An Approach for Setting the Stocking Rate

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One of the most basic problems confronting the range manager concerns determination of the correct stocking on different ranges. Although this problem has received considerable attention since the beginning of scientific range management in the early 1900's, specific procedures or approaches to solve this problem beyond trial and adjustment are generally unavailable.

On yearlong ranges, most decisions regarding adjustment in stocking rates are made at the end of the growing season in the fall. The standing crop is estimated and animal numbers are adjusted so a minimum residue of dry matter remains prior to the time that growth is initiated the following year. The premise here is that a certain minimum level of dry matter should always be present on a particular range to maintain the soil, forage plant vigor, livestock diet quality, and wildlife habitat.

Critical dry matter residue levels have been derived for some range types in the United States. Enough information is available that they can be deduced for others. In the shortgrass prairie country of eastern Colorado, 300 lb will give maximum economic returns and maintain forage production. On southeastern Oregon big sagebrush ranges, grass residues of 160 lb/acre should maintain or improve range condition on most sites. In the California annual grassland type, from 250-1,100 lb/acre of minimum residue are needed, depending on the site.

Considerable information is available on the percent utilization various ranges in the United States can withstand under continuous or season-long grazing. These studies are summarized in Table 1. Shown are the average degree of use

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Table 1. Utilization guidelines for different range types in the USA.

Average annual precipitation CM	In	% Use of Key Species[1] for Moderate Grazing	Range Types	References
10-13	4-8	25-35	Salt Desert Shrubland	Hutchings and Stewart 1953
			True Desert (Mojave)	Hughes 1982
13-30	8-12	30-40	Semidesert Grass and Shrubland	Paulsen and Ares 1961
				Valentine 1970
				Martin and Cable 1974
13-30	8-12	30-40	Sagebrush Grassland	Pechanec and Stewart 1949
				Laycock and Conrad 1981
30-50	12-20	30-40	Palouse Prairie (Bunchgrass)	Pickford and Reid 1948
				Skovlin et al. 1976
25-100	10-16	40-50	Shortgrass Prairie	Klipple and Costello 1960
				Burzlaff and Harris 1969
25-100	10-40	50-60	California Annual Grassland	Hooper and Heady 1970
				Bartolome et al. 1980
				Rosiere 1987
40-65	16-25	40-50	Northern Mixed Prairie	Sarvis 1941
				Lewis et al. 1956
				Houston and Woodward 1966
				Smoliak 1974
40-65	15-25	40-50	Southern Mixed Prairie	McIlvain and Shoop 1965
				Kothman et al. 1975
				Heitschmidt et al. 1987
40-130	16-50	30-40	Coniferous Forest	Pickford and Reid 1948
				Johnson 1953
				Skovlin et al. 1976
40-130	16-50	30-40	Mountain Shrubland	Pickford and Reid 1948
				Skovlin et al. 1976
40-130	16-50	30-40	Oak Woodland	Merrill and Miller 1961
40-130	16-50	20-30	Alpine Tundra	Thilenius 1979
65-100	25-40	45-55	Tall Grass Prairie	Herbel and Anderson 1959
100-175	40-70	50-60	Southern Pine Forest	Pearson and Whitaker 1974
100-175	40-70	50-60	Eastern Deciduous Forest	

[1]Ranges in good condition and/or grazed during the dormant season can withstand the higher utilization level, while those in poor condition or grazed during active growth should receive the lower utilization level.

the primary forage species can sustain without loss of productivity.

Some conclusions can be drawn from these studies dealing with intensity. Desert shrubland characterized by ranges such as the sagebrush grassland, Chihuahuan desert, and the Mojave Desert with under 12 inches of average annual precipitation can withstand between 25 and 35% use of the primary forage species, depending on the condition of the range, type of grazing system, season of use, and degree of aridity. The grassland ranges that receive 12-25 inches such as the shortgrass prairie can sustain 35-45% use. Humid ranges receiving over 25 inches average annual precipitation such as the tallgrass prairie and southern pine forest can withstand 45-60% use. Studies from California and Africa show that annual grasslands can generally withstand higher grazing intensities (50-60%) than perennial grasslands. The general guideline of take half and leave half of the current season's growth recommended by early range managers appears applicable only to humid and annual grassland ranges.

The other question regarding what grazing intensity to select concerns livestock production. Several studies reviewed by Holechek et al. (1988) show heavy grazing invariably leads to a gradual loss in forage productivity, high death losses and higher costs for supplemental feed in drought years. Table 2 shows two examples of stocking rate influences on livestock production and economic returns. Based on

Table 2. Influence of grazing intensity on winter sheep production at the Desert Experimental Range in Utah and cattle production at the Central Great Plains Experimental Range in Colorado.

	Heavy Grazing	Moderate Grazing
	Sheep-Desert Experimental Range, Utah[1]	
Utilization, %	68	35
Ewe weight change (fall to spring), lbs	+1.1	+9.3
Average fleece weight, lbs	9.68	10.63
Lamb, crop, %	79	88
Death loss, %	8.1	3.1
Net income, (3,000 head flock), $	5,072	10,390
Net income per ewe, $	1.69	3.45
	Yearling Heifers - Central Great Plains Experimental Range, Colorado[2]	
Utilization, %	60	40
Death loss, %	1.43	.33
Gross income (acre), $	1.54	1.93
Gross income (heifer), $	81.22	96.02

[1]Data from Hutchings and Stewart (1953).
[2]Data from Klipple and Costello (1960).

a survey of available literature considering forage productivity, livestock productivity, and net economic returns, it is suggested that desert shrubland ranges be assigned a 30% level of use, arid grasslands a 40% level of use, humid grasslands a 50% level of use, and annual grasslands a 55% level of use when initial stocking rates are being established and grazing intensity information is unavailable for the ranges involved.

Knowledge of average forage production on a range over a series of years is considered necessary for any estimate of long-term grazing capacity. Forage fluctuates considerably between years in response to changing climatic conditions. On ranges dominated by perennial forages, a 30% downward adjustment of standing crop at the end of the growing season should give a reasonable estimate of average long-term forage production if growing conditions are considered good (more than 125% of annual average precipitation), whereas an upward adjustment of 30% should work well when growing conditions are poor (less than 70% of average annual precipitation). In years when precipitation deviates by 50% or more from the average, reliable estimates of grazing capacity in most cases will not be possible. These adjustments are suggested after reviewing several studies that show forage fluctuations of about 30% from the mean in good and poor years (Hutchings and Stewart 1953, Klipple and Costello 1960, Pearson and Witaker 1974, Smoliak 1971).

In rough, rugged terrain, cattle congregate on the more convenient, flat areas such as valley bottoms, riparian zones, and ridgetops. Forage on the steeper slopes (over 60%) receive little or no use by cattle and these areas must be deleted from the grazable land area. Table 3 gives guidelines on grazing capacity adjustments for slope.

Table 3. Suggested reductions in cattle grazing capacity for different percentages of slope.

% Slope	% Reduction in Grazing Capacity[1]
0-10	No Reduction
11-30	30
31-60	60
Over 60	100 (Consider These Slopes Ungrazable)

[1]Supporting literature includes Mueggler (1965), Cook (1966), and Gillen et al. 1984.

Because of the smaller size, greater agility, and stronger climbing instinct, sheep and goats make much better use of rugged terrain than cattle. In most cases, sheep are under control of a herder and can be readily forced to use the steeper hillsides, minimizing overuse of the valley bottoms. A New Mexico study found sheep on winter range uniformly used slopes of less than 45%. However, utilization was sharply reduced when slopes exceeded 45% (McDaniel and Tiedeman 1981). Based on their study, slopes greater than 45% should be considered unusable by sheep, but little or no adjustment appears necessary for slopes under 45%.

Failure to adjust stocking rates for travel distance to water has resulted in considerable range degradation, particularly in the hot, arid rangelands of the southwestern United States, parts of Australia, and in the Sahel region of Africa. On the cold desert ranges of the Intermountain United States, snow reduces water availability problems in winter.

Several studies show cattle make little use of areas farther than two miles from water. Table 4 provides guidelines on adjustments in cattle stocking rates as distance from water increases. Unlike cattle, sheep and goats do not require water every day. They will readily use areas that are two or more miles from water, based on a New Mexico study

Table 4. Suggested reductions in grazing capacity with distance from water.

Distance from Water, Miles	% Reduction in Grazing Capacity[1]
0-1	None
1-2	50
2	100
	(Consider This Area Ungrazable)

[1]Supporting literature includes Valentine (1947), Martin and Ward (1973), Squires (1973) and Beck (1978).

(McDaniel and Tiedeman 1981).

The key-plant and key-area concepts have proven highly useful to managers in evaluating grazing effects on range vegetation. A key species is one whose use indicates the degree of use of the associated species and is important in the management program. Key management species are those on which the grazing management of a specific range is based. The key species and key area serve as indicators of management effectiveness. Generally, when the key species and key area are considered properly used, the entire pasture is considered correctly used.

In most cases, one to three plant species are used as key species. These plants should be abundant, productive, and palatable. They should provide the bulk of the forage for the grazing animals within the pasture. The ice-cream plants are not used because of their scarcity and low resistance to grazing. Conditions do exist where the climax plants are not the most desirable or in which a reduction in stocking rate will not restore the climax plants within a reasonable time frame (5-15 years). In these cases, a palatable increaser plant may be selected as a key species. It is important to recognize that key species for one type of animal may be different than those for another type due to differences in food habits. As an example, bitterbrush is the key species for mule deer on many eastern Oregon ranges, but the key species for cattle on these ranges is bluebunch wheatgrass. The key species for elk would be Idaho fescue. Under the key species approach, secondary forage species, i.e., sandberg bluegrass in eastern Oregon, will receive the light use (10-25%); key species (bluebunch wheatgrass) will receive moderate use (30-40%); whereas, the ice cream plants (arrowleaf balsamroot) may be used excessively (over 40%).

The key area is a portion of range which, because of its location, grazing or browsing value, and/or use, serves as an indicative sample of range conditions, trend or degree of seasonal use. The key area guides the general management of the entire area of which it is part.

The key area concept is based on the premise that no range of appreciable size will be uniformly utilized. Even under light grazing intensities, areas around watering points, salt grounds, valley bottoms, and driveways will often be heavily used. These preferred areas are referred to as sacrifice areas because setting stocking rates for proper use of these areas will result in underuse of the bulk of the pasture. A major objective of specialized grazing systems is to minimize the size of sacrifice areas and provide them with periodic opportunity for recovery (Holechek 1983).

When selecting the key area, parts of the pasture remote from water, on steep slopes, or with poor accessibility due to physical barriers should be disregarded. Proper use of these areas will generally result in destructive grazing of most of the pasture. These areas should be omitted when carrying capacity is estimated. The success of range management practices within a pasture is usually judged by the response of the key plant species on the key area.

In recent years, considerable information has become available on daily forage intake by ruminant animals (Table 5). Ruminants consume about 2% of their body weight per day in dry matter when data are averaged across periods when forage is dormant and actively growing. If a range is to be grazed only during the dormant period when forage is low in quality, it is suggested that daily forage demand is 1.5% body weight, while during active growth when forage is high in quality, 2.5% is suggested.

Table 5. Daily dry matter consumption by various range animals based on their body weight.

Animal	Animal Weight lb[1]	Daily Dry Matter Intake, lb	Animal Unit Equivalents (A U_I)
Cattle (Mature)	1,000	20.0	1.00
Cattle (Yearling)	750	15.0	.75
Sheep	150	3.0	.15
Goat	100	2.0	.10
Horse	1,200	36.0	1.80
Donkey	700	21.0	1.05
Bison	1,800	36.0	1.80
Elk	700	14.0	.70
Moose	1,200	24.0	1.20
Bighorn Sheep	180	3.6	.18
Mule Deer	150	3.0	.15
White-tailed Deer	100	2.0	.10
Pronghorn Antelope	120	2.4	.12
Caribou	400	8.0	.40

[1]Average weight of mature male and female animal.

Because horses and donkeys have monogastric digestive systems with enlarged cecums, they can consume more forage per unit body weight than ruminants. Daily intake by horses and donkeys is about 3% body weight for most forages.

Once information is obtained on average standing crop of grazable forage, total amount of grazable area in the pasture, level of grazing intensity the pasture can sustain, and average weight of the animals to be grazed, a stocking rate can be calculated. Hypothetical situations will be used to demonstrate use of the above information.

Situation 1

Our first situation will involve a shortgrass prairie (blue grama) range in northeastern New Mexico with the following characteristics:

1. Range condition = good
2. Annual average precipitation = 14 inches
3. Total precipitation during previous 12 months = 10.5 inches
4. Total area in pasture = 1,000 acres
5. Physical characteristics:
   a) Flat terrain

No part of pasture is over two miles from water
6. Time of year = end of growing season (October 1)
7. Average forage standing crop = 800 lb/acre (assume ungrazed)
8. Period of use = yearlong
9. Type of livestock operation = cow/calf
10. Size of cows = 900 lb

Question: How many cows should you have in your base herd:

Calculation of Total Usable Forage

Forage production (lb/acre) × percent allowable use × area (acre) = Total forage (lb) available for grazing

800 × .45 × 1,000 = 360,000 lb

Calculation of Forage Demand

Weight of cows (lb) × daily dry matter intake (% body weight) × number of days pasture will be grazed = Forage demand (lb) per cow per year

900 × .02 × 365 = 6,570 lb

Calculation of Stocking Rate

Total usable forage (lb) ÷ 6,570 = 55 cows

Since one bull is recommended per 20 cows, this range would support a base herd of 52 cows and 3 bulls. No adjustments are needed for slope, distance from water or drought.

Situation 2

This situation will involve a summer range in the mountains or northeastern Oregon grazed by cattle with the following characteristics:

1. Range condition = fair
2. Annual average precipitation = 18 inches
3. Total precipitation during previous 12 months = 24 inches (133% of annual average)
4. Key forage = Idaho fescue
5. Total area in pasture = 3,000 acres
6. Physical characteristics:
   a) Rugged terrain: 40% of area = 0--10% slope
      20% of area = 11--30% slope
      30% of area = 31--60% slope
      10% of area = over 60% slope
   b) No part of pasture more than two miles from water
7. Time of year = end of growing season (September 15)
8. Average forage standing crop = 600 lb/acre (assume ungrazed)
9. Period of use = 120 days 1 June to 30 September)
10. Type of livestock = yearling steers
11. Weight of yearlings = 650 lb

Questions: How many yearling steers will this range carry?

Calculation of Total Usable Forage

Forage production (lb/acre) × percent allowable use × area (acre) = total forage (lb) available for grazing

600 × .30 × 3,000 = 540,000 lb

Calculation of Forage Demand

Weight of steers (lb) × daily dry matter intake (%) body weight × number of days pasture will be grazed = Forage demand (lb) per steer for the grazing season

650 × .02 × 120 = 1,560 lb

Calculation of Stocking Rate

Total usable forage (lb) ÷ 1,560 = 346 steers

Adjustment for Above-average Precipitation

346 steers
× .70 (30% reduction due to precipitation 133% of annual average during previous 12 months)
242 steers (grazing capacity adjusted for previous year's growing conditions)

Adjustment for Slope

[Amount of area with 0–10% slope (40%) × adjustment for slope (100–0] +
[Amount of area with 11–30% slope (20%) × adjustment for slope (100–30] +
[Amount of area with 31–60% slope (30%) × adjustment for slope (100–70] +
[Amount of area with 60–10% slope (10%) × adjustment for slope (100–100]
× [242 steers] = adjusted grazing capacity of pasture.

[.40 × 1] + [.2 × .7] [.3 × .3] + [.1 × 0] × 242 = 152 steers

It is recognized on this range that forage productivity will vary between the different types of terrain. Further, forage losses to rabbits, game animals, rodents, insects and trampling by livestock can be substantial on some ranges. The stocking rate we have calculated will probably have to be further adjusted as experience is gained with actual animal use of the pasture.

The procedures previously discussed provide some guidelines for establishing an initial stocking rate for a particular range that can be adjusted as experience is gained. It is important to recognize there is no substitute for experience. Local ranchers, state extension personnel, and Soil Conservation Service personnel can provide useful advice on setting initial stocking rates to new ranch owners.

Downward trends in range condition are not always due to overgrazing. A few small exclosures (2-6 acre) on key grazing areas on a ranch can be useful in separating climatic from grazing influences. The utilization guidelines devloped are based on long-term studies involving five or more years. Data from several studies show that underuse in wet years will compensate for some overuse in dry years, even on desert ranges.

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SRM Trivia

Question: Which SRM members are several months behind on up-to-date techniques which can be found in *JRM* or *Rangelands*?

Answer: Those who didn't send in a a four week notice of their change of address to SRM, 1839 York Street, Denver, CO 80206.