

BIG-GAME AND RODENT RELATIONSHIPS
TO FORESTS AND GRASSLANDS
IN NORTH AMERICA

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The primary objective of this report is to summarize the factors which are of most importance in the environmental interrelationships of those species of big-game animals and rodents which inhabit the forest and grasslands of North America. The factors considered include not only the effects of the habitats on the animals, but conversely the effects of the animals, on their habitats and ultimately upon themselves as well.

Obviously in order to cover a subject of this magnitude in a short paper, it has been necessary to condense the presentation as much as possible. The species of animals include only those typical of forests and grasslands north of the Mexican boundary. Species primarily dependent upon the Arctic Alpine Life-zone above or north of timber line, or those found exclusively in areas of tundra or marshland have not been included. Because of their close affinity to rodents the native Lagomorpha are discussed, but the various exotic rodent and big-game species which have become established are not covered.

Although individual authors are not given specific credit, this report is to a considerable extent a summary of the literature and all of the ideas expressed are by no means original. On the other hand only those ideas which are considered valid have been used and little attempt has been made to discuss the relative merit of the many diverse opinions which have appeared in print.

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General Considerations.

Animals are chiefly dependent upon their habitats to supply food and cover and since most of the species involved in this discussion are herbivores, their relationships to the vegetation of forests and grasslands are of prime importance. Climatic conditions of light, temperature and moisture along with edaphic factors influence the basic distribution of plants. In turn, the presence of certain species of plants determines where many animals can exist. Although this report is most concerned with food relationships, the importance of vegetative cover should not be minimized. Without proper cover to protect them against predation and extremes of weather, many animal species cannot occupy some available habitats even though food supplies may be present.

In classifying plant-animal relationships it is possible to separate the various big-game and rodent species on the basis of a number of different characteristics. First, they can be divided on their preference for forest or grassland habitats, and also upon the type of food they eat. Superimposed on these differences are the effects of successional versus climax vegetation. Additionally, the influences, both natural and man-made, which cause succession in vegetation, should be considered. However, some of the more ubiquitous groups, particularly among the rodents, do not readily fall into any of these categories. They are so widely distributed and eat such a variety of foods that they are found in all sorts of habitats. In brief, animal-plant relationships are often so complex that they can not always be reduced to simple, easily defined groupings.

Food and Habitat Relationships.

In recent years, as knowledge of food habits and food requirements of animals has increased, it has become apparent that both quality and quantity of foods are important. Given a free choice, wild animals are able to select not only the most nutritious plants, but the particular parts of the plants which have the highest food value. The ways in which they do this are still somewhat obscure, but certainly the senses of taste, smell, sight and touch are used in varying degrees. Different species of animals undoubtedly use different methods and criteria in their selections, but it has been found that the content of such ingredients as sugar, protein, and volatile oils, as well as succulence are important. With big-game in particular, a number of studies have indicated that

they usually select forage which is high in protein content, although some recent findings show that protein may be taken inadvertently while the animals are actually seeking certain sugars.

Food preferences are known to change rapidly from one season to another, partly as a result of availability, but likewise because the chemical, and hence the nutrient, content of most food plants changes with the growth stages. In general most forage species have their highest protein values during early growth stages or periods of rapid growth. Likewise the terminal parts which are growing fastest are higher in protein than the older tissues. Carbohydrate values are usually high in the meristematic tissue and succulence is determined by the balance of proteins to carbohydrates. If available nitrogen in the soil is low, plants correspondingly have a low protein content, often resulting in a high ratio of carbohydrates to proteins. Under these conditions cell walls are excessively thickened and succulence is reduced. Unfortunately space does not permit a full discussion of the complexities of the nitrogen cycle in forest and grassland soils. Precipitation and temperature relationships along with many other factors are of importance, but in general forest soils are more deficient in nitrogen than grassland soils.

Within forests there is the effect of shading which influences nutrient content primarily by lowering carbohydrate levels. Nitrogen uptake of plants is not lowered, however, so that shading alone does not reduce protein content. Long periods of cloudy or foggy weather such as are experienced in north Pacific coastal areas can apparently duplicate or accentuate this shading effect. Since carbohydrates are necessary for the production of cellulose which forms cell walls, less plant tissue or fiber is produced. On the other hand lignin, an undigestible constituent of fiber, can be increased by shading.

What does all this mean in terms of animals nutrition? Ruminants, together with other herbivores having large caeca, maintain a bacterial flora in their digestive tract which aids them in digesting cellulose. Digested cellulose, as well as carbohydrates, furnishes these animals with energy. It has also been found that a certain amount of energy can be obtained from protein, particularly when carbohydrates are lacking. However, when carbohydrates are present in sufficient quantity animal requirements for protein are lowered. Therefore forage produced in forest areas, particularly those with high rainfall and dense canopies which shade understory vege-

tation, is usually of poor quality. Studies have shown that big-game, such as deer, existing in these situations are generally undernourished and smaller than those in opener, drier areas. Likewise total carrying capacity is reduced and densities of deer are often as low as one or two per square mile.

Several investigations have demonstrated the correlation between nutrition and reproductive rate of animals. When the nutritional plane is adequate, more ova are shed by the females, more young are conceived, more are born, and more survive to become adults. Further evidence of the close correlation between food supply and reproduction is to be found in the timing of the reproductive cycle to coincide with the phenology of forage plants. Young are usually born at the most favorable time of year to insure their survival. Deer and certain of the rodents, as for example white-tailed prairie dogs, have been found to be particularly sensitive to changes in plant phenology associated with altitude or climatic differences. Very likely further work will show that such correlations are common to most if not all species.

Both big-game animals and rodents through their foraging habits have the ability of modifying their own habitats. Big-game browsing can produce spectacular effects on shrubs and trees. Because animals are selective in their choice of food, the preferred species of trees and shrubs receive proportionately heavier use than the less choice species. Over a long period, especially when the numbers of game animals rise above range capacities, selective browsing can radically alter the species composition of local plant communities. Not only are established plants progressively weakened through over browsing to the point where they can no longer produce seed, but if this process continues long enough, they may also be killed outright. Seedlings of the preferred species likewise have little chance of survival in many forested areas.

Browsing, or for that matter grazing in moderation, can stimulate plants to put forth additional growth, but responses of various species of plants to this stimulus differ greatly. Certain shrubs and trees respond to browsing by putting forth numbers of adventitious sprouts, while others put their growth effort out at higher levels above the reach of browsing animals, thus forming the so called browse line so common to our forests. Probably the most drastic example of tree and shrub use with resultant adventitious growth is the cutting of aspen and willow for their bark by beavers. If beavers were not so closely tied to their aquatic habitat and were as wide ran-

ging as some of the big-game species, results of their work would indeed be catastrophic.

Direct mechanical damage to plants can be inflicted in a number of other ways. In addition to beavers, many species of animals eat bark either regularly or occasionally. Among the rodents, porcupines, tree squirrels, wood rats and certain of the microtines are bark eaters, along with rabbits, moose and elk. Even black bears sometimes strip the bark from redwood trees along California's northern coast, presumably to obtain the cambium layer beneath. Practically all of the male cervids commonly rub their antlers on small trees and bushes with attendant loss of bark and breakage of branches.

As previously mentioned, animal relationships to plant succession are of major importance. The detailed accounts of species and genera list the animals that are favored by successional stages of vegetation as opposed to those that are more adapted to climax situations. The principal factors which are important in producing or maintaining sub-climax vegetation include burning, logging and livestock grazing. These influences are generally associated with man's activities, although naturally occurring lightning fires can have the same effects as man-set fires. Wildlife use of vegetation for food, as well as the seed gathering and digging activities of rodents all tend to disturb climax vegetation or maintain succession. While it may not be entirely proper to classify all of these factors as extrinsic, they certainly should be differentiated from such influences as long-term geologic erosion and changes in weather cycles which similarly produce gradual changes in plant succession. In general animal-plant relationships can best be explained by the polyclimax view of succession rather than on the basis of monoclimate theory.

Successional stages of vegetation benefit the species of big-game and rodents which are especially dependent upon the types of food and cover provided in these circumstances. Animals in this category are those which thrive in « edge » situations where cover types, are interspersed. For example, among the big-game, deer and moose are favored by fire and logging which break the canopy of climax forest allowing successional shrubby browse producing species to come in along with the forest reproduction. Conversely, fire destroys the « reindeer lichens » which caribou are dependent upon in winter where they range into the taiga zone of the far northern forests. Similarly bison, because of their dependence

upon the perennial grasslands of the plains, appear to be another example of a species more adapted to climax vegetation.

It is difficult to generalize on the requirements of rodents and rabbits. Many of the widely distributed genera such as *Peromyscus*, *Perognathus* and *Eutamias* can take advantage of a variety of situations. Within these groups, however, certain species may have rather strict habitat requirements so that vegetational changes may favor one species at the expense of another. When climax perennial grasslands are broken up by heavy livestock or big-game grazing which allows annual grasses and herbaceous plants to invade, ground squirrels, kangaroo rats and jack rabbits find conditions especially suitable and usually increase in numbers. Although the changes in food plants contribute greatly to these increases, the height of ground cover, which influences the ability of rodents to observe the approach of predators, is apparently of equal importance.

Certain rodents appear to favor a climax habitat, but at the same time are somewhat dependent upon sub-climax plants for food. *Aplodontia*, the mountain beaver, and *Neotoma*, the wood rat, seem to follow this pattern in forested areas of the western United States. Relatively few rodents are primarily associated with climax vegetation. Tree squirrels of the genus *Sciurus* and red squirrels of the genus *Tamiasciurus*, and the red-backed tree mice and red tree mice of the genera *Clethrionomys* and *Phenacomys* are representative of this category. All of these rodents are essentially dependent upon food supplies found in climax forest associations.

As noted above, the complexities of animal relationships to their environment make broad generalizations such as these quite risky and it is much safer to describe food and habitat requirements on an individual basis. The following accounts of big-game species and rodent genera attempt to summarize briefly their relationships to forests and grasslands.

BIG-GAME — Accounts of Species Found in Forests and Grasslands.

White-tailed Deer — *Odocoileus virginianus*.

Although white-tailed deer are primarily a species of the eastern United States and Canada, they do extend across the continent to the Pacific Coast in Oregon, Washington and British Columbia. In point of numbers they are the most numerous species of big-game and an esti-

mate made in 1956 totaled some 5,262,000 head in the United States and 1,885,000 in Canada.

Without doubt numbers have increased greatly since the settlement of the continent began, chiefly as a result of the breaking up of the climax forest stands by fires, logging and clearing for agriculture. Prior to the coming of the white man, most deer probably existed along the edges or forests or where there were natural openings. Since they are primarily browsers, white-tails respond rapidly to the increased food supply produced when second growth trees and bushes fill up openings in cleared forests. The carrying capacity of various ranges for deer is determined largely by the amount of food available on key areas where they are forced to congregate during the most critical season of the year. Usually these key areas are the winter ranges which may be cedar swamps or south facing slopes in the northeastern states, glades or « balds » in the Ozarks and Appalachian Mountains, and sand ridges or cypress swamps in the Southeast. The Everglade deer of Florida depend upon the tree islands for food during periods of flood.

With settlement, the large predators, the wolf, mountain lion, coyote and bobcat which formerly preyed on deer were largely eliminated over most of the white-tail range. In their place hunting by sportsmen must now be relied upon to control deer numbers. Unfortunately, however, hunting is seldom sufficiently effective to cope with the expanding herds and overstocking has been widespread. Resultant overuse of preferred browse species on key areas has through the years markedly reduced the overall carrying capacity of large sections of range for deer. Concurrently extensive damage has been done to forest reproduction, both conifers and hardwoods, by the hungry herds forced to turn to second and third choice foods.

Of equal or perhaps greater significance has been the gradual regrowth of forests throughout the eastern states following the initial waves of logging, clearing and burning that accompanied the early settlement. Even though regrowth has been retarded by heavy deer browsing, a return toward climax conditions with lowered capacity for deer has slowly been taking place. Future deer numbers will undoubtedly stabilize at a level well below that attained when forage production was at its peak.

Northward in the eastern part of Canada, the cycle of forest disturbance and regrowth has not progressed at the same rate. Large forest areas are still in the

early regrowth stage and deer populations are increasing and extending their ranges in response to the abundant supply of forage available. Not all regrowth cycles are necessarily so prolonged. Some small scale slashings can change from poor deer range to good and back to poor deer range in a span of ten years. The type of vegetation and the climate control the length of the cycle. Effects of deer browsing are in general inversely proportional to the size of the area involved. Only a few deer concentrating on a small clearing can produce drastic effects on the regrowth whereas even a heavy deer population cannot utilize the forage produced in a large burn or clearing.

When deer are exposed to good range abundantly stocked with nutritious food plants, studies in many parts of the country have shown that they respond by growing larger, increasing their antler size, reproducing at a higher rate, and living longer. White-tails also have a higher basic, reproductive capacity than the mule deer of the West, for on good range up to about a third of the females bear young their first year. Even with abundant forage, mule deer normally do not have fawns until their second year. White-tails are therefore able to respond more quickly to favorable changes in vegetation.

Without control of numbers by hunting or predation, deer populations usually follow an irruptive pattern typical of many forms of animals. The well known sigmoid or exponential curve of population growth applies well to deer with the asymptote being reached as food supplies on key areas fail through overuse. Population declines often result from mass starvation accompanied by lowered reproduction and in some areas are complicated by outbreaks of parasitism and disease. All of these decimating factors are closely linked to nutrition which is dominant in the life of any deer.

Mule Deer — *Odocoileus hemionus*.

As western representatives of the genus *Odocoileus*, mule deer range throughout the western United States and northward through western Canada to southern Alaska. A scattered population of this species is also found as far east as Minnesota. In 1956 estimates of total numbers amounted to 4,392,000 in the United States proper and 1,850,000 in Canada and Alaska. For the most part the mule deer, including its several subspecies, is an animal of broken forested mountains, brushlands and high deserts. One race does, however, occupy the Lower Sonoran desert of the Southwest.

Like the Whitetail it thrives on successional vegetation and finds unbroken climax forest a barrier to its distribution. Logging, fire, and livestock grazing have all benefited mule deer and numbers have increased since the settlement of the country. Good forage evokes the same biological responses as in the white-tail.

Where their ranges overlap in the West, there is frequently serious competition between livestock, elk and deer for both browse and grass. This situation is usually most critical on winter ranges where numbers of game animals are forced to congregate by deep snow, although livestock use of these areas is often during the summer period before the game arrives. In the West competition with livestock for range forage is more severe than in the East where domestic animals are more closely confined to fenced pastures. Even though browse normally makes up over three-quarters of the total forage intake of mule deer, they do take considerable quantities of grass and herbaceous plants. These foods are taken at lower altitudes when they are green during the winter and spring months, but are also eaten at higher elevations through the summer when deer make extensive use of mountain meadows.

Since the middle of the 19th century when the effects of settlement became important in the West, increasing amounts of forest lands have been logged and burned allowing choice deer food plants to enter. In dense coastal forests in particular, it is the practice to clear cut Douglas Fir and allied species and the subsequent burning of the slash produces outstanding increases in deer densities. When such a cycle takes place, numbers of deer rise from one or two to 30 or more per square mille. Following the slash burn, the highest quality feed is produced in the first three to five years, largely as a result of the fertilizing effects of the ash and the increased sunlight, but the highest capacity for deer is not reached for 10 to 15 years. Within 20 to 25 years most browse species have grown beyond the reach of deer or have become too dense to provide good forage. After logging if the slash is not burned, the capacity for deer never reaches such a high peak. It has been found that deer damage coniferous reproduction most severely about ten years after the timber has been removed when the more palatable shrubs are being crowded out or are growing out of reach.

A number of other range relationships should be mentioned at this time. Usually the physiography and distribution of cover types on any range has a major

bearing on its capacity for deer. Relative sizes of summer and winter ranges are of great importance. Usually summer ranges are many times as large as the winter range, but on some conical, isolated mountain peaks, the summer area on top may actually be smaller than the winter range extending around the bottom of the mountain. In such cases the summer range is usually the key area which regulates the overall carrying capacity. Even where this inverse size relationship does not exist the quality of the summer range and the consequent condition that deer attain during the summer often determines their success in surviving on the winter range.

Interspersed cover types, as noted earlier, favor deer and many other species of animals as well. In British Columbia deer have been found to grow considerably larger where extensive alpine meadows exist as opposed to areas which are completely forested. Also broad-leaved forests usually are found to have a higher carrying capacity for deer than coniferous forests. Not only do broad-leaved forests grow more browse, but they produce acorns and other fruits plus fallen leaves, mistletoe, lichens and edible bark as well.

The pristine grasslands were not favorable deer range, but with the coming of livestock herds, intense grazing allowed the invasion of many shrubby species which provided excellent browse and cover for deer. This trend is probably most noticeable in the Great Basin area of the West but also has been important in parts of the Intermountain Region and the Southwest. Although this process initially increased deer carrying capacities, continued heavy livestock use has subsequently lowered range quality in many areas.

In the West predation on deer is much more important than in the East, but even so it does not control numbers appreciably. Sport hunting must be depended upon as the main method of control. It is unfortunate, however, that deer herds in this area as elsewhere are generally not subjected to sufficient hunting pressure to achieve positive control. As a result the numerous overstocked herds continue to inflict major damage on forest reproduction and agricultural crops.

Moose — *Alces americana*

The moose, largest member of the deer family, exists in moderate numbers in the northeastern corner of the United States and in parts of the northern Rocky Mountains as well. To the north in the forested areas

of Canada and Alaska moose are a dominant part of the biota and are increasing in numbers. In 1956 an estimate of their numbers totaled 12,400 head in the United States proper in addition to 192,000 in Canada and 32,500 in the state of Alaska.

Except for the summer periods when they may eat a variety of herbaceous and aquatic plants, moose are almost exclusively browsers. Throughout much of their range, particularly in the North, willow, birch and aspen are their staple foods. When these species are in short supply, however, they frequently turn to less preferred foods such as alder. From a forest standpoint, moose are definitely favored by successional vegetation. When fire or logging breaks up mature forest, the resultant secondary growth of birch, aspen, willow and cottonwood produces first class moose range. Moose have the ability to browse much higher than other big-game species and in addition often push over small trees and bushes, straddling them so that they can feed on the tops.

Throughout most of their range moose are subjected to only very low hunting pressure. In fact the island of Newfoundland is the sole area where both sexes are shot. Even though wolves prey upon them extensively throughout parts of Canada and Alaska and black bears may in some areas take numbers of calves, there is no clear evidence that predation is a major population control. The result has been that, especially in parts of Alaska, the all too familiar signs of overstocked ranges are appearing. When faced with an insufficient forage supply, moose are extremely hardy and large scale starvation die-offs are rare. Instead, lowered production and survival of calves seems to be the usual mechanism for adjusting numbers to range capacities.

Elk — *Cervus canadensis*

Although elk were formerly distributed throughout much of the United States and Canada, today, with the exception of a few small introduced herds in the East, they are restricted to the western states, extending north along the Rocky Mountains and on into Canada. A few elk are also found in central Canada and some have been planted in Alaska. In 1956 their numbers were estimated at 304,500 in the United States, 32,000 in Canada and 350 on Afognak Island in Alaska.

Unlike other North American Cervids which are primarily browsers, elk consume quantities of a wide

variety of foods including grass, herbaceous plants and browse. Thus when they become overstocked, their effects on the range are much broader and the results more serious than with other game. In addition they frequently compete for range forage with livestock as well as other game species and often make serious inroads on agricultural areas. Elk have occupied many diverse habitats from the mature redwood and fir forests of the Pacific Coast to the open grasslands of the central plains. On the plains, however, where they have now been generally eliminated, they were usually found in close proximity to the wooded watercourses, presumably because of their liking for cover and browse.

Although natural predation is not at present an effective population control on elk, hunting is generally much more efficient in keeping their numbers in check than it is with deer. Large numbers of elk are found in remote forested areas, but even so enough hunters pursue them avidly to kill a sizeable proportion each year. Under adverse circumstances they survive nearly as well as moose and major die-offs do not occur as frequently as they do with deer. However, overstocked conditions do cause some losses, lowered reproduction and outbreaks of parasitism and disease.

Caribou — *Rangifer arcticus*

At the present time caribou are almost non-existent in the United States proper and only a few head are found near the Canadian border in northern Washington and Idaho. Northward they are generally distributed across most of Canada and Alaska with the exception of some of the coastal forests and plains areas. In 1956 they were estimated to number approximately 426,000 head in Canada and 300,000 in Alaska.

For purposes of this report it is difficult to say what proportion of the total frequent the forested areas as opposed to the northern tundra. Actually a sizeable portion of the herds which range across the tundra in summer move southward to the taiga zone of the spruce forests to winter. In the taiga they depend primarily upon the branching « reindeer lichens » for survival. As previously mentioned, these lichens because of their extremely slow rate of growth, cannot withstand heavy prolonged grazing and are eliminated entirely for long periods by fires. Caribou are therefore considered to be benefited by undisturbed climax conditions as opposed to moose which occupy much of the same range and

thrive on the secondary browse produced when fires have burned the forest.

Although wolves prey extensively on caribou over much of their range, there is no clear evidence that they suppress numbers below range capacities. In some areas hunting by Eskimos and Indians takes a heavy toll, but such effects are generally not widespread. In recent years the northern herds beyond the effects of fires have tended to increase, while those farther south have decreased, but the exact results of range depletion on caribou are as yet not well understood.

Pronghorn Antelope — *Antilocapra americana*

Pronghorns are strictly a western species, at present extending from the plains area west to the eastern edge of California, north into the southern part of Alberta and Saskatchewan and southward into Mexico. In 1956 it was estimated that there were some 27,000 in Canada and slightly over 268,500 in the United States.

Since the coming of the white man, antelope numbers have declined drastically, mostly as a result of habitat changes. Much of the plains area which they shared with the bison is now broken up into farmland, but farther west where there is still much open range, heavy livestock use is probably the major limiting factor.

Pronghorns take a rather wide selection of foods, but appear to be chiefly dependent upon successional stages of vegetation including a number of broad-leaved herbaceous plants and certain browse species such as sagebrush (*Artemisia*), rabbit brush (*Chrysothamnus*), and salt bush (*Atriplex*). Although grass is taken seasonally, it is not consumed in large quantities. Presumably when numbers of bison roamed the plains, their heavy grazing and trampling of local areas in the climax grassland permitted the invasion of broad-leaved herbs upon which the antelope fed. The races of antelope which range through the southern desert areas of Arizona and New Mexico and on into Mexico proper appear to be more adapted to climax conditions. Disturbance of the desert vegetation, especially by livestock grazing, lowers capacity for antelope.

Although predation, particularly by coyotes, may have important local effects on antelope herds, range limitations are the prime factors regulating numbers. Management of antelope through hunting has in general been fairly successful for they are a relatively easy species for hunters to take in the open habitat which they

frequent. Because of their wide ranging habits, their effects on the range are usually insignificant.

Bison — *Bison bison*

The bison, or as it is commonly known the American Buffalo, was at one time probably the most abundant large game animal in the world. During the 17th and part of the 18th centuries they ranged over nearly two thirds of what is now the United States and extended far north into Canada. Estimates of their total population are necessarily inexact, but considering the known numbers killed for their hides and meat during the latter part of the 19th century, it is not improbable that prior to about 1830 there may have been in excess of 40,000,000 head. At present only a few thousand remain in various reserves, parks and Indian reservations in the United States, Canada and Alaska.

Even though the largest portion of the bison were plains animals subsisting on the climax perennial grasslands, a sizeable number roamed the forested areas both in the eastern and western states and as far north in Canada as the Great Slave Lake. However, even in forested areas bison depended upon the grassy openings and parklands for their food supply. As with most wild grazing animals, bison ranged widely but their movements appear to have been quite erratic and regular seasonal migrations were not the rule except possibly in the southern portion of their range.

In spite of the tremendous grazing pressure that they must have exerted on the grasslands, there seems to have been a reasonably good balance between the bison and their forage supply. Before white men penetrated into their habitat in the 16th century, there is evidence that bison were still expanding their range, but on the central plains area where they must have been fully stocked for over two centuries, numbers were probably somewhat controlled by many natural decimating factors plus Indian hunting.

The decline and virtual extinction of bison in their wild state can be conclusively attributed primarily to mass slaughter by white settlers and secondarily to the encroachments of agriculture pushing westward and the expansion of livestock herds which destroyed their habitat.

Collared Peccary — *Pecari angulatus*

This small wild pig, the only native species found north of Mexico, is restricted to the southwestern states

of Arizona, New Mexico and Texas. Their numbers were estimated at about 118,000 head in 1956, with by far the largest portion of these in Texas. Peccaries typically range in low lying desert areas possessing a thick cover of brush. They are quite omnivorous and consume a variety of foods, the greatest portion being composed of plants or plant products. A large number of items such as fruits, roots, bulbs, acorns, pine nuts, berries and leaves contribute to their diet and they also take considerable quantities of green grass on occasion.

In spite of their habit of rooting up the ground in search of food, it is doubtful that peccaries produce very noticeable effects on their habitat. Because of their predilection for brushy cover, the area of range suitable for them has undoubtedly been increased by the spread of scrub throughout much of the former grassland of the Southwest as a result of heavy livestock use and lack of fire. In contradistinction, however, once brush has become established, heavy livestock use of these ranges or even the areas originally covered by brush does not appear to favor peccaries.

RODENTIA GENERA	Nº SPECIES INVOLVED	RANGE	HABITAT	FOOD	REMARKS
Mountain Beaver <i>Apodontia</i>	1	Sierra - Nevada Mts. and along N. Coast of Calif. north to Southern British Columbia.	Climax forest and edges of wet meadows.	Vegetation—leaves and stems of a variety of plants, sometimes eats bark of firs, etc.	Lives in burrows but forages on surface. Climax habitat, but eats sub-climax food plants. Effects on habitat—slight.
Marmots <i>Marmota</i>	5	Alaska and across U. S. and Canada except Southwest, South and Great Plains.	Forests, or broken forests mixed with agricultural areas. Often in rock piles or talus slopes.	Vegetation—grass, herbaceous plants, planted crops.	Live in burrows which often cause soil disturbance, favored by subclimax situations. Ranges widely on surface for food.
Prairie Dogs <i>Cynomys</i>	5	Central plains and adjacents Mts. to west. Primarily within U.S.	Open grassland areas.	Vegetation—primarily herbaceous plants, some grass. Sometimes eats insects.	Live in burrows, usually colonial, surface feeder. Thrives on sub-climax vegetation which it is able to maintain through intensive feeding activities.
Grounds Squirrels <i>Citellus</i>	25	Across Alaska, U.S. and Canada.	Very ubiquitous, found in most habitats.	Vegetation, fruits, seeds, insects, small animals, etc.	Primarily burrowing, but forage on surface. Some species colonial, others solitary. Favors sub-climax situations. Burrows cause erosion, foraging removes much vegetation.
Eastern Chipmunk <i>Tamias</i>	1	Southeastern Canada and Eastern U.S. except southern states, West to Great Plains.	Open forest land.	Fruits, nuts, seeds, insects, small animals, fungi, birds' eggs.	Lives in burrows, but forages widely on surface and in trees. Prefers sub-climax areas.

Chipmunk <i>Eutamias</i>	14	Forested areas of Canada westward from Great Lakes, U.S. west of Great Plains.	Mostly in forests and brushlands, also in high desert areas.	same	Lives in burrows, but forages widely on surface and in trees. Lives in both climax and sub-climax situations. Seed gathering retards forest reseedling.
Tree Squirrels <i>Sciurus</i>	8	Forested areas of eastern U.S. and southern Canada N. to Great Lakes, Mountains and foothills—Calif. Oregon, Wash., Arizona Colo., New Mexico.	Forest or riparian woodlands.	same	Live and nest in trees, but also forage on ground. Primarily associated with climax habitats. Seed gathering retards forest reseedling.
Red Squirrels <i>Tamiasciurus</i>	2	Forested areas of Alaska, Canada, Western U.S. and northeastern U.S.	Forests.	Fruits, nuts, seeds, insects, small animals, fungi, birds' eggs.	Live and nest in trees, but also forage on ground. Primarily associated with climax habitats. Seed gathering retards forest reseedling.
Flying Squirrels <i>Glaucomys</i>	2	Forested areas of Alaska, Canada, and U.S.	Forests, both hardwood and coniferous.	same	Live and nest in trees but forage on ground to a considerable extent. Primarily nocturnal. Seed gathering retards forest reseedling.
Pocket Gophers <i>Thomomys</i>	10	Western U.S. and Southern Canada.	Ubiquitous Burrows in all sorts of soils.	Vegetation—primarily grasses, herbaceous plants, roots, bulbs.	Fossorial, but forages close to burrow openings on surface to a great extent. Foraging greatly reduces vegetation; burrowing causes soil disturbance and erosion.
Pocket Gophers <i>Geomys</i>	7	Central and southeastern U.S.	same	same	same

RODENTIA GENERA	NO SPECIES INVOLVED	RANGE	HABITAT	FOOD	REMARKS
Pocket Gophers <i>Cratogeomys</i>	1	Parts of Colorado, Texas and New Mexico.	same	same	same
Pocket Mice <i>Perognathus</i>	20	Western and central U.S. to edge of Canada.	Primarily grassland, desert and foothill and some forested areas. Mostly found in arid regions.	Primarily seed eaters, but may take vegetation at times.	Live in burrows, but forage widely on surface. Food gathering activities retard range reseeding.
Kangaroo Rats <i>Dipodomys</i>	14	Western and central U.S. N. to southern Canada.	Arid foothill desert and plains areas.	same	Live in burrows, but forage widely on surface. More favored by sub-climax vegetation. Seed gathering activities retard range reseeding.
Kangaroo Mice <i>Microdipodops</i>	2	Desert areas of Great Basin in U.S.	High desert areas with sandy soil.	same	Live in burrows, but forage on surface. Closely associated with sagebrush (<i>Artemisia</i>). Effects slight.
Beaver <i>Castor</i>	1	Most of N. Amer. except waterless areas and Northeastern. Canada in tundra.	Aquatic—streams, lakes.	Primarily bark of willow, aspen, cottonwood, alder, etc.	Restricted to aquatic habitat, but cut down trees and bushes on banks for bark. Lives in bank burrows or houses of twigs built in water. Tree cutting retards forest development. Builds dams forming extensive ponds which retard run off and erosion.

Rice Rats <i>Oryzomys</i>	2	Southeastern U.S.	Grassy clearings, marshes and wet meadows.	Seeds, grasses, sedges, fruits, nuts, berries, crustacea, and mollusks.	Prefers heavy cover of grass or aquatic vegetation. May damage grassland to some extent locally by cutting vegetation. Lives mostly above ground, but digs some short burrows.
Harvest Mice <i>Reithrodontomys</i>	5	Primarily U.S. except north central and northeastern states.	Quite ubiquitous, mostly found in grassy areas, not in high mts. or dense forests.	Seeds and vegetation especially of grasses.	Usually found in dense vegetation, lives mostly above ground. Effects slight.
White-footed Mice <i>Peromyscus</i>	15	Throughout most of U.S., N. through central Canada and Alaska.	Ubiquitous in all sorts of habitats.	Seeds, nuts, fruits, some vegetation, insects, fungi, etc.	Most widespread genus in N. Amer. Very adaptable, lives mostly above ground, but finds refuge in holes in rocks or burrows of other species. Forages widely on surface and in trees, seed gathering retards forest reseeding.
Pygmy Mouse <i>Baiomys</i>	1	Southern states, west small area of New Mexico and Arizona along Mexican border.	Grassy areas usually with fairly dense cover.	Mostly grass.	Cuts considerable amounts of grass. Lives mostly above ground. Effects on habitat slight.
Grasshopper Mice <i>Onychomys</i>	2	Western and west-central U.S.	Usually in dry areas, plains and deserts.	Mostly arthropods, small animals and some seeds.	Probably the most insectivorous of the rodents. Wide ranging and aggressive nature. Slight effects.
Cotton Rats <i>Sigmodon</i>	3	Southern states west along Mexican border to edge of Calif.	Heavy cover of grass and weeds.	Seeds, grasses, sedges, insects, birds' eggs.	Very abundant within their range, live mostly above ground, damage to agricultural crops more severe than to range.

RODENTIA GENERA	NO SPECIES INVOLVED	RANGE	HABITAT	FOOD	REMARKS
Wood Rats <i>Neotoma</i>	9	Primarily U. S. through West, Southwest, Southern and southeastern states.	Wide variety of habitats from deserts to dense forests.	Principally vegetarians, take twigs and buds of many trees and shrubs, nuts, acorns, fruits, seeds, cacti, bark.	Live mostly above ground, construct bulky nests of twigs in trees, among rocks or on ground. Most effects on forests through foraging on twigs, buds and bark. Seed gathering retards forest re-seeding.
Bog Lemmings <i>Synaptomys</i>	2	Southern Alaska, northwestern and southern Canada, northeastern U.S.	Sphagnum bogs, grassy fields under dense canopy of grass or weeds.	Vegetation, some seeds and fungi.	Live primarily above ground or in shallow burrows, usually colonial. Cut some vegetation but total effects not great.
Red-backed Mice <i>Clethrionomys</i>	3	Most of Canada and Alaska, Mts. of Calif., Rocky Mts., northeastern states south through Appalachian Mts.	Dense forests, sphagnum bogs, wet meadows.	Vegetation, buds, bark, berries, nuts, roots, fungi, etc.	Live mostly above ground, but utilize runways and burrows of other species. Populations often dense, but not necessarily colonial cuts vegetation and gathers seeds, but effects on forest and meadows not great.
Red-backed Tree Mice <i>Phenacomys</i>	5	Parts of western, central and eastern Canada, northwestern U.S., Rocky Mts., northern Calif.	Forests, mountain tops, grassy clearings in forests.	Vegetation, fir needles, fruits, nuts, berries, mollusks.	Most species ground dwellers, one species arboreal in fir forests of Pacific Coast. Exist in sparse populations with little effect on habitat.
Meadow Mice <i>Microtus</i>	16	Across Alaska, central and western Canada, U.S. except East and South.	Grassy areas, wet meadows, bogs, prefers dense vegetative cover.	Vegetation—stems and leaves of grass and herbaceous plants, some roots and bark.	Ubiquitous, digs shallow burrows but spends much time above ground, forages mostly on surface, often colonial. Foraging activities remove large quantities of vegetation. Some trees killed by girdling. Favored by sub-climax situations.

Meadow Mice <i>Peromyscus</i>	2	Eastern and central U.S.	same	same	same
Pine Mice <i>Pitymys</i>	2	same	Forests and grasslands.	Roots, tubers, bark.	Lives almost exclusively in shallow tunnels beneath forest litter or matted vegetation in grassy areas. Sometimes girdles trees and reduces vegetation by cutting roots.
Sagebrush Meadow Mouse <i>Lagurus</i>	1	Great Basin area of U.S. North to southern Canada.	Deserts and dry plains areas.	Vegetation—leaves and stems of grass and herbaceous plants, leaves of shrubs, particularly sagebrush, (<i>Artemisia</i>).	Lives in shallow burrows, but forages above ground. Little effect on habitat.
Jumping Mice <i>Zapus</i>	5	Alaska, across Canada, U.S. except extreme southern portion.	Wet meadows, sometimes dry fields with high grass.	Grass, seeds, insects, berries.	Lives mostly above ground, only digs shallow burrows. Slight effects on habitat.
Woodland Jumping Mouse <i>Napeozapus</i>	1	Northeastern U.S., south to Carolina, eastern Canada.	Forested areas.	Insects, fruits, berries, some grass.	same
Porcupine <i>Erethizon</i>	1	Alaska, across Canada, western, and northeastern U.S.	Forested or high desert areas.	Bark, herbaceous plants, some roots and tubers.	Lives to a considerable extent in trees, but often travels and forages on surface. Girdles considerable numbers of trees, particularly conifers.

LAGOMORPHA GENERA	No SPECIES INVOLVED	RANGE	HABITAT	FOOD	REMARKS
Hares <i>Lepus</i>	6	Alaska, across Canada and U.S. with exception of south central and southern states.	Ubiquitous, occupies most habitats including forests, grasslands, deserts.	Wide variety—grasses, herbaceous plants, browse including twigs and bark, berries, fruits.	Live on surface, mobile, forage widely. Favored by sub-climax conditions. Foraging removes large quantities of vegetation, some species girdle numbers of trees.
Rabbits and Cottontails <i>Sylvilagus</i>	8	Across U.S. and edge of southern Canada.	Brush fields, edges of forests, swamps, riparian woodlands, deserts.	Wide variety—grasses herbaceous plants, browse including buds, twigs, bark, fruits, sometimes insects.	Live in burrows but forage on surface. Less favored by sub-climax than <i>Lepus</i> , often live in situation approaching climax vegetation. In places remove quantities of vegetation, sometimes girdle trees.