

# Chapter 2:

## Large Native Ungulates

### Introduction

This chapter addresses the large native ungulates (American bison (*Bos bison*), elk (*Cervus elaphus*), white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), and pronghorn (*Antilocapra americana*) of the grasslands. The information presented includes historical background, description of the species' biology and ecology, and management in relation to domestic animals.

### American Bison

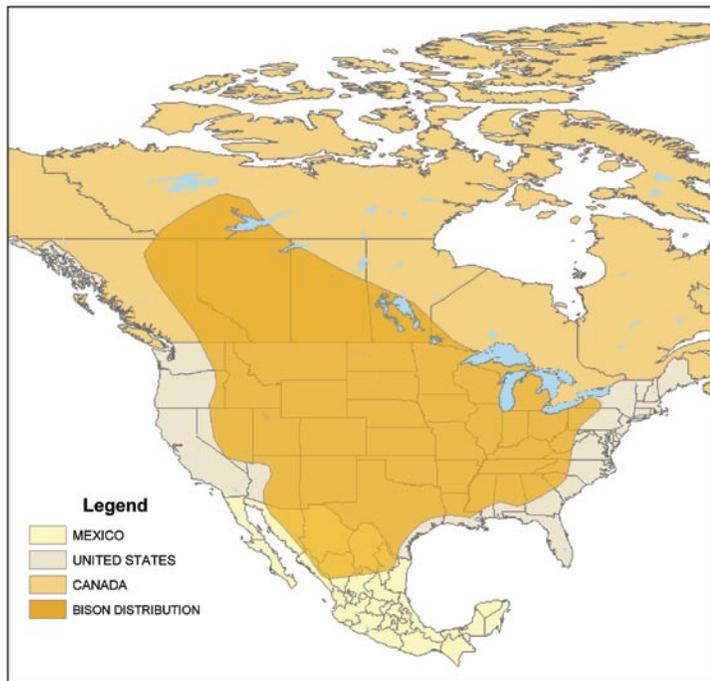
Historically bison were widespread in North America from Alaska and Western Canada across the United States into Northern Mexico (fig. 2-1). They are currently found in isolated units throughout and external to historical range. Three separate subspecies are recognized: the American bison (*Bos bison*), the wood bison (*Bos bison athabasca*), and the bison (*Bos bison bison*).

The wood bison and bison are primarily distributed in Canada (NatureServe 2004). Population size of bison in North America may have been between 30 million to 60 million about the time of Euro-American settlement and reduced to about 1,650 by 1903. The population in 1983 was estimated at 75,000 (Meagher 1986). In Yellowstone National Park, the herd was estimated at 3,000 to 3,500 in 1996 (Keiter 1997); however, more than 1,000 were killed during the winter



Bison on prairie dog site. (Photo by Paulette Ford.)

of 1996 to 1997 by agency personnel (NatureServe 2004). Populations of American bison have fluctuated dramatically during the 11,000 years of the present interglacial (the Holocene) and probably were at their peak in the Great Plains when Europeans first arrived in the 16<sup>th</sup> century (Parmenter and Van Devender 1995). A prolonged drought in the mid-19<sup>th</sup> century in concert with greater hunting pressures from Native American residents and American settlers and increasing competition with domestic livestock (notably horses and cattle) for riparian winter grazing lands, brought the bison to the brink of extinction. Today,



**Figure 2-1.** Map of the historic range of bison (NatureServe 2004).

there are approximately 30,000 bison in North America (Parmenter and Van Devender 1995). Bison currently play only a small role in the ecology of the grasslands of the Southwestern Region. They are discussed here because historically they had influence on some of the Great Plains grasslands and possibly on the desert grasslands (fig. 2-2) in the Region and because of their relationships with other wildlife species. They are also discussed because of their role as herbivores and the comparison with cattle.

Bison were common on the eastern plains of New Mexico in early historic times, although they did not inhabit the Rio Grande Valley or country to the west. Formerly abundant, and an important source of meat for Pueblo peoples, bison were essentially gone from New Mexico by 1860. Strips of buffalo skin kept among the Taos Indians were highly prized and were still being used primarily for decoration and ornamentation. Supposedly at this time, a fine buffalo robe would be saved by one of the Indian men for his burial. As with many Pueblo Tribes, the Taos Indians had among them a buffalo clan. The buffalo dance was one of the principal dances of the tribe, and it was set to music of drum and voice to represent the low hum of the grazing herd, and the thunder of a stampede (BISOM-M 2005). Unconfined herds of bison in the early 19<sup>th</sup> century moved over extensive areas of the Great Plains. Historical evidence shows that bison were present year round on short-grass, tallgrass, and mixed-grass regions. Herd movements were localized

and flexible, indicating that movements were in response to changing forage quantity and quality, making regular, long-range migrations unnecessary (Shaw 1996).

Currently in the Southwestern Region, there are no large herds of bison. Where they do exist, the herds are comparatively small and are reintroductions or transplants managed for hunting or recreation or to maintain the species.

## How Bison Modify Habitat

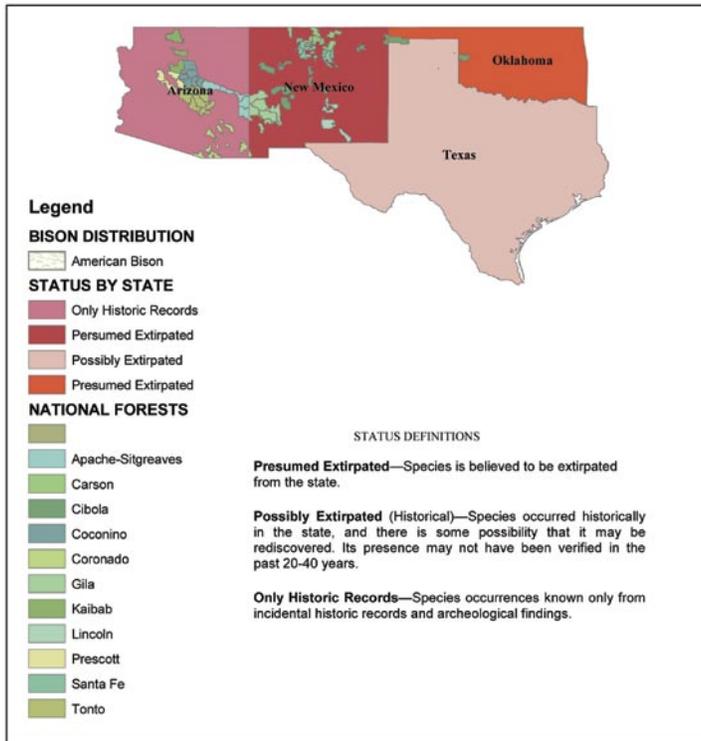
Bison have been identified as keystone species in the Great Plains (Knapp and others 1999). As a keystone species, bison had a principal role in the formation and maintenance of grassland ecosystems.

**Grazing**—Bison are primarily graminoid feeders (Shaw 1996, Wisdom and Thomas 1996) and avoid forbs and woody species. Thus, within a bison grazing area, forbs are often conspicuously left ungrazed and are surrounded by grazed grasses (Knapp and others 1999).

Bison and large herbivores influenced landscapes at multiple scales. Therefore, in their planning, managers should consider the role these large herbivores had historically on grasslands. At broad scales, watershed and landscape, the long-term consequences of bison activities included cover reduction, and changes in dominance of plant species and productivity of grasses. Bison grazing may result in a competitive release of many subdominant plant species resulting in an increase in the abundance of forbs, an overall increase in plant species richness and diversity, and increased spatial heterogeneity (Hartnett and others 1996).

Although alterations in plant community composition can be attributed to the direct effects of grazing by bison, increased plant species richness is also likely to be a product of increased microsite diversity generated by nongrazing activities, such as dung and urine deposition, trampling, and wallowing. These and other bison activities contribute significantly to the increase in the spatial heterogeneity that is characteristic of grazed tallgrass prairie (Knapp and others 1999).

Bison use of grasslands alters nutrient cycling processes and patterns of nutrient availability. Their effects on nitrogen cycling are critical because nitrogen availability often limits plant productivity in these grasslands and influences plant species composition (Knapp and others 1999). Bison and other ungulates in grasslands consume plant biomass that is difficult to digest and return labile forms of nitrogen (that is, urine) to soils (Knapp and others 1999). Nitrogen in bison urine is largely urea, which can be hydrolyzed to ammonium in a matter of days, facilitating nitrogen cycling in the grasslands (Knapp and others 1999). The



**Figure 2-2.** Map showing the historic range of bison overlaid by the States within the USDA Forest Service Southwestern Region, and the status of bison within each State (NatureServe 2004) and the National Forests within the Region.

net effect of bison grazing on nutrient cycling appears to be increased rates of nitrogen cycling, coupled with an increase in spatial heterogeneity in nitrogen availability (Knapp and others 1999).

**Are Bison and Cattle Functional Equivalents in Tallgrass Prairie?**—Studies that have focused exclusively on cattle generally concur that their grazing activities can increase spatial heterogeneity and enhance plant species diversity, as long as stocking density is not too high (Hartnett and others 1996). Because bison grazing in tallgrass prairie has a similar effect, one could conclude that either herbivore can alter resource availability and heterogeneity and reduce the cover of the dominant grasses sufficiently to enhance the success of the subdominant species. Perhaps of greater importance than differences in foraging patterns between bison and cattle, however, are the numbers of nongrazing activities, such as wallowing and horning (rubbing on trees) that are associated exclusively with bison (Hartnett and others 1996). These activities, when combined with the spatial redistribution of nutrients and selective consumption of the dominant grasses, may further increase plant species richness and resource heterogeneity, particularly at the landscape scale.

Nevertheless, it is likely that because bison and cattle are functionally similar as large grass-feeding herbivores, management strategies (stocking intensity and duration) will have a greater influence on the degree of ecological equivalency achieved than inherent differences in these ungulates (Hartnett and others 1996). The degree of overlap in diet and foraging patterns is greater between bison and cattle than between cattle and other historically important native herbivores (Hartnett and others 1996) such as antelope, deer, and elk.

The important elements of bison grazing activities can and should be incorporated into conservation and restoration strategies for remnant prairies (Knapp and others 1999). One approach to accomplish this goal is the substitution of cattle for bison. In Knapp and others (1999), an argument was presented that the choice of whether to use cattle or bison as a management tool in grasslands is scale- and context-dependent. Clearly, reintroducing bison may not be appropriate for small prairie remnants with public access and low economic resources. But cattle, managed for their ecological rather than their economic value, may be suitable in such cases.

## Relationship of Bison with Other Herbivores

Elk have such wide feeding niches that they use some of the same forages as bison (Shaw 1996). Diets of domestic sheep overlap partially with those of bison (Shaw 1996). Diets of mule deer and white-tailed deer do not converge with those of bison under normal conditions. Deer favor browse, forbs, and mast, whereas bison concentrate on graminoids. Deer favor woodier habitats while bison more frequently use open meadows and grasslands. Pronghorn share common ranges and habitats with bison but have divergent diets. Pronghorns eat almost exclusively forbs and browse. Horses forage on a wide range of plant foods, and their diets can overlap with those of bison (Shaw 1996).

## Bison in the Desert Grasslands

The role bison played in desert grasslands is not clear. We do know that they occurred in the Southwest, but to what extent is still a question. An extinct bison (*Bison antiquus*) with massive widespread horns was prevalent in Arizona and Sonora, Mexico, during the last Ice Age, the Wisconsin Glacial Period (Parmenter and Van Devender 1995). There have been several archaeological findings that indicate bison where in the Southwest (Parmenter and Van Devender 1995).

- The last confirmed hunting record of native bison in eastern New Mexico was in 1884 (Findley and others 1975).
- Bison horn cores, teeth, and bones were recovered in the excavation of Snaketown, a Hohokam settlement in the Gila River valley in Pinal County south of Phoenix that was occupied from before the birth of Christ until A.D. 1200 (Parmenter and Van Devender 1995).
- Bison bones associated with the years A.D. 1200 and 1380 were identified from two rooms in a 1968 excavation of the Hohokam Las Colinas site in Maricopa County near Phoenix (Parmenter and Van Devender 1995).
- Bison bones, some of them painted, found in a Babocomari Village excavation, were dated to A.D. 1200 through 1450 (Parmenter and Van Devender 1995). The Babocomari River, a tributary of the San Pedro River, flows through desert grassland on the north end of the Huachuca Mountains east of Elgin in Cochise County, Arizona. In the 1970s, a bison skull was found eroding out of sediments in the same area (Parmenter and Van Devender 1995).
- At Murray Springs, in the desert grasslands in the San Pedro River valley near Sierra Vista on the eastern base of the Huachucas in Cochise County, bones of extinct bison were found. This desert grassland site was likely dominated by grasses prior to 1890 but is presently covered with velvet mesquite (*Prosopis velutina*). At the same excavation, the skeleton of a female bison with a near-term fetus inside was discovered (Parmenter and Van Devender 1995) and radiocarbon-dated to A.D. 1700.

Not only were bison an archeological part of the desert grassland fauna, they were present according to historical accounts at least into the 17<sup>th</sup> and even into the 19<sup>th</sup> century. Parmenter and Van Devender (1995) present a postulate that the bison expanded its range into Arizona from the desert grassland valleys of northwestern Chihuahua during cooler, moister climatic fluctuations. It is a mystery why bison disappeared from desert grasslands before Euro-Americans began recording their observations in the 1820s (Parmenter and Van Devender 1995).

Bison have been introduced into Arizona and New Mexico since the early 1900s (Chung-MacCoubrey 1996, Findley and others 1975). Several small bison herds now exist in the desert grasslands of the Southwest.

## Elk

Elk are an important herbivore in North American rangelands. Their large body size, herding behavior, pioneering habits, and high mobility make them a



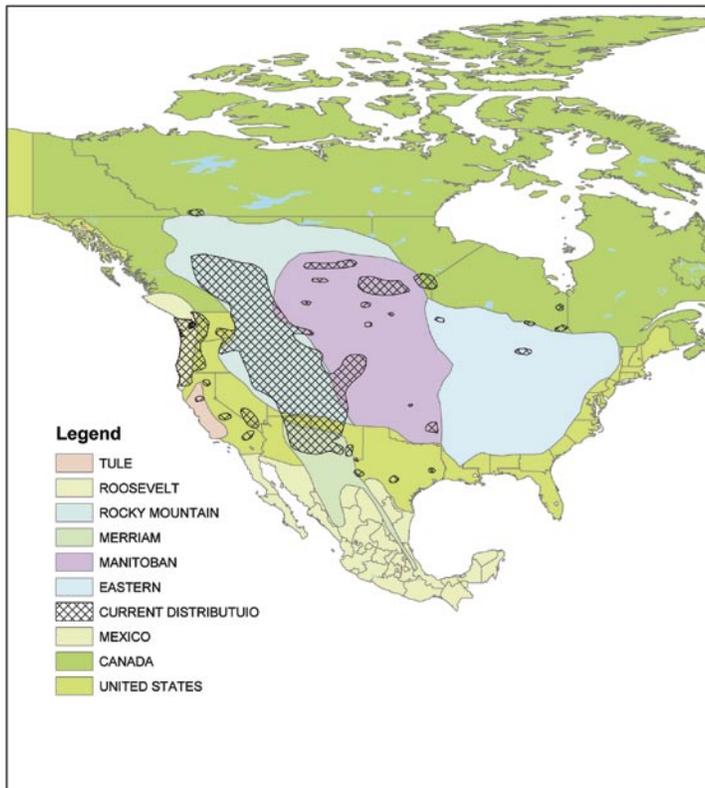
Elk photo by Lane Eskew.

conspicuous wildlife species on open grasslands. The potential for elk to compete with livestock makes them an obvious source of controversy between ranchers, farmers, and wildlife advocates (Wisdom and Thomas 1996).

Elk use a broad spectrum of habitats including alpine, conifer, hardwood and mixed forests, grasslands, savanna, and shrubland/chaparral. They often frequent open areas such as alpine pastures, marshy meadows, river flats, and aspen parkland, as well as open meadows in coniferous forests, brushy clear cuts or forest edges, and semidesert areas. On more level terrain, they seek wooded hillsides in summer and open grasslands in winter. No special calving ground is typically used; calves are born in valleys or in areas as high as alpine tundra. Newborn initially may be hidden in rough terrain or dense cover.

## Historical Distribution of Elk

The elk that live in North America today are direct descendants of red deer that migrated from Asia approximately 120,000 years ago. Currently, most biologists consider all the elk in North America to be the same species as the red deer in Asia and Europe (Rocky Mountain Elk Foundation 2004). Before European settlement, elk were among the most common and widely distributed of the wild ungulates in North America (Shaw 1996, Wisdom and Thomas 1996, Yoakum and others 1996). Historically, six subspecies of elk inhabited areas from the Atlantic to the Pacific Coasts. The Eastern elk (*Cervus elaphus Canadensis* extinct) once lived in Ontario, southern Quebec, and over much of the Eastern United States. Roosevelt elk (*Cervus elaphus roosevelti*) are found in the Pacific Northwest coastal forests of northern California,



**Figure 2-3.** Historic distribution of elk in North America (Bryant and Maser 1982, in Wisdom and Thomas 1996) and the current distribution (NatureServe 2004).

Oregon, Washington, and Vancouver Island. The smallest of the subspecies is the Tule or California elk (*Cervus elaphus nanodes*), which once lived in large numbers in California's San Joaquin and Sacramento Valleys and has adapted to semidesert conditions. The Rocky Mountain elk (*Cervus elaphus nelsoni*) ranges from New Mexico to Northcentral British Columbia and through the Intermountain region. It has been introduced into many places in North America and elsewhere in the world. Merriam elk (*Cervus elaphus marriami* extinct) once lived in the mountains and chaparrals of western Texas, New Mexico and mountains of Arizona. Manitoban elk (*Cervus elaphus manitobensis*) ranges from the southern Prairie Provinces of Canada to North Dakota. (fig. 2-3) (North American Elk Subspecies 2004, Rocky Mountain Elk Foundation 2004, Wisdom and Thomas 1996).

Controversy exists on whether elk once occupied rangelands of the Great Basin and Desert Southwest. This controversy centers on recent transplants of elk and/or recent colonization by elk into these areas (Yoakum and others 1996) and the potential for competition with livestock.

According to Yoakum and others (1996) and Wisdom and Thomas (1996), elk originally occupied most of the grasslands throughout Western North America, including major areas of the Great Basin and Desert

Southwest. However, lack of permanent water likely restricted elk distribution in the driest portions of these regions, and these dry areas presumably are outside the historical range of the species (fig. 2-3). This agrees with evidence that large, wild ungulates historically were absent from or sparsely distributed across large areas of the Intermountain West (Wisdom and Thomas 1996).

## Population Declines and Extirpations

Shaw (1996) estimated numbers of North American elk at 10 million before the arrival of Euro-American settlers. By contrast, with the exception of the Rocky Mountain and Roosevelt subspecies in the West, elk are now distributed in small, disjunct populations across much of their former range (Wisdom and Thomas 1996) (fig. 2-3).

Elk numbers declined as Euro-American settlers moved west in the 17<sup>th</sup>, 18<sup>th</sup>, and 19<sup>th</sup> centuries. By the early 1800s, the eastern subspecies was likely extinct (Wisdom and Thomas 1996). Populations of Tule elk, once abundant in valleys and bottomlands of California, were reduced to approximately 100 animals by 1875 (Wisdom and Thomas 1996).

The Merriam subspecies was extirpated from the Southwest by 1906 (Wisdom and Thomas 1996). By the early 1900s, Manitoban elk of the northern prairies were close to extinction (Wisdom and Thomas 1996). During the same period, populations of Rocky Mountain and Roosevelt elk were reduced to scattered, isolated pockets within their former range (Wisdom and Thomas 1996). Unregulated hunting, overgrazing by livestock, and conversion of habitat to agriculture and city land led to these broad-scale declines and extirpations (Parmenter and Van Devender 1995, Wisdom and Thomas 1996).

## Current Abundance and Distribution

In 1910, an estimated 60,000 elk remained in North America, with fragmented populations present in seven Western States. By this time, most States had enacted legislation that prohibited the hunting of elk. Then, efforts to recover elk populations were initiated through programs of translocation. From 1892 to 1939, more than 5,000 elk were live-trapped and transported from the Yellowstone area for release in 36 States and parts of Western Canada (Wisdom and Thomas 1996).

By the 1930s, elk numbers and distribution increased substantially, with the population estimated at 165,764 by 1937 and 236,787 by 1941. In the 1960s, elk populations had grown to approximately 440,000 and increased to 500,000 by the late 1970s and 600,000 by 1987 (Wisdom and Thomas 1996).

Today an estimated 700,000 elk exist in North America. Populations are generally increasing and

translocations continue. Elk are present in at least 22 States (fig. 2-3). Native predators, particularly wolves (*Canis* spp.), have been extirpated throughout the Southwestern range of elk except in limited reintroduction areas, and therefore, elk numbers are no longer naturally regulated. Hunting has replaced predation as a means for maintaining elk populations.

## Elk on Public Versus Private Lands

Before Euro-American settlement, elk often made expansive seasonal movements in response to annual changes in weather and forage availability (Wisdom and Thomas 1996). Such movements are not possible today. Many seasonal habitats used historically by elk are now privately owned and managed exclusively for agriculture, livestock, and timber production (Wisdom and Thomas 1996). Elk use of these areas is not tolerated or tolerated only minimally. In other cases, historic habitats have been converted to cities, industrial developments, and recreation areas (Wisdom and Thomas 1996). Elk now reside in “ecologically incomplete” or “ecologically compressed” habitats across much of their historic range (Wisdom and Thomas 1996).

Patterns of land ownership in the Western United States exemplify the problem. In the West, more than 90 percent of elk use public lands during summer while they use privately owned lands for the majority of their winter range. Large numbers of elk are produced on publicly owned summer range, where they are valued for hunting and viewing. Elk then migrate to privately owned ranges at lower elevations during the winter. On such lands, elk often encounter severe shortages of habitat features and active programs of population control to minimize competition with livestock and damage to crops (Wisdom and Thomas 1996).

Efforts to control elk damage and consumption of crops and cattle forage on privately owned lands are intense and varied. Activities include providing landowners elk hunting permits to sell to hunters, government financial compensation for loss of revenue due to damages caused by elk, permission to landowners to kill “nuisance” elk, special hunts, fencing to exclude animals from private ranges, and leasing or acquisition of additional winter range to maintain winter carrying capacity.

The shortage of year-round, ecologically complete habitats for elk and other wild ungulates poses significant management problems on North American rangelands. Many of today’s management problems can be attributed to fragmented ownerships and the associated differences in land use goals between public and private lands (Wisdom and Thomas 1996).

## Other Economic and Social Values

Elk hunting and viewing are highly valued experiences, both aesthetically and economically. New sources of revenue from consumptive and nonconsumptive users of elk and other wildlife, combined with growing political influences of such users, are causing shifts in economic and social values that affect management of public lands (Wisdom and Thomas 1996).

## Elk-Livestock Interactions

Grazing by elk and livestock is perhaps the most significant land use issue affecting management of both species on public and private lands. Issues of forage allocation and competition are subjects of unending debates (Wisdom and Thomas 1996).

In relation to dietary overlap between elk and cattle, the following 12 generalizations can be made (Wisdom and Thomas 1996):

- The potential for competition between elk and cattle is highest on winter and spring-fall ranges where either forage quantity or quality is limited and where both species can commonly share “ecologically compressed habitats” on low-elevation bottomlands or foothills.
- Competition between elk and cattle is usually low on high-elevation summer ranges where forage of moderate to high quality is readily available during late spring and summer and where animals have a more expansive land base from which to make optimal grazing choices with carryover effects into winter and spring.
- The potential for competition between elk and cattle increases during late summer and fall on high elevation summer ranges following the onset of prolonged seasonal drought and the subsequent decline in forage quality.
- Elk and cattle often distribute themselves spatially in a manner that minimizes competition.
- Elk and cattle can distribute themselves temporally (seasonally) in a manner that minimizes or heightens competition between the two.
- On ranges where spatial or temporal distributions overlap, differences in the diets of elk and cattle can sometimes minimize competition.
- The potential for competition between elk and cattle is high on unproductive rangelands, especially in arid ecosystems. Potential for competition also is high on rangelands grazed to full or maximum use by elk or cattle, and on rangelands experiencing a declining trend in condition.

**Table 2-1.** How elk respond to various grazing regimes (Wisdom and Thomas 1996).

Grazing system	Result
Season-long, deferred-rotation (in northeastern Oregon)	Elk preferred ungrazed areas and showed no difference in their use of season-long versus deferred-rotation pastures.
Season-long, deferred-rotation grazing (in northeastern Oregon)	Higher elk use under season-long than deferred-rotation grazing with cattle light stocking. The opposite preference was found when stocking was high.
Rest-rotation grazing, season-long grazing (in Montana)	Elk preferred pastures in rest and avoided pastures actively grazed by cattle. However, overall use by elk was not significantly different under rotation grazing than that observed under season-long grazing.
Season-long, rest-rotation grazing (in east-central Idaho)	No changes were found in population trends of elk following a change from season-long to rest-rotation grazing. It was concluded that elk preferred pastures in rest and avoided those actively grazed by cattle.

- High densities of elk may induce negative effects on forage conditions similar to that caused by high stocking rates of cattle, resulting in lower animal performance. Intraspecific competition among elk, and resultant negative effects on forage, likely are density-dependent and manifested at high population densities.
- Elk show an aversion to the presence of cattle that may or may not restrict their grazing choices.
- On productive rangelands that were grazed historically by native herbivores, systems of cattle grazing can be designed to enhance forage or foraging conditions for elk. Likewise, grazing by elk can enhance conditions for cattle.
- Competition can be high at a given time and place during a year and low or nonexistent in the same place and time in subsequent years.
- Perception is rarely reality when judging competitive interactions between elk and cattle.

## Elk and other Native Large Herbivores

Distributional overlap can occur with mule and white-tailed deer, bison, pronghorn, and bighorn sheep, which apparently partition forage and habitat resources to minimize competition in areas of overlapping distribution such as Yellowstone National Park (Shaw 1996). Often, patterns of foraging and habitat use are complementary. Grazing by elk can enhance forage conditions for pronghorn and mule deer (Shaw 1996).

Regardless, competition does occur in some situations (Wisdom and Thomas 1996). In contrast to mule deer and bighorn sheep, elk generally are more opportunistic and varied in their diet selection. Elk more easily digest forage of low quality, are more mobile and wide-ranging, and form larger herds, all of which may result in a competitive edge when resources are limited, presuming that elk out-compete mule deer on winter ranges that are limited in size and forage availability. Wisdom and Thomas (1996) also believed that mule deer would leave

or avoid areas of heavy use by elk, even if forage was available and dietary overlap with elk is low.

## Grazing Management Trade-Offs Between Elk and Livestock

**Type of Grazing System**—Little data exist about elk response to various systems of livestock grazing because there are few tests of elk response under experimental replication. Most research focuses on the effect of livestock grazing. The information that is available is inconclusive regarding elk preference for or aversion to any particular grazing system. Table 2-1 summarizes how elk respond to various grazing schemes.

**Effect of Stocking Rate**—Stocking rate of livestock, more than any other grazing variable, influences the composition, quantity, and nutritive value of forage ungrazed (Wisdom and Thomas 1996). This premise, combined with the potential for forage competition between elk and cattle, provides a framework for describing the effect of stocking rate on forage conditions for elk:

- Regardless of the grazing system used, the composition, quantity, and quality of forage available to elk is determined largely by the stocking rate of cattle, interacting with the density of elk, the inherent characteristics of the site, and weather.
- Light stocking rates of cattle can be neutral or positive in their influence on the composition and nutritive value of forage for elk.
- Moderate stocking rates of cattle, with allowable use of key species between 25 and 60 percent, can be positive, neutral, or negative in their effect on elk forage. Much depends on the timing of grazing, the physiological response of key forage plants to grazing, and the inherent productivity of the range and its condition.
- On relatively unproductive rangelands of the Great Basin and Desert Southwest, it is likely that

cattle use more than 25 percent will negatively affect forage conditions for elk.

- High stocking rates of cattle invariably heighten the potential for competition with elk for limited forage. Similarly, high densities of elk may induce intraspecific competition for forage (Shaw 1996, Wisdom and Thomas 1996), magnifying potential competition with cattle.
- Regardless, cattle use of key species at levels 60 percent or higher may significantly reduce or eliminate key forage plants for elk and cattle on nearly all range types (Wisdom and Thomas 1996). The remaining forage will likely be abundant but of low nutritive value, or scarce but of high nutritive value.
- On desert rangelands, both low quantity and quality of vegetation may result from overgrazing, negatively affecting both elk and cattle. These effects on elk forages may explain the inverse relationship between stocking rates of cattle and habitat use by elk (Wisdom and Thomas 1996). This relationship generally holds true for all types of grazing systems that have been studied.

**Water Developments**—Water is considered limiting to elk on many arid and semiarid rangelands. Elk may concentrate near water sources in extremely dry areas. Increasing the distribution and availability of water on many of the driest grasslands will likely enhance elk use of such areas, especially during dry seasons or years (Wisdom and Thomas 1996).

However, water development can be a “double-edged sword” if livestock have access to the water. Livestock use is usually highest within 1.6 km of water; this is the zone of most direct competition between elk and livestock. Improving the distribution of water—that is, making water more evenly and readily available throughout a pasture—will also result in a more even distribution of livestock (Wisdom and Thomas 1996) when all things are equal. This may increase the potential for competition with elk, or reduce elk use in favor of cattle use for two reasons: First, most water developments have road access; elk avoid areas near roads. Road densities and traffic will likely to increase with an increase in number and distribution of water developments. Elk are especially vulnerable to human harassment during hunting seasons when roads facilitate hunting (Wisdom and Thomas 1996). The second reason is that elk avoid livestock but return to grazed areas after livestock have left. A more even distribution of livestock, resulting from a more even distribution of water, may hinder grazing choices by elk unless livestock-free areas also are available within a herd’s seasonal home range.

**Roads**—Wherever elk occur, they consistently and dramatically avoid areas near roads that are open to

motorized traffic (Perry and Overly 1977, Wisdom and Thomas 1996). Implications of this relationship cannot be underestimated. All of the positive elk management that could be accomplished could be partially or wholly offset by the negative effects of open roads. This is especially true in areas of open grasslands and gentle terrain; here, vegetation and topography provide limited hiding and security from human activities. Aggressive programs of road management, obliteration and closure, is necessary to facilitate elk use of grasslands.

## Conflict Resolution of Elk-Livestock Problems

**Ecosystem Management of Elk**—Elk are mobile, adaptive, and opportunistic; they use a variety of habitats that span many jurisdictions and land ownerships. Their annual movements can encompass hundreds of square kilometers, bringing them into contact with a multitude of landowners and land uses.

At the same time, human development continues unabated on elk ranges. Traditional users of rangelands, such as farmers and livestock growers, are generally intolerant of high elk numbers. Hunters, wildlife viewers, and urbanites value these same rangelands, desiring more elk for hunting and watching. Given these conditions, elk land use conflicts will continue to grow in frequency and intensity.

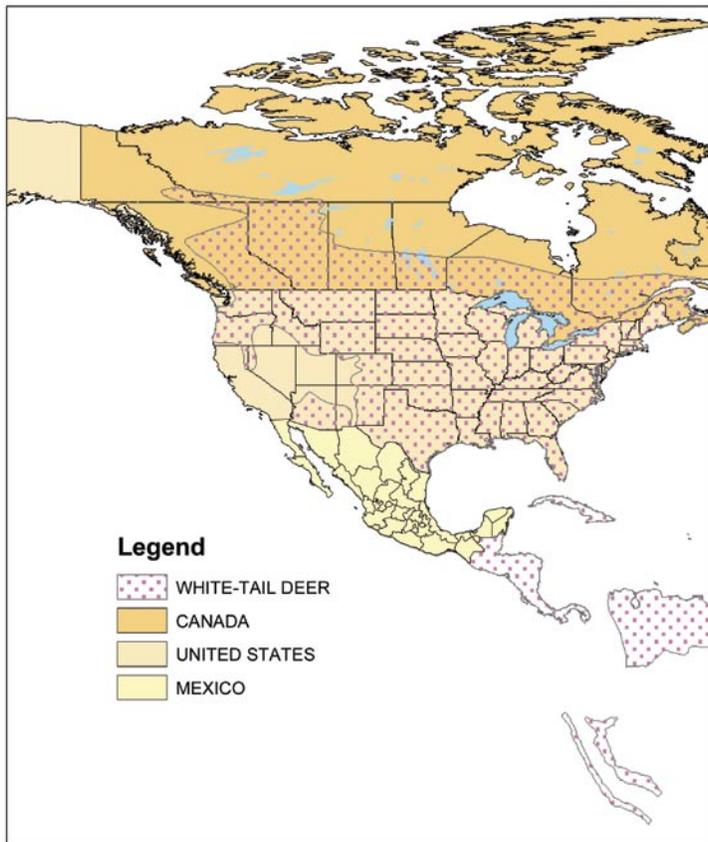
If polarized interest parties can adopt an ecosystem or a landscape approach to elk management, all of them will benefit. The geographic scale must change from that of an individual pasture, watershed, landowner, or allotment to that of an entire herd range, such as 10,000 ha or more. Within each herd range, partnerships such as those under way in Colorado (Wisdom and Thomas 1996) must be forged. Such partnerships are politically effective and provide an ecological basis upon which all interested parties can plan and implement the proper combination of land treatments and hunting regimes necessary to achieve the desired demography and distribution of elk across all land ownerships in time and space.

## Deer

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### White-Tailed Deer

Of all the big game animals in North America, the white-tailed deer is the most widespread and numerous member of the deer family, *Cervidae*. It is also the most important big game species recreationally and economically. It occurs in all States except California, Nevada, and Utah (fig. 2-4) (Southeastern Cooperative Wildlife Disease Study 1982). There are 38 races or subspecies ranging from southeastern Alaska through parts of



**Figure 2-4.** White-tailed deer distribution in North America (NatureServe 2004).

southern Canada into practically all of the contiguous United States and through Central America and as far south as northern South America (Teer 1996).

The ecology and management of the different races of white-tailed deer are similar across the various ecosystems they inhabit. Therefore, management is habitat- and herd-specific and must be adapted to the vegetation type and other elements of their habitat.

Unlike those in forested habitats, white-tailed deer numbers in the grasslands in the western United States have increased as a result of encroachment of woody vegetation and agricultural fields. In the Great Plains, deer were associated primarily with riparian systems but began to extend their ranges into upland habitats in the 1940s. In prairie-agricultural habitat in east-central Montana, white-tailed deer selected riparian habitat and its interspersions with cropland and rangeland habitats (Teer 1996). White-tailed deer on the lower Yellowstone River are associated with grassland (Teer 1996) and use adjacent farmland. Their numbers are positively related to density of riparian cover.

**Habitat**—White-tailed deer are extremely adaptable. They thrive in close association with humans and their agricultural and industrial developments.

The requirements of white-tailed deer are met in practically every ecological type, including grasslands, prairies and plains, mountains, hardwood, coniferous and tropical forests, deserts, and even farmland where it associates with woodlots and riverine habitats (Teer 1996).

Woody vegetation used by deer for cover and often for browse and mast is not an absolute requirement of deer habitats, although white-tailed deer are most often associated with brushlands and forested habitats. The species does occur in low densities in open pasturelands and grasslands. White-tailed deer in open grassland habitats occur in areas having screening or protective cover nearby for escape. Cover in such habitats may be herbaceous. Woody cover may be available in riparian zones associated with grasslands and plains.

White-tailed deer are also reported to use hardwood draws that often surge down into grasslands and mesic shrublands (Teer 1996). They often use these habitats during summer.

**Management of Livestock for White-Tailed Deer**—White-tailed deer and livestock are compatible and even synergistic, if livestock are managed for deer. Livestock can change the quantity and quality of forage by affecting erosion processes and nutrient losses, and consequently, even change

the quality of the soil on which the feed is produced (Teer 1996). No other factors in deer ecology and management, outside of poaching and the plow, have influenced the habitat and productivity of deer on rangelands more than livestock (Teer 1996).

Traditionally, the economic worth of livestock made them the animals of choice, the priority, in grasslands. Livestock were often stocked in combinations on common-use ranges where browse, forbs, and grasses provide preferred foods. Until recently, white-tailed deer and other wildlife species were not considered in livestock management. Changes that have occurred in management of rangeland for wildlife have been the result of commercialization of hunting, recreation, and, more recently, the growing interest in wildlife viewing. The changes from traditional uses of grasslands, particularly of public lands, are due to environmental groups challenging many of the traditional uses in favor of management of wildlife.

**Competition for Resources**—Competition between deer and domestic livestock is important when populations are dense. Sheep and goat competition with deer can be especially severe because the seasonal and dietary overlaps of these species are almost 100 percent. Cattle are less competitive with deer because their diets are primarily grasses and grasslike plants, whereas, deer use grasses sparingly (Teer 1996).

Good deer habitat consists of diverse vegetation. Availability of seasonal food sources is imperative in satisfying the whitetail's nutritional requirements. White-tailed deer reach their greatest numbers in rangeland communities where seral stages are below climax. Thus, disturbed land is often the best deer range because the habitat contains an array of annual and perennial herbaceous plants that serve as food, and woody plants provide food and protection from enemies and weather (Teer 1996).

**Behavioral Relationships with Livestock**—It is not clear if whitetails avoid cattle in pastures that are grazed. Deer on the Welder Wildlife Foundation in southern Texas avoided pastures stocked with cattle. Deer did not alter their home ranges but chose pastures in unstocked portions of their range. Avoidance was mostly in heavily stocked, short-duration grazing pastures. Similar avoidance occurred with greater distances between deer and cattle than between deer and other cervids (Teer 1996).

Whitetails ignored cattle and commonly grazed with them. They also ignored riderless horses but avoided horses with riders. Deer avoided pastures where forage supply was decimated by heavy grazing (Teer 1996). Whitetails do not appear to avoid livestock when stocking is low or moderate. Deferred rotation pastures contained deer in higher numbers than pastures grazed more intensively.

In the past, criteria used by range and wildlife managers to judge carrying capacity or quality of the range for livestock had little relationship to quality of white-tailed deer habitat or other wildlife species' habitats. Great differences occur in food and cover requirements of various kinds of domestic animals and deer, and these differences were largely ignored in classification systems.

Several researchers have attempted to determine forage relationships between livestock and whitetails. Animal unit equivalents proposed on the Edwards Plateau of Texas were five sheep, or six goats, or six white-tailed deer to one 489 kg cow with calf at side (Teer 1996). Teer (1996) reported that 13 deer were equivalent to one cow on the King Ranch in southern Texas. These ratios are viewed as rough standards for interpreting stocking rates and for developing diet relationships among various herbivores.

The impact of stocking rates of livestock on white-tailed deer is a two-pronged relationship. Overgrazing is obviously harmful to deer habitat, and undergrazing can also reduce its quality. Light to moderate grazing promotes plant vigor and diversity and increases production (Teer 1996). When grasses dry, cattle will switch to woody plants, which affect the quality of browse for white-tailed deer.

In addition to the effects grazing may have on the quality of white-tailed deer habitat, ranching activi-

ties also have an influence. Hood and Inglis (1974) found roundups disturbed white-tailed deer. Bucks reacted to roundups with long flights to adjacent pastures and, at times, extending their home range or left their home range for a time. Does, on the other hand, took a circuitous course that began and ended in their home range. Before the roundups the mean home range for does was 173 ha (427 acres), and after the disturbance the mean size of the home range had not change significantly, 190 ha (469 acres). The mean home range for bucks enlarged significantly from before the roundups, 285 to 402 ha (704 to 993 acres) (Hood and Inglis 1974). These before-disturbance home ranges are in close agreement to those determined by Rogers and others (1978) of a mean of 2.9 square miles (751 acres) in semidesert grass-shrub community in Arizona.

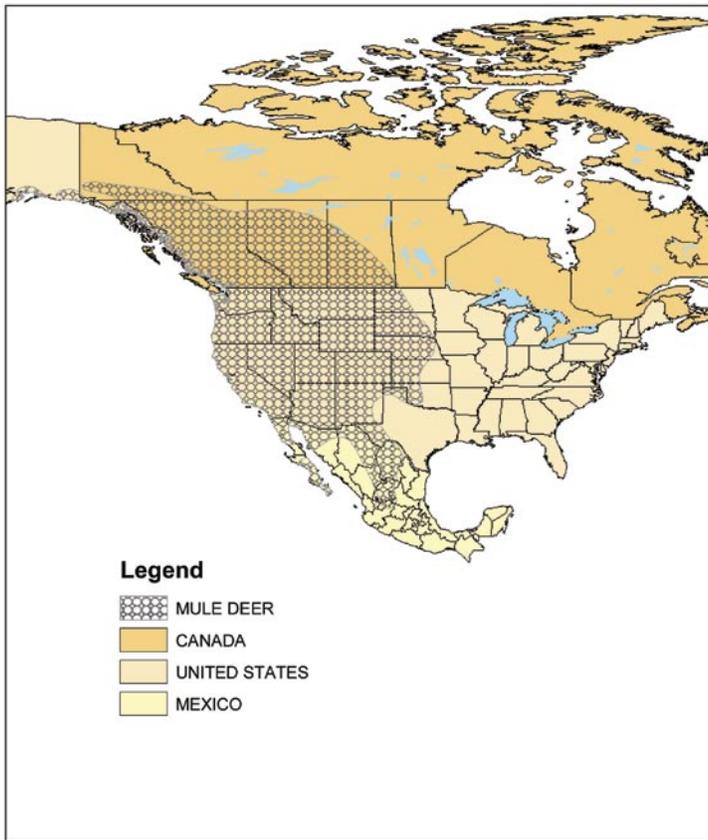
## Mule Deer

**Population Trends and Changes with Habitat**—Mule deer are found throughout Western North America (fig. 2-5). There is disagreement on how common they were prior to Euro-American settlement. Diaries and journals from the period 1820 to 1834 of early Euro-American explorers and mountain men indicate that mule deer were seen only incidentally. Also, researchers estimate that no more than five million, and possibly fewer, mule and black-tailed deer occupied the western United States during pre-Columbian times (Teer 1996).

Human settlement, unrestricted hunting, drought, severe blizzards, and the conversion of habitat to agriculture caused declines in mule deer populations. By the early 1900s, mule deer were generally scarce throughout much of the West. Widespread and intensive livestock grazing, logging, and burning proved beneficial to mule deer. Plants that were more palatable to mule deer than those that originally dominated native vegetation either invaded or increased in abundance (Teer 1996). This improvement in habitat along with strict hunting regulations, control of predators, and perhaps favorable weather conditions allowed populations to increase to all-time highs during the 1920s through the 1950s (Peek and Krausman 1996).

Since those high population levels, a variety of factors including overpopulation, the aging of shrub habitats to less productive seral stages, liberalized hunting regulations, and severe winters and drought led to declines in mule deer populations. By the mid-1960s and early 1970s, mule deer populations in many areas of the West had declined sharply (Peek and Krausman 1996).

The vegetation communities that supported mule deer have been subjected to livestock grazing, fire



**Figure 2-5.** Mule deer distribution in North America (NatureServe 2004).

suppression, uncharacteristically hot wildfires, and logging. These factors combined with natural successional processes have changed the natural habitats of mule deer. In some areas excessive grazing reduced grasses and brought about a reduction of fine fuels necessary to carry wildfires (Peek and Krausman 1996). This created a favorable environment for trees and shrubs, allowing many browse species to become larger and more vigorous and establish in higher densities. For example, important species such as bitterbrush (*Purshia tridentata*), sagebrush, curlleaf mountainmahogany (*Cercocarpus ledfolius*), and rabbitbrush increased. Eventually, however, lack of fire or some other stand renewal process led to decadent/senescent older aged shrub stands that are less productive for mule deer. Dense, older aged shrub stands can restrict animal movements and browse availability (Peek and Krausman 1996).

Invasion by exotic annual grasses such as cheatgrass (*Bromus tectorum*) has caused range deterioration in some areas. Cheatgrass can out-compete native species and tends to burn frequently, thus eliminating the opportunity for woody browse species to become established. Ranchers and range managers encourage the production of grasses as forage for livestock and

not woody browse for mule deer. Fire, mechanical manipulation, and herbicides are all employed to control and eradicate woody species. Because only a part of mule deer diet is composed of woody plants it is difficult to establish how these treatments have impacted mule deer numbers (Peek and Krausman 1996).

**Predation**—Predators include coyotes (*Canis latrans*), bobcats (*Felis rufus*), golden eagles (*Aquila chrysaetos*), wolf (*Canis spp.*), mountain lion, grizzly bear (*Ursus arctos*), and black bear (*Ursus americanus*) (Peek and Krausman 1996, Shawn and Dood 1984). The effect of predators, alone or in combination, on the dynamics of ungulate populations will vary with relative size of the predator and ungulate populations, ungulate dispersion patterns, sex and age, and general health of the populations. The effects of predation are difficult to isolate from all the factors concurrently acting on populations.

Deer population size will often influence the role predation plays. Predators, particularly those whose numbers are only slightly influenced by prey density, generally will have a relatively greater effect on deer populations whose numbers have been reduced by other factors (Wisdom and Thomas 1996).

**Grazing and Mule Deer**—Livestock grazing may interact with mule deer by altering plant succession to favor or reduce deer forage and cover. Changes in plant productivity caused by livestock grazing may also affect mule deer. Kie (1996) found that when cattle stocking rates increased during the fall and early winter when herbaceous forage was limited, then mule deer maximized energy by spending less time feeding. And when herbaceous plants began to grow rapidly there appeared to be no competition between deer and cattle, and increased cattle stocking rates had no effect on the time deer spent foraging.

Mule deer can also be directly disturbed by livestock and associated human activity. Mule deer responses may include changes in distribution patterns and habitat use, modification of activity, or alteration in population density (Peek and Krausman 1996).

**Forage Choice by Mule Deer and Cattle**—Peek and Krausman (1996) describe winter mule deer diet as consisting of an average of more than 74 percent shrubs and trees, 15 percent forbs, and 11 percent grasses and sedges and rushes (table 2-2). Spring diets include shrubs and trees (49 percent), grasses, sedges, and rushes (26 percent), and forbs (25 percent) (table 2-2). Summer diets include shrubs (49 percent) and forbs (46 percent) and minor proportions of grasses, sedges, and rushes. The fall diet showed an increase in dietary use of shrubs and trees to an average of 60 percent, while forbs declined to an average of 30 percent, and grasses, sedges, and rushes were 9 percent (table 2-2).

**Table 2-2.** Comparison of forage use by season between mule deer and cattle.

Season	Mule deer	Cattle
<b>Winter</b>		
Shrubs and trees	Averaged > 74% of (range = 27-100%)	Shrubs and trees typically receive light use.
Forbs	Averaged 15% (range = 0-43%)	
Grasses and grasslikes (sedges and rushes)	Average 11% (range = 0-53%)	
<b>Spring</b>		
Shrubs and trees	Average 49% (range = 6-92%)	Shrubs and trees typically receive light use.
Forbs	Average 25% (range = 0-43%)	Forbs appear to be used more in spring and when grazing is light.
Grasses and grasslikes (sedges and rushes)	Average 26% (range = 4-64%)	
<b>Summer</b>		
Shrubs	Average 49% (range = 12-95%)	Shrubs and trees typically receive light use.
Forbs	Average 46% (range = 3-77%)	
Grasses and grasslikes (sedges and rushes)	Very low	Grasses generally predominate in the summer diet of range cattle, but forbs may constitute a significant proportion in some areas.
<b>Fall</b>		
Shrubs and trees	Average 60% (range = 3-97%)	Shrubs and trees typically receive light use.
Forbs	Average 30% (range = 2-78%)	
Grasses and grasslikes (sedges and rushes)	Average 9% (range = 0-24%)	

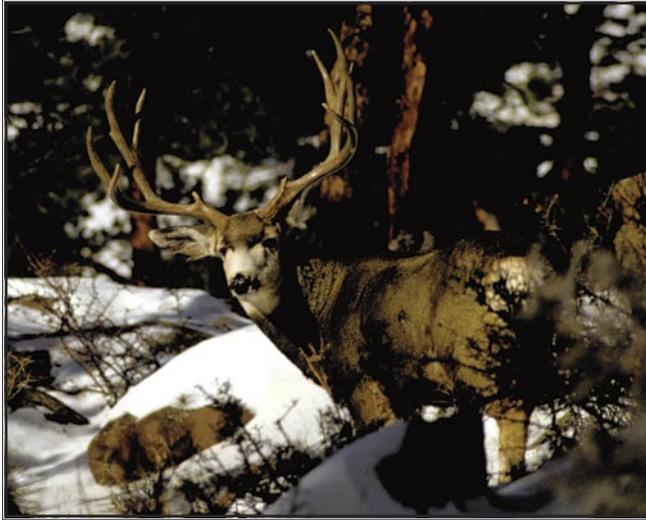
The general diet for mule deer shows high variability across the range depending on what is available. Habitat manipulations can stimulate changes in plant use. For example, burning or grazing that removes standing litter and stimulates early growth of bluebunch wheatgrass (*Agropyron spicatum*) can increase wheatgrass palatability, encouraging use by mule deer (Peek and Krausman 1996).

Forage used by livestock changes with intensity of use of a range, between areas, seasons, and years, as with mule deer. Grasses generally predominate in the summer diet of cattle, but forbs may constitute a significant proportion of cattle diet in some areas (Peek and Krausman 1996). Forbs are used more in spring diet of cattle and when grazing is light. Highest forb use occurred in late spring on eastern Oregon grasslands (Wisdom and Thomas 1996). Foraging use of shrubs and trees by cattle is light during all seasons, but woody plants may be a significant part of the diet during some years and in some areas.

The contrast between cattle and mule deer forage preferences is best exemplified by their usages of grasses. Cattle concentrate on the most abundant grasses that are often dominants in the ecosystem while mule deer tend to use subdominant species such as the bluegrasses, fine-leaved species such as fescues, or tips of leaves of species such as crested wheatgrass.

**Potential Overlaps in Forage Choice**—Drought and intensity of grazing are significant factors that influence the potential for competition for forage between mule deer and livestock (Julander 1955). When the highly palatable forb yellow sweetclover (*Melilotus officinalis*) was reduced in abundance because of low precipitation, greater use of shrubs and grasses by deer and cattle resulted (Bowyer 1986). If grazing is heavy, then cattle and mule deer may be forced to compete for scarce forage. Diet choice may be expected to vary between years for both species, depending upon what is available and what is palatable. Managing for several plant species may provide the level of nutrients needed. In maintaining mule deer habitat, it is important to provide a variety of forage choices and species diversity in plant communities. Heavy grazing or drought that reduces plant diversity or plant productivity can increase the potential for forage competition among the different grassland wildlife species (Peek and Krausman 1996). Forage availability in early summer is much higher than later in the season when forages become senescent. While range managers cannot anticipate the weather, the implications are to keep grasslands productive with a diversity of forage so animals have opportunities to exercise free choice and minimize potential competition.

In winter, forage use and species abundance are influenced by snow depth (Peek and Krausman 1996).



Mule deer photo by Lane Eskew.

Although mule deer may forage on a combination of forbs, grasses, and browse plants during snow-free periods, snow conditions may limit the use of forbs and grasses covered with snow that might otherwise be selected. Releasing livestock on winter ranges prior to snowfall should help to minimize reductions in available forage for mule deer.

**Plant Succession**—Sagebrushes may compose a moderate to heavy part of the winter and spring diet of mule deer (Peek and Krausman 1996) when forbs are unavailable and grasses are cured. Mule deer using less nutritious woody browse forage will switch to green grasses and forbs when they appear in spring without shifting to new habitats.

Mule deer graze many exotics plants, including cheatgrass, tansy mustard, filaree (*Erodium cicutarium*), and tumble mustard. Wyethia, dandelion, salsify (*Tragopogon dubius*), and the eriogonums (*Eriogonum* spp.), which would be expected to increase with cattle grazing, are also foraged by mule deer. However, balsam-root (*Balsamorhiza* spp.), tall asters (*Aster* spp.), bluebells (*Mertensia* spp.), and geraniums (*Geranium* spp.), which would be expected to decrease with livestock grazing, may be locally important mule deer foods (Peek and Krausman 1996).

The semidesert grasslands of the Southwest have also been subject to extensive modifications due to grazing and reduction of fire (Peek and Krausman 1996). There has been a general trend from grass-dominated communities in semidesert grasslands to shrub-dominated communities, but this trend has occurred in both grazed and ungrazed areas. An increase in shrubs is attributed to a hotter and drier climatic trend (Bock and Bock 1996). These grasslands are extremely important mule deer habitats and probably have become more so as shrubs have proliferated.

Rangeland conditions have generally improved since the drought of the 1930s (Peek and Krausman 1996). However, “improvement” is often interpreted in relation to livestock forage and might not reflect improvement for mule deer. Increases in livestock forage may mean that ground cover has improved, even if numbers of palatable mule deer forage species have declined. Mule deer habitat may benefit in some circumstances where plant species diversity is enhanced (Peek and Krausman 1996).

**Grazing Systems and Their Influence on Mule Deer**—This section includes some recommendations that will benefit mule deer (Peek and Krausman 1996):

- Construct fences that will permit passage of deer. These fences can be constructed to minimize interference with movement between pastures.
- Water developments may be used by deer, and guidelines exist to accommodate wildlife (Boroski and Mossman 1966, Peek and Krausman 1996, Rickel and others 1996). However, water development may allow cattle or other native ungulate species to graze areas previously not grazed and may displace deer.
- Forage use by livestock must be kept at levels that will ensure enough food for mule deer or will enhance growth of forages palatable to deer following grazing. This assumes that the objective of the grazing system is merely to integrate grazing with retention of mule deer habitat. However, if objectives include improvement of habitat by increasing shrub production, then special grazing management is indicated.

Peek and Krausman (1996) suggests that dual use of range by cattle and mule deer, when effectively managed, can be efficient land use even when both herbivores are utilizing the same forage species.

**Use of Livestock to Enhance Mule Deer Habitat**—Complete removal of livestock may not maintain nor increase needed shrub production on mule deer winter ranges, and efforts to enhance shrub retention and growth require active manipulation of plant cover (Peek and Krausman 1996). Fire and grazing management are logical tools for manipulating cover. They are relatively economical to apply, and managers have experience in their use.

Livestock grazing can be used to improve vegetation conditions for mule deer. Early observations that browsing stimulated production of additional twigs showed the potential for retention or improvement by grazing, recognizing that cattle might be used to alter shrub form and productivity to promote use by mule deer. The following objectives may be achieved by grazing livestock on mule deer habitat (Peek and Krausman 1996):

- Removing old growth to stimulate new growth palatable to deer.
- Reducing shrub heights to levels that are available to deer.
- Removing old growth that blocks access to palatable forage for deer.
- Using forage less palatable to deer, and consequently reducing competition with forage used by deer.

Timing of grazing is important where mule deer and livestock may have similar diet preferences. Timing of livestock grazing can be adjusted to influence forage production to benefit deer. Spring grazing may be appropriate to support shrubs that compose the major part of mule deer's winter diet. On ranges where the grass-forb components are important for deer, fall grazing is more appropriate. It has been found that sheep grazing from early summer to late summer improves forage quality in fall and increases forage quantity in spring for deer in Oregon's Coast Range. Springtime sheep grazing of a Utah winter range increased bitterbrush current annual growth and reduced the standing dead grass cover, which allowed mule deer to select a more nutritious diet that included more herbaceous material (Fulgham and others 1982). Longhurst and others (1983) explains that grazing maintained oak-woodland vegetation in a productive seral stage for deer by promoting growth and production of important deer forages. Cattle grazing could be used to drive plant composition in ways similar to sheep management (Peek and Krausman 1996). These results demonstrate how livestock can manipulate forage composition and productivity to achieve mule deer habitat objectives, suggesting that complete exclusion of livestock may not be necessary.

Long-term changes in vegetation composition may occur when special grazing treatments are used, and these changes should be monitored to ensure that trends in rangeland conditions are detected and modifications of grazing, if necessary, are timely (Peek and Krausman 1996). Manipulation of timing and species of livestock to enhance mule deer range has been effectively demonstrated and should be more broadly applied in future habitat management programs for mule deer and other wildlife. While such range management programs may require more flexibility and coordination, benefits derived may more than offset the added efforts. We can now purposefully manage grasslands to benefit livestock, mule deer, and rangeland vegetation by establishing suitable objectives and developing grazing programs that are flexible and tailored to the specific situation (Peek and Krausman 1996).

## Deer Management

**Herd and Population Management**—Maintenance, growth, and reproductive states require different nutritional intakes. Three seasons of the year are particularly critical for mule deer: fall, winter, and spring. Fall is important for putting on fat and for fetus development during the winter. A good winter diet is important for survival during the cold months. Then in spring, the plants that are early spring growers are critical for fetus development and lactation. Plus, aside from forage requirements, fawns need tall vegetation for hiding from predators. The importance of diets for fall, winter, and spring is similar for all Cervidea. Healthy growth of fawns after weaning is dependent on protein in their diets. Males have higher protein requirements than females. During latter stages of pregnancy, protein requirements are intermediate between that of growth and maintenance (Teer 1996).

Although deer can subsist for long periods on water obtained from vegetation, free water is an important component of deer habitat. Rickel and others (1996), in modeling mule deer habitat, concluded that the maximum traveling distance to water for fawns was 1 mile, for does 2 miles, and for bucks 3 miles. Water is usually supplied by natural water areas or can be provided through stock ponds and troughs used to water livestock.

Starvation results from the exhaustion of food resources and is a consequence of poor deer herd management or of no management. If the habitat will not support the herd and if the annual crop of deer is not removed by other means, starvation will remove it. This is an axiom in deer management. Natural regulation of herbivore populations is difficult when natural systems have been disrupted by man.

**Predator Control**—Predators are often cited as the chief cause of deer declines by the general public. Coyotes, mountain lions, bobcats, and other carnivores do kill deer, and their impacts on deer numbers can be important. However, quality of habitat and hunting may be much more important than predation.

Whether predators can control numbers of deer has been the subject of long debate. Now, however, considerable evidence has accumulated to show that coyotes, mountain lions, and other predators can substantially impact, if not control, herd numbers in certain situations (Teer 1996).

Coyotes are omnivorous and opportunistic in relation to diet. They take vegetable materials (that is, fruits, mast) when available and animal prey when abundant and easily caught (Teer 1996). Deer fawns are a large proportion of coyote diets especially when cover is sparse and other foods are scarce.

Control of predators through some kind of bounty system or other subsidized control program is often

the remedy called for by misinformed citizenry. Bounty systems by government agencies have often been abused by those engaged in predator management. Cost and benefit evaluations of the bounty system indicate it is ineffective in preventing predation or encouraging deer numbers (Teer 1996).

Predation along with sport hunting can be used to control deer populations. Conversely, when deer numbers are to be increased or protected, predator control may be an important activity (Teer 1996). A blanket recommendation cannot be made about predator control; each situation must be addressed separately.

## Pronghorn

The pronghorn is one of the key herbivores on both the plains and desert grasslands (fig. 2-6). The pronghorn's scientific name, *Antilocapra americana*, means "American antelope goat." However, the deer-like pronghorn is neither an antelope nor a goat. They evolved in North America and are the sole surviving members of an ancient family dating back 20 million years (The Pronghorn 2004, Yoakum and others 1996). Pronghorn existed with bison in legendary numbers when Lewis and Clark made their historic journey across the continent (fig. 2-6).

Today, an estimated 98 percent of pronghorn share their habitat with domestic livestock (Yoakum and others 1996). An estimated 60 percent of all pronghorn live on private lands and the remainder on Federal or State government-administrated lands.

## Pronghorn Distribution

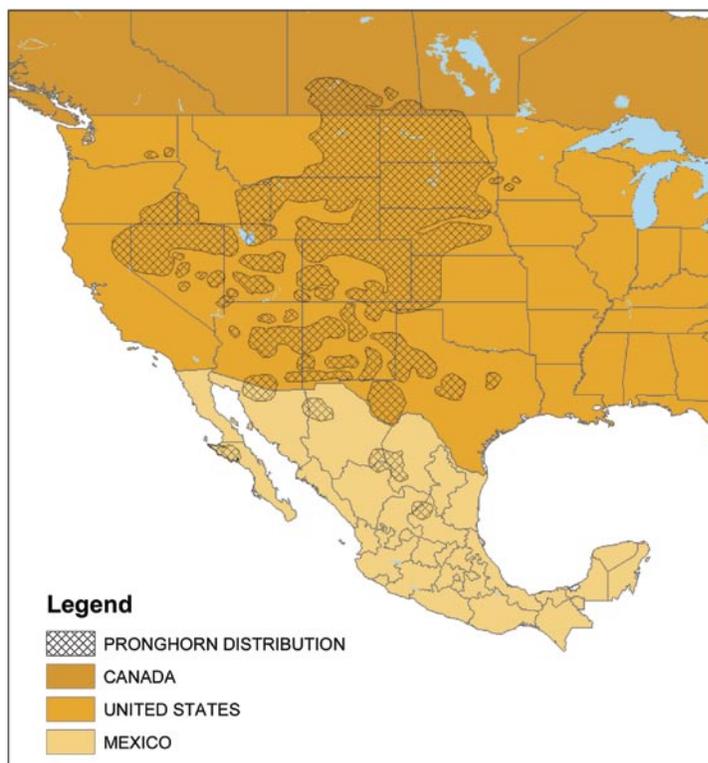
When Euro-Americans began to explore North America, they found pronghorn from the plains of south-central Canada (Alta., Saskatchewan, Manitoba), south through most of the Western United States and into Mexico (fig. 2-6). Herds ranged from the Mississippi River to the Pacific Ocean in central California. Herds extended from the Gulf of Mexico in Texas to the Pacific Ocean in lower California.

Pronghorn populations reached greatest densities with bison on grasslands of the Great Plains. Smaller populations occupied Intermountain and desert regions. They did not occur east of the Mississippi River (Yoakum and others 1996). Pronghorn now occupy many of their historic grasslands but in greatly reduced numbers. Contemporary herds are confined to smaller isolated habitats (fig. 2-6), unable to make historical seasonal movements because of freeways, railroads, fencing, and other anthropogenic constraints. The pronghorn is the most representative big game species dependent upon Western grasslands (Yoakum and others 1996).

## Pronghorn Abundance

Yoakum and others (1996) estimated there were 30 to 60 million pronghorn at the beginning of the 19<sup>th</sup> century. Some reports indicate they were as numerous or possibly more abundant than bison (Shaw 1996, Yoakum and others 1996). During the late 1800s, sport and commercial hunters hunted pronghorn herds and killed animals regardless of sex or age. Much of the best habitat was lost to the plow, and pronghorn movements became increasingly restricted by fences and other human-made impediments. Pronghorn also were subjected to livestock diseases and parasites to which they had little resistance. Numbers dropped from an estimated 35 million in 1800, to perhaps 13,000 in 1910 (Yoakum and others 1996). Public concern arose, protective laws were enacted, and supporting conservation and management practices were implemented. Within a decade, populations more than doubled and have continued to recover. Currently, pronghorn antelope number approximately 1 million (Pronghorn 2004). They are now second only to deer in large herbivore abundance and harvest in the United States.

**Two subspecies**—Sonoran pronghorn (*A. a. sonoriensis*) and Chihuahuan (Mexican) pronghorn (*A. a. mexicana*)—are found in the southern part of Arizona and New Mexico. The Sonoran pronghorn is Federally endangered. Of the total pronghorn population in North America, less than 1 percent is classified as



**Figure 2-6.** Pronghorn antelope distribution in North America (NatureServe 2004).

endangered (Yoakum and others 1996). The endangered populations are on the grasslands along the Mexico-United States border (BISON-M 2005, Ockenfels and others 1996, Yoakum and others 1996).

**Chihuahuan (Mexican) Pronghorn**—Historically this subspecies ranged throughout southeastern and south-central Arizona and inhabited grass-shrub valleys and grasslands. In Arizona by 1900, Chihuahuan pronghorn populations had been reduced, and they were not reported in Arizona after the 1920s (BISON-M 2005). Chihuahuan pronghorn populations in Arizona were probably extirpated by uncontrolled subsistence hunting and changing land-use patterns (BISON-M 2005). Populations were reintroduced from Texas stock in several areas within historic range from 1981 through 1985 and 1987, including Empire Ranch near Sonoita, San Bernardino Valley, Fort Huachuca, and Buenos Aires National Wildlife Refuge (most western extent of its range) (Arizona's Natural Heritage Program: Heritage Data Management System 2005).

The Chihuahuan pronghorn in Arizona are classified as big game, permitting it to be hunted. Only bucks are harvested annually (Arizona's Natural Heritage Program: Heritage Data Management System 2005).

**Sonoran Pronghorn**—Sonoran pronghorn has been described as the smallest of the five subspecies. Some females lack horns (Arizona's Natural Heritage Program: Heritage Data Management System 2005).

The historic range is difficult to determine because the subspecies was not described until 1945, many years after the population had declined and marginal populations were extirpated (BISON-M 2005). Herds that were observed along the lower Gila River, Arizona, by early travelers are presumed to have been Sonoran pronghorn. They are thought to have ranged from Hermosillo to Kino Bay, Mexico, to the south; Highway 15, Mexico to the east; Altar Valley and the Tohono O'odham Indian Reservation to the North; and Imperial Valley, California to the west (BISON-M 2005).

Presently, in Arizona, they are found on the Cabeza Prieta National Wildlife Refuge, the Organ Pipe Cactus National Monument, the Luke Air Force Barry M. Goldwater Gunnery Range, and possibly the Tohono O'odham Indian Reservation. In Mexico, they are believed to be confined to the northwest part of Sonora (Arizona's Natural Heritage Program: Heritage Data Management System 2005).

Based on a study conducted in 1984 using collared Sonoran pronghorn, four males had home ranges ranging from 64.5 km<sup>2</sup> to 1,213.6 km<sup>2</sup> (24.9 miles<sup>2</sup> to 468.6 miles<sup>2</sup>) an average of 799.7 km<sup>2</sup> (179.8 miles<sup>2</sup>), while six females had home ranges ranging from 40.7 km<sup>2</sup> to 1,143.7 km<sup>2</sup> (150.7 miles<sup>2</sup> to 441.6 miles<sup>2</sup>) and an average of 465.7 km<sup>2</sup> (176.3 miles<sup>2</sup>). The large variation



A doe and buck pronghorn. (Courtesy of NatureServe© Larry Master)

in home range size for this study appears to be tied to forage and possibly water availability (BISON-M 2005). These animals must use large tracts of land to obtain adequate forage.

Sonoran pronghorn exhibit the same social doe/fawn, territorial, and flight behaviors as noted for other pronghorn. A heightened response to human traffic has been noted. Once aware of an observer, Sonoran pronghorn are quick to leave the area (BISON-M 2005).

Fawning for Sonoran pronghorn takes place from February to May, and as early as January for populations in Mexico. Although the stress of summer rutting on pronghorn is higher, spring drop is desirable to coincide with temperate weather and spring forage. Sonoran pronghorn fawns are nursed for 60 days, unlike northern populations, which nurse up to 90 days (Arizona's Natural Heritage Program: Heritage Data Management System 2005).

Sonoran pronghorn were observed browsing on forbs, shrubs, and cacti. Forbs and cholla (*Cactaceae* ssp) were browsed on during the summer and fall seasons, while shrubs, cholla, and ocotillo were browsed on the remainder of the year (Arizona's Natural Heritage Program: Heritage Data Management System 2005). Cholla appears to be a key succulent forage item in their diet during the summer, constituting nearly 50 percent of their diet, apparently to meet their water requirements (Arizona's Natural Heritage Program: Heritage Data Management System 2005).

Free-standing water is limited within range of the Sonoran pronghorn in Arizona. In 1984, collared Sonoran pronghorn were observed at water troughs in November, January, and August. Tracks were observed leading up to, then away from, seasonal potholes during the monsoon season. The collared pronghorn exhibit movements apparently tied to water, as well as forage, availability. During a study conducted in 1995 using collared animals, Sonoran pronghorn were observed using an ephemeral supply of water on a daily basis in a crater on the Barry M. Goldwater Gunnery Range

(Arizona's Natural Heritage Program: Heritage Data Management System 2005).

In Arizona, the reason for population decline is attributed mainly to loss of habitat and drought. The drying of major rivers and overgrazing significantly altered Sonoran pronghorn habitat in southwestern Arizona by the 1930s. The population has not recovered since the establishment of three large public land withdrawals and the removal of cattle from these areas in the early 1980s (Arizona's Natural Heritage Program: Heritage Data Management System 2005). The only significant loss of habitat in recent years in Arizona occurred on the Tohono O'odham Indian Reservation where severe overgrazing by cattle, coupled with drought, resulted in the loss of large areas of pronghorn habitat (Arizona's Natural Heritage Program: Heritage Data Management System 2005). In Mexico, it is believed that economic exploitation of habitat (grazing and agriculture) and poaching are still causing population and habitat losses (Arizona's Natural Heritage Program: Heritage Data Management System 2005).

Measures have been taken to protect and enhance this endangered pronghorn. The establishment of three large public land withdrawals in Arizona, Cabeza Prieta National Wildlife Refuge, Organ Pipe Cactus National Monument, and Luke Air Force Gunnery Range (Barry M. Goldwater Gunnery Range). The removal of hunting from these sites, and the restriction of vehicle traffic further protects the Sonoran pronghorn. The removal of fencing between the Cabeza Prieta NWR and Organ Pipe Cactus NM, and within the Cabeza Prieta NWR in the 1990s has allowed for easier natural movement of Sonoran pronghorn (Arizona's Natural Heritage Program: Heritage Data Management System 2005).

## Predators

Predators of all pronghorn include coyotes, bobcats, mountain lions, golden eagles, and wild dogs. Coyotes are the primary predator of fawns in Arizona and New Mexico. Losses of pronghorn due to predation vary with pronghorn and predator numbers, habitat type, and availability of alternative food sources for predators. A pronghorn's speed and exceptional eyesight are its main defense from predators; pronghorn can detect movement up to 4 miles away. A fawn's best defense from predators is to choose good cover to lay down and to lie motionless (Arizona's Natural Heritage Program: Heritage Data Management System 2005, BISON-M, Yoakum and others 1996).

## Pronghorn Habitat Requirements

Currently, 68 percent of the herds inhabit grasslands, 31 percent shrub-steppes, and 1 percent deserts

(Arizona's Natural Heritage Program: Heritage Data Management System 2005, BISON-M, Yoakum and others 1996)). Most populations historically occurred in grasslands and shrub-steppes with large expanses of flat or low rolling terrain without major physical barriers to seasonal movements.

Pronghorn forage studies show that pronghorn prefer forbs, then shrubs, and that grasses were the least preferred forage. Thus, pronghorn management should promote an abundance of preferred forb species. However, an abundance of less preferred forbs and reduced grass cover resulting from excessive livestock grazing is detrimental to pronghorn.

Pronghorn select palatable, nutritious, succulent forage, and being selective, take small bites of preferred leaves, flowers, and terminal parts. Rarely do they feed extensively in one place but move frequently as they forage. Pronghorn consume less than 1 percent of forage produced on Western grasslands in the United States (Yoakum and others 1996).

The quality and quantity of vegetation appear to be major factors affecting pronghorn densities and production. Habitat quality is directly related to proper percentages, quantities, and distribution of physiographic and vegetative characteristics; too little or too much of any component may limit pronghorn production and survival. Pronghorn population dynamics between the shrub-steppes of the Great Basin and the grasslands of the Great Plains were compared, showing that fecundity was 190 fawns per 100 producing does for both ecosystems (Yoakum and others 1996). But fawn survival was twice as high, and grass and forb production was higher on the Great Plains than in the Great Basin. Nutritive values (particularly protein) of grasses and forbs were greater than shrubs during late spring and early summer when fawning occurred. Fawn survival was higher on the Great Plains because of abundant, nutritious grasses and forbs during late gestation and early lactation (Yoakum and others 1996). The lesser amount of grasses and forbs in the Great Basin, partly because of livestock grazing, apparently resulted in grasslands of lower carrying capacity for pronghorn.

## Pronghorn Relationships with Other Grassland Wildlife

**Prairie Dogs**—Because forb production is high in the centers of prairie dog colonies, it is speculated that prairie dogs (*Cynomys* spp.) may enhance grasslands for pronghorn by consuming grasses and disturbing soils, thereby increasing the abundance and variety of forbs (Yoakum and others 1996).

**Predators**—Predatory birds and mammals kill some pronghorn, but predation usually is significant only on marginal grasslands or sites where predator numbers are high in relation to pronghorn numbers. Most predator losses occur among fawns 1 to 3 weeks

**Table 2-3.** Dietary overlap for forage classes between pronghorn and bison, white-tailed deer, mule deer, and elk (Yoakum and others 1996).

Species	Location	Biome	% dietary overlap			
			Grasses	Forbs	Shrubs	Annual
Bison	Wichita Mountain National Wildlife Refuge, OK	Grassland	1	1		2
	Pawnee Grasslands, CO	Grassland	41	3	0	44
	National Bison Range, MT	Grassland	2.8	1.4	0.1	4.3
Elk	Wichita Mountain National Wildlife Refuge, OK	Grassland	0.1	24	0	24.1
	National Bison Range, MT	Grassland	2.9	4.6	3.8	11.3
	Trickel Mountain, CO	Shrub-steppe	3.5	11.5	45.5	60.5
Whitetailed deer	Wichita Mountains National Wildlife Refuge, OK	Grassland	0	99	0	99
	National Bison Range, MT	Grassland	2.9	24.8	18.5	46.2
Mule deer	Yellowstone National Park, WY	Shrub-steppe	16.6	9.2	52	77.8
	National Bison Range, MT	Grassland	2.3	27.1	33.3	62.7
	Northeast California, northwest Nevada	Shrub-steppe	2.3	4.2	82.3	88.8
	Trickle Mountain, CO	Shrub-steppe	3.5	10.2	79.5	93.2
	Sheldon National Wildlife Refuge, NV	Shrub-steppe	5	31	39	75

of age, while separated from their dams (Yoakum and others 1996).

**Bison**—Bison and pronghorn shared the same range, foraging and watering on the vast grassland prairies (Yoakum and others 1996). Apparently bison did not coexist with pronghorn historically in the Great Basin or on deserts. In comparing diets of bison and pronghorn in Colorado, diet differences were attributed to the species rather than to the grasslands (Yoakum and others 1996). Diets of bison and pronghorn studied in Montana overlapped minimally: bison consumed mostly grasses while pronghorn ate forbs and shrubs (table 2-3) (Shaw 1996). Bison disturbed dominant grass communities by trampling, wallowing, and grazing that resulted in greater production of forbs and shrubs favored by pronghorn.

**Elk**—There were larger range and habitat overlaps between elk and pronghorn historically than now. Elk and pronghorn have been observed foraging together with no acts of aggression and little dietary overlap (table 2-3) (Yoakum and others 1996). There is little overlap in habitat use between elk and pronghorn in Montana and little competition for space, water, or forage (Yoakum and others 1996). Elk forage primarily on grasses, whereas pronghorn prefer forbs and shrubs; consequently, dietary overlap was low.

**Deer**—Pronghorn occur on grasslands with whitetailed and mule deer; however, their distributions usually do not overlap (Yoakum and others 1996). All have similar diets (primarily forbs and shrubs) but overlaps are minimal (table 2-3) because of differences in habitat occupancy patterns. Behavioral interactions are also minimal because pronghorn are generally diurnal while deer are crepuscular and nocturnal.

## Pronghorn Relationships with Livestock

**Pronghorn and Livestock Forage Competition**—An estimated 98 percent of pronghorn populations share grasslands with domestic or feral livestock during some of the year (Yoakum and others 1996). Livestock on Western grasslands are either domestic animals such as cattle, sheep, and horses, or feral stock, primarily horses. Table 2-4 is a summary of the dietary overlaps between pronghorn and cattle, horses, and domestic sheep on grasslands and shrub-steppes.

Livestock grazing may alter pronghorn habitats more than any other human-controlled activity by changing vegetation structure and composition (Shaw 1996). When pronghorn and livestock grazed grasslands in southeastern New Mexico, they used many of the same forage species. Pronghorn did not switch to less preferred forage classes and were adversely affected when forbs and shrubs were depleted through drought or heavy livestock grazing (Shaw 1996).

Pronghorn use of plants noxious to livestock has been well documented (Shaw 1996), and for this reason pronghorn may be considered beneficial to livestock on grasslands. Spines of bull thistle (*Cirsium* spp.), Russian thistle (*Salsola* spp.), and cacti are less palatable to livestock, but pronghorn frequently eat them. Other noxious plants that livestock do not eat but are consumed by pronghorn include: in Oregon—woolly locoweed (*Astragalus mollissimus*), larkspur (*Delphinium* spp.), lupine (*Lupinus* spp.), death camas (*Zigadimus* spp.) (Shaw 1996); in Texas—locoweed (*Astragalus* spp.), woody senecio (*Senecio* spp.), Riddell groundsel (*Senecio* spp.), (Yoakum and others 1996); in Colorado—cocklebur (*Xanthium* spp.), snakeweed (*Gutierrezia* spp.), bull thistle, Russian thistle, cacti,

**Table 2-4.** Forage class dietary overlap among pronghorn and cattle, horses, and domestic sheep (Yoakum and others 2006).

Class of livestock	Location	Biome	Percent dietary overlap			
			Grasses	Forbs	Shrubs	Annual
Cattle	Trans-Pecos, TX	Grassland	4	7	9	20
	Southwest, MT	Grassland	3	20.3	1.6	24.9
	Winnett, MT	Shrub-steppe	3	13	0	16
	Rawlins, WY	Shrub-steppe	7.1	0.2	39.4	46.7
	Pawnee, CO	Grassland	46.3	2	6	54.3
	Northeast California, northwest Nevada	Shrub-steppe	4.1	3.4	3.7	11.2
	Southwest, UT	Shrub-steppe	0	0	27	27
	Roswell, NM	Grassland	4	15.2	1.3	20.5
	Panhandle, TX	Grassland	2.5	19	8.5	30
	Trickle Mountain, CO	Shrub-steppe	3.5	5	14	22.5
	Little Lost-Birch Creek, ID	Shrub-steppe	3	2	11	16
	Burns Junction, OR	Shrub-steppe	9.4	4.6	0.2	14.2
	Sheldon National Wildlife Refuge, NV	Shrub-steppe	5	9	1	15
Horse	Sheldon National Wildlife Refuge, NV	Shrub-steppe	3	23	2	28
	Northeast California, northwest Nevada	Shrub-steppe	2.5	5.2	5	12.7
	Trickle Mountain, CO	Shrub-steppe	3.5	2	31	36.5
	Burns Junction, OR	Shrub-steppe	13.5	2.1	0.3	15.9
	Sheldon National Wildlife Refuge, NV	Shrub-steppe	5	6	0	11
Sheep	Trans-Pecos, TX	Grassland	4	19	10	33
	Red Desert, WY	Shrub-steppe	3.2	2.6	28.4	34.2
	Southeast, MT	Grassland	3	27.3	25.3	55.6
	Rawlins, WY	Shrub-steppe	7.1	1.2	39.9	48.2
	Pawnee, CO	Grassland	46.3	18	3.3	67.6
	Southwest, UT	Shrub-steppe	0	0	46	46
	Little Lost-Birch Creek, ID	Shrub-steppe	3	14	39	56
	Roswell, NM	Grassland	4	50.2	6	60.2

chokecherry (*Prunus* spp.) (Hoover and others 1959); in Texas—tarbush (*Flourensia cernua*) (Hailey 1979); and in Utah—halogeton (*Halogeton* spp.) (Shaw 1996).

A potential exists for forage competition between pronghorn and domestic sheep. Yoakum and others (1996) reported intense competition for preferred forbs. A study of pronghorn and domestic sheep forage competition conducted during the early 1980s in New Mexico determined that livestock used as much as 40 percent of available forbs (Shaw 1996). As forbs declined in number or decreased in moisture content, livestock increased their use of grasses, increasing the potential competition for forbs. Overlap is highest when forbs are most available and lowest when they are least available. Yoakum and others (1996) reported that moderate use of shrubs on the cold desert of southwestern Utah by domestic sheep during winter created unfavorable conditions for pronghorn until the spring regrowth occurred.

Horses predominantly feed on grasses while pronghorn prefer forbs and shrubs. Five studies listed dietary overlap as low to moderate (11 to 36 percent) (table 2-4), suggesting that competition for food was limited.

**Pronghorn and Livestock Behavioral Relationships**—The behavioral relationship between pronghorn and livestock is nonaggressive while both species are feeding, drinking, or resting. Pronghorn does avoid cattle during fawning, resulting in selection of less favorable fawn-production sites (Shaw 1996).

Domestic and feral horses occupy grasslands with pronghorn (Yoakum and others 1996). Both animals have been observed to water together, with pronghorn giving ground only when directly approached by horses (Shaw 1996). Pronghorn and feral horse relationships in the Great Basin have shown various instances where pronghorns were displaced by horses.

**Pronghorn and Livestock Diseases**—Exposure to diseases is a concern when pronghorn and cattle share grasslands because their spatial distributions usually overlap. There is concern that either species may serve as a reservoir for diseases that affect the health of the other (Yoakum and others 1996). Blue tongue is probably the most serious disease of pronghorn, and cattle are a primary agent for spreading this disease to pronghorn. Blue tongue is fatal to domestic sheep. Neither pronghorn nor sheep are important reservoirs

for this disease because few animals survive to become carriers (Yoakum and others 1996). Leptospirosis causes some mortality in pronghorn, but evidence is insufficient to implicate either pronghorn or cattle as a primary reservoir of infection (Yoakum and others 1996).

Pronghorn had higher rates of parasitism on grasslands grazed by domestic sheep than grasslands grazed by cattle. In Wyoming, illness and deaths of pronghorn fawns have been attributed to parasitic infections that were prevalent on grasslands grazed heavily by sheep (Yoakum and others 1996).

## Pronghorn Management

Grassland management practices and improvements can be beneficial or detrimental to pronghorn populations, depending upon how they are planned and implemented. If the biological requirements of pronghorn are not met, then any management action could be detrimental.

Effective management systems should consider the control of livestock and range improvements for livestock, determine how many livestock will use certain grasslands, and take into account seasons of livestock use, results of monitoring studies, physiology of plants, and the effects and needs of wildlife on the grasslands.

For grasslands used by pronghorn and livestock, the following guidelines are recommended for designing livestock grazing systems (Yoakum and others 1996):

1. When allotting forage, the habitat requirements of pronghorn should be considered.
  - Adequate amounts of preferred plant species should be reserved as forage for pronghorn. These include grasses, forbs, and shrubs determined from diet studies in the same or similar ecosystems. Consideration should be given to proper use of key forbs and shrubs. Make sure that these are not grazed beyond their physiological tolerance levels.
  - Natural vegetation should be managed to provide an abundance and variety of forage classes. Most livestock graze grasses; pronghorns primarily consume forbs and shrubs. Grasslands producing mixtures of grasses, forbs, and shrubs will best serve livestock and wildlife. The challenge is to maintain existing grasslands in good ecological condition comprised of native vegetation. When deteriorated sites require rehabilitation, practices that restore vegetation to natural diversity are more desirable than practices that bring about monocultures and other unnatural conditions.
  - Practices that increase availability of long-term drinking water sites are highly beneficial to both animal groups. Water should be available

every 1.5 to 6.5 km. Water improvements can be designed in a number of ways; however, those that simulate natural waters are favored and cause fewer problems.

- Both pronghorn and livestock experience problems with predation, diseases, and parasites. Managers need to recognize how these factors affect the animals and coordinate control techniques beneficial to both groups.
2. Drinking water should be available during all seasons that pronghorn are in the area.
  3. Fence construction should meet specifications to allow movements year-round for all pronghorn age classes.
  4. When livestock grazing systems are designed using the “key plant species” concept, forbs and/or shrubs preferred by pronghorn should be included as key species.
  5. Livestock use should be limited on pronghorn natal areas during the fawning season.
  6. Livestock grazing systems that restrict, alter, limit, or deleteriously affect the habitat requirements of pronghorn should include mitigating measures and alternate procedures for enhancing pronghorn habitat.

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