant to heavy grazing than bunch grasses.

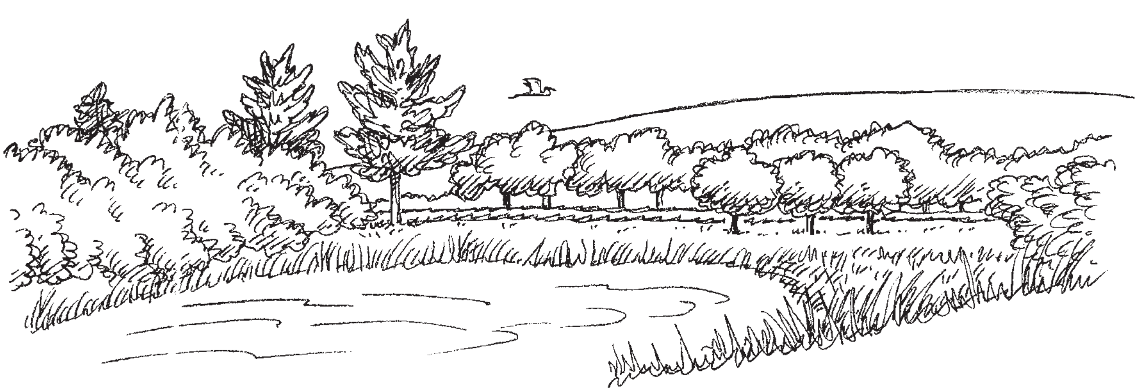
Unfortunately, limited research seriously restricts the ability to generalize about grazing practices for enhancing or restoring native grass species.[102] This makes it difficult to plan grazing programs to favor native grass species without site-specific experience and data. There are many reasons that reliable data on enhancement or restoration of native grasses is limited. These include:

- long-term studies required to detect changes in grassland species composition, especially with native species, requires long-term time and funding commitments
- observational studies have limited value because of the difficulty in separating grazing effects from other effects; a common pitfall is the practitioner's desire to see a positive outcome
- there are many variables that affect a grazing regime and a multitude of possible combinations, yet a limited number of variables can be compared in any one study
- different species may respond differently to a particular grazing regime – what's good for purple needlegrass may not be what's good for California oatgrass
- native and exotic species within a guild may respond similarly; for example, grazing responses of California oatgrass versus Australian oatgrass or purple needlegrass versus a non-native needlegrass (*Nassella formicarum*) may be analogous

Identification of the habitat needs and responses to grazing of individual native plant species must be carried out on site- and species-specific bases.

Riparian Systems

Riparian areas are made up of rivers, streams, and creeks, their floodplains, vegetation, and dependant wildlife species. They are highly resilient, dynamic systems with naturally high levels of disturbance.[103] Riparian areas concentrate nutrients, water, and energy, making them highly productive. They include waterways that flow all year as well as



Rules of Thumb for Riparian Grazing

- Off-stream water should be provided so animals don't have to enter the stream to drink. If this isn't possible, controlled stream access points should be provided to encourage animals to drink in specific, managed locations.
- Supplements should be strategically placed away from riparian areas to encourage grazing in upland areas.
- Riparian grazing should be avoided when streamside vegetation is the only green feed in the pasture.
- Areas near streams should never be used to concentrate livestock. Corrals, paddocks, and feed racks should never be located near or within stream channels.
- Livestock should be kept off saturated pastures near streams. Grazing on saturated streambanks can exacerbate erosion.
- Timing of grazing will vary depending on seasonal weather patterns and grazing objectives.
- Where human contact with pathogenic organisms are a concern, *Cryptosporidium* and other pathogen inputs into water should be minimized. Calves under six months of age should not be present when water is flowing.
- Where ground- and shrub-nesting bird protection is a riparian pasture management objective, grazing should be eliminated, reduced, or closely managed during nesting season (March to July) to prevent trampling of nests, maximize the understory habitat value, and minimize foraging habitat for cowbirds. Alternatively, if riparian grazing is necessary during this time of year to meet other management goals, grazing should begin before March to prevent birds from building nests that could be trampled later[104]. A thick riparian understory can also be crucial to successful rearing of young birds, so excluding part of the riparian area to allow understory development could also be a solution. The Riparian Habitat Joint Venture[105] suggests establishing wide riparian pastures and moving cattle often to avoid the impacts of year-round grazing on nesting birds.

seasonal or ephemeral drainages. Healthy riparian areas include structurally diverse plant communities composed of graminoids, forbs, shrubs, and trees. These varied types of plants provide a diversity of habitats for a variety of wildlife, including insects, amphibians, reptiles, fish, birds, and mammals. While many species depend entirely on riparian areas, many more use them during only a portion of their life cycle. Riparian areas are also essential to the proper functioning of watersheds. They act like the plumbing within a watershed, transporting concentrated water flows through large drainage networks and moving, filtering, and storing sediment and nutrients.

Serious damage has been caused to riparian areas by unmanaged or poorly managed grazing. Although new perspectives on riparian grazing have improved riparian management over the past 20 years, plenty of examples of grazing-induced riparian damage can still be found locally and throughout the West.

Given this, it's natural to wonder why riparian grazing is even considered here.

Although poorly managed livestock grazing within riparian areas can cause serious resource damage, at the other extreme, complete exclusion of grazing can also be ecologically damaging by allowing exotic plant species to flourish unchecked. From the perspective of livestock production, riparian areas are especially valuable as they are often highly productive due to deep, rich soils and abundant moisture. Riparian pastures can stay green, providing nutritious forage for weeks after upland pastures have dried up.

Riparian Grazing Management

By preventing or carefully controlling access to streams during critical periods, riparian areas can provide desired habitat and other environmental values as well as providing forage at appropriate times of year. After an extensive survey of riparian grazing literature, Creque[106] concluded that the common threads in successful riparian grazing strategies throughout the West are minimizing grazing time in riparian areas and maximizing flexibility and control by managers.

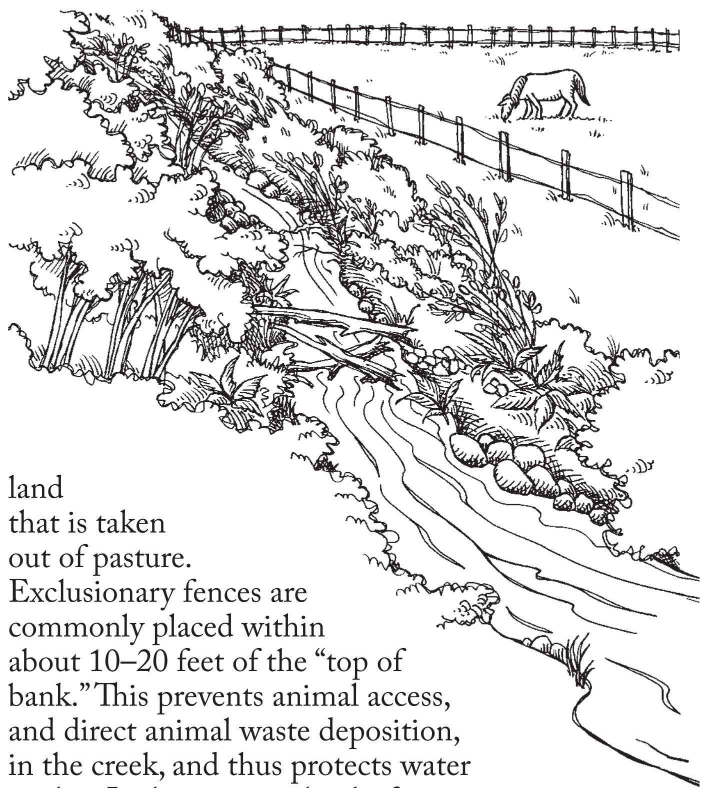
Fencing, which provides control over livestock, is an essential component of successful riparian grazing management. Several different approaches can be taken. Complete livestock exclusion with fencing has been the protection method of choice for many public agency landowners and resource agencies in recent years. The other option is development of riparian pastures where cross fencing is used to create grazed pastures that include riparian areas. A slight variation on these two approaches is the occasional grazing of excluded riparian corridors, which can be done to manage biomass within narrow boundaries.

Management strategies that do not involve fencing can also be used, but are much less likely to provide adequate control over livestock. Techniques such as placing mineral licks and other attractants well away from riparian areas and developing upland water sources may reduce the time that animals spend in riparian areas,[107] but do not provide enough control over animals for effective riparian protection in many cases.

The exclusion and riparian pasture approaches to grazing management each have advantages and disadvantages, which should be carefully considered before choosing one over the other. In fact, alternating periods of limited use with periods of complete exclusion may be the best management approach in some cases. Site characteristics, management goals, and human resources available for on-site management should be weighed before deciding on a strategy.

Exclusionary Fencing

Exclusionary fencing is used to protect narrow corridors adjacent to riparian areas. On private lands where maximizing forage availability is a priority, excluded areas are usually narrow to minimize the amount of



land that is taken out of pasture. Exclusionary fences are commonly placed within about 10–20 feet of the "top of bank." This prevents animal access, and direct animal waste deposition, in the creek, and thus protects water quality. It also protects banks from erosion by trampling and safeguards woody vegetation from animal damage. Disadvantages to this type of fencing include :

- constriction of channel geomorphology
- establishment of exotic weeds that thrive in the absence of grazing such as

Himalayan blackberry (*Rubus discolor*) and poison hemlock; western riparian areas are subject to invasion by a growing number of non-native plant species, and weed growth will often surge after livestock exclusion;[108] brush and weed management are among the greatest potential environmental benefits that managed grazing offers to riparian areas[109]

- accumulation of thatch can decrease grassland species diversity, favoring species that are adapted to high thatch conditions
- potentially high fence maintenance demands from damage due to flooding
- can restrict access to riparian areas for some wildlife species
- loss of forage resources

Despite these disadvantages, exclusionary fencing may be preferred in some situations, primarily because it requires less management oversight than do riparian pastures.

Riparian Pastures

Riparian pastures contain riparian areas that are integrated with the grazing unit. Rather than completely excluding livestock, the riparian area is carefully managed in conjunction with adjacent uplands. Although more management oversight is needed, riparian pastures can have several advantages over complete exclusion. Advantages include:
- less likelihood of establishment of certain exotic plant species
- better biomass management and less thatch buildup
- dynamic channel morphology permitted without flood damage to fencing
- less impact on wildlife movement

Disadvantages, which are most likely to become problems with inadequate management oversight, include:
- damage to young, woody riparian plants (depending on season)
- erosion/water quality impacts (depending on time of year)

In hot weather, livestock are especially attracted to the shade and water offered by riparian areas which usually have green forage later in the year than uplands; this serves as an additional attractant. If riparian grazing occurs during summer weather, special attention should be taken to prevent animal congregation in riparian areas.

Actual grazing prescriptions for a given riparian area should be site-specific based on biological, ecological, hydrological, and geomorphological characteristics, and management goals. Variables such as timing, duration, and frequency of grazing, stocking rate, kind and class of animal, utilization level, and animal distribution are all subject to management control. They can be adjusted to meet management goals and riparian condition objectives. Determining appropriate timing of grazing is perhaps the most difficult aspect of riparian grazing. Restricting livestock use of riparian areas to infrequent, short periods minimizes the potential for negative impacts. Ideally, riparian pastures should be of a size that will allow the herd to make use of available forage over a few days, allowing ample regrowth of vegetation between grazing periods.[110]

Grazing should be restricted to times when streambank soil moisture is low to minimize streambank erosion and prevent bank shearing.[111] In the SRCD, riparian area soils may not be firm and dry enough to prevent streambank damage by livestock until fairly late in the spring. However, short, dry periods during the rainy season may create appropriate conditions for short periods of grazing. During the green forage season, animals are not likely to be attracted to streambanks, especially if off-stream water sources are provided.

If woody vegetation is young or newly established, livestock may need to be completely excluded from the riparian area for several years, depending on plant species of concern and their growth rates. For best protection, grazing should be avoided or minimized during the summer when herbaceous species are dry and woody species are green and most attractive. Herbaceous riparian vegetation is important for filtering and trapping sediments and nutrients, providing soil cover, and for providing habitat for grassland plant and animal species. Stubble height guidelines are used by some public agencies for managing riparian grazing use. Common stubble height guidelines allow for grazing down to three inches in height and allowing regrowth to six–eight inches before animals can be returned to riparian pastures. However, Lile et al.[112] point out that direct links between herbaceous stubble height and specific riparian resource goals are not clearly illustrated in the published scientific literature. These somewhat arbitrary numbers may have little real meaning in terms of riparian condition.

Selection of season of use should also involve consideration of soil conditions to limit compaction and damage of streambanks, and the vulnerability of key plant species to defoliation at particular periods of the year. The protective role of vegetation during periods of high flow, as well as forage availability, palatability, and nutritional value throughout the year must also be considered in the design of a riparian pasture management strategy.[113]

Conclusion

This handbook addresses many issues related to the complex and fascinating topic of grazing. Hopefully, it will help interested resource managers start grazing programs on appropriate lands. It should also be useful for informing and adapting existing grazing use to meet natural resource goals and objectives.

There are *many* other sources of information on grazing and related issues, from range management text books, to research papers, to scientific journals. Many of these resources are available on the internet. One of the best and easiest ways to learn more about grazing is to talk to experienced people. The UCCE, NRCS, and RCDs all have personnel who can help. These agencies have offices throughout California and are only a phone call away. The Appendix includes a list of information sources related to many of the topics covered in this handbook.

Last but not least, local livestock producers are also a valuable resource. They understand the economic and practical limitations of applying scientific information to the land. Without them, this valuable management tool could not be implemented.

Appendix

Related Organizations and Sources of Information

California Grasslands

California Native Grasslands Association. Various information including bibliography. Visit www.cnga.org

Coastal Training Program. Coastal prairie, grasslands monitoring and management and other related topics. Visit www.elkhornsloughctp.org/reference

Grazing and Range Management

Natural Resources Conservation Service. The NRCS provides information on many topics including soils, grazing, grasslands, and related.

For information specific to California, visit www.canrcs.usda.gov and search by topic.

The NRCS National Range Handbook is accessible on line at http://www.glti.nrcs.usda.gov/technical/publications/nrph.html

Society for Range Management. Publications and other information about range management in the U. S. and other countries. Visit www.rangelands.org.

Society for Range Management, California/Pacific Section. Information about Certified Rangeland Managers and section meetings. Visit www.casrm.org

Certified Rangeland Managers. For more information about regulations pertaining to, visit: www.fire.ca.gov/CDFBOFDB/pdfs/1600Regulations.pdf
www.fire.ca.gov/CDFBOFDB/pdfs/PRC750.pdf

University of California Cooperative Extension. Provides research-based information on range livestock production and management, rangeland water quality, Integrated Hardwood Range Management Program, wildlife management, and livestock health. Visit http://danr.ucop.edu/uccelr/uccelr.htm

Understanding Livestock Grazing Impacts. Visit www.grazingimpacts.info

Livestock

California Cattlemen's Association. Visit www.calcattlemen.org

California Wool Growers Association. Visit www.woolgrowers.org

California Dairy Herd Improvement Association. Visit www.cdhia.org

American Boer Goat Association. Visit www.abga.org

American Dairy Goat Association. Visit www.adga.org

Vernal Pools

California Vernal Pools. Information and resources about vernal pools. Visit www.vernalpools.org.

RDM Monitoring

Rangeland Monitoring Series Publication 8092: California Guidelines for Residual Dry Matter (RDM) Management on Coastal and Foothill Annual Rangelands.

http://californiarangeland.ucdavis.edu/monitoring_series(PDF).htm

Residual Dry Matter (RDM) Monitoring Photo-Guide Wildland Solutions Field Guide series. Available from Keith Gunther of Wildland Solutions. Visit www.wildlandsolutions.com

Photographic Monitoring

Ground-based Photographic Monitoring. www.fs.fed.us/pnw/pubs/gtr503/

Plant and Animal Population Monitoring

Monitoring Plant and Animal Populations: A Handbook for Field Biologists. 2001. Caryl Elzinga and Dan Salzar. Available at www.blackwellpublishing.com

Special-status Species

Recovery Plans for Special-status Species are available from the U. S. Fish and Wildlife Service. Visit www.fws.gov/sacramento/es/recovery_plans.htm

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Note: Plant names conform to nomenclature in:
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Glossary

Animal Unit (AU). A1,000-pound cow or its equivalent in potential forage intake.

Animal Unit Equivalent (AUE). A number that relates the amount of forage (dry matter intake) of a specific kind or class of animal compared to one AU. For example, one mature sheep consumes about 1/5th of the forage intake of a 1,000-pound cow, so the AUE for one sheep is .2.

Animal Unit Day/Month (AUD, AUM). The potential forage intake of one animal unit for a period of one day (animal unit day or AUD) or 30 days (animal unit month or AUM). Based on 750 pounds of dry matter. One animal unit day (AUD) equals the amount of forage required to sustain an animal unit for one day (about 30 lbs. of forage or about 3% of the body weight of a 1,000-pound cow. Actual consumption is about 26 pounds per day plus waste). Forage weights used for this definition are variable. Some range managers use 1,000 pounds of forage for one AUM, which accounts for wasted forage. Others use a lower rate based on actual consumption (26 pounds per day per AU) and apply a "grazing efficiency rate" to account for wasted forage.

Available Forage. Forage that is available for consumption by livestock. Total forage crop – forage consumed by wildlife – amount to be retained after grazing (RDM etc.) = available forage.

Browse/Browsing/Browser. Browse is leaves and twigs from shrubs and trees consumed by herbivores. Browsing is the consumption of browse (as compared to grazing where herbaceous vegetation is consumed). A browser is an herbivore whose primary foraging method is browsing.

Class of Animal. Age, sex, or "stage-of-production" group within a kind (species) of animal. Examples include heifer, ewe, or ram.

Cover. Vegetation cover means the amount of ground surface covered by a plant, as observed from above the plant. This is usually expressed in percentages.

Deferment. A period of nongrazing, usually from the beginning of forage growth within a year (fall in California) until after seed set (late spring). A practice sometimes used to enhance seed production of perennial grasses. "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, or the accumulation of forage for future use."

Disturbance (ecological). Any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, availability of substratum, or the physical environment.

Evapotranspiration. The combination of evaporation and plant transpiration, which is the loss of water vapor through leaves and other plant parts.

Forage. Vegetation that is available and appropriate for consumption by grazing or browsing animals.

Forb. A broad-leaved herbaceous plant (not a graminoid).

Forested Landscapes. Forested landscapes are legally defined as "tree dominated landscapes and their associated vegetation types on which are growing a significant stand of tree species or which are naturally capable of growing a significant stand of native trees in perpetuity." This has been legally defined as canopy cover of 10 percent or more of the total rangeland.

Geomorphological. Pertaining to geomorphology, which is the science that treats the general configuration of the earth's surface.

Graminoid. A grass or grass-like plant such as a sedge or rush.

Grass. Plants in the family *Poacea*.

Grazers. Animals that consume standing (versus harvested) herbaceous vegetation.

Grazing Period. The length of time that grazing animals occupy a specific land area.

Grazier. A person who 'grazes' livestock, typically a livestock producer.

Grazing Season. The time period during a year when grazing is feasible or practical. In low-elevation California the grazing season can be year-around.

Grazing Systems. The manner in which grazing and nongrazing periods are arranged within the maximum feasible grazing season (in coastal central California, the grazing season is year around), either within or between years. Grazing systems often have descriptive names such as: Continuous or Yearlong Grazing, Short-duration Grazing, and Rotational Rest Grazing. Continuous Grazing is the simplest grazing system and is very common in low-elevation California. Short-duration Grazing involves short periods (days) of grazing alternated with non-grazing periods that are based upon plant growth characteristics. Rotational Rest Grazing is a multi-pasture system in which a full year's rest is scheduled among the pastures on a rotating basis.

Grazing Capacity. The amount of forage (in AUMs) available for grazing from a unit of land without causing resource damage. Carrying capacity can be used synonymously or it can refer to the capacity of land to support wildlife and other resources in addition to livestock.

Grazing Intensity. A relative and general term generally expressed as light, moderate, or heavy etc. These levels of grazing intensity have been described and illustrated by academic institutions and public agencies.

Herbaceous. Non-woody plant material.

Herbivore/Herbivory. An animal that subsists principally or entirely on plants or plant materials.

Humus. The more or less stable part of the organic matter of the soil, so well decomposed that the original sources cannot be identified

Intermediate Feeders. An animal species that consumes herbaceous and woody plants and can adjust their feeding habits to the type of forage available.

Kind of Animal. An animal species (i.e. *Bos* sp.) or species group (i.e. cattle) of livestock or game.

Meristematic. Pertaining to the meristem, which is the embryonic tissue of a plant from which definitive tissues arise by cell multiplication and differentiation. More simply, plant growing points.

Overgrazing. Traditional definition: continued, heavy grazing which exceeds the recovery capacity of the forage plants and causes deterioration of grazing lands. Alternative definition: Grazing during active growth that is both severe and frequent, generally resulting in the eventual death of the plant.

Paddock. A relatively small, fenced enclosure used to separate livestock. Can also be used to mean a small pasture that is part of a rotational grazing scheme, program or system.

Pasture. A grazing area separated from other areas, usually by fencing; the management unit for grazing land.

Peak Standing Crop. The stage at which the year's forage crop (grassland vegetation) is at peak maturity and before seeds drop. Forage production is generally described in units of weight per unit area (pounds per acre or kilograms per hectare). The unit of weight would be measured at peak standing crop, then dried to determine its dry weight.

Phenology/Phenological. Phenology is the study of the periodic biological phenomena, such as flowering, breeding, and migration, in relation to climatic conditions.

Preference. The selection of certain plants or plant parts over others by grazing animals.

Range. Rangeland that is grazed by livestock.

Range Condition. Traditional definition: The present state of vegetation of a range site in relation to the potential natural (or climax) plant community for the site based on kinds, proportion, and amounts of plants present; suggests current productivity relative to natural productivity potential. This term is being phased out. Preferred terms are successional status and range similarity index. Author's note: The concept of "range condition" should be related to specific management goals for a given property.

Rangeland. A type of land that includes grasslands, savannas, and shrublands, exclusive of cropland, forestland, and urban land.

Residual dry matter (RDM). The old plant material left standing or on the ground at the end of the grazing season or beginning of the new growig season (the fall). Plant material included in RDM measurements is typically limited to forage species.

Rest. Leaving an area of grazing land ungrazed for a specific period of time, such as a season or a year.

Reticulo-rumen. The anterior compartment of the ruminant stomach including the large rumen and the smaller reticulum.

Rhizobia. The plural of *Rhizobium*, a genus of bacteria that lives symbiotically with the roots of certain plants (mostly legumes, in the family *Fabaceae*) that fix nitrogen from the atmosphere.

Rotational Grazing. A general term used for grazing systems that include two or more pastures (or paddocks) between which grazing animals are moved in sequence, thereby resulting in grazing periods being followed by nongrazing periods. Rotational Rest grazing incorporates rotations with planned rest periods. This is slightly different than simple rotational grazing as the term rest implies longer nongrazing periods between the grazing periods.

Ruminant. Even-toed, hoofed mammals that chew the cud and have a 4-chambered stomach, the first one of which is the rumen. Includes cattle, sheep, goats, bison, buffalo etc. Compare with cecal-digesting ungulates such as the horse.

Sensitive Plant Species. Sensitive plant species are those included on the California Native Plant Society (CNPS) lists 1 through 3. List 1A includes plant species presumed extinct in California; List 1B includes rare or endangered plant species in California and elsewhere; List 2 includes rare or endangered plant species in California, more common elsewhere; and List 3 includes plant species that CNPS needs more information on in order to evaluate their status.

Stocking Density. Number of animals per unit area of land at any one point in time. Can be expressed as AUs/acres.

Stocking Rate. Number of animals per unit area of land over a specified period of time. Can be expressed as AUMs/acre. Differs from Stocking density by incorporation of time.

Supplemental Feed (also called maintenance feeding). Harvested forages and concentrates provided to livestock to meet minimum daily animal maintenance requirements, thereby partially or completely replacing grazing of the standing forage crop.

Thatch. Dead plant biomass accumulated on the ground surface.

Trampling. The impact to soil and vegetation caused by animals, especially when congested.

Undergrazing. Continued underuse, thus often resulting in waste of forage. Can also be used to indicate an undesirable state for individual plants or grasslands that accumulate senescent plant residue or thatch.

Ungulate. A hoofed animal, including ruminants but also horses, tapirs, elephants, rhinoceroses, and swine.

Unpalatable. Not palatable. Palatability, or the relish with which animals will consume certain plant species or plant parts, is determined by numerous plant characteristics.

Utilization. The proportion of the current year's forage production that is consumed or destroyed by grazing animals. Can refer to a single species or to the vegetation as a whole. Expressed as percent utilization. A grazing plan might call for removing animals after 50% utilization of purple needlegrass.