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MANIPULATIVE GRAZING OF PLANT COMMUNITIES

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INTRODUCTION

In northern climates livestock grazing is often restricted to 4 to 6 months of the year. This time is critical to livestock operations as it represents the period of time when weight gain potential is greatest and cost of gain is minimized. However, in many environments weight gain may only occur during a portion of the grazing season (Vavra and Raleigh, 1976) due to increasing plant maturity and decreasing soil moisture (Figure 1). It is not uncommon for cattle to even lose weight during a portion of the grazing period (Vavra and Phillips, 1979).

In many ecosystems enough diversity exists within the grazing environment that through managed pasture arrangements (fencing and season of use) extension of the period of livestock gain is possible. Differing phenological development, floristic composition of pastures, aspect, elevation and cultural practices contribute to the diversity of available forages. Conventional pasture construction and grazing systems are seldom planned to encompass a specific set of forage circumstances that may be available during a portion of the grazing season. Manipulation is defined as control of an action or course by management, or utilization of a resource by controlling or managing. Manipulative grazing refers to the incorporation of specific forage circumstances or characteristics into pasture design and season of use.

ELEVATION

The most common form of manipulative grazing and the one with the longest history of use in the western United States is movement of livestock along an elevational gradient. Movements encompassing an 1800 m change from winter to summer are not uncommon. Livestock graze desert range or are fed hay during November through March, foothill range April through June and mountain range July through October (Figure 2) (Cook

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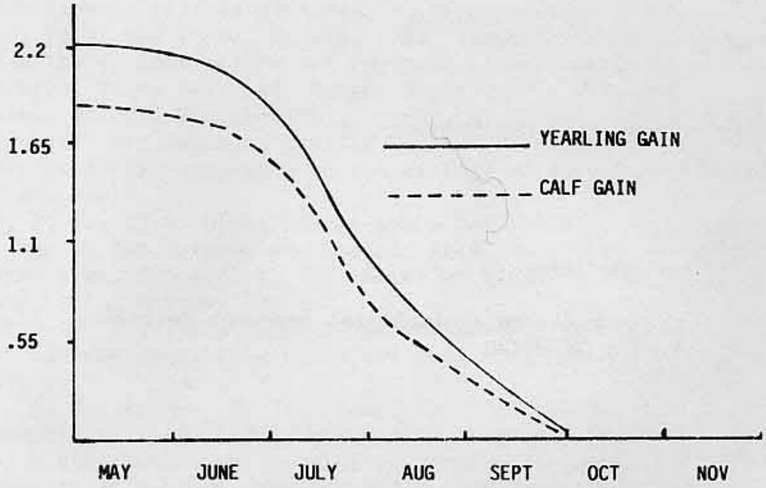

Figure 1. Average daily gain of yearling cattle and suckling calves on sagebrush-bunchgrass range in Oregon (Raleigh, 1970).

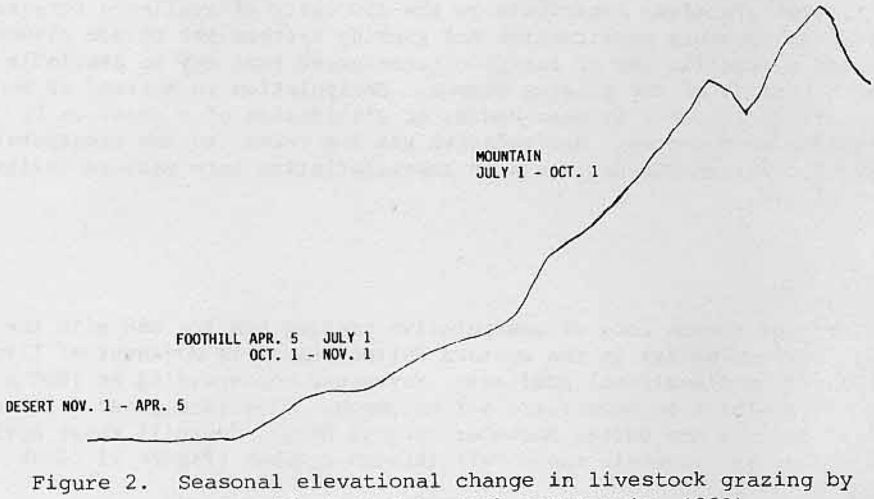

Figure 2. Seasonal elevational change in livestock grazing by season (derived from Cook and Harris, 1968).

and Harris, 1968). Foothill range may again be used during the fall transition to wintering grounds.

Movement of livestock to high elevations allows animals to consume forage that is less mature (Cook and Harris, 1968). Clary (1975) reported in Arizona ponderosa pine (Pinus ponderosa) forests, squirreltail (Sitanion hystrix) flowered in early June at the lowest elevations, but at the mid and high elevations flowering did not occur until mid-July to early August. Roberts (1926) and McCreary (1927) (both cited in Laycock and Price, 1970) explained that development of plants is ofted delayed as elevation increases, and precipitation increases with increasing elevation. Nutritional composition of forages on a given date is a function of stage of plant development and soil moisture. In their research, crude protein, phosphorus and nitrogen free extract content of forages increased with increasing altitude; while crude fiber content decreased. In a study of forage availability on rangeland in northeastern Oregon, Svejcar and Vavra (1985) reported crude protein content of dominant forages on various plant communities at different elevations. Higher elevation ranges retained greater protein content in the forage later in the grazing season than did lower elevation ranges (Table 1). Available soil moisture played a confounding role as meadows declined in forage quality more rapidly than did forest communities.

Cook and Harris (1968) also observed that mountain ranges had the highest diversity of plant communities available to grazing. Grasses, forbs and shrubs were readily available so animals were able to exert a high degree of preference in grazing. Diet optimization and hence weight gain optimization was theoretically possible. The diversity in plant communities on mountain ranges may modify the effects of elevation (Table 1) and create livestock distribution problems. In the mountains of eastern Oregon, Gillen et al. (1984a) observed that cattle showed a high preference for meadow communities.

Table 1. Percent crude protein of dominant forages on various plant communities at different elevations of rangeland in northeastern Oregon (Svejcar and Vavra, 1985).

Community	Elevation (m)	Forage type	Sampling Date					
			4/25	5/25	6/25	7/25	8/25	9/25
Native foothill grassland	1160	grass	19.0	11.5	9.5	6.0		
Mixed conifer forest	1430	grass shrub			12.5	10.4	10.2	7.4
Seeded Mountain Meadow	1670	grass				10.0	4.5	2.4
Lodgepole Pine (Pinus contorta)	1980	grass			16.7	12.7	10.8	7.2

PLANT COMMUNITY

As just mentioned, the diversity often found among plant communities on a given grazing area may create distribution problems under traditional management systems. Gillen et al. (1984) found 50 percent of the cattle in a given pasture located on 5 percent of the area. Gillen et al. (1985) also found unrestricted season long cattle use continually removed forage growth as it occurred, so no increase in standing crop on meadows was noted. Cattle remained on riparian meadows even after forage levels decreased below the physical limits of grazing.

Harris (1954) studied cattle utilization patterns on a mixture of forested and grassland communities and found cattle rarely used the forest even when forage quality on the grassland was less than on the forest. Forest use by cattle was restricted to periods of intense heat or drought; or as an escape from high populations of insects. Cattle also preferred forage in open meadows over that grown under ponderosa pine forest in the Black Hills of South Dakota (McEwen and Dietz 1965). They also reported development of plants on forested sites to be 1 to 2 weeks behind those in meadows. Poa pratensis and other grasses and sedges grown under the forest canopy contained more crude protein, calcium, phosphorus and crude fiber than meadow species; but less nitrogen free extract. The authors stated meadows were first choice to livestock based not only on higher palatability but also on certain unexplained behavioral traits.

Vallentine (1967) suggested a seasonal suitability grazing system for desert ranges in the southwestern United States. He defined the system as making use of the various vegetation types, subtypes, and/or condition class areas comprising a ranch when grazing is most advantageous to vegetation or livestock, or both. Such a system is applicable to northern climates where diversity exists. A ranch unit so fenced would optimize use on available forage and decrease problems involved with animal preference for specific plant communities, forage types, slope classes or other interacting factors in the grazing environment.

Holechek et al. (1981) proposed such a system based on research that restricted cattle to forest or grassland pastures. In a June through October grazing season, grasslands and forests were similar in cattle response during June, while the forest surpassed the grasslands from July through mid-September. Animal gains were dependent on fall rains during the final month of grazing. Grasslands responded to fall precipitation by producing high quality regrowth and subsequent cattle gains increased. Forest vegetation did not respond in like manner probably due to interception of the moisture by the forest canopy (Skovlin, 1967), and cattle did not gain as well as on the grassland. Crude protein and digestible energy intake estimated from esophageal fistula samples and total fecal collection (Table 2) indicated a system that included grazing the grassland for 1 month in late spring, the forest for 2 months in summer, and fall use on the grassland, made most efficient use of the forage resource. In years of inadequate fall moisture (Table 2, 1978 data) grasslands should not be expected to provide forage superior to forests.

In the United States riparian zone management is an increasingly important topic. Total exclusion of livestock has been suggested in some cases. However, alternatives exist. Where stringer meadows along streams exist in sufficient hectarage to warrant fencing and grazing, the development of special use pastures is possible. In many cases riparian meadows are underlaid by high water tables that provide soil moisture to plants late into the dry portion of the grazing season. If the riparian pasture is deferred until late summer so as to provide nutritious forage for livestock that would otherwise be grazing poor quality upland range, increased gains can be expected. In Table 3 both groups of cattle grazed upland range until August 23 when they were allotted to either upland or meadow community pastures.

Restricting riparian meadow utilization to specific time periods and utilization levels also provides for other uses. Late summer grazing allows the undisturbed nesting and fledging of ground nesting birds; elk (Cervus elaphus Nelsonii) and mule deer (odocoileus hemionus) calving and fawning is undisturbed, and vegetation may complete its growth cycle prior to grazing (Kaufmann et al. 1982).

Cattle graze the Eastern Oregon Agricultural Research Center's experimental range in the Wallowa Mountains in a manipulative grazing scheme (Vavra and Phillips, 1979 and 1980). Cattle graze specific pastures based on quality of available forage (Figure 3). Figures 4 and 5 illustrate the seasonal changes in cow weight change and calf average daily gain. In 1977, a drought year, pasture changes were made more rapidly and the curves reflect those movements. Late summer rains in 1977 ended the drought and provided regrowth which in turn allowed the cows to gain weight in the fall.

Table 2. Average daily intake of crude protein (kilograms) and digestible energy (megacalories) on the forest and grasslands in 1976, 1977 and 1978 (Holechek, et al 1981).

Sampling period	1976 Forest	1976 Grass-land	1977 Forest	1977 Grass-land	1978 Forest	1978 Grass-land
			Crude protein intake			
Late spring	.45[a]	.66[b]	.84	.76	.85	.80
Early summer	.68	.60	.63[a]	.51[b]	.72[a]	.63[b]
Late summer	.87[a]	.78[b]	.66[a]	.47[b]	.50[a]	.38[b]
Fall	.72	.66	.67	.70	.84[a]	.63[b]
			Digestible energy intake			
Late spring	11.4[a]	13.7[b]	20.6	19.9	18.8[a]	21.3[b]
Early summer	19.9[a]	17.1[b]	16.1[a]	14.4[b]	18.7[a]	17.3[b]
Late summer	18.2	17.6	17.2[a]	12.6[b]	12.4	12.1
Fall	14.7[a]	19.9[b]	16.0[a]	19.3[b]	19.9[a]	14.3[b]

[a,b]Means within sampling period and year with different superscripts differ ($P < .05$).

Table 3. Cattle weight changes (kg) and average daily gains (ADG) (kg) from upland[1] and riparian meadow pastures (Vavra, 1984).

Date	Pasture type	Calves Weight change	Calves ADG	Cows Weight change	Cows ADG
6/14 to 8/23	upland	63	.89	-35	-.49
	upland	65	.93	-26	-.44
8/23 to 9/12	upland	10	.47	-20	-.97
	meadow	18	.88	6	.31

[1] Primarily Pinus ponderosa - Calamagrostis rubescens - Poa pratensis communities.

CULTURAL PRACTICES

Cultural practices have long been used to improve rangeland for livestock production. Forest logging and seeding introduced species are common. Such practices often increase the flexibility of a grazing program.

It has been recognized that logging practices improve the amount of understory vegetation available for grazing. McConnell and Smith (1970) noted a 550 percent increase in understory vegetation after thinning an overstocked ponderosa pine forest to 8 m spacings. Miller and Krueger (1976) found a 10 fold increase in forage production following clearcutting and reseeding. McLean and Clark (1980) observed on lodgepole pine clearcuts seeded species produced more than native species, but native species retained forage quality later into the summer. However, orchardgrass (Dactylis glomerata), the principal seeded species, responded to fall precipitation and provided nutritious regrowth in September, whereas the native pinegrass (Calamagrostis rubescens) did not. Svejcar and Vavra (1985) reported similar results. They also noted as did McEwen and Dietz (1965) that native species on logged sites declined in forage quality more rapidly than adjacent unlogged sites (Table 4). Efficient use of forage resources in the cases just mentioned would include grazing logged and reseeded areas earliest in the grazing season, followed by logged areas with native grasses, followed by unlogged native areas. Reseeded clearcuts again could be used in fall if regrowth was present.

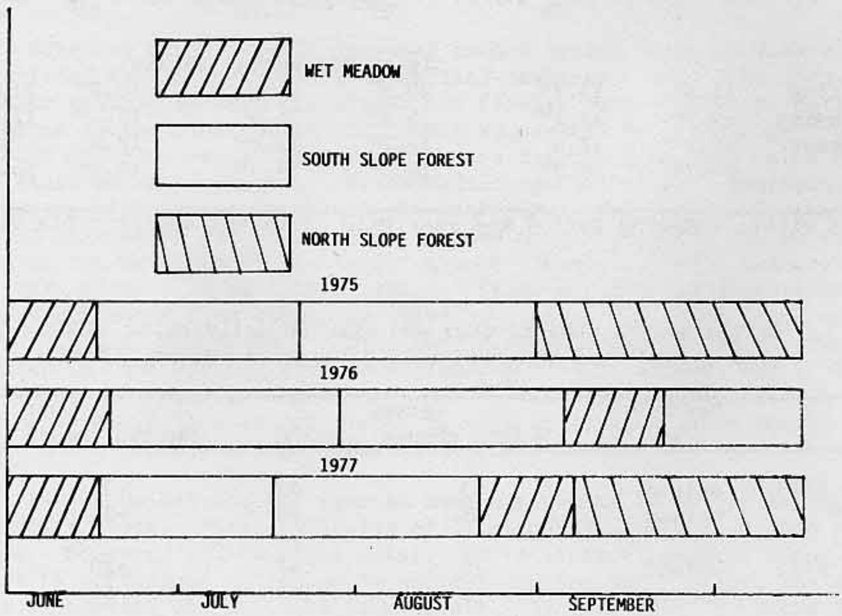

Figure 3. The summer grazing schedule by pasture type. Vertical lines indicate pasture changes (Vavra and Phillips, 1980).

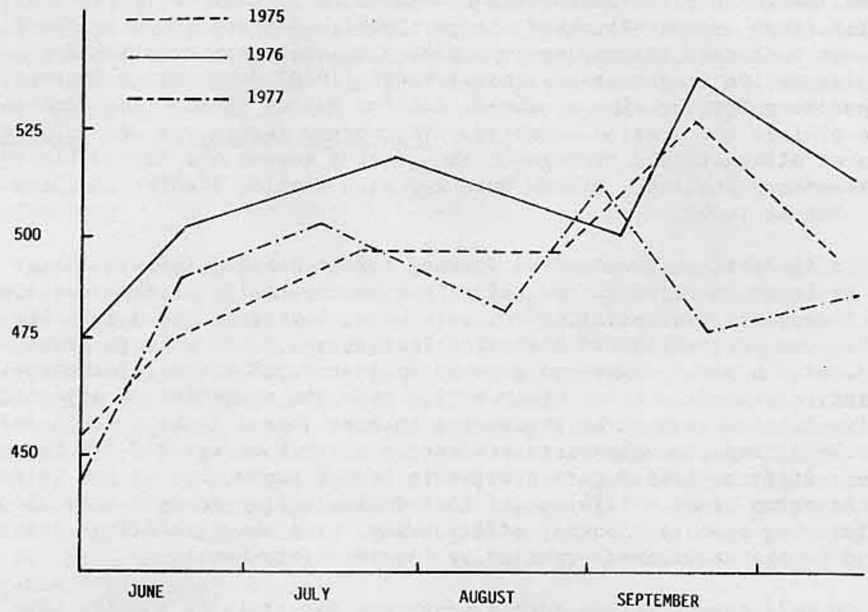

Figure 4. Cow weights (kg) for the summer grazing seasons (Vavra and Phillips, 1980).

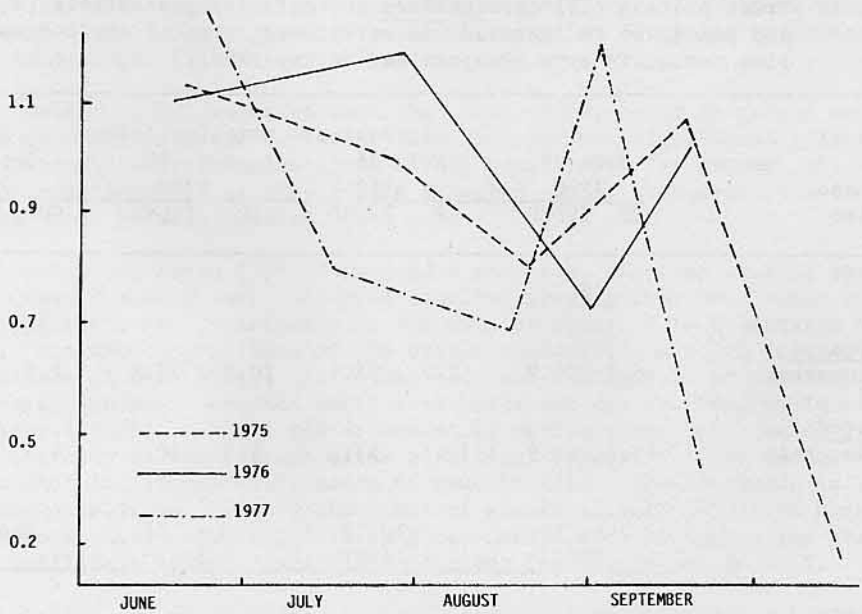

Figure 5. Average daily gain (kg/day) of calves for the summer grazing seasons (Vavra and Phillips, 1980).

In the Great Plains and Great Basin, seeded ranges have been used to extend the grazing season through both earlier turnout or later fall grazing (Cook and Harris, 1968; Lodge, 1970). Ranges seeded to species that are resistant to grazing are often used when the potential for damaging native ranges is greatest. Lodge (1970) developed a system for the northern Great Plains of Canada and the United States. He used native mixed prairie and crested wheatgrass (*Agropyron desertorum* and *cristatum*) pastures alternatively throughout the grazing season and termed his system complementary grazing. Others have reported similar studies (Smoliak 1968, Currie 1969).

In the arid western United States, forage quality in late summer and fall is based on regrowth resulting from precipitation at the same time of year. Adequate precipitation may only occur 1 year out of 2 (Skovlin 1967). One possibility of improving fall forage quality is to graze ranges with a shrub component or seed an introduced shrub. Intensive logging treatments such as clearcutting have the potential to stimulate massive increases in shrub production in some forest types. Irwin and Peek (1979) reported clearcuts produced a shrub biomass of 7,300 kg per ha while a light selection cut resulted in forage production of 100 kg per ha. Edgerton et al. (1975) noted that while logging damaged many shrub plants, they soon resprouted; additionally, many shrub seedlings established in the environment created by logging disturbance.

On cold desert ranges *Kochia prostrata* and *Atriplex* species have received recent attention in reseeding efforts (Tiedemann et al., 1983). These, as well as native species, maintain crude protein levels above that needed to maintain production in cattle (Davis, 1979).

Table 4. Crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) for pinegrass on improved and unimproved sites of the lodgepole pine community type (Svejcar and Vavra, 1985).

Site and species	Approximate sampling dates: June 25, 1980 CP	June 25, 1980 IVDMD	July 25, 1980 CP	July 25, 1980 IVDMD	Aug. 25, 1980 CP	Aug. 25, 1980 IVDMD	Sept. 25, 1980 CP	Sept. 25, 1980 IVDMD
	%		%		%		%	
Unimproved Pinegrass	16.7	66.2	12.7	55.1	10.8	48.8	7.2	51.9
Improved Pinegrass	14.8	63.9	11.5	53.3	9.2	50.1	4.9	46.6
	June 25, 1981		July 25, 1981		Aug. 25, 1981		Sept. 25, 1981	
Unimproved Pinegrass	18.3	62.6	12.5	54.9	10.9	51.6	8.2	49.7
Improved Pinegrass	15.3	60.2	10.7	55.5	8.4	50.8	5.3	47.6

On seasonal ranges shrub dominated communities are best utilized late in the grazing season when herbaceous species have matured. In situations where range is available year round, shrub dominated ranges at low elevations are used as winter range (Cook and Harris, 1968). Current research in the western United States is focusing on increased use of rangelands in winter or early spring months to decrease the amount of expensive harvested forage fed per cow per year.

FACILITATION

Another form of manipulative grazing is to use one set of grazing animals to modify the growth or species composition within a pasture to provide a more palatable and/or nutritious forage for another set of animals. Anderson and Scherzinger (1975) in northeastern Oregon used spring and early summer cattle grazing to modify the growth form of bunchgrass range that served as an elk winter range. The authors hypothesized controlled cattle grazing allowed forage regrowth that was superior in nutritional quality to ungrazed forage. Palatability of the forage to elk was also enhanced. Jensen et al. (1972) found that sheep could be grazed on a mule deer winter range with little damage to the shrub component necessary for wintering deer. Sheep grazing has to be timed properly; it should begin early in the grazing season and terminate when bitterbrush (Purshia tridentata) sets seed.

Scotter (1980) in a review of wild ungulate habitat management reported that on a mixed shrub-grass range cattle grazing of herbaceous material allows shrubs to gain a competitive edge. Conversely, without cattle grazing, but with continued mule deer grazing of the shrub component in winter, grasses gain the competitive edge. Austin et al. (1983) suggested cattle graze about 2/3 of the winter range area per year; the other third being rested, but providing mature forage for severe snow cover periods. This agreed with the prescription developed by Anderson and Scherzinger (1975) for elk winter range.

Urness (1982) reported that sheep and cattle could be grazed on a mule deer winter range during May and June without significant grazing on bitterbrush. Horses appeared to be the best grazer for removal of herbaceous material as they seldom selected shrubs even well into the summer when grasses matured.

Hyder and Sneva (1963) proposed a one-crop, two-crop grazing system for crested wheatgrass. One-crop involved grazing from boot stage to when the spikelets are in anthesis at the rate of about .4 to.8 hectares per cow. The two-crop portion of the system would begin a month earlier and terminate at boot stage. An annual rotation combination of one-crop, two-crop systems, provided sufficient hectarage was present, would allow earlier turnout on range and deferment of native range until about July 1. The two-crop portion should allow sufficient regrowth of the forage so that another grazing entry could be made in fall. This regrowth is of higher nutritional quality than that of plants allowed to mature ungrazed. Therefore, cattle grazing in spring can manipulate the vegetation grazed and facilitate improved grazing conditions for themselves in fall.

Cattle and sheep have also been used to impact herbaceous plant communities to improve tree growth. Adams (1975) reported that uncontrolled grazing frequently caused damage to regenerating conifer stands. However, livestock could be used as an effective tool to control competing vegetation and reduce fire hazard, if the grazing were strictly controlled. In northeastern Oregon, Krueger et al. (1984) reported after 20 years tree height and diameter breast height were superior in trees growing in a pasture grazed by elk, mule deer and cattle; compared to pastures grazed by cattle alone or deer and elk. Currie et al. (1978) observed significant damage to tree seedlings only at a heavy stocking rate; moderate and light levels caused little damage. In other studies, the authors reported almost no damage to naturally regenerating ponderosa pine seedlings and slight damage to some trees in a plantation of 12,000 nursery seedlings. Damage and mortality to seedlings from sources other than cattle far exceeded cattle damage (176 damaged trees versus 3 damaged by cattle). McLean and Clark (1980) working on lodgepole pine forest in British Columbia, stated that where cattle numbers and periods of grazing were controlled little damage to regenerating trees occurred.

SUMMARY

Manipulative grazing involves a total inventory of the grazing resources available in a livestock enterprise. This paper has discussed some characteristics of native and modified plant communities that can be incorporated into a grazing plan to improve efficiency of livestock production. It is based on the premise that livestock, like other mammals, live by the law of least effort (Geist, 1982); that is, animals obtain necessary resources with a minimum of effort. Livestock, even though we have developed in them the genetic potential for rapid growth, do not have bred in them the desire to fulfill that potential. Animals on range are content to meet minimum obligations of production such as lactation, wool growth, or body mass growth, and to live in a comfortable environment that is acceptable to certain evolved behavioral traits. Comfortable environments may include riparian zones, areas in a pasture that are level, areas that have cool breezes during hot periods, or areas away from frost pockets. Evolved behavioral traits may include a preference for open grasslands as opposed to forest and a desire to exist in herds. In manipulative grazing, pasture forage composition and season of use choices are made by the manager through pasture design and livestock movement rather than left to the livestock as in a large season-long use pasture. Manipulative grazing considers potential animal production in pasture design. However, maintenance or improvement of plant species composition of grazed pastures, wildlife habitat or forage considerations and watershed factors are important resources aspects that also may have to be incorporated into the system.

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