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Objective Development of Grazing Strategies

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INTRODUCTION

A **grazing strategy** is a plan for accomplishing a set of objectives based on comprehensive knowledge of available resources, and the production and marketing environment. Management can be greatly simplified when grazing strategies are based on clearly stated and prioritized resource-management and livestock-production objectives (Fig. 1). Decisions on when and how to use plant resources have profound effects on the success of grazing strategies. Plant resources can be used for livestock production or wildlife cover and ecosystem functions such as hydrologic condition and site stability.

While many rangelands in the central and northern Great Plains are dominated by grasses and grass-like species, shrubs and forbs also are potentially valuable sources of nutrients and cover in these ecosystems. All of the above-ground, non-woody growth of plants is collectively called **herbage**, regardless of palatability. Livestock and wildlife also may consume **browse**, defined as the palatable portions of woody plant growth. **Forage** is composed of palatable herbage and woody plant growth that are accessible to the grazing animal.

Efficient use of herbage and woody plant growth can be evaluated only when all management objectives related to plant resources are clearly understood (Fig. 1). For example, if sustaining a prairie-grouse population is one of the resource-management objectives, uneven distribution of grazing may leave enough standing herbage in parts of pastures to provide adequate nesting cover. In contrast, if livestock production is the major objective, uniform grazing distribution becomes important. If adequate distribution cannot be accomplished with strategically-placed water or salting locations, cross fencing areas into smaller pastures and/or increasing livestock density with rotation-grazing systems may be effective methods of accomplishing livestock production objectives. **Grazing systems** define periods of grazing and non-grazing. They are important tools for executing grazing strategies. When different grazing systems have similar likelihood of accomplishing a prioritized set of objectives, the simplest system generally is the most economically and ecologically efficient.

BEST MANAGEMENT PRACTICES

Decisions on when and where to graze plant resources should be based on clearly defined animal-production and resource-management objectives (Fig. 1). Production objectives for growing livestock should be defined in terms of target weights at a future date that reflect future ownership and production plans. Target cow condition scores at selected points during the annual reproductive schedule should be based on knowledge of seasonal

patterns in nutritive value of available forage resources. Relatively low cow condition scores may be acceptable during the second trimester of pregnancy if highly nutritious forage will be available during much of the third trimester as with summer calving herds. If ownership of livestock will be retained, less than maximum potential gains by growing cattle on rangeland may be acceptable if natural-resource-management objectives are not compromised (Fig. 1). Cattle sold off grass generally are most profitable when average daily gains are near the maximum potential for the available forage resources.

Grazing management, the manipulation of grazing animals to accomplish desired results, should be based on probable plant and animal responses. Air temperature and soil moisture change as the growing season progresses in semi-arid environments. Consequently, the opportunity for relatively rapid plant growth and recovery from grazing is limited to only a portion of what we typically call the growing season. Plants may remain green throughout the growing season; however, 75 to 100% of herbage production of individual species occurs during 45 to 60 days when soil moisture and air temperatures are simultaneously favorable (Fig. 2). Sedges and cool-season grasses such as needlegrasses, prairie junegrass, and wheatgrasses produce most of their herbage in the spring and may produce additional herbage in the fall if soil moisture is available. In contrast, warm-season grasses such as prairie sandreed, bluestems, switchgrass, and grama grasses produce the bulk of their herbage during the summer. Removing more than 60% of the current-year herbage during a species' primary period of growth precludes its ability to capitalize on the limited number of days with favorable growing conditions in semi-arid regions.

The average amount of herbage from which each animal in a pasture selects a daily diet declines and the likelihood of overgrazing preferred plant species increases as grazing pressure increases. **Grazing pressure** is the demand/supply ratio between dry matter requirements of livestock and the quantity of forage available in a pasture at a specific time. **Stocking rate** is the dry matter requirement of livestock per acre regardless of the amount of forage. Consequently, measurable differences occur in grazing pressure when the same stocking rate is applied at different times of the year Reducing the length of the "summer" grazing season and increasing herd size to obtain the same end-of-season stocking rate increases grazing pressure regardless of grazing system.

CHARACTERISTICS OF GRAZING SYSTEMS

Because grazing systems simply define periods of grazing and non-grazing, there can be an overwhelming number of potential grazing systems. However, environmental, economic, and resource constraints limit the number of acceptable systems. Conceptually, most feasible grazing systems fit into the following 4 categories.

Season-long Continuous Grazing

Compared to multiple-pasture grazing systems, the risk of management mistakes are minimized with only 1 decision on when to begin and 1 decision on when to end grazing each year under season-long continuous grazing. Daily rates of herbage removal per acre are relatively small because cattle are dispersed over the entire acreage in contrast to 1/4 or less

of the total acreage in most rotation systems. Livestock have the greatest possible opportunity to select a high quality diet under continuous grazing. Light to moderate stocking rates can be used to optimize gains on replacement heifers or first-calf heifers. While costs for fence and water are lowest for continuous grazing, more labor may be required to check widely dispersed cattle. Uneven distribution of grazing at light to moderate stocking rates can provide adequate cover for wildlife in little used areas of the pasture. Blowouts or other disturbed areas likely will not heal regardless of lowered stocking rates or delayed entry dates. Consequently, risk of damage to vegetation under drought conditions can be very high in preferred areas. The potential for these problems to occur can be reduced by shifting a pasture from season-long continuous grazing to rotation grazing for several years. When it is not possible to shift from continuous to rotation grazing, periodically switching use of individual pastures from growing-season to dormant-season use (seasonal rotation) will enhance plant vigor.

Rest-Rotation Grazing

This grazing system was initially developed to improve range condition by resting 1 or more pastures for a minimum of 1 year. However, stocking rates in grazed pastures are traditionally increased to compensate for non-use in the rested pasture(s). Concentrating livestock into remaining pastures will facilitate livestock management and may improve distribution of grazing within pasture. However, because stocking rate is increased in grazed pastures to offset non-use in the rested pasture(s), higher cumulative grazing pressure is expected to reduce animal performance in the last 1 or 2 pastures grazed each year compared to other rotation systems. Each spring the rested pasture and the pasture grazed first during the preceding year will provide the greatest amount of nesting cover for upland game birds. Deferring grazing in these pastures until mid-June or early July will ensure optimal use of nesting or brood-rearing cover.

Traditional rest-rotation systems are more likely to be successful when used for relatively long "summer" grazing seasons. Spreading the same end-of-season stocking rate over 6 compared to 4 months would reduce stocking density and daily removal of forage by 33%. Fewer cattle would stay in pastures for more days removing less forage per day when key forage species are growing rapidly. The likelihood of sustaining increases in stocking rate also increases the more frequently pastures receive full growing-season deferment.

If nesting cover was a relatively high ranking objective, a 6-pasture, rest-rotation system might be used to provide good cover on 33% of the land area by resting 2 pastures and using 4 pastures for grazing each year (Fig. 3). A staggered schedule of resting pastures with a 6-pasture system would provide year-to-year continuity of high quality cover and a sequence of 4 years of grazing followed by 2 years of rest. Stocking rates would traditionally increase by 33% in grazed pastures in this 6-pasture rest-rotation system which may be excessive for a relatively short "summer" grazing season. Reducing the stocking rate and/or increasing the length of the grazing season would increase the likelihood of accomplishing natural-resource and livestock-production objectives. Rest-rotation grazing and moderate stocking rates in grazed pastures are primarily used to provide nesting cover for game birds.

Deferred-Rotation Grazing

The combination of using 4 or more pastures with 1 grazing period per pasture and moderate stocking rates is often a relatively efficient method of maintaining high levels of vigor in key plant species, improving range condition, and healing disturbed areas (Fig. 4, Tables 1 and 2). Dividing an area into 4 or more pastures can improve the distribution of grazing by reducing diversity of range sites within pastures. Distribution of grazing may also become more uniform because of reduced distance to water or increased stocking densities. However, improving distribution of grazing will limit the availability of cover for wildlife in most pastures. Generally each pasture in a deferred-rotation system is only grazed 1 time each year and the length of grazing periods is relatively long compared to intensively-managed systems (IMG). During 5- to 6-month "summer" grazing seasons, 50 to 70% of the pastures in deferred-rotation systems are not grazed when dominant forage species are growing rapidly compared to some use in most pastures during this time in IMG systems. Advanced plant maturity in the last pasture(s) under deferred-rotation may reduce animal performance late in summer grazing seasons compared to season-long continuous or intensively-managed grazing.

Pasture sizes and grazing-management practices used for deferred-rotation grazing systems are well suited for seasonal rotation. Dormant-season and growing-season use can be rotated among pastures where logistically feasible. Inadequate protection from storms, use of crop residue for winter grazing, or short-term livestock ownership plans may reduce the feasibility of dormant season grazing. If little opportunity exists for seasonal rotation, plant vigor can be maintained in most grasses by delaying the initial turnout date until key species have begun rapid growth and providing periodic deferment of each pasture until September or October.

Intensively Managed Grazing

Smaller pastures and shorter distances to water, commonly associated with intensively- managed grazing systems, improve distribution of grazing compared to the other systems. The highest possible fence and water costs are associated with IMG; however, the large number of pastures used for these systems provides maximum flexibility for accomplishing individual pasture-management objectives. Grazing plans can be designed to alter stocking rates, provide rest, or reduce the number of grazing periods in selected pastures. The potentially negative effects of high grazing pressure on animal performance (Fig. 5 and 6) can be partially offset by rapidly moving livestock among pastures to capitalize on forage resources before seasonal declines in nutritive value occur. However, high cumulative grazing pressure in all pastures during the first half of the growing season can cause measurable reductions in the vigor of key grasses (Fig. 7). Multiple grazing periods, more uniform distribution of grazing, and commonly high grazing pressure during the growing season preclude the provision of adequate nesting cover for upland game birds when IMG systems are restricted to the "summer" grazing season. Sustainable prairie-grouse populations have been observed when moderate stocking rates were applied over 8 to 12 months with a large number of pastures, often more than 20. Relatively high grazing pressure and numerous decisions of when to begin and end grazing in individual pastures,

inherent with IMG, require a relatively high level of commitment to monitoring and management.

SELECTING A GRAZING SYSTEM

The relative likelihood of accomplishing 11 different objectives with 4 hypothetical grazing systems in the Nebraska Sandhills is presented in Table 1. *The general seasonal distribution of grazing and non-grazing days for each grazing system selected and graphically summarized for this decision making process* (Fig. 4) *may be considerably different from one ranch to another as land, livestock, labor, and financial resources change.* Information in university publications can be used to determine the relative likelihood of accomplishing specific objectives for different sets of grazing systems.

Stocking rate is a critical variable in grazing management because it is directly related to cumulative grazing pressure which affects livestock- production and natural-resource-management objectives (Fig. 1, 5, 6, 7, and 8), regardless of grazing system. *Comparisons of grazing systems should be based on similar end-of-season stocking rates.*

KEY POINTS OF THE EXAMPLE

Stocking rates in the grazed pastures of the rest-rotation system are 20% higher compared to the other 3 grazing systems in Figure 4 to compensate for non-use in the rested pasture.

Total end-of-season stocking rates averaged over the entire land area are moderate for each of the 4 hypothetical systems compared in Table 1.

Differences in the length of grazing periods in the rotation and intensively-managed systems (Fig. 4) indicate progressively higher stocking rates for individual pastures that correspond to increasing amounts of available forage as the growing season progresses (Fig. 2).

Comparison Index (CI) Values in Table 1 indicate the likelihood of each grazing system to accomplish an objective compared to the other systems. Numerical values do not indicate that a grazing system is good or bad. Differences in herbage allocation, controlled by stocking rate and date of grazing (Fig. 1), may change the Comparison Index (CI) Values. For example, if the stocking rate in the rest-rotation system (Fig. 4) was reduced by 20%, CI values for plant and animal responses would be similar to deferred rotation (Table 1). Under intensively-managed grazing, skipping several pastures during the first cycle and delaying grazing until after mid-September (Fig. 4) would increase the CI values for plant responses.

Once resource-management and livestock-production objectives (Fig. 1) have been clearly defined (Table 1), they need to be ranked. The relative value (RV) of a given objective compared to each of the other objectives can be indicated with a simple weighting method. Divide 10 points among the objectives, giving the most important objective(s) the highest value(s) and the least important objective(s) the lowest value(s) (Table 2). Using whole numbers, move points among the objectives until the values correctly represent the relative importance in most 2- and 3-way comparisons of objectives. For example, in

Scenario 1 (Table 2) improving range condition is more important than any other objective. Ownership of growing cattle will be retained, good sources of water are readily available, and if needed, electric fence will be used to divide pastures. Consequently, maximizing average daily gains and minimizing fence and water costs are least important and similar in relative value. Labor is a limited resource and intermediate in value (RV=3) between the animal performance and infrastructure objectives (RV=1) and improving range condition (RV=5).

Relative values of objectives are multiplied by CI values (Table 1), yielding scores (Table 2) that indicate the relative likelihood of each grazing system (Fig. 4) to accomplish a specific objective. The sum of these scores [(RV) x (CI)] indicates which grazing system is most likely to accomplish a given set of ranked objectives. Total scores (Table 2) in this process do not indicate that a grazing system is good or bad. They simply help to identify the most effective grazing system for a given set of prioritized objectives.

Clearly one system is not best for all grazing strategies. Changing objectives and/or relative importance of objectives can change the most suitable grazing system as demonstrated by the 3 scenarios in Table 2. Total scores for Scenario 1 (Table 2) indicate that the deferred-rotation system described in Figure 4 is most likely to accomplish that set of ranked objectives. Continuous and rest-rotation grazing are much less likely to be effective. The IMG system has intermediate potential to accomplish the objectives.

When range condition has improved to target levels in all pastures, the relative value of this objective may be reduced or the objective may be deleted as long as condition does not decline. In Scenario 2, the relative values of improving range condition and maximizing average daily gains are reversed compared to Scenario 1, and 2 objectives are different (Table 2). Additionally, less distinction occurs among objectives in Scenario 2 compared to Scenario 1 with only a 1-point separation compared to a 2-point separation between each of the top 3 objectives. Consequently, intermediately ranked objectives may have a greater cumulative effect on the grazing system selection process than the highest ranked objective. Continuous and rest-rotation grazing are least likely to accomplish the objectives of Scenario 2, even though average daily gains are likely to be highest under continuous compared to the other systems. The intensively-managed (IMG) and deferred-rotation grazing systems have a relatively high likelihood of accomplishing ranked objectives in Scenario 2. If existing pastures and livestock water are adequate for IMG, the decision is relatively easy. If the cost for needed infrastructure is relatively high, the deferred-rotation grazing system may be the prudent choice.

It is often assumed that the best or only way to recover the cost of additional fence and water is to increase stocking rate. Increasing stocking rate at this point in the decision-making process has 2 potentially negative consequences. First, doing so invalidates the decision making process. A new set of Comparison Index Values (Table 1) should be estimated and used for comparing all systems at the proposed increased level of stocking. Secondly, the number 1 objective in Scenario 2 is to maximize average daily gains. The potential of exceeding critical cumulative grazing pressure and reducing average daily gains increases as stocking rate increases. Measurable increases in stocking rate will compromise the most important objective in Scenario 2, especially when drought occurs.

Placing a relatively high value on the highest ranked objective, as demonstrated by placing 7 of 10 possible points on nesting cover in Scenario 3, increases the likelihood of a single objective dominating the decision-making process (Table 2). When stocking rate, averaged over all pastures, is moderate for each system, the rest-rotation system is most likely to accomplish and the IMG system is least likely to accomplish the Scenario 3 objectives. Continuous and deferred-rotation grazing have intermediate potential to accomplish this set of prioritized objectives.

Over time, modifying or changing grazing systems to account for changes in objectives and resources may be beneficial. The preceding discussion of the decision-making process for selecting grazing systems was based on scenarios in which the selected rangeland area is grazed only during the "summer" grazing season. Many ranches in the semi-arid region of the Great Plains have cow-calf enterprises and often have a herd of livestock on the ranch throughout the year. Providing full growing-season deferment to every pasture every 2 to 4 years frequently increases sustainable stocking rates compared to pastures grazed only during the summer.

MONITORING

Initial records of range condition, livestock performance, and/or wildlife populations provide valuable baseline information for long-term assessments. Grazing, precipitation, and livestock-performance records are critical for understanding plant and animal responses, planning turn-out dates and pasture use sequences in the subsequent year, and annually evaluating the effectiveness of grazing systems. Guidelines for grazing records are available from land-grant Universities and the Natural Resources Conservation Service. Precipitation information can be collected from on-site rain gauges or purchased from the High Plains Regional Climate Center for about $40.00/year (online @ hpccsun.unl.edu), (phone 402-472-6709), or (fax 402-472-8763).

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Hart, R.H. 1978. Stocking rate theory and its application to grazing on rangelands, p. 547-550. In: D.N. Hyder (ed.) Proc. First Int. Rangeland Congr. Soc. Range Manage. Denver, Colo.

Nosal, D.A. 1983. Seasonal changes in production and composition of native forage on a sands range site in Nebraska. M.S. Thesis. Univ. Nebraska. Lincoln, Nebr.

Reece, P.E., J.D. Volesky, and W.H. Schacht. 2001. Cover for wildlife after summer grazing on Sandhills rangeland. J. Range Manage. 54:126-131.

RECOMMENDED READING

P.E., J.D. Volesky, and W.H. Schacht. 2001. Integrating management objectives and grazing strategies on semi-arid rangeland. Univ. Nebraska-Lincoln Extension. EC01-158.

Table Relative likelihood of accomplishing management objectives on upland range sites during the growing season with different grazing systems (Fig. 4) **when stocking rate**, averaged over all pastures, **is moderate for each system**.

Controlling Variable(s) and Management Objectives	Grazing Systems: "Season-long Continuous"	"5-pasture, Rest-rotation" 1 pasture rested,	"5-pasture, Deferred-rotation" each pasture grazed	"10-pasture, Intensively Managed Grazing" most pastures grazed
	Comparison Index Values[1] (5 = most likely, 1 = least likely)			
Stocking Rate and Date of Grazing				
• Provide nesting cover for prairie grouse	3	5	3	1
• Maximize average daily gains	5	1	4	4
Number of Pastures				
• Minimize fence and water expenses	5	3	3	1
• Improve grazing distribution	1	3	3	5
• Minimize risk of mistakes on selecting a turn-out date and making pasture moves	5	3	3	1
• Facilitate livestock management	1	4	4	5
• Minimize time required to monitor herbage resources	5	3	3	1
• Flexibility in accomplishing individual pasture management objectives	1	2	4	5
Date of Grazing and Stocking Rate				
• Improve range condition	1	2	5	3
• Increase vigor of preferred plant species	1	3	5	4
• Heal disturbed sites	1	3	5	5

[1]Comparison Index Values in this example are based on observations and published studies in the Nebraska Sandhills.

able 2. Examples of ranked livestock-production and natural-resource-management objectives and use of indices for comparing the relative likelihood of accomplishing each objective to identify the most appropriate grazing system when grazing occurs only during the "summer" grazing season. Scores are derived by multiplying relative values of objectives for each scenario by the estimated comparison index values in Table 1.

Objectives	Relative Value of Objectives (1 to 10, Σ = 10)	Continuous		Rest Rotation		Deferred Rotation		Intensively Managed	
		Index	Score	Index	Score	Index	Score	Index	Score
Scenario 1									
Improve range condition	5	1	5	2	10	5	25	3	15
Reduce time checking livestock	3	1	3	4	12	4	12	5	15
Minimize fence and water costs	1	5	5	3	3	3	3	1	1
Maximize average daily gains	1	5	5	1	1	4	4	4	4
			18		26		44		35
Scenario 2									
Maximize average daily gains	4	5	20	1	4	4	16	4	16
Flexibility for pasture management objectives	3	1	3	2	6	4	12	5	15
Uniform use of forage	2	1	2	3	6	3	6	5	10
Improve range condition	1	1	1	2	2	5	5	3	3
			26		18		39		44
Scenario 3									
Provide nesting cover for grouse	7	3	21	5	35	3	21	1	7
Minimize risk of grazing management mistakes	2	5	10	3	6	3	6	1	2
Heal disturbed sites	1	1	1	3	3	5	5	5	5
			32		44		32		14

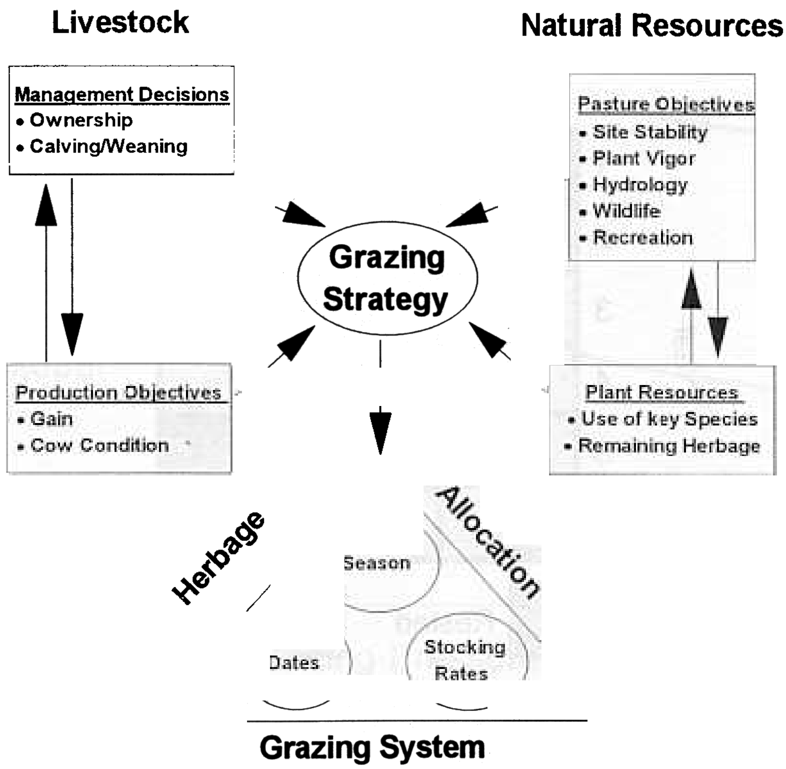

Figure 1. Grazing strategies should be based on prioritized livestock-production and natural-resource-management objectives. These overall plans provide clear guidelines for herbage allocation and selection of an efficient grazing system.

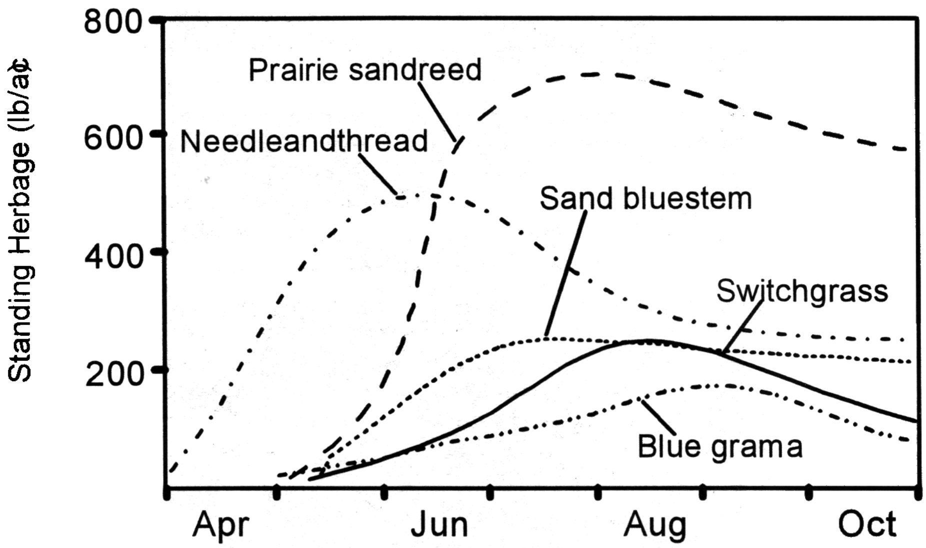

Figure 2. Seasonal distribution of current-year herbage by species in the Nebraska Sandhills on sands range sites in good to excellent range condition with average precipitation (Nosal 1983).

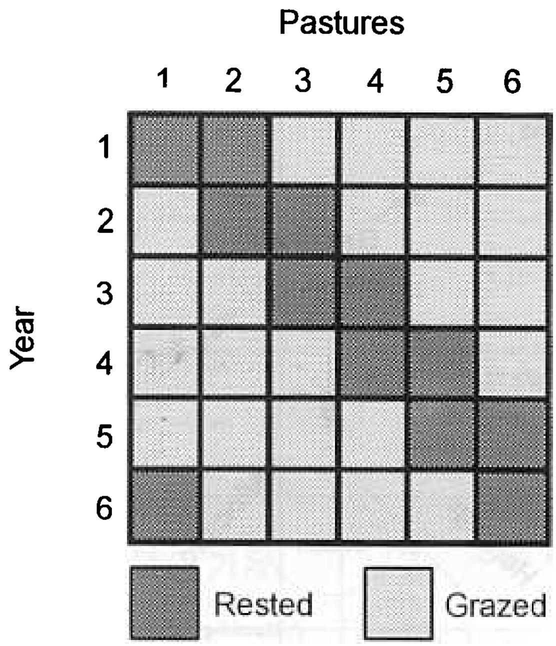

Figure 3. An example of a rest/graze schedule for a 6-pasture, rest-rotation grazing system with 2 consecutive years of rest applied to each pasture.

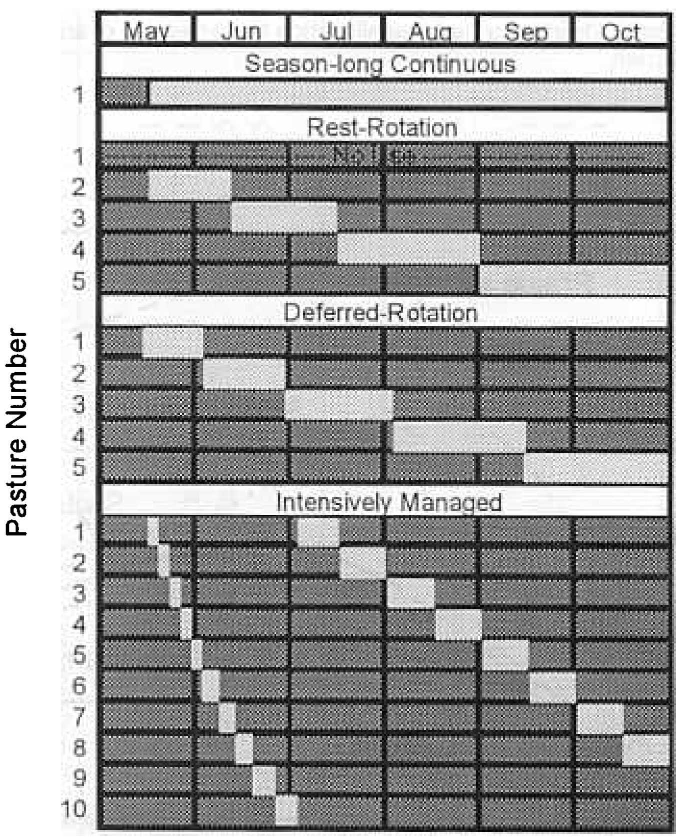

Figure 4. Seasonal distribution of grazing for systems that are compared in Tables 1 and 2.

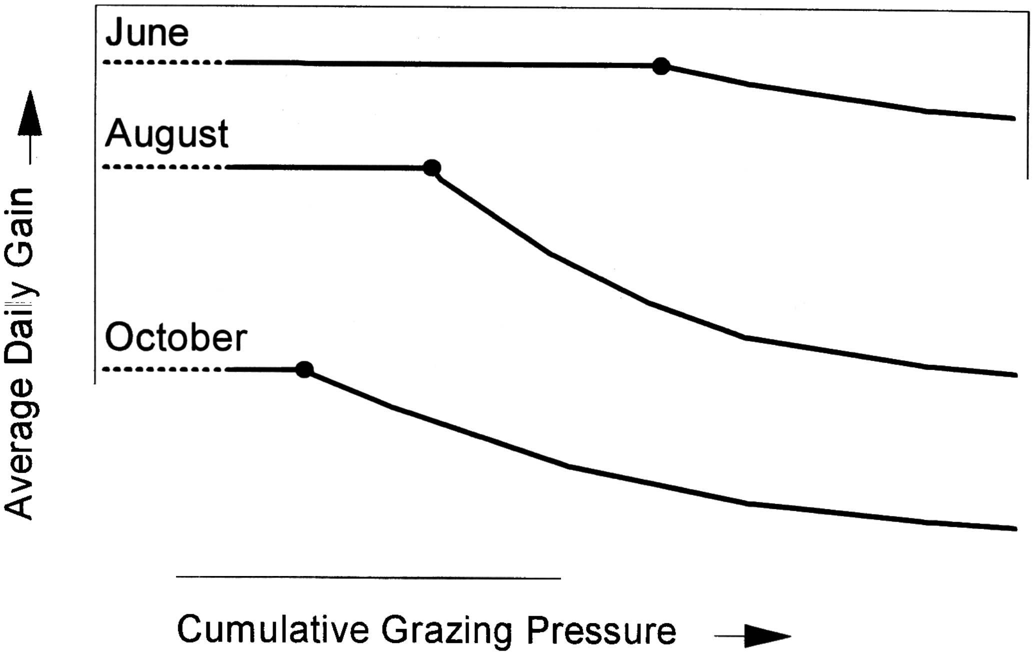

Figure 5. Seasonal declines in critical grazing pressure (●) for animal performance as vegetation matures and forage quality declines (modified from Hart 1978).

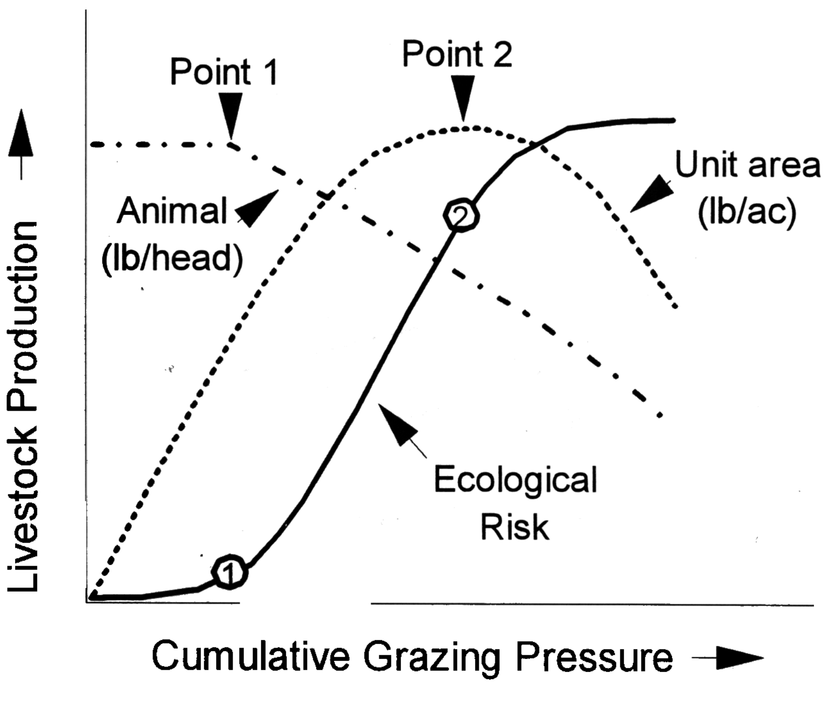

Figure 6. Effects of cumulative grazing pressure on average daily gain (- . -), total livestock production per acre (. . .), and ecological risk (—) at the end of the "summer" grazing season. Maximum production per unit land area (Point 2) is always associated with relatively low average animal performance which begins to decline at the critical cumulative grazing pressure (Point 1).

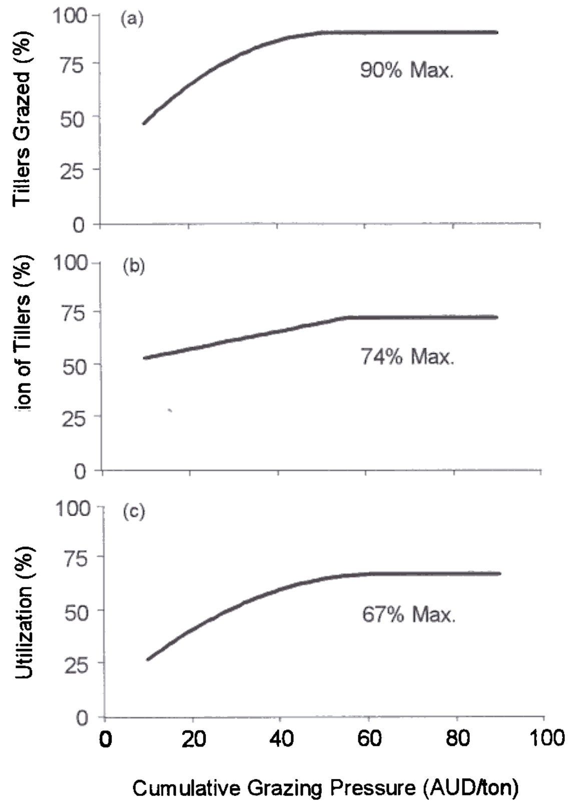

Figure 7. Effect of grazing pressure on (a) the percentage of tillers grazed, (b) degree of defoliation of grazed tillers, and (c) overall use of prairie sandreed herbage during June and July (Cullan et al. 1999).

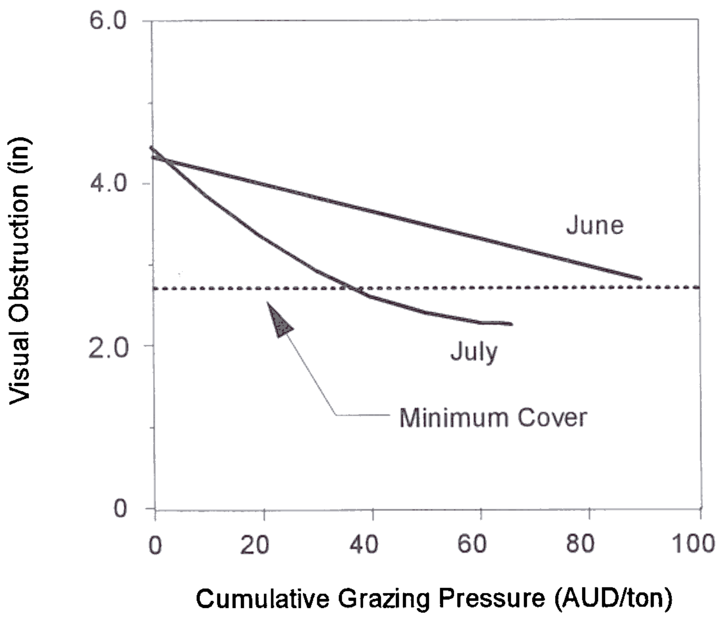

Figure 8. Average cover during September after pastures were grazed only in mid-June or mid-July. Minimum average visual obstruction needed to just sustain prairie grouse populations in the Sandhills is about 2.7 in. The number and quality of safe nesting sites increases as mean values of visual obstruction increase (Reece et al. 2001).