Table 8.4 Effects of Long-Time Grazing at Different Intensities on Certain Soil Characteristics of Two Sites in Alberta, Canada

Cattle data from Johnston et al. (1971)

Sheep data from Smoliak et al. (1972)

	Soil moisture percent		pH		Carbon/nitrogen ratio	Soil temperature, C
	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle
Ungrazed	19.0	.....	6.4	.....	9.1	.....
Light	15.1*	40.0	6.3*	5.7	9.9*	13
Moderate	15.0*	37.0*	6.0*	5.8*	10.4*	15*
Heavy	11.1*†	31.0*	5.8*	6.0	10.3*	15*
Very heavy	.....	24.0*†	.....	6.2*	.....	17*†

*Value differs significantly from ungrazed (sheep) or light grazing (cattle).
†Value differs significantly from all other grazing intensities.

contrast no inhibition was found among six dominant grasses (Neal, 1969).

INDICATORS OF PROPER LIVESTOCK NUMBERS

Although long-term production records are indexes to correctness of range stocking, records may not be available and one must rely on range condition and indicators. Deteriorated range conditions may precede reduced livestock production; hence unsatisfactory situations may be discovered by careful ecological study before production is seriously impaired.

The use of vegetation as an indicator is based upon the ecological premise that vegetation is the product of its environment; the product, therefore, can be used as an indicator of the causal relationships. The most accurate indexes of overgrazing are the early changes that take place in the vegetation as a result of plant succession. Grazing gradually reduces the more desirable plants and makes available soil nutrients and moisture for less desirable plants. The result is a change in the composition (Fig. 8.2). Early recognition of such changes is of the greatest value in determining the adequacy of existing management procedures.

Just as it is important to the physician to recognize and diagnose disease before it has progressed so far that recovery is impossible, so it is important to the range manager and rancher to recognize range ills in their developmental stage.

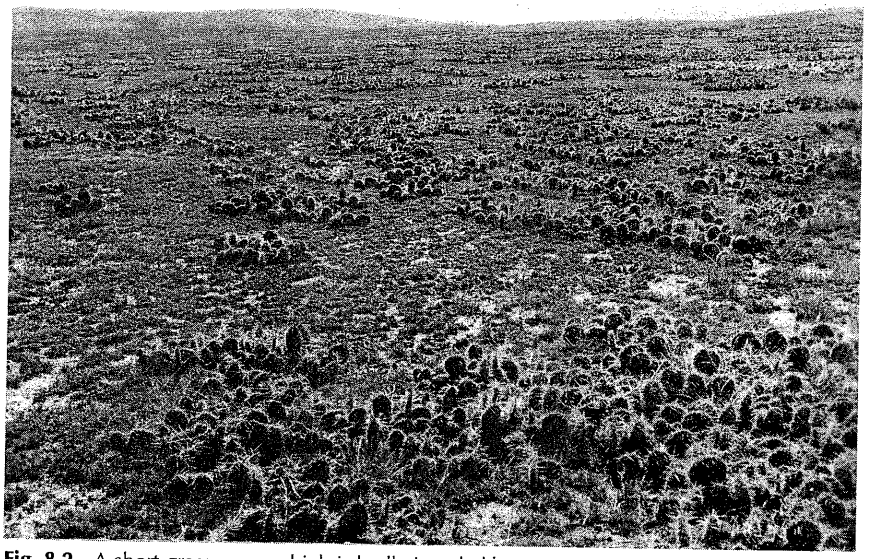

Fig. 8.2 A short-grass range which is badly invaded by cactus *(Opuntia)* as a result of heavy grazing. In such large quantities, this plant is a reliable indicator of misuse. *(Photograph by J. E. Weaver.)*

Unsatisfactory range condition may result from habitat factors other than the biological factor of grazing. Drought and fire, especially, should be studied as causative factors. Much confusion has resulted from interpreting degeneration from drought to be a result of excess grazing. Erosion resulting from abnormal weather conditions often erroneously is attributed to mismanagement. Many of the so-called grazing indicators are in reality indicative of poor growing conditions or disturbances from other causes. Poor soil may support weedy or stunted species that superficially appear to be misused. Before a decision is made it is necessary to learn all that is possible of the history of settlement, cultivation, grazing, climate, recent weather conditions, and normal vegetation. It is well to remember that an indicator is only an indicator and that one, alone, may be unreliable. All possible clues should be considered. (See range-condition indicators in Chapter 6.)

Plant Indicators of Too Heavy Grazing

There are countless plants that are useful and well-known indicators of overuse, but few such plants by their occurrence alone categorically confirm overuse. Many are normal constituents of climax or near-climax vegetation and mere presence does not indicate unsatisfactory condi-

tions. It is when they occur in unnaturally large proportions that they indicate deterioration in range conditions. Invaders more clearly indicate overuse of the range but these, too, may have been present in ecologically impoverished areas from which they spread as range conditions worsened and additional niches were provided for them. A knowledge of each range type and site is indispensable to the range manager if he is to correctly interpret range conditions from evidence on the ground, often spoken of as "reading the range." Nevertheless, some guidelines are possible. The following are conditions that, generally, are cause for concern:

Preponderance of plants of low palatability
Vegetation dominated by a few species
Presence of a high percentage of annual plants, particularly forbs
Palatable shrubs hedged and with dead branch stubs (Fig. 8.3)

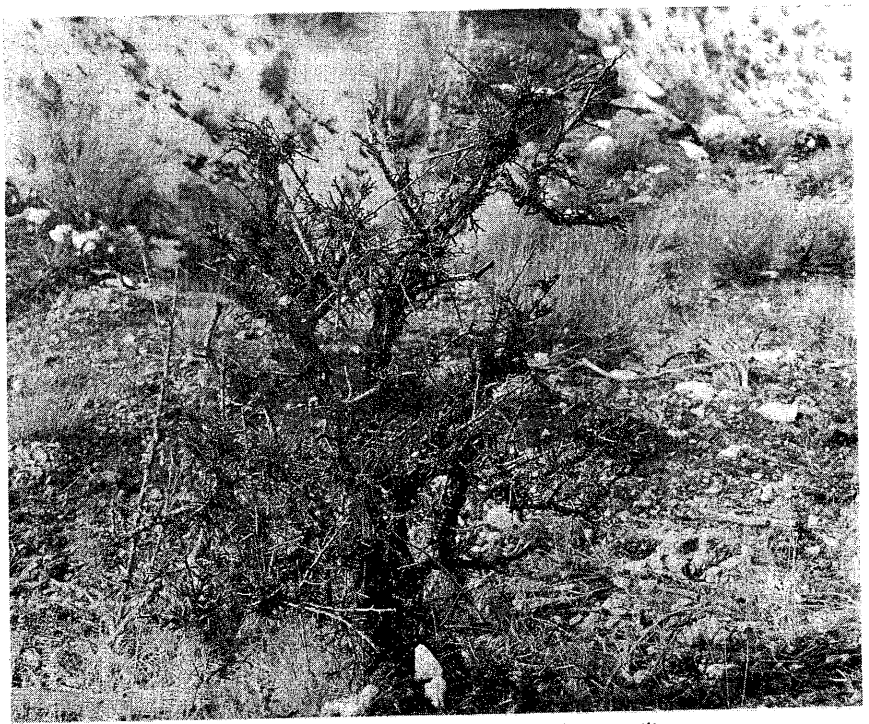

Fig. 8.3 Bitterbrush *(Purshia)* plant showing effects of too-heavy utilization. Note stubs of large branches and broomlike clustering of smaller twigs due to cropping and regrowth from basal buds. Palatable shrubs can be used as guides to range use.

The range manager must become familiar with the vegetation and the potential for each range area so that he can recognize and identify plants useful as indicators and be able to detect a "sick" range before animal-production potential declines.

Disturbances Indicating Heavy Grazing

Many indicators of the past use of rangeland are associated with disturbance of the soil. Soil changes, like vegetation changes, should be recognized early, for by the time that they are obvious, much damage has been done. That concentrations of animals can have a profound effect upon soil is evident from terracing of steep slopes by animals moving constantly back and forth (Fig. 8.4). This may be so severe as to utilize a major part of the area in trails.

Other signs of overuse are (1) widespread networks of gullies, (2) steep gully banks in major drainage channels, (3) pedestaled plants resulting from removal of soil from the base of plants, and (4) hummocks where soil has been deposited under plants by wind. Unfortunately, by the time these signs are evident range deterioration is in an advanced stage.

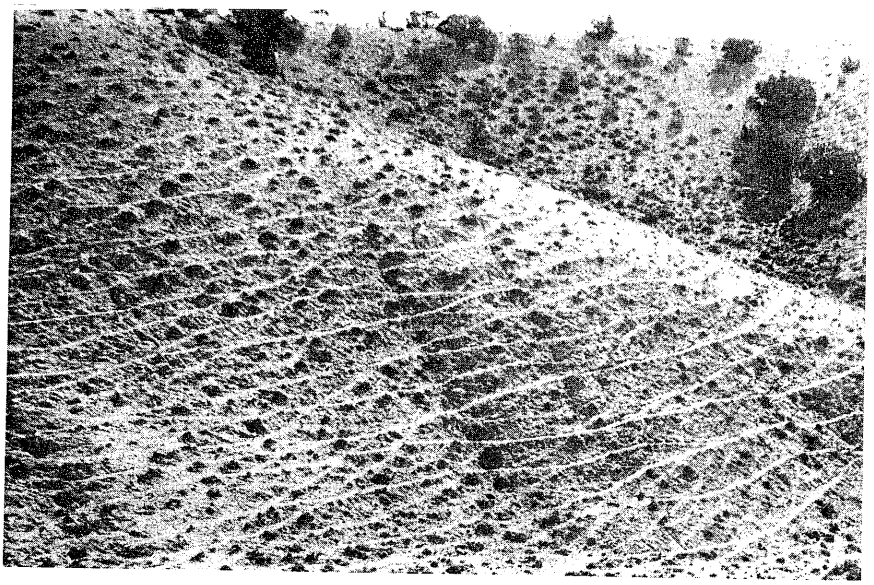

Fig. 8.4 Evident terracing of a hillside resulting from trampling by livestock. Forage production is prevented on such trails, and the soils are too compacted to permit infiltration.

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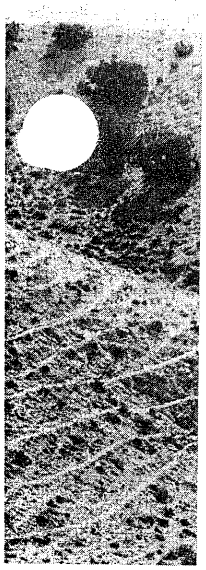

Livestock Condition as a Grazing Indicator

If their animals are vigorous and thrifty, stockmen sometimes consider range condition to be satisfactory. Research has shown, however, that range deterioration may progress for a considerable time before the change is reflected in livestock condition. Forage condition is a more sensitive indicator.

Use of forage condition as the criterion of proper grazing does not imply that meat production is ignored. Continued and dependable meat production is contingent upon maintaining the forage production at its maximum. Forage production is a means to that goal.

IMPORTANCE OF CORRECT NUMBERS TO ANIMAL PRODUCTION

Most ranchers understand that ranges are harmed by misuse, but some do not understand how directly this affects their income. That they do not practice better management is attributable to insufficient understanding of the problems confronting them. Range management is a business of no mean complexity. Often, its intricacies are secondary in the minds of men more concerned with meeting bills and paying taxes. Management procedure must be coldly practical and economically sound to be acceptable. The technical advisor should not become so obsessed with the desire to improve range conditions that he loses sight of the economic limitations to range-management theory. Nor should the rancher be so concerned with immediate income that he loses sight of the far-reaching influence of good husbandry upon his economic welfare.

In a business largely controlled by economic necessity, any management practice must pay its way if it is to be acceptable. Fortunately, the objectives of sound range management can be made consonant with the more impelling economic forces. In no other way can good management be generally acceptable. If it is not economically sound, there is need for improvement in the practice or for reordering of the economic structure so that ranchers can adopt what to them, all too often, seems highly theoretical objectives.

Proper grazing has an important bearing upon the success of the ranching business. Through improved grazing management, the calf and lamb crop may be increased, the death loss minimized, more livestock produced and marketed, and animals sold at higher prices. Good range conditions increase the number of calves and lambs produced. High calf and lamb percentage is likely the most reliable index to success of a commercial breeding-livestock operation. By maintaining animals in

better vigor, they are more able to withstand the vicissitudes of bad weather, diseases, and other adverse factors to which they are subjected; hence death loss is decreased.

Determining Effects of Stocking Rates on Production

Grazing intensities can be evaluated from their effect on individual animals (weight gains, weaning weights, calf or lamb crops, and wool yields) or per unit area. These do not lead to the same conclusion. Wherever conducted, results have shown high gains per animal at low stocking rates and high gains per unit of range at heavy stocking rates. When a few animals are stocked on a range, their diet is not limited and gains are limited only by diseases, social behavior, or factors other than nutrition. Under such circumstances, their genetic potential for gain may be approximated if proper husbandry practices are applied. As the stocking rate is increased, forage becomes scarce and possibly less nutritive, and less productivity results.

Lowered productivity may express itself in a lower percentage calf or lamb crop, less wool produced, or less gain on market animals. In all cases productivity declines *per animal unit* as stocking rate increases. Productivity *per unit area,* on the other hand, usually increases with increased stocking rate (Fig. 8.5). One cannot have maximum animal gains and maximum area yield concurrently. Animals may feed longer and travel more, and food intake may be lower as grazing intensities increase, as shown by merino sheep in Australia (Leigh et al., 1968).

Grazing Intensities and Turnoff

The classic experiment designed to measure the effects of grazing intensity on production was conducted in North Dakota on mixed short- and mid-grass range (Sarvis, 1941). Stocking was about 4, 2.8, 2.0, and 1.2 ha per steer over a 5-month season. Gains per animal were successively smaller as stocking intensity was increased, and gains per hectare were successively larger. Similar results have more recently been reported from Kansas (Table 8.5).

Yield of animal products, called *turnoff,* over long periods determines the success of livestock operations. Hereford cows grazed on Montana short-grass ranges at the rates of 9.4, 12.3, and 15.7 ha per cow-year produced over a 12-year period an average weaned-calf weight per cow of 126.8, 146.4, and 148.6 kg, respectively (Hurtt, 1946).

Cows were grazed for 11 years on California annual grass foothill ranges for a 6-month season at rates of about 4.0, 6.1, and 8.1 ha per head (Bentley and Talbot, 1951). Cows gained 65.0, 101.8, and 109.1 kg,

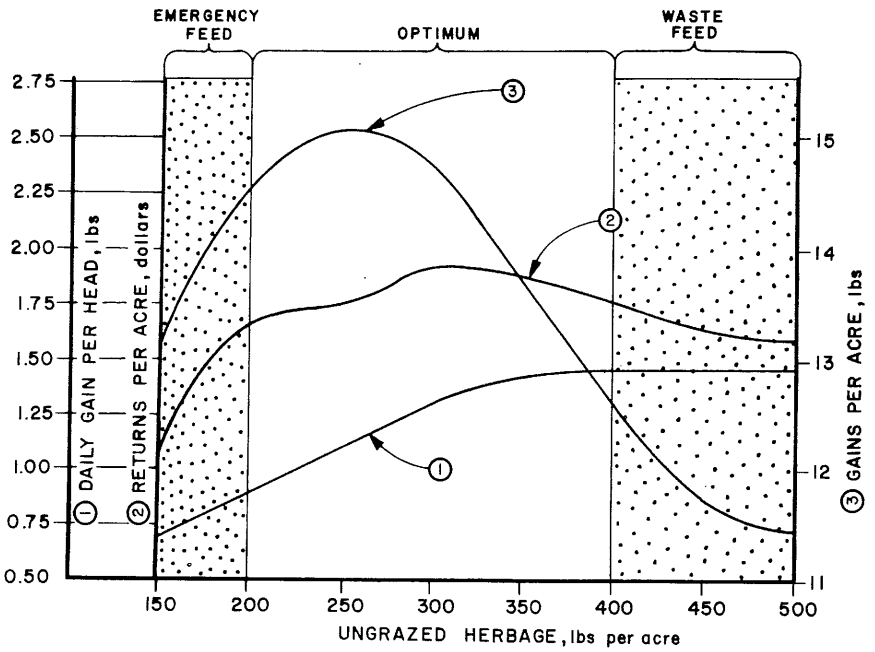

Fig. 8.5 Optimum animal production is neither with maximum gains per unit area nor per head. Moderate stocking provides most returns in the short run and assures continued high yields of forage. *(Adapted from Bement, 1969.)*

and weaning weights of calves were 171.8, 196.4, and 205.5 kg, respectively.

Open pine ranges in central Colorado mountains were grazed by yearling Hereford heifers from June 1 to October 31 for a 6-year period at three intensities giving utilization of 10 to 20 percent, 20 to 40 percent, and 50 percent or more (Johnson, 1953). Average gains were

Table 8.5 Rates of Stocking, Gain per Head, and Gain per Acre of Steers Grazed on Native Pastures, Average for 11 Years

Data from Launchbaugh (1957)

Acres per head 6-month season	Season gain per head, lbs	Season gains per acre, lbs
5.1	217	43
3.4	188	55
2.0	122	61

107.3, 100.9, and 82.3 kg per head and 9.5, 17.9, and 16.6 kg per hectare, respectively.

On mixed prairie vegetation in South Dakota, Hereford cows were grazed during the 7 summer months for a 5-year period at rates as follows: light, 1.3 ha per head per month; moderate, 0.9 ha; and heavy, 0.6 ha. Average utilization of forage was 29, 34, and 54 percent, respectively. For the following 3 years, hectares per head were decreased to 1.0, 0.7, and 0.4 to give utilizations of 48, 60, and 74 percent, respectively (Johnson et al., 1951). Calf weights at weaning were 175.9, 170.5, and 164.1 kg in the first 5-year period and 170.5, 160.9, and 158.6 kg in the subsequent 3 years.

Hereford steers were grazed yearlong at three rates of stocking in the southern Great Plains in Oklahoma for 10 years. Animals were allowed 2.6, 3.9, and 5.2 ha per head and gained an average of 164.1, 174.5, and 181.8 kg, respectively, per head (McIlvain, 1953). Per-hectare gains, however, were 62.7, 44.8, and 34.7 kg.

With one exception (Oklahoma), range deterioration or reduced forage yield accompanied heavy use in the instances cited above. Moderate grazing was regarded as most desirable.

On salt-desert range in Utah (Hutchings and Stewart, 1953), sheep were grazed over an 11-year period for about 5 winter months at two intensities, one about one-fourth heavier than the other. Ewes under moderate grazing weighed 1.8 to 8.2 kg more than those under heavy grazing at the end of the season, and produced 0.45 kg more wool and an 11 percent higher lamb crop. The moderate stocking resulted in improved range condition and increased herbage production.

Economic Returns

The many experiments on intensity of grazing are inconclusive because (1) they did not sample sufficient levels of grazing intensity, (2) they were not continued long enough to determine vegetation and soil responses, and (3) they were not analyzed in terms of true economic effect upon the operator or sociological costs to the nation. For immediate maximum production of meat and wool, heavy grazing may be profitable. Overgrazing, however, can only lead to reduced herbage production and low profit if continued indefinitely. In the short run, an individual may benefit from deliberate overgrazing to secure quick income, provided the land will respond rapidly to good management following overgrazing. By thus *mining* the land, he is ahead, even though his range declines in productivity and value. If soil is not eroded by misuse, improved practices or seeding may bring the land back to its original productivity at reasonable cost. Klipple and Bement (1961) cite evidence

that light grazing is an economical means of improving ranges that have not been too greatly deteriorated. Of course, the social hazard of deliberate misuse of land, especially if it results in land abandonment or expensive publicly financed range-improvement projects, should not be ignored.

Light or moderate grazing may have special economic significance on ranges that are grazed during the growing season. Ample forage is usually available early in the season even on heavily grazed areas, and there is little difference in gain between stocking rates. As the season progresses, the animals on moderately grazed pastures continue to gain, while animals on heavily grazed pastures actually lose weight (Fig. 8.6).

The advantage of different grazing intensities may be neither with maximum gains per head or per area and consequently, with light or heavy grazing. Due to differing investments and operating costs most profits can be expected from some intermediate stocking. Hutchings and Stewart (1953) concluded that moderate grazing of sheep during winter was most profitable, and Johnson (1953) reported lower income from heavy grazing by cattle (Table 8.6). Pearson (1973) concluded that maximum profit on ponderosa pine rangeland came from moderate use. Conversely, higher incomes through heavy grazing were reported by McIlvain (1953) on the southern Great Plains.

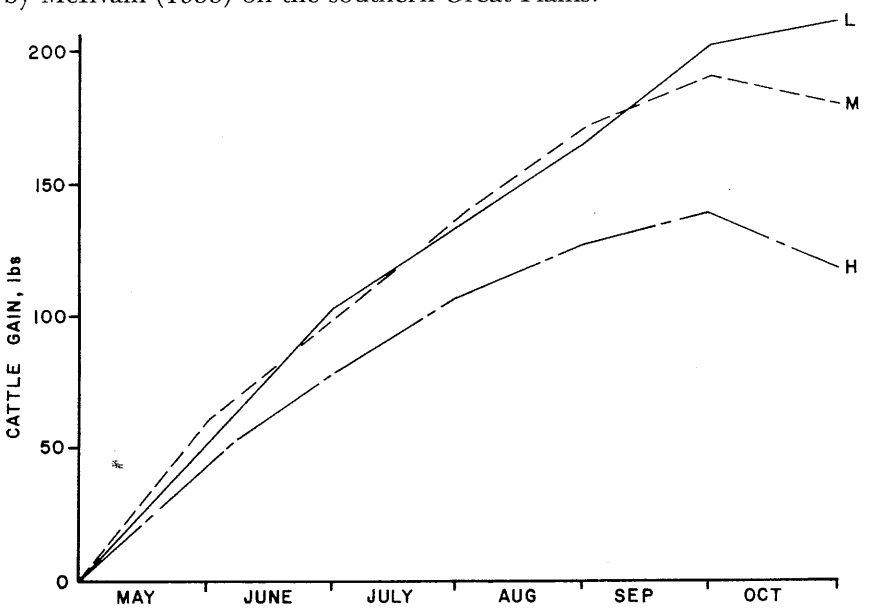

Fig. 8.6 Gains in weights of steers in summer in Kansas under different stocking rates. Under heavy use weight losses occur at the end of the season. *(From Launchbaugh, 1957.)*

Table 8.6 Production and Estimated Return per Section from Pine-Bunchgrass Range in Colorado Grazed at Three Intensities, 1946–1947

Data from Johnson (1953)

	Heavy grazing	Moderate grazing	Light grazing
Animals per section	53	47	27
Gain per head (5 months), pounds	172	211	231
Gross return per section, dollars	661	1,027	724
Costs (death loss, grazing fee,* interest, etc.), dollars	188	163	97
Net return per section, dollars	473	864	627

*Land costs used were the cost of standard Forest Service fees. This results in the same cost per head regardless of stocking intensity. Actually, of course, the landowner by heavy stocking reduces the forage cost per head since interest and taxes chargeable to land are independent of stocking intensity.

Bement (1969) used data from 19-year grazing experiments in Colorado and by means of budget analyses determined the dollar returns based on then current beef prices. The results clearly show that heavy or light grazing gives lower profits than stocking somewhere in between (Fig. 8.5). He prepared a utilization guide suggesting that leaving 224 to 448 kg of forage per hectare gave satisfactory returns, and leaving 336 kg per hectare gave maximum returns.

Light or moderate stocking is especially important during drought. Studies in Texas following the drought of the 1950s and in Australia (Heathcote, 1969) showed that ranch operators who stocked their ranges lightly came through drought periods with more assets and less financial loss than those who stocked heavily.

Over a long-time period conservative stocking will pay dividends. When the cost of (1) extra investment in animals and the accompanying extra work, extra salt, and extra equipment, (2) reduced calf or lamb crops, (3) reduced gains, (4) reduced price per pound for poorer stock, and (5) increased supplemental feed are considered and weighed against the cost of more land to supply needed forage, the rancher can appreciate that overstocking does not make for high income on a sustained basis. It not only decreases the meat yield but ultimately it greatly injures the range. Conservative stocking results in a healthy, productive range.

IMPORTANCE OF SEASON OF GRAZING

From the discussion in Chapter 4 it is evident that an animal-unit month of grazing may affect the range quite differently depending upon season of the year. The start of the growing season is the most critical period for

RANGE MANAGEMENT

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