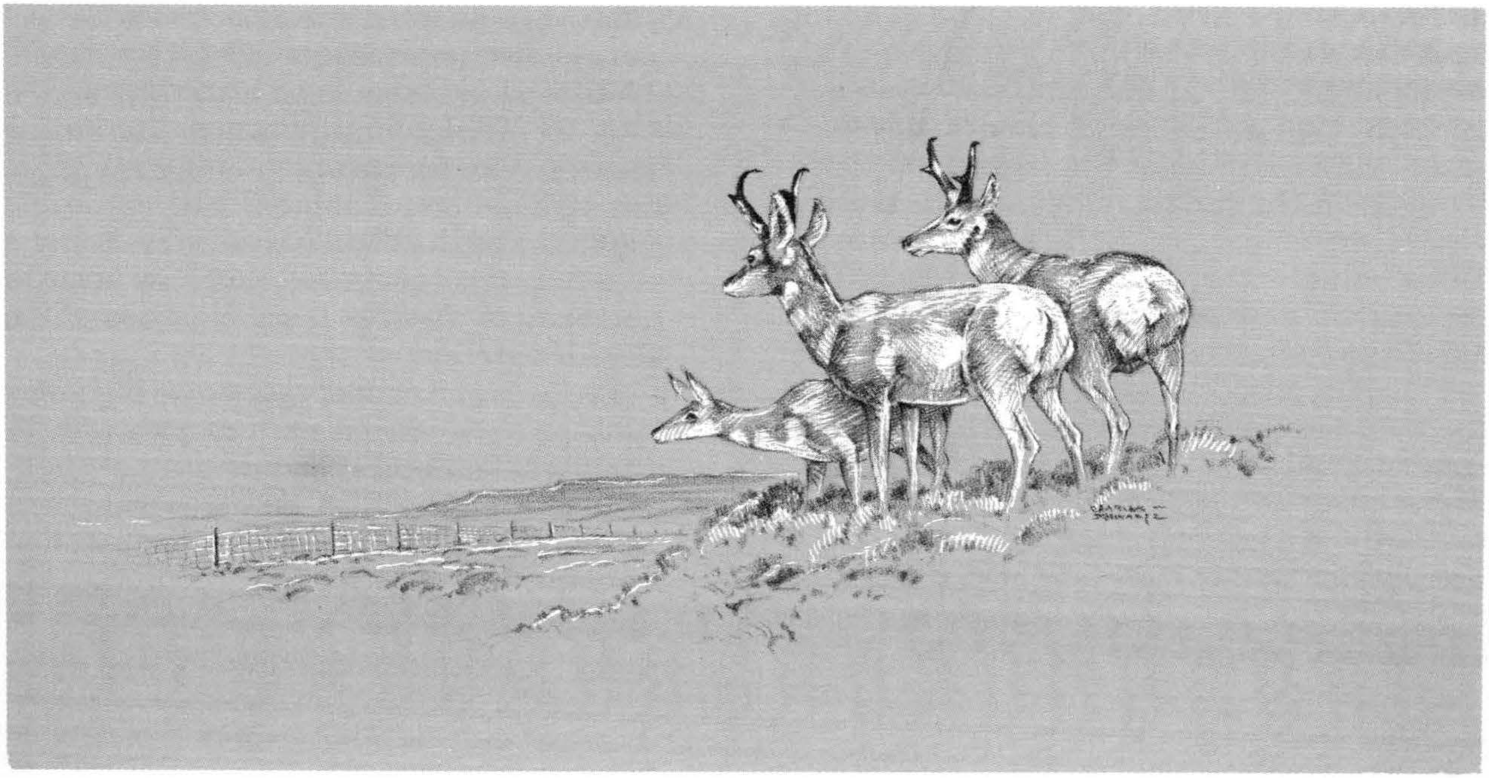
HABITAT CHANGES AND MANAGEMENT



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The purpose of this chapter is two-fold. First, I will sketch the nature of land-use changes in North America that have occurred since 1935 and some of their implications for big game resources. The second half of the chapter will present a brief overview of the current state of the arts of habitat management practices for big game animals.

LAND-USE CHANGES: 1935–PRESENT

Sweeping alterations of the North American landscape during the first four centuries of European man's habitation of the continent were described in Chapter 17. The Twentieth Century also witnessed striking changes in major human uses of the land, virtually all of which affected big game habitat. Some merely were continuations or reversals of trends in plant-successional trends resulting from earlier disturbances of the pristine habitat and involved logging, livestock grazing, fire suppression and agricultural practices.

However, the Twentieth Century involved a new dimension, namely the multiplicity of environmental disturbances in the wake of the rapid growth of human population and its increasing mechanization. This genre of land-use changes—including urban sprawl, development of transportation systems, mineral exploration and energy development—differed in that the impacts of these changes on the landscape generally are indelible. In many cases, the consequence of Twentieth Century land use has been the permanent or long-term loss of big game habitat.

Thus, for purposes of discussion, I will distinguish between successional changes and technological and sociological influences. These two categories obviously are not mutually exclusive, since improved technology enables us to increase both the extent and intensity of a particular disturbance and, hence, its impact on big game habitat.

Successional changes

1. Forestry practices. Modern forest science in North America emerged in the present century. It predicated a shift in consumptive emphasis from mere exploitation to management. Timber harvest still remains the most visible aspect of forest management. However, numerous practices now associated with intensive forestry, such as fire control, prescribed burning, reforestation, timber stand improvement and road construction, have considerable effect on wildlife resources.

   With respect to big game habitat, perhaps the most ubiquitous of these trends has been the progressive exclusion of wildfire as a result of sophisticated fire detection and suppression techniques. The elimination of fire as a major ecological disturbance has not been limited to forested areas, but also has occurred on vast acreages of western brushlands and grasslands as well. The statistics in Table 40 illustrate this trend clearly. The figures for the latter half of the 1960s show an approximate eight-fold decrease in the total acres burned and a five-fold decline in average fire size in contrast to figures from a period three decades earlier.

   Impacts of fire suppression on big game habitat have varied with respect to both the plant communities and animal populations involved. In many forest ecosystems, the effect has been maturation of plant communities toward climax conditions, often with attendant declines in forage productivity and nutrient quality. This succession has resulted in reduced quantity and quality of habitat for some big game populations, including those of deer and moose, which thrive best on ranges dominated by early and/or mid-successional vegetation. Longhurst et al. (1976) considered the decreased amount of acreage subject to wildfires and prescribed burns in California as a major factor contributing to recent deer declines in that state.

Table 40. Average annual wildfire statistics for the United States[a].

Period	Number of fires (thousands)	Area burned: Hectares (millions)	Area burned: Acres (millions)	Average size of burn: Hectares	Average size of burn: Acres
1936–1940[b]	211	12.6	31.2	59.9	148.0
1965–1969	120	1.5	3.8	12.7	31.5

[a]From annual wildfire statistics compiled by the United States Forest Service (1969) for federal, state and private lands.
[b]Figures for this period do not include those of Alaska.

In certain plant communities, however, the influence of fire exclusion on big game habitat has been somewhat positive. This was the case for extensive acreages of shrub-grass communities, such as sagebrush, pinyon-juniper and the desert grasslands of the Southwest. In these communities, the effect of continued fire suppression, in concert with excessive livestock grazing, has favored the shrub component at the expense of competing grasses, thereby creating improved habitat for mule deer.

Generalization about the net effects of timber removal during the Twentieth Century on big game habitats and populations is difficult. Farming, settlement and timber exploitation of forest lands in eastern North America partially replaced the natural role of wildfire in terms of rejuvenating pristine forest ecosystems. In the Northeast, many vast, once-cultivated areas were abandoned by settlers in search of more productive land. In time, some areas reverted to second-growth forests of benefit to white-tailed deer and, to some extent, moose populations. However, maturation of these second-growth woodlands during the past several decades has resulted in the deterioration of big game habitat. In the eastern United States, timber growth now exceeds timber cut.

By the 1930s, most of the original southern hardwood forest had been removed as a result of agricultural development and logging. Subsequent decades have seen the emergence of this region as the most important timber-producing area of the United States. Contemporary silviculture in much of the South is based largely on even-aged management of several rapidly growing pine species. Prescribed burning is employed extensively to reduce fuel accumulations and control the encroachment of competing understory hardwoods. Periodic burning induces low sprout growth that is within reach of browsing deer (Lay 1956, 1957, Lewis and Harshbager 1976). In some

Cut-over areas and stump farms, following settlement of eastern North America, temporarily set back forest succession in some areas to the benefit of big game. Photo by C. H. Park; courtesy of the National Archives.

areas, however, the excessive application of this technique has led to degradation of deer habitat by the virtual exclusion of mast- and browse-producing hardwoods in pine monocultures with "clean" understories.

Although logging activities in forests of the West date back to the late 1800s, large scale timber harvest on public lands commenced in the 1930s and did not increase substantially until after World War II. In comparison to successional changes caused by early wildfires and livestock grazing, logging per se probably was not a major factor in the mule deer population "booms" experienced by several western states in the 1950s and early 1960s. However, in dense coastal forests of the Northwest, increased levels of palatable forage on recently logged areas temporarily improved black-tailed deer habitat.

Modern logging practices and public attitudes toward timber harvesting have changed. Some earlier logging operations were linked to the railroads. A common practice was to clearcut progressively all timber adjacent to rail lines (Hooven 1973). The advent of heavy-duty logging trucks and crawler-type tractors made practicable the harvest of timber on smaller units. In the interim, land managers were forced to accept the fact that very large clearcuts are of limited value to most wildlife species, since such practices merely substitute one monoculture for another. Increased public awareness of the unsightliness of large clearcut tracts also influenced timber interests to harvest smaller units, with resultant benefits for some big game species and populations.

Other practices associated with intensive silviculture for production of conifers on a monocultural basis frequently are inimical to big game populations. The increasing application of reforestation techniques to shorten the cutting cycle may limit regrowth of desirable forage species following logging, thus reducing the usefulness of the "disturbed" area for big game (Hines 1973). In some forests on the west coast, timber stand improvement practices include removal of competing hardwoods, especially oaks, to favor conifers. This practice can be harmful to deer, for which acorns are a nutritious food source. Another interesting consequence of intensive forestry was noted in the Appalachians by Beeman et al. (1977), namely the removal of large decadent trees that provide den sites for black bears.

Road construction, a by-product of both timber harvest and fire control, has both positive and negative implications for big game. Forest road systems provide access to forest areas by conventional as well as off-road vehicles and, thus, increase the vulnerability of big game populations to human disturbance, particularly during hunting seasons. Logging roads, however, are not always detrimental to big game. Secondary and lower-level roads within logging areas may facilitate movements of big game to foraging areas created by logging. Seasonal closures of these roads following logging have minimized human disturbances and enhanced use of logged areas by big game, particularly elk.

2. Livestock grazing. The dust bowl era of the 1930s focused attention on abuses of public lands in the West. The year 1934 marked passage of the Taylor Grazing Act, which was intended to regulate grazing on these lands. This law established the predecessor of the Bureau of Land Management, curtailed grazing on severely overgrazed areas and brought some control to grazing on other areas. The forerunner of the Soil Conservation Service was established in 1935 to control soil erosion on public lands and provide private landowners with financial and technical assistance for the proper management of their lands.

Wagner (1977) analyzed records of the United States Department of Agriculture's Statistical Reporting Service to as-certain historical changes in the number of domestic livestock grazed on public lands of the 11 westernmost states (Figure 67). From 1935–1975, sheep numbers declined significantly. However, this decline was offset by a gradual but continuous increase in cattle numbers. Thus, Wagner concluded that the potential forage demand of domestic livestock on western rangelands was at an all-time high in 1975. However, increased use of supplemental feeding and implementation of modern range-management practices, such as fencing, water development and measures to distribute grazing pressures, partially compensated for the effects of increased numbers of domestic livestock on public lands.

Certain facets of this scenario have produced changes in big game habitat. The excessive grazing pressures of the late Nineteenth and early Twentieth centuries occasioned the invasion or increase of woody plants on grassland areas of the West, thereby creating favorable forage and cover conditions for deer. Throughout much of the West during the first half of this century, deer populations increased to unprecedented levels.

In some areas of the Mountain and Intermountain West, where grazing has been eliminated or drastically curtailed in recent years, there appears to be a reversion of brushy foothill ranges to the original bunchgrass vegetation (Smith 1949, Wagner 1969). While such changes probably have improved the quality of habitat for elk, they have worked to the detriment of mule deer.

Other livestock-oriented activities such as range-improvement programs, predator control and fencing also have affected big game habitat. Vegetation type conversions and water developments will

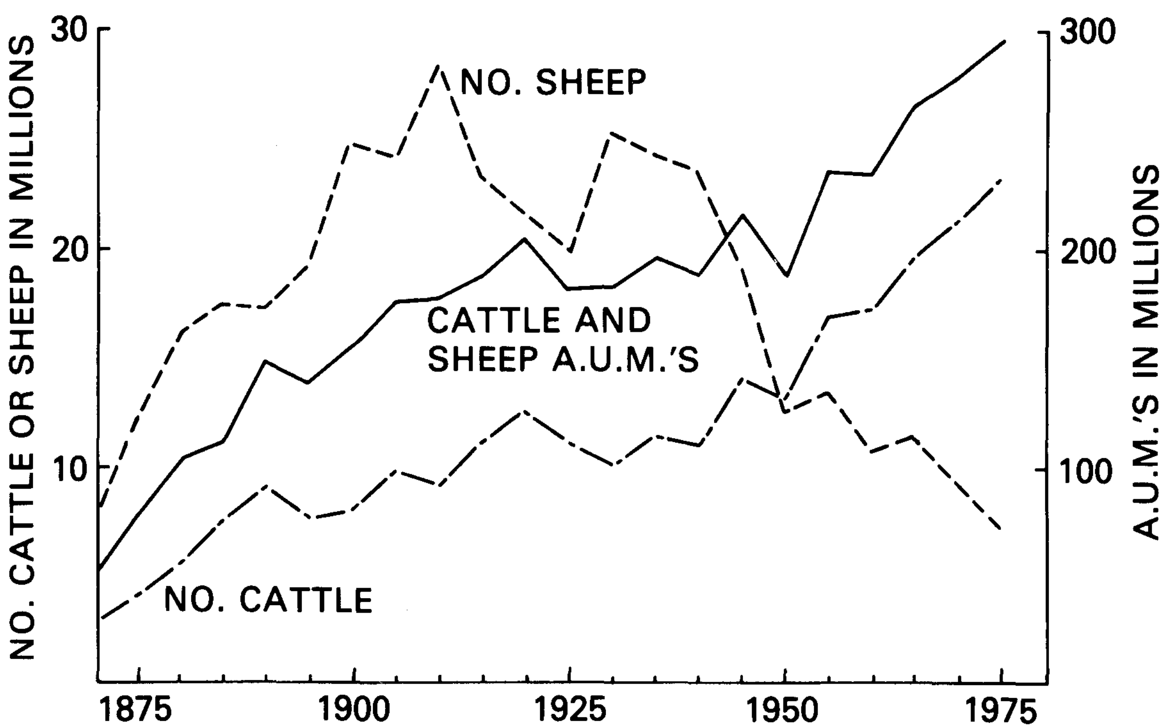


Figure 67. Chronological trends of sheep and cattle numbers (excluding lamb and calf crops), and estimated total livestock forage need (Animal Unit Months) in the 11 westernmost states (after Wagner 1977).

be treated later in this chapter, and the impact of predator control efforts is covered in other chapters.

Fencing is an integral aspect of livestock production. Certain economic factors have resulted in a substantial increase in fencing of both public and private rangelands in the West. In the past, herders tended sheep on both winter and summer ranges, without need for fences. In areas where sheep remain, the cost of hiring capable herders has led to fencing of some sheep ranges.

The general transition from sheep to cattle ranching throughout much of the West also has necessitated extensive fencing. This trend promises to continue as federal land management agencies implement rest-rotation systems for grazing lands. These systems involve systematic rotation of grazing on different subunits ("pastures") of a given grazing allotment at monthly, seasonal or yearly intervals. Within a given rotation cycle, each pasture is "rested" during at least one interval to allow its vegetation to recover. The use of such systems requires fencing of the component pastures within each allotment.

While most big game animals can clear livestock fences easily, occasional mortalities occur when animals become entangled in the wire. Pronghorn are affected most severely by fences. They do not leap fences readily, but can pass through or under barbed wire fences used to confine cattle. However, woven-wire fences represent virtually impenetrable barriers to pronghorn movements. Where such fences confine pronghorn during severe winters, many may die of starvation.

In recent years, feral horses and burros have become a significant ecological factor in western North America. The forerunners of the modern horse evolved

The effects of livestock grazing on big game ranges are striking when contrasted to "rested" or ungrazed land. The soils of heavily grazed areas can be compacted and, thereby, contribute to rapid erosion and topsoil loss. Rest-rotation systems have shown that multiple uses of rangeland can be compatible. Photo courtesy of the U.S. Bureau of Land Management.

in North America and spread to Asia via the Bering Strait land bridge, after which other modern equid forms such as asses and zebras arose (Clabby 1976, Stirton 1959). Horses suffered the same mysterious demise as many other large prehistoric land mammals, becoming extinct on this continent some 12,000 years B.P.

Spanish exploration and settlement occasioned the reintroduction of horses and burros to the American West in the Sixteenth Century. Subsequently, many of the animals escaped from captivity and proliferated in the wild. By the mid-Eighteenth Century, virtually all Indian tribes of the West had horses, and their warriors were skilled horsemen. Estimates of the number of free-roaming horses in North America at that time range from 2–5 million (McKnight 1959). During the Nineteenth Century, most horse populations occurred west of the Rocky Mountains. Wild herds were augmented by animals released or lost by ranchers and the U.S. Army during the late 1800s and into the present century. By 1935, an estimated 150,000 feral horses existed on public lands in the 11 western states (Zarn et al. 1977). Subsequently, these numbers were reduced severely by commercial exploitation and removal to reduce competition with domestic livestock.

Public concern about the demise of feral horses prompted passage of protective federal legislation—most recently the Wild Horse and Burro Act (Public Law 92–195) in 1971. Under the protection afforded by this law and in the absence of effective natural predator populations, feral horse and burro populations have increased dramatically, some by as much as 20 percent per year. In 1975, there were more than 50,000 horses and 5,500 burros on public lands in the West.

At present, ecologists know very little of the impact of these animals on the desert and mountain ecosystems they occupy (primarily shrub-dominated habitats). Potential competition for food exists among feral equids and several big game ungulate populations of mule deer, elk, pronghorn and bighorn sheep. Of particular concern is the possibility that burros may exclude desert bighorns, whose future is already precarious, from vital water sources. The question of competition and conflict among feral equids and native big game animals has not yet received adequate study. One thing is clear, however: lacking some form of control, the continued increase of horses and burros will intensify whatever competition does exist. Very probably, this will result in the degradation of habitat of all species involved.

Technological and sociological influences

An in-depth treatment of the many influences of our growing technological society on big game resources is beyond the scope of this chapter's brief overview. However, a few major influences must be considered.

1. Urban sprawl. The continuing flux of an increasing human population into urban centers and the attendant urban sprawl of large and small cities alike in recent years have resulted in significant and permanent losses of big game habitat. This trend is particularly acute in the mountainous areas of the West, where suburban subdivisions often are located in foothill areas that formerly provided crucial wintering ranges. Excessive snow depths prevent the animals from wintering at higher elevations. Uncontrolled dogs comprise another problem associated with the encroachment of suburbia on big game habitat. Where these animals are allowed to roam freely, they may inflict losses on local deer populations.
2. Transportation systems and vehicles. A serious consequence of technological progress during the Twentieth Century has been the proliferation of vehicular

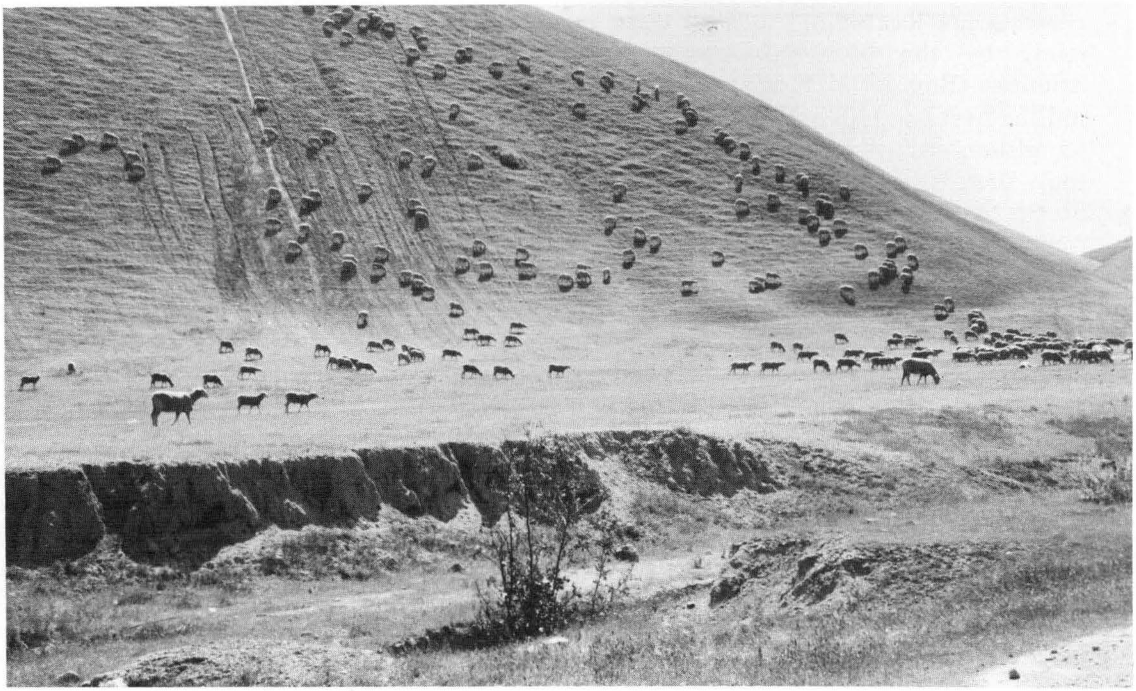
transportation systems. Highways in particular have had substantial direct and indirect impacts on many big game populations. While highways and highway construction result in some losses of big game habitat, more important are their effects on migration routes, the separation and isolation of otherwise contiguous habitats, and more ready access to remote natural areas by recreationists. The construction of the interstate and other multilaned highway systems in recent decades has aggravated these conflicts.

Not to be overlooked is the loss of big game in collisions with vehicles. Puglisi et al. (1974) reported that deer-vehicle collisions in Pennsylvania increased by 218 percent from 1960–1967. They noted that this increase was due in part to the construction of an interstate highway across the state. Longhurst et al. (1976) noted that at least 20,000 deer are killed annually on California highways. This represents approximately 60 percent of the average number of deer harvested annually on a statewide basis for the period 1970–1975. In recent years, some efforts have been made to reduce deer-vehicle collisions by the construction of high fences along segments of rights-of-way that intersect known summer or winter range areas or traditional migration routes. These fences force the animals to use special underpass structures to cross the highways.

The phenomenal increase in the popularity and number of off-road recreational vehicles (ORVs) during the past 15 years represents yet another manifestation of advanced technology, affluence and increased leisure time. Prior to the mid-1950s, production of four-wheel-drive vehicles, motorcycles, snowmobiles, and most recently, all-terrain vehicles was insignificant. A report of the United States Department of Interior (1972b) estimated the total number of all types of these vehicles in the United States at more than 5 million. These figures represented a trend, and at least with regard to snowmobiles, the trend undoubtedly applies to Canada as well.

At present, the impact of ORVs on big game animals is not well-documented. However, at least two major impacts are obvious. One is the increased disturbance and possible displacement of animals from areas subject to heavy ORV traffic (Dorrance et al. 1975). These effects are most critical during seasons when young are born and during winter. In the latter case, forced movements of animals deplete energy reserves at a time when they already are under environmental stress. Such disturbance also can displace animals from areas of vital shelter and food resources. In terms of habitat degradation, the long-term effects of ORVs represent an even greater liability. Soil

Gullies and rills initiated by ORV traffic precludes restoration of the area to big game habitat for many years, once the traffic is banned. Photo courtesy of the United States Geological Survey.



Sheep graze along a hillside on public land in California where ORV hill-climbing contests took place the weekend before. Livestock grazing, in some places, can accelerate erosion and reduce vegetative growth. When land, almost anywhere, is exposed to persistent livestock grazing plus recreational use, its viability as big game habitat is seriously diminished or lost. Photo courtesy of the U.S. Bureau of Land Management.

or snow compaction, erosion, destruction of vegetation, and change of species composition all are potential impacts of ORV traffic on big game habitat. Such habitat damages vary in terms of duration, but all are of serious consequence.

3. Water developments. Large-scale water impoundments, developed largely since the 1930s, have inundated millions of hectares of big game habitat. A compilation by Martin and Hanson (1966) revealed more than 1,500 large reservoirs in the United States with a total impoundment acreage of almost 6 million hectares (15 million acres). As with highway construction, the detrimental effects of these impoundments are not limited to the areas actually flooded. Large reservoirs often disrupt big game migration patterns and may result in the isolation of otherwise suitable habitat. Indeed, where critical winter ranges of migratory populations are inundated, the total effective loss of habitat may involve a much larger area.
4. Mineral exploration and energy development. Looking to the future, mineral exploration and energy development hold considerable potential for the destruction of big game habitat. According to Platts (1974), surface mining currently accounts for approximately 80 percent of the ore and solid fuels produced. By 1971, in the United States alone, some 1.6 million hectares (4 million acres) of land had been disturbed by surface mining and related activities. Wildlife habitat accounted for approximately one-half of the disturbed land. While in the past mining was centered in the Appalachian and midwestern states, the West will bear the brunt of future mineral extraction activities. For example, 42 percent of the United States' known phosphate

reserves are located in the West. Also, a study by the National Academy of Sciences (Box 1973) indicated that 0.6 million hectares (1.5 million acres) of the 51 million hectares (126 million acres) of coal underlying the western United States could be surface mined using current methods. This same study projected a total surface disturbance of about 780 square kilometers (300 square miles) by the year 2000. While the magnitude of this disturbance may seem small in relation to the total area impacted by forest, range and agricultural activities as well as urban sprawl, it represents only a fraction of the total disturbance for all mineral and energy reserves in North America. Oil shale and tar sands also underlie vast areas in the western United States and Canada.

Surface mining is one of the more potentially devastating environmental disturbances on big game habitat, since it involves not only the removal of vegetation but disruption of the soil profile and local topography as well. In many cases, however, properly executed reclamation of disturbed sites can create habitat that actually is more attractive to big game than that which existed prior to mining activities. These effects are particularly important where mineral reserves underlie extensive tracts of presently marginal habitat.

Site disturbance represents only one of many factors involved in the impact of mineral and energy development on big game habitats and populations. Other consequential factors include increased harassment and adverse effects associated with support facilities such as roads, construction camps and pipelines. For example, studies (Klein and Hemming 1976) confirmed initial fears that the construction of large diameter pipelines for transfer of crude oil and natural gas over arctic habitats can impede movements of caribou and to a lesser degree, other ungulates. Where pipelines intersect traditional migration corridors specific modifications are necessary to minimize their impact.

HABITAT IMPROVEMENT PRACTICES

As human populations and land uses continue to impinge upon big game habitat, we can no longer rely merely on the largess of the land for big game production. Future big game populations will require deliberate and effective habitat management strategies.

The following discussion is predicated on the assumption of continued emphasis on consumptive use of big game resources. Should hunting no longer be a viable big game population management option or opportunity in coming decades, habitat management concerns likely will change. Wildlife habitat still will be important, but not in terms of optimizing big game production as is now the case.

A cautionary note at the outset of this discussion must be interjected. The limited scope of this chapter precludes enumeration of the specific effects of various habitat manipulation practices in all the numerous climatic and vegetative regimes of North America. At the same time, the response to a particular treatment is largely site specific, thus rendering generalizations difficult at best. The reader should bear in mind that beneficial effects obtained by a given practice in one area may not be duplicated on another site where plant composition and growth conditions differ markedly.

The essence of habitat management for any big game population is to provide optimum interspersion of those vegetation types required by the animals for food and cover. This usually entails manipulation of existing vegetation either to maintain or alter its successional stage. In terms of effects on vegetation, different manipulative methods may be employed to achieve similar results. For example, given a closed pinyon-juniper stand with a sterile understory, a manager may use either fire or mechanical

When juniper—a low quality forage—is browsed to this extent by deer on winter range, the habitat is not adequate to maintain a healthy and productive herd. A Wildlife Management Institute photo; taken by Seth Gordon.

means to rehabilitate the stand for use by deer or elk. The choice will be determined by economic and aesthetic constraints as well as biological considerations.

Where the weight of such constraints does not dictate an alternative course of action, "natural" methods of vegetation manipulation such as prescribed burning, controlled grazing and silvicultural practices should receive higher priority than artificial manipulations, including mechanical and chemical methods. Unexpected side effects, which many plant communities cannot readily absorb, more frequently are incurred with artificial techniques than with natural methods or phenomena.

The wildlife literature contains the results of numerous studies that purportedly document beneficial effects for big game populations of various habitat manipulation practices. Most studies report marked increases in animal utilization of treated areas, but few show conclusive population responses such as increased birth rates and/or survival and population growth. Such responses might simply reflect redistributions of static populations with no increases in numbers. A notable exception is the work of Biswell et al. (1952) in which the investigators documented substantial increases in both the density and reproductive rate of a black-tailed deer population in response to opening up dense stands of chamise brush in northern California. While differential attractiveness of treated areas to big game cannot be rejected summarily, the utility of future habitat improvement measures must be evaluated in terms of definitive population responses, not just circumstantial evidence.

Most habitat improvement practices are aimed at increasing forage supplies. These practices often are based on the sometimes erroneous assumption that food resources in a given area are a limiting factor to the big game population(s) of that area, in terms of either nutritional quality or available quantity. Such an assumption can lead to manipulations of vegetation that produce foods that are neither needed nor used. In the process, the actual limiting factor may be ignored to the further detriment of the population(s).

It is imperative that managers not overlook the fact that residual, untreated areas of vegetation usually provide animals with essential cover as refuge from human activity and natural predators as well as protection from adverse weather conditions. To a certain extent, the nutritional status mediates the dependency of an animal on protective cover for thermoregulation. However, microclimatic attributes of some cover types are virtually indispensable to the survival of big game animals during periods of climatic extremes. This is the case with winter "yarding" areas in northern portions of white-tailed deer range. Numerous investigators, including Verme (1965b) and Ozoga (1968), showed that the dense, usually coniferous cover of preferred yarding areas has less snow accumulation, warmer ambient temperatures, and lower wind velocities than do surrounding uplands. In addition, Moen (1968b) demonstrated that a dense canopy of swamp conifers markedly reduced radiation heat losses from deer, particularly on clear and cold nights when, without overhead cover, emissions would have been excessive.

Cover may be equally important in providing animals with protection from heat stress. Linsdale and Tomich (1953) noted that California deer sought out chamise brush and closed woods for protection from summer heat. Similar behavior was reported for peccaries by Bissonette (1976). Edgerton and McConnell (1976) attributed higher summer elk use of dense, unlogged conifer stands to the more stable thermal environment found there than in adjacent partial-cut and clearcut stands. Also, although moose are not affected adversely by extreme cold, they are not well-adapted to high temperatures. In the southern limits of moose range, the shade of forest stands provides moose with a vital refuge from extreme summer temperatures (Kelsall and Telfer 1974).

The point of this discussion is that the size and spatial distribution of openings will determine their utility to big game animals regardless of the method of treatment employed to create openings in forested stands. Depending on the species, the animals generally will venture only a limited distance into open areas to feed. Openings whose dimensions exceed this distance will be utilized only at their periphery.

Recommended sizes for forest openings prescribed by several authors for various big game species are summarized in Table 41. Although the figures relate primarily to logging practices, they also should serve as guidelines for other methods of vegetation conversion. Of the statistics given, those for maximum width (or diameter) of a treatment unit are most critical. Treatment units exceeding the recommended maximum area may be acceptable, provided widths are not appreciably greater than prescribed maximums. Aside from the maximum areas and widths specified, individual treatment units should be well-dispersed within a larger management block to provide a balanced mosaic of food and cover tracts.

Controlled grazing

Since at least the turn of the century, sportsmen, scientists and conservationists have debated whether domestic livestock grazing is detrimental to big game habitat. The subject of grazing is inherently too complex to permit pat generalizations or conclusions. For any given situation, the impact of livestock grazing on wildlife habitat is determined by feeding behavior of the species involved, stocking rates, the plant community and the season in which the grazing occurs.

Table 41. Recommended maximum sizes of openings in forest or woodland cover for various big game populations.

Species and source	Location and/or vegetation type	Allowable maxima			
		Area		Width	
		Hectares	Acres	Meters	Feet
White-tailed deer (McCaffery and Creed 1969)	Northern Wisconsin, mixed hardwood and conifers	2	5	100	330
Mule deer and elk (Reynolds 1966a, Patton 1974)	Arizona, Ponderosa pine	18	46	490	1,600
Mule deer and elk (Reynolds 1966b)	Arizona, spruce-fir	8	20	320	1,060
Mule deer (Terrel 1973)	Utah, pinyon-juniper	10–30	25–75	320–640	1,060–2,120
Deer and elk (Leopold and Barrett 1972)	California	8	20	200	660
Deer and elk (Hooven 1973)	Oregon, Douglas fir	12–24	30–60		
Moose (Telfer 1974)	Canada, boreal forest	130	320	500	1,640
Moose (Peek et al. 1976)	Minnesota, spruce fir	80	198		

Excessive grazing sometimes causes irreparable habitat damage and often is detrimental—at least in the short term—to some big game populations. Extreme grazing pressures of the late Nineteenth and early Twentieth centuries resulted in loss of habitat for bighorn sheep, elk and pronghorn populations in the West. While successional changes caused by grazing ultimately proved beneficial to some deer and elk populations, these same changes appear to have eliminated bighorns and pronghorns permanently from much of the animals' former ranges.

Given this somewhat pessimistic introduction, the positive aspect of grazing should be emphasized, namely its potential as a tool for manipulation of wildlife habitats. The practice of grazing, regulated with respect to timing and intensity, to maintain a specific plant community or produce desired successional changes represents a relatively new and viable management strategy.

Prescribed grazing involves deliberate application of forage consumption by one species of domestic herbivore on a plant community to modify competition among the plants of that community, thereby enhancing production of forage species preferred by wild herbivores. Successful use of this method requires that: (1) stocking rates are such that the domestic grazers forage on their preferred food, and (2) timing and duration of grazing be applied at the appropriate stage of plant growth to effect desired changes in the plant community. Failure to observe these constraints spells the difference between desired optimum utilization and unwanted direct competition.

In most cases, populations of two or more herbivore species can utilize primary production of a given plant community more effectively than can a population of a single herbivore species. Conversely, total animal biomass that a unit of habitat can support on a sustained basis usually is greater with multiple-species use than with single-species use. An example is the relationship of big game and livestock populations in the Intermountain West. In recent studies, Smith and Doell (1968) and Jensen et al. (1972) investigated the compatibility of spring grazing by cattle and sheep on deer-elk winter ranges, where the primary browse species was bitterbrush. These investigators found that spring livestock grazing caused little competition with big game for forage provided that grazing was restricted to the early growing season before rapid growth of shrubs. In fact, removal of herbaceous vegetation around the bitterbrush plants by grazing livestock increased moisture available to bitterbrush. This significantly increased browse production for winter use by deer and elk.

Similar results in vegetation manipulation can be obtained by the use of an appropriate combination of big game animals. In fact, in natural grazing communities, the feeding niches of wild herbivores show considerable diversification that minimizes direct competition for food and allows effective utilization of available forage in a given habitat. An interesting example of such interactions among native ungulates was found at Elk Island National Park in Canada, described by Holsworth (1960) and more recently by Wagner (1969). In this ecosystem, browsing by elk and moose was largely responsible for maintenance of grassy openings utilized by bison. In the absence of browsing pressure by elk and moose, openings would have been invaded by shrubs and trees, ultimately resulting in the exclusion of bison.

Use of the grazing animal to manipulate habitat for big game represents an effective and ecologically sound management tool. In terms of cost effectiveness, this approach usually is less expensive than use of mechanical methods that would produce comparable results because the tool itself represents a marketable product.

Forest management

Virtually all silvicultural practices have been shown to affect forest-dwelling big game animals in one way or another. These practices include timber harvest and slash disposal, site preparation and regeneration efforts, rotation lengths and timber stand improvement measures. Of these, timber-cutting programs have by far the greatest impact. Indeed, Shaw (1970) suggested that 90 percent of habitat manipulations required by forest wildlife can be achieved by properly planned cutting programs. Given this premise, the following discussion is framed primarily in the context of enhancing big game habitat through timber-harvest procedures.

Most forest-dwelling big game animals, in either deciduous or coniferous forest habitats, thrive best where a diversity of age and composition classes of plants occur in relatively small stands interspersed with small openings (Telfer 1974). There is even some evidence that woodland caribou, inhabitants of extensive stands of boreal forest, also may benefit from a diversity of cover types (Bergerud 1971c). Fire was the major primeval agent that maintained this diversity. With progressive exclusion of wildfire from managed forest ecosystems, timber harvest constitutes the most practicable means of creating or restoring the necessary variety of cover types.

A major ecological consequence of forest maturation and closure of the forest canopy is a decrease in diversity and production of shade-intolerant shrubs and herbaceous plants in the understory. This generally results in a reduction of palatable forage for big game. Conversely, the primary benefit of opening up a dense forest stand is to allow light to reach the forest floor, thereby stimulating the production of understory forage plants.

The wildlife literature contains numerous references documenting increased diversity, productivity and nutrient content of forage plants following logging, as well as increased big game utilization of cutover tracts. In this respect, moderate-sized clearcuts or patch cuts generally are more beneficial than selective-cutting or thinning operations (Murphy and Ehrenreich 1965). For example, the great increase in Scandinavian moose populations during the present century has been attributed largely to the shift from selective-cutting systems to clear cutting (Lykke and Cowan 1968). There probably exists for each combination of forest cover type and site potential some threshold below which residual canopy cover or basal area must be reduced to stimulate an appreciable increase in forage production. With respect to the transition zone between coniferous and deciduous forests in

Canada's Maritime provinces, Telfer (1973) stated that the residual basal area of a logged stand must be reduced below 17.2 square meters per hectare (75 square feet per acre) before increased browse production results.

Increased light penetration represents only one cause for increased forage production often observed following logging. Other factors include: (1) increased availability of soil moisture, and (2) the release of nutrients previously tied up in tree biomass. Of course, some nutrients are removed permanently from the site when it is logged, but Horwitz (1974) estimated that two-thirds of the nutrients in trees are left on the logging site in the form of roots, branches and other unharvested material. Hence, the method of "slash," or logging debris, disposal becomes an important consideration for the release of nutrients for future forage production and the utility of a cut for big game. In areas of high precipitation, such as eastern North America, organic decomposition of slash will result in relatively rapid return of the nutrients to the soil. However, in the drier climate of the mountainous West, slash may remain largely intact for many years. Under these circumstances, slash disposal by prescribed burning will insure more rapid nutrient release.

These facts do not imply that all logging operations are inherently beneficial to big game animals. Pengelly (1972) identified some detrimental aspects of large clearcuts, including increased snow accumulations and wind velocities, barriers created by logging debris, and losses of vegetative diversity. Pengelly also pointed out that success in rehabilitating big game ranges by logging often varies along a moisture gradient. Moderate-sized clearcuts may improve habitat for deer and elk in dense, coastal forests where forage supplies are limiting. However, a cut of the same size in the sparser and moisture-limited forest stands of the eastern Rocky Mountains likely will be less beneficial, since browse regeneration often is poor on drier sites. The moisture variable also will determine, to some degree, the relative longevity of those benefits to big game that might result from logging. In areas with lower rates of annual precipitation, the seral stages that follow the disturbance of timber harvest generally persist longer.

Whether silvicultural practices are beneficial or detrimental to big game is determined by many factors, the most important of which are the size and pattern of the treatment units and the site potential for both plants and animals. Cutting schemes and the ensuing practices of slash disposal, site preparation, reforestation and timber stand improvement should be planned and executed with purposeful, not incidental, benefits in mind.

Prescribed burning

Some biologists have long recognized the role of fire to maintain or rejuvenate habitat quality for certain big game populations. Indeed, as we have seen, species like deer and moose benefited fortuitously from early wildfires and from some fires prescribed for timber management. Only recently, however, has the planned use of fire gained some measure of acceptance as a valuable tool to enhance and improve big game habitat.

The objective of prescribed burning is periodic application of controlled fire to produce the ecological benefits of a natural state, while minimizing the negative effects of wildfire.

Fire may be used to alter plant species composition and increase production of selected species. The response of the vegetation to a given burn is determined by an assortment of factors too numerous to consider in detail here. Some of the more important variables include existing plant community composition, season, weather, intensity of the burn (heat) and fire frequency.

Impressive and sometimes spectacular increases of herbaceous and browse plant species have been observed following fire. Such responses can occur for a number of reasons, including increased availability of nutrients released in the ash and decreased competition among new-growth plants for available light and soil moisture. Frequently, increased levels of protein and other nutrients in plants on burned-over areas accompany the quantitative increases in forage production. The duration of elevated nutrient levels depends on local site and climatic conditions as well as the nature of vegetative cover prior to burning, but it seldom exceeds three to five years.

Where browse has grown out of reach of big game animals, fire damage to the aerial portions of the plants often induces prolific sprouting from root stocks. As a result, stem densities frequently increase dramatically over preburn levels, thereby producing an abundant browse supply that remains available to big game animals for several years.

A prime example of the use of fire to improve big game habitat can be drawn from recent studies in northern Idaho and Montana by Leege and Hickey (1971) and Gordon (1976), respectively. In these areas, extensive wildfires of the early 1900s created seral brush fields that were important winter ranges for elk, moose and deer. The principal browse species in these areas include redstem ceanothus, willow, red osier dogwood, serviceberry, mountain maple, chokecherry and aspen. In the absence of recurring fire, browse production in many of these areas decreased because of invading conifers, and the remaining palatable shrub species grew too tall to be utilized effectively. During the past decade, prescribed spring and fall burning has been used effectively to curb conifer growth and rejuvenate production of preferred accessible browse species.

When contemplating the use of prescribed burning for big game habitat, the manager should heed Komarek's (1966) advice that wildlife needs may not be met by application of burning techniques developed for other purposes. The forester and range manager seek clean burns and maximum coverage, whereas burning appropriate for big game usually is less intensive and thorough. Timing, frequency and size of burns for wildlife purposes do not necessarily coincide with other land-use interests, but vary according to the species, habitat and region. The challenge to the land manager is to optimize beneficial effects of prescribed burning for big game in conjunction with other recognized land-use objectives.

Mechanical and chemical methods

Since World War II, numerous mechanical and some chemical methods for vegetation

An experimental area in Florida before the last of a series of prescribed burns.

Same area as in previous photo, soon after the last prescribed burn.

conversion have been developed. These include bulldozing, cabling, chaining, railing, root plowing, and aerial or ground-based application of herbicides. Such treatments have been used extensively on western rangelands in projects variously termed as "brush control," or "range rehabilitation." The shrub types involved are varied and in-

Same area as in previous two photos, eight years after last prescribed burn. This sequence demonstrates the powerful influence fire has in regulating the composition and physical structure of vegetation. In the hands of an experienced wildlife manager, fire can be used to develop or maintain the diversity of flora on nearly any landscape. When, where, and at what frequency and intensity fire is employed can provide suitable forage and shelter for one or more species of wildlife including big game animals. Photos by Roy Komarek; courtesy of the Tall Timbers Research Station.

clude mesquite, pinyon-juniper, sagebrush and chaparral. As the result of overgrazing and fire suppression, many of these brush communities developed into "closed stands" with little or no herbaceous understory.

The treatment regimen is fairly standard; namely, removal of the brushy cover followed by seeding to a mixture of grasses and forbs (and sometimes browse). Early conversion programs were conducted with increasing forage production for livestock as the primary objective. Wildlife and watershed considerations were of secondary importance, and what enhancement of big game habitat did occur was largely accidental. Uniform conversion of large tracts to homogeneous grasslands often nullified the potential benefits of such "improvement" practices to big game populations of deer, pronghorn, elk and bighorn sheep. For example, between 1950 and 1964, 1,200 projects converted some 1.2 million hectares (3 million acres) of pinyon-juniper woodland in the United States. This translates to an average treatment unit of 1,000 hectares (2,500 acres). Admittedly, not all of the treatment units were this size; the point is that many far exceed the recommended maximum sizes shown in Table 41.

In some areas, juniper eradication by chaining can enable regeneration of nutritious understory vegetation. Photo by Don Domenick; courtesy of the Colorado Division of Wildlife.

The "Big Mac" is the ultimate weapon among mechanical methods of vegetation type conversions. Photo courtesy of the U.S. Forest Service.

Vale (1974) estimated that approximately 10–12 percent of the total area (40 million hectares: 99 million acres) of sagebrush vegetation in the western United States has been subjected to some form of control. Despite the relatively slight impact of these treatments on the total extent of this vegetation type, projects involving winter ranges represent a potential threat to big game habitat. Specifically, sagebrush is a staple, nutritious winter food for many mule deer populations. Its large-scale removal can appreciably decrease a habitat's winter carrying capacity.

Vale (1974) stated: "If designed, however, to achieve a heterogenous vegetation of small grassy regions, local areas of dense brush, and expanses of open shrubs with abundant herbaceous growth, sagebrush control should help both wildlife and domestic livestock. Control projects already completed have been planned to produce not this type of vegetation, but pure homogenous grasslands. Rangeland environments with little brush are beneficial only for livestock, not wildlife."

As suggested, such programs need not be detrimental to big game. In fact, where properly designed, substantial enhancement of big game habitat can be achieved. The specifics of a properly planned and executed project will differ according to the vegetation type and primary animal population(s) involved, but some generalizations can be made.

Individual treatment units should be small and well-interspersed throughout a larger complex of residual cover. This means abandonment of the massive area approach. Terrel (1973) considered that the proper concept for pinyon-juniper management on deer winter ranges was to "punch" strategically spaced holes in the forest stands rather than leaving islands of woody vegetation in units cleared by chaining. Treatment should not be done on sites where terrain, soil type or average annual precipitation is inadequate to insure the desired conversion (Plummer et al. 1968). Likewise, treatment should be avoided on ridgetops that provide important cover tracts. Where reseeding of disturbed brushfields is part of the treatment, palatable browse species should comprise a substantial component of the seed mixtures used. Since establishment of browse-producing shrubs may take several years, livestock grazing on treated areas should be deferred initially. Some reduction in densities of big game populations through liberal harvests also may be necessary to insure establishment of seeded species.

Lyon and Mueggler (1968) described the results of efforts to increase browse production by herbicide treatment of several shrub species in northern Idaho. They found some lag in the mortality of competing, undesirable shrub species. Desired browse plants showed relatively quick recovery from crown dieback and poor persistence of sprouting, but the most desirable browse species, redstem ceanothus, was killed by all treatments. The investigators concluded that herbicide spray projects for browse improvement should be based on consideration of the plant composition of the shrub community and careful weighing of the positive and negative effects of spraying at different times of the year.

Other habitat improvement practices

1. Water developments. Water represents the third vital element of the habitat trilogy for any wildlife population. Water requirements differ seasonally, among species and populations, and even among sex and age classes within a given population. For example, lactating does have greater water demands than do bucks. In arid areas where the distribution of surface water sources is a limiting factor, the carrying capacity of habitat for some big game animals may be improved by adding water areas. This may entail modification of existing springs or, more frequently, construction of "guzzlers." Basically, these devices consist of large and impervious rain-collecting aprons that drain water into permanent storage tanks for later use. Guzzlers originally were developed for desert game birds, but may be of particular benefit to desert bighorns, deer and pronghorns. Big game animals will also use simple dugouts installed for livestock as a part of range-improvement programs. To a large degree, optimum distribution of such water sources depends on the cruising radius of the target animal(s).
2. Browse rejuvenation. Many hardwood browse species sprout vigorously following moderate mechanical injury. This phenomenon may be employed advantageously to stimulate browse production, especially where browse plants are excessively tall, dense or decayed. In the East, hand cutting has been used in some hardwood stands to improve browse production for white-tailed deer. Similar results may be obtained through properly conducted thinning or "cleaning" operations during timber stand improvement (Della-Bianca and Johnson 1965). Mechanical treatment is most beneficial when conducted immediately prior to or

during winter, because the downed material yields a browse supply that otherwise may be unavailable.

Numerous other methods of browse rejuvenation have been employed, particularly in shrub-dominated communities in the western United States. Ferguson and Basile (1966) found that "topping" of old-age bitterbrush plants resulted in a nine-fold increase in twig growth the following year. The magnitude of response declined substantially in subsequent growing seasons but, even after four years, production of the treated plants was twice as great as that of untreated plants. In California chaparral, brushfields have been treated by crushing, mowing, rolling and chopping to encourage new growth in the form of crown sprouts or seedlings (Dasmann et al. 1967).

3. Supplemental feeding. Artificial feeding of wild ungulates to carry them through stress periods long has been championed by sportsmen as a panacea, but generally decried by biologists as impractical. Specifics of winter feeding are covered in the chapter on nutrition. The following brief discussion focuses primarily on the rationale involved.

Artificial feeding is rarely, if ever, justified as an alternative (1) to improve natural food supplies through habitat manipulation, or (2) to implement adequate harvest regulations to maintain a big game population within carrying capacity limits. Certain special circumstances, however, may dictate its use. In some cases, the economic returns to be gained by supporting overwinter population levels of big game in excess of natural carrying capacity may justify the expense of supplemental feeding. Such situations do exist on commercial hunting reserves or on intensively managed areas. One example of the latter situation is provided by the forest areas of middle Europe where winter feeding of big game has been practiced for centuries. Other considerations may dictate judicious and usually local use of winter feeding, such as: (1) to keep deer and elk out of commercial orchards, (2) to supplement temporary habitat losses on winter range due to highway construction, suburban development, etc., and (3) to help bring an ungulate population through an unusually severe winter as an emergency measure.

The success of an artificial feeding program depends both on the foods used and the species involved. In the past, alfalfa hay was used widely but, in recent years, pelleted foods for deer and even pronghorn have become increasingly popular. Being broad-spectrum feeders, elk generally fare reasonably well in winter-feeding operations. With deer, however, unless feeding—especially of hay—is commenced early in the winter before the animals experience nutritional stress, their rumen microorganisms will not be able to cope with abrupt change in diet. Under these conditions, mortality may be as great or greater than it would be without supplemental feeding. This problem may virtually negate the use of short-term, spontaneous, artificial-feeding programs as an emergency measure for deer in severe winters. For white-tailed deer, a browse-cutting program as described earlier may represent a more effective emergency measure.

Regardless of the food materials used or the big game species involved, overutilization of and damage to vegetation from concentration of animals on feeding grounds represents a deleterious side effect of artificial feeding. There is also an ethical consideration that should be mentioned, namely the obligation to wild animals to allow them the opportunity to remain wild (Leopold 1933). Habitat management provides that opportunity.

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