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Animal and plant response to stocking intensity

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Quick Facts

Proper stocking rates vary within and among years due to fluctuating forage supply.

Animals stocked at heavier rates gain less and the differences among stocking rates increases as the season progresses.

Maximum dollar return per area falls between maximum gain per animal and maximum gain per area.

The most important impact of overgrazing on vegetation is reduction in productivity, especially when it occurs in conjunction with drought.

Livestock production is an important agricultural enterprise in Colorado. Managers would like to be able to determine proper stocking rates. It is difficult, if not impossible, to determine the "correct" rate to stock rangeland prior to the grazing season. Proper stocking rates vary within and among years due to fluctuating forage supply.

Numerous terms have been used to describe stocking intensity. Stocking rate is the most commonly used term and refers to the number of animal units per unit area for some specified time.

The goals of managers include: resource stability (minimum variation among seasons or years), resource sustainability (no change in long-term productivity) and enterprise profitability. Some tradeoff among these resource properties is inevitable.

The "optimal" stocking rate is an economic question. How many animals should be on an area to maximize profit and maintain a risk position?

Ecological impact is measured by unacceptable loss of plant cover and productivity, loss of biological diversity or changes in the composition and structure of the plant community.

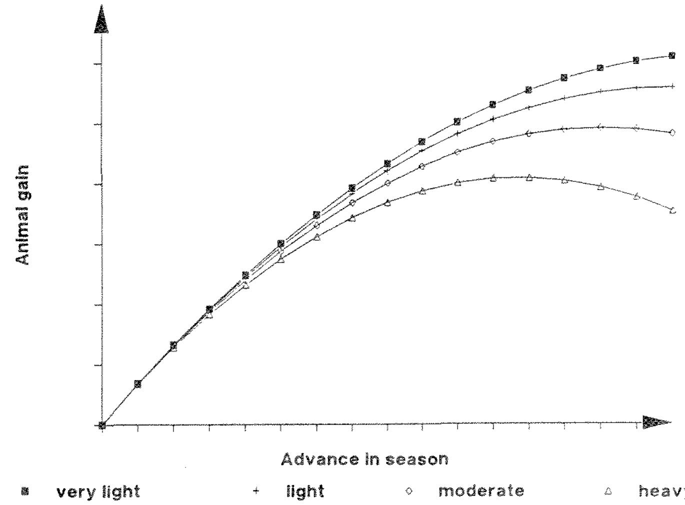

Figure 1: Change in animal weight with advance in season under different rates of stocking.

Animal Response

Animal performance is related to stocking rate. The relationship integrates a large number of plant and animal factors that are expressed as animal response over some period of time.

Usually, average daily gain (ADG) of growing animals declines throughout the grazing season. Progressively heavier stocking rates result in progressively poorer ADG. Animals stocked at heavier rates gain less and the differences among stocking rates increase as the season progresses (Figure 1).

Low stocking rates probably have little impact on ADG, especially early in the growing season. However, there is a stocking rate when adding one more animal reduces the gain of all animals (Figure 2).

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Total gain per area (G) can be calculated from ADG and SR. At first, adding more animals results in a proportional increase in red meat because all animals gain at the same rate. When SR reduces ADG, G increases at a decreasing rate until a maximum is reached (Figure 2).

Maximum production (maximum G) per area (gain, wool production, calving percentage, etc.) does not represent maximum net return. Maximum dollar return per area, or maximum R, falls somewhere between maximum gain per animal and maximum gain per acre (Figure 2).

Even if you assume that costs remained constant over time, the best strategy to maximize net revenue is illusive; the SR of maximum ADG and maximum G change continuously. Whether you increase stocking rate and profits depends on where you are on the response curve. Some general rules, however, can be applied.

1. In all instances (except when all costs are zero) the stocking rate to maximize net dollar return is lower than the rate that maximizes G.
2. Fixed costs influence only the level of return and not the optimal stocking rate.
3. As variable costs increase, the stocking rate at which net return is maximized (the optimum) declines; as selling price increases, the stocking rate at which net return is maximized increases.
4. Heavy stocking generally maximizes gross returns, but more moderate rates of stocking maximize net return.
5. There is an optimal SR for each grazing system, for example, time-controlled vs. season-long. Differences in livestock response to the grazing system result in differences in the impact of variable costs and selling price on the economic optimal stocking rate.

Aside from the problem of dealing with a variable biological system and variable costs and selling prices, choosing a stocking rate is not straight-forward. Operators that primarily have cow-calf units have fewer decision alternatives and are concerned about season-long optima. The main concern is dealing with variability among years. Optimal stocking is primarily a function of variable costs while generating enough total revenue to cover fixed costs. Operators who primarily grow yearling animals may be more concerned with intra-seasonal variability. Many more ownership options are available. Because net return is a result of costs, selling price and stocking rate, all must be considered simultaneously.

Because the return from adding one more animal increases at an ever decreasing rate near the stocking rate that produces maximum biological production, large changes in stocking rate result in small changes in animal production. For example, in most cases, a 20 percent reduction in stocking below the rate to maximize G only reduces production about 3 percent to 5 percent. The closer you stock to the biological maximum, the greater the risk on the average of exceeding the optimal stocking rate just because of the uncertainty in predicting response to variable environmental conditions. On those years when you might have too many animals, the loss in production might be small but the ecological risk is greatly increased.

Plant response

The most important impact of overgrazing on vegetation is a reduction in productivity. Loss in production comes first as a reduction in plant vigor and then through changes in vegetative composition. Continued overgrazing results in gradual degradation of soil and vegetative resources that often go unnoticed.

Plants have many adaptive mechanisms to overcome the effect of grazing, for example, genetic variation, protected growing points, mobile nutrient reserves, ability to compete for resources, etc. The most important factors to consider when developing grazing management plans are: 1) frequency of defoliation, 2) intensity of defoliation and 3) opportunity for regrowth. Plants on ranges stocked at heavy compared to light rates are more subject to multiple defoliations that result in greater intensity of defoliation. Continuous grazing may not allow opportunity for regrowth.

An important question is how long does the effect of grazing last? In many cases the impact is of little consequence beyond the current grazing season. Severe defoliation with little opportunity for regrowth, especially during drought, may reduce productivity for several years. Desert browse plants are especially susceptible to defoliation during the growing season and drought.

Over longer periods of time, managers try to maintain stable range condition or provide opportunity for an upward trend. Moderately overgrazed rangelands with more than 15 inches precipitation (much of the Great Plains or many mountainous areas) generally respond favorably to reduced grazing pressure or change in season of use. Significant changes in productivity can be measured in five to 10 years. Removal of grazing pressure in riparian areas often results in dramatic changes in vegetation production and plant-community structure within two or three years. However, brush infested rangelands under poor precipitation show little or no response to removal of grazing pressure or change in season of use even after decades of non-use.

Although some benefit can be gained from maintaining rangelands in good condition, the important fact is that managers are faced with weekly or seasonal operational decisions. The tactical decision may be to insure an upward trend in range condition, but other variables, such as weather, may have a greater impact on vegetation composition than grazing intensity. Drought and other environmental stressors will augment the impact of grazing.

Rangelands in eastern Colorado are resilient to changes in grazing pressure. High grazing pressure greatly reduces productivity, but only small changes in vegetation composition may occur. The potential for irreversible environmental damage (desertification) in drier areas on the western slope is high. Removal of vegetative cover may result in topsoil loss and irreversible production loss, especially in steep topography.

Death losses from poisonous plants are higher on heavily grazed than moderately-grazed ranges. That is because nonpoisonous, palatable plants are less available.

Experience has shown that rangeland can be managed for sustained yield of forage. Year-to-year productivity is variable. Risk-averse operators should maintain moderate levels of stocking. There is evidence that year-to-year risk of inadequate forage supplies can be reduced in some locations by different deferred grazing systems.

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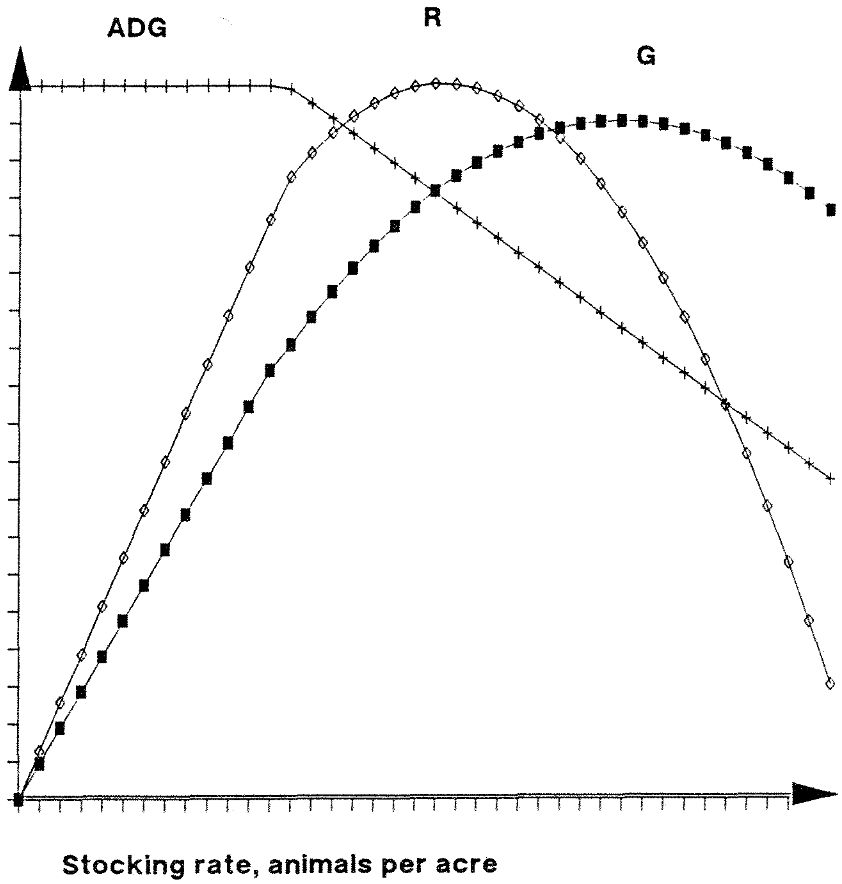

Figure 2: Average daily gain (ADG), economic return (R) and total gain per area (G) over the course of a grazing season change as more animals are added per area. Note that maximum R occurs someplace between maximum ADG and maximum G. The precise stocking rate to maximize depends on variable costs and selling prices.