

# Comparative Contribution of Grasses, Forbs, and Shrubs to the Nutrition of Range Ungulates

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Knowledge of the role of different forages in meeting the nutritive needs of different range ungulates is critical for good range management. This knowledge is particularly useful for decisions regarding brush control, range seeding, grazing management, and forage allocation to different ungulates. This paper will discuss the role of grasses, forbs, and shrubs in meeting the nutritional requirements of range ungulates.

## Forage Selection by Different Ungulates

Range ungulates can be divided into three groups based on their foraging habits. These groups include the grazers which consume grass-dominated diets, the browsers which consume primarily forbs and shrubs, and the intermediate feeders which use equal amounts of grasses, forbs, and shrubs.

### The Grazers

Cattle, elk, bighorn sheep, mountain goats, musk oxen and bison are North American ungulates considered to be grazers. However, on some ranges these ungulates, with the exception of bison and musk oxen, do consume large amounts of forbs and shrubs. This occurs primarily when green grass is unavailable. These ungulates show a strong avoidance of shrubs high in volatile oils (junipers, rabbitbrush, various sagebrushes, etc.) because they lack mechanisms to reduce the toxic effects of these substances.

### The Browsers

Moose, pronghorn, mule deer, domestic goats, and white-tailed deer feed primarily on forbs and shrubs throughout the year regardless of location. With the exception of domestic goats, these ungulates experience digestive upsets if forced to consume diets dominated by mature grass. This group of ungulates consumes a limited amount of grass in the spring when it is green and forbs and shrubs are unavailable. However, dry mature grass is almost completely avoided. The smaller ruminants in this group can consume large amounts of forages high in volatile oils because their small, pointed mouth parts enable them to select the portions of these plants with the lowest levels of volatile oils. In addition, the small ruminants chew their food to a much greater extent than large ruminants or monogastric animals. Apparently fine chewing of plants high in volatile oils results in release of

these substances as gases and greatly reduces their assimilation by the animal's digestive system. If assimilated at high levels, the volatile oils found in many sagebrushes, rabbitbrushes, and junipers can be toxic to the animal.

### The Intermediate Feeders

Domestic sheep, burros, and caribou are considered to be intermediate feeders. These animals have the greatest capability to adjust their feeding habits to whatever forage is available. Domestic sheep are probably better adapted to the forage resource in the Intermountain West than any other ungulate because they will readily use grasses, forbs, or shrubs depending on availability. The primary problem with domestic sheep is that their short legs and relatively large body make them very susceptible to predation.

## Comparative Nutritive Value of Grasses, Forbs and Shrubs

On ranges of the western United States, the primary nutrient constraints on ungulate productivity are inadequate concentrations of energy, protein, phosphorus and vitamin A in the diet. With a few localized exceptions, mineral deficiencies other than phosphorus are not a problem.

Various studies on forage nutritive quality show different forages provide different levels of critical nutrients at different times of the year. Therefore, ranges with the widest diversity of plant species provide the best nutritional conditions for domestic or wild ungulates when year-long grazing is practiced.

### The Grasses

Grasses typically have lower crude protein, phosphorus, and lignin concentrations and higher total fiber and cellulose concentrations than do forbs and shrubs. Digestibility of grasses is generally less than forbs and shrubs. At comparable growth stages cool-season grasses are higher in crude protein, phosphorus, and digestibility and lower in fiber than warm-season grasses. Plant fiber is digested more slowly than the cell contents. The high cellulose (digestible portion of fiber) concentration and high cellulose to lignin (indigestible portion of fiber) ratio makes grasses best suited to large ruminants such as cattle or cecum digestors (horse) that have low nutrient requirements per unit body weight. Leaves of grasses are nutritionally superior to stems. For this reason short grasses are nutritionally superior to mid and tall grasses particularly during dormancy. Grasses are usually the component of the forage resource available in the great-

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est quantity unless overgrazing has been severe. Their high availability makes them important to large ruminants that have a total forage requirement.

### The Forbs

Forbs have higher levels of crude protein, phosphorus and digestibility and lower levels of fiber when actively growing than grasses or shrubs. Leaves from deciduous shrubs are similar to forbs in nutrient content. When dormant, forbs and deciduous shrubs leaves rank intermediate between grasses and evergreen shrubs in nutritive quality. Because of their low fiber levels, forbs and deciduous shrub leaves break down quickly in the rumen and permit higher intakes than grasses or evergreen shrub leaves during active growth. Forbs and deciduous shrub leaves are critical dietary components to small ruminants such as white-tailed deer and pronghorn that require low fiber diets.

It is important to recognize many forbs are poisonous. For this reason they have often been collectively considered undesirable by range managers. Studies conducted by myself in Oregon with cattle and Leo B. Merrill in Texas (JRM, 1978, 31:351) with cattle, sheep and goats show that poisonous forb problems are minimal if the range is in good condition (a high diversity of palatable plants) and grazing intensity is moderate. The ranges I studied in Oregon contained a wide variety of forbs. Many of these forbs were poisonous. During three years of study involving over 350 different cattle, no death losses due to poisonous plants occurred although many poisonous plants occurred as minor dietary species. These ranges were in good condition and stocked so approximately 30% use of the forage resource occurred.

### The Shrubs

Evergreen shrub leaves and buds from deciduous shrubs have higher crude protein, phosphorus, carotene (Vitamin A) and digestibility levels and lower fiber levels than grasses and forbs when forage is dormant. Woody material from shrubs is highly lignified and very low in nutritive value. Therefore grazing animals are highly selective for leaves, buds, fruits, and young twigs with low lignification. Ruminants with small mouth parts such as goats or pronghorn can select against woody material much better than cattle or elk. However, evergreen shrub leaves do provide an important crude protein, phosphorus, and carotene supplement to cattle and elk on many ranges when grasses are dormant. Deciduous shrubs with broad leaves such as snowberry and ninebark are heavily used by cattle during periods of drought. Many evergreen shrubs such as the oaks, sagebrushes, and junipers have volatile oils or tannins which bind up proteins, reducing the nutritive value of the forage. Animals with small mouth parts that can be highly selective such as goats, deer and pronghorn use these plants most efficiently.

## General Discussion

### Digestive Systems

In order to understand ungulate forage selection, some knowledge of their digestive physiology is necessary. I will provide a discussion of the primary aspects of this subject

that explains why different ungulates select different levels of grasses, forbs, and shrubs in their diets.

Ungulates have two basic types of digestive systems which include the rumen and cecum systems. Both systems evolved to enable ungulates to digest plant fiber (plant cell walls) by microbial (bacteria and protozoa) fermentation. The fermentation processes are quite similar in both the rumen and cecum. The systems differ in that the rumen is an enlarged portion of the digestive tract that food must pass through before entering the true stomach. The cecum occurs as an enlarged portion of the large intestine that food enters after passing through the true stomach.

The rumen system has two advantages over the cecum system. The process of rumination (regurgitation and rechewing of forage) results in considerable reduction of particle size that provides more surface area for microbial digestion. Because food must be broken down to fine particle size to leave the rumen, retention of fiber is longer than in the cecum. This results in more complete digestion of fiber in the rumen than cecum since fiber digestion is a time dependent process. A second advantage is that in the rumen system, microbes are passed from the rumen into the abomasum where they are digested and then absorbed, providing the animal with an important source of protein. Little microbial protein is absorbed by cecum digestors because microbial fermentation occurs after the food has passed through the stomach. However, recent research shows horses will ingest their feces when their diet is low in protein, which partially compensates for the inefficient use of microbial protein associated with cecum digestion.

The primary advantage of cecal digestion of fiber is that forage material can pass easily out of the cecum without any great reduction in particle size. Although fiber digestion is less complete by cecum digestors compared to ruminants, compensation occurs because they can consume a much greater amount of forages as they do not have to break fiber down to a small particle size to pass it out of their system.

On the basis of the previous discussion it is apparent that cecum digestors can subsist on lower quality diets than ruminants. However, they must have a greater forage supply since they use the forage less efficiently. This explains why horses can survive on coarse, mature grasses better than cattle.

Large ruminants can subsist on higher fiber diets than small ruminants because they have lower nutrient requirements per unit body weight. Therefore a large portion of the diet is typically comprised of highly available forage such as grasses for bison and cattle or woody material from shrubs and trees as in the case of the moose. The small ruminants such as white-tailed deer and pronghorn must consume diets dominated by leafy material and fruits from forbs and shrubs that have high levels of crude protein, phosphorus and digestibility and low levels of fiber. These animals can afford to be selective for these materials because they have a low total forage demand.

Domestic sheep are small ruminants that subsist well on grass dominated diets. This is because they have a relatively large rumen size in relation to their body weight compared to other small ruminants like white-tailed deer or pronghorn.

### Management Implications

In the past, range management practices have often been geared towards replacing forbs and shrubs with pure stands of grasses. The vast acreages of crested wheatgrass in the Great Basin and lovegrasses in the Southwest support the above statement. Rangelands with a pure stand of grass provide good forage for cattle or in some cases elk and mule deer during active growth but poorly meet the nutritional requirements of large or small ungulates during most of the year. Research in the Great Basin and the Southwest show that inclusion of palatable forbs and shrubs in seeding mixtures with grasses can greatly improve livestock performance during forage dormancy and provide better habitat for small wild ungulates and other wildlife species than pure stands of grasses.

Range condition is usually based on the density and production of native, palatable, perennial grass. A better criterion might be the diversity of palatable forage species. Under this criterion it might be desirable if up to 20% of the yearly

forage production was comprised of palatable annuals. It is important to recognize many annual grasses and forbs grow in periods when perennials are dormant. Research by Randy Rosiere and others (JRM, 1975, 28:89) in south central New Mexico and myself in northern New Mexico shows annual forbs provide an important nutritional contribution to cattle, sheep and pronghorn diets and reduce pressure on palatable perennial grasses during the growing season. In the Northwest, Martin Vavra's research shows the introduced annual, cheatgrass, provides green forage for cattle, mule deer, and sheep in the fall, winter, and early spring when the native perennial grasses are dormant.

A large number of studies involving both domestic and wild ungulates in North America are consistent in showing that forage selection changes tremendously within and between years. The nutritive quality of various forage species also shows great fluctuations within and between years. The greater the degree of forage selection a range provides domestic or wild ungulates, the more likely they will be to meet their nutrient needs. ●

## Viewpoint: Ecological Site/Range Site/Habitat Type

Rexford Daubenmire

My attention has recently been called to a note that appeared in the August 1983 issue of *Rangelands*, p 187-188, which contains some misconceptions as well as errors that should be pointed out.

In espousing his preference for the term "range site," the author of that note, E. William Anderson, stated that "the habitat type\* does not have management implications" for rangelands. This is completely at odds with much work published by range specialists. The latter have worked out identifying characters of habitat types in western rangelands and pointed out their management implications in work done in New Mexico (Francis and Aldon 1983), Colorado (Francis 1983), Idaho (Tisdale 1979, Hironaka, et al. 1983), Montana (Jorgensen 1979, Mueggler & Stewart 1980, 1981) and British Columbia (McLean 1970). Other workers have adopted the concept but have not used the term habitat type.

It is curious to note that Anderson has seen that essentially the same type of virgin vegetation (bluebunch wheatgrass/-Idaho fescue) occurs on north-facing slopes in dry climates at low elevation, but shifts to south-facing slopes under higher rainfall at higher elevations. This he views as indicating different "ecological sites." To a plant ecologist this vegetation is indicating the reappearance of a habitat type at places having essentially the same ecologic sum of climatic and soil conditions, as a result of microclimates of the contrasted slopes compensating for differences in macroclimates.

The concept of "range site" suggests a single-purpose objective, i.e., management of land for producing livestock forage. Habitat type, in contrast, emphasizes similarities and differences in ecosystems which carry implications for a variety of land management objectives such as livestock, wildlife and timber production, for predicting disease hazard, for indicating hydrologic cycles, etc. It is not clear what Anderson means by "ecological site," but if these words carry their usual meaning, the concept should coincide with habitat type, for the latter represents a narrow range of soil plus climatic conditions, as indicated by the tendency for this combination to favor a remarkably few species out of hundreds in the flora, and to determine which among them will dominate all others. The concept was first developed solely as a basis for arranging a wide variety of disturbed vegetation types in ecologically equivalent units. However, it soon became evident that these units had practical value in forest management with respect to choice of species to favor maximum productivity in each habitat type, and which habitat types are best suited for the growth of a particularly desirable species. Habitat types provide a guide to distinguish between land where dwarf mistletoe can and cannot infect ponderosa pine. Especially significant was the fact that when independently checked by field workers in applied ecology, the system proved easy to use and capable of adding materially to the stock of economically useful information.

The claim that the "range site concept is widely used in the U.S. and is becoming internationally accepted as the basic unit of resource inventory for the purpose of planning use

\*Habitat type is a collective term for all parts of the earth's surface which support, or are capable of supporting, the same kind of plant association, i.e., the same climax. The plant association must have the same potential dominants in all layers.