Diet of Black-Tailed Jackrabbits on Sandhill Rangeland in Colorado[1]

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Highlight

The diet and forage preferences of the black-tailed jackrabbit (*Lepus californicus*) were studied by stomach content analysis to determine the degree of competition between cattle and jackrabbits on sandhill rangeland. Grasses were most important in the diet in early spring and summer. Forbs were important during summer and fall and shrubs were eaten in fall and winter. Competition for forage between jackrabbits and cattle was greatest in early spring and least in late fall and winter. Jackrabbits influence the longevity of reseeded forage stands and the secondary succession on old fields. A thorough knowledge of diet and forage preferences of jackrabbits permits the land manager to make better decisions for efficient range use.

The black-tailed jackrabbit is a common inhabitant of much of the western United States. It has been recognized as a pest on range and croplands and has been reported to compete with livestock for forage (Vorhies and Taylor, 1933; Arnold, 1942; Currie and Goodwin, 1966). The food habits of the black-tailed jackrabbit have been studied more intensively than those of other jackrabbits, but little is known about the seasonal diet of jackrabbits on sandhill rangelands. Previous observations on the study area in eastern Colorado indicated that rabbits ate some of the same species of plants that were consumed by cattle (Sanderson, 1959).

The objectives of this study were to determine the seasonal diet and food preferences of the black-tailed jackrabbit on sandhill rangeland and to relate this information to the diet of cattle grazing on the same pastures.

Methods

Field studies were conducted at the Eastern Colorado Range Station, 17 miles north of Akron, Washington County, Colorado. The climate of the area is semiarid with an average annual precipitation of about 15 inches, most of which comes as rain during the growing season. The terrain is predominately dune type with many small depressions. Range sites vary from the "deep sand" sites in the sandhills to the "sandy plains" sites where the topography is more nearly level and the soil is slightly heavier.

The vegetation of the study area is dominated by blue grama (*Bouteloua gracilis*), prairie sandreed (*Calamovilfa longifolia*), and needleandthread (*Stipa comata*). On the heavier soils western wheatgrass (*Agropyron smithii*) forms an important portion of the vegetation. Grasses make up about 90% of the total vegetation. Sand sagebrush (*Artemisia filifolia*) is the most abundant shrub, and summer cypress (*Kochia scoparia*), wooly indianwheat (*Plantago purshii*) and scarlet globemallow (*Sphaeralcea coccinea*) are common forbs. Many species of forbs occur in the area, but each comprises only a small part of the total vegetation. A detailed description of the study area is given by Reppert (1960).

Reclaimed blowouts and old fields on the Station support a variety of seeded and volunteer species, including alfalfa (*Medicago sativa*), yellow sweetclover (*Melilotus officinalis*) and white sweetclover (*Melilotus alba*). Several alfalfa hay fields, fenced to exclude cattle but not jackrabbits, have been established near the center of the Station.

The diet of wild black-tailed jackrabbits was studied from September 1965, through November 1966. A total of 250 rabbits were collected for stomach analysis. Ten samples, each consisting of 25 animals, were collected at approximately monthly intervals during the spring and summer and at bimonthly intervals during the fall and winter. Jackrabbits were usually killed during the late evening hours or at night using a shotgun and a spotlight. The stomachs were removed and frozen within a few hours after collection. An attempt was made to collect the rabbits in proportion to their relative numbers from all parts of the Station.

The contents of each stomach were washed, mixed in warm water, and placed on absorbent paper to dry. The dried material was ground in a Wiley laboratory mill over a 20 mesh screen. Ground stomach contents were washed again over a 200 mesh screen to insure mixing and to remove dirt and very small plant fragments. One microscope slide was prepared from a sample of the contents of each stomach, according to procedures outlined by Bear and Hansen (1966).

Tissue of identified plants collected on the study area was prepared and mounted on microscope slides. Plant species in the stomach samples were identified by comparing the epidermal tissue of food material with known plant material on reference slides (Davies, 1959; Croker, 1959; Brusven and Mulkern, 1960; Storr, 1961).

The percentage of each food item in the diet was estimated by examining 20 systematically located fields on each stomach slide with a binocular compound microscope at 125 power magnification. The species present in each microscope field were recorded. Average frequency percentages were computed for all species present in the composite sample of 25 jackrabbits (500 fields). The frequency percentages were then converted to density per field (Fracker and Brischle, 1944) and percent composition of each food item was calculated for the sample.

As an aid in determining food preferences, botanical composition was taken at each kill site using the step-point method described by Evans and Love (1957). Twenty-five points at pace intervals were read in the cardinal directions from the kill site, thus 100 points were located at each site.

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Table 1. Seasonal botanical composition (mean percentage) of the most abundant plants on areas where jackrabbits were collected.

Plants	Fall	Winter	Spring	Summer
Grasses and grass-like plants:				
Agropyron smithii	4	7	13	7
Andropogon hallii	<1	1	<1	<1
Aristida longiseta	1	<1	<1	<1
Bouteloua gracilis	55	55	52	46
Bromus sp.	<1	—	2	<1
Buchloe dactyloides	1	2	<1	3
Carex heliophila	2	1	3	3
Calamovilfa longifolia	9	12	4	11
Festuca octoflora	—	—	7	2
Sporobolus cryptandrus	5	3	1	4
Stipa comata	4	7	6	6
Forbs:				
Artemisia ludoviciana	<1	<1	<1	<1
Conyza canadensis	<1	<1	2	<1
Eriogonum annuum	<1	<1	<1	<1
Kochia scoparia	6	2	<1	1
Plantago purshii	<1	1	<1	1
Sphaeralcea coccinea	<1	<1	<1	<1
Shrubs:				
Artemisia filifolia	2	3	2	2
Opuntia humifusa	<1	<1	<1	<1

Botanical composition of the feeding areas was determined for all but the one sample that was taken when the ground was covered with snow. A summary of the botanical composition of the areas where jackrabbits were killed is presented in Table 1. Food preference indices were determined by dividing the mean percent composition of that species in the diet by the mean percent composition that plant comprised in the feeding areas.

Results

The diet of the black-tailed jackrabbit in the study area followed definite seasonal trends that were influenced by forage maturity and availability (Fig. 1, Table 2). A total of 41 species of plants were identified in the diet. Fifteen species, each comprising at least 1%, accounted for 86% of the yearly diet (Table 3).

Grasses

Although grasses comprised approximately 89% of the botanical composition of the study area, they made up only 50% of the yearly diet of the jackrabbit. Grasses were eaten most frequently during early spring and summer.

Western wheatgrass was the most important plant in the diet. It comprised 22% of the yearly diet and occurred in 72% of the stomachs examined (Table 3). It was eaten throughout the year but was most important in late fall and early spring. The fall regrowth of this grass provided green forage during the winter season when most plants were dormant, and it was one of the first grasses

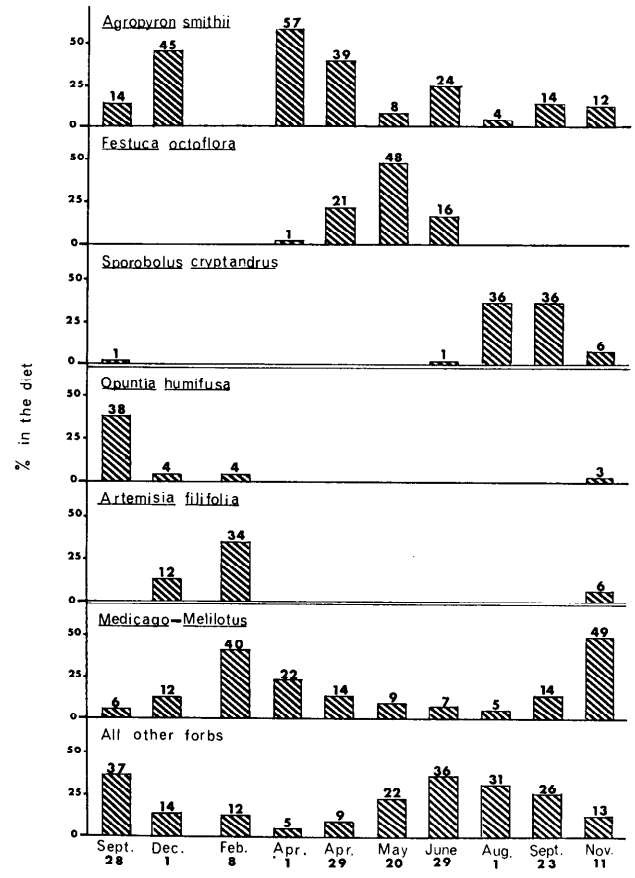

FIG. 1. Mean percent composition of most important food items in diet of the black-tailed jackrabbit from September 1965, through November 1966.

to initiate growth in the spring. Western wheatgrass constituted 45% of the diet in December and 57% of the diet in early April (Fig. 1, Table 2). It was eaten in but minor amounts throughout the summer.

Sixweeks fescue (*Festuca octoflora*), an annual grass, was a major component of the diet during the latter part of April, May, and early June. The seed heads of this grass were heavily utilized in late May, when it comprised 48% of the diet (Fig. 1, Table 2). Only small amounts of this grass were eaten during the remainder of the year. Sixweeks fescue made up 8% of the yearly diet and occurred in 28% of the stomachs analyzed (Table 3).

The diet contained 36% sand dropseed (*Sporobolus cryptandrus*) in August and September, although it was seldom eaten during other parts of the year. Jackrabbits ate the leaf sheaths surrounding the inflorescences and the seeds were common in the stomach contents and in the feces. Sand dropseed was 8% of the yearly diet and occurred in 28% of the stomachs examined.

Needleandthread grass was important for only a short period in early spring. This grass comprised 11% of the diet on April 29 but was eaten in

Table 2. Species composition (mean percent of food items) in monthly diet of the black-tailed jackrabbit.

Plants	Sept 28	Dec 1	Feb 8	Apr 1	Apr 29	May 20	June 29	Aug 1	Sept 23	Nov 11
Grasses:										
Agropyron smithii	14	45	<1	57	39	8	24	4	14	12
Festuca octoflora	<1	<1	—	1	21	48	16	—	—	<1
Sporobolus cryptandrus	1	<1	—	—	—	<1	1	36	36	6
Stipa comata	<1	3	—	7	11	6	1	<1	1	3
Calamovilfa longifolia	<1	—	<1	—	<1	4	6	10	2	<1
Bromus sp.	—	7	<1	4	2	2	1	—	<1	3
Bouteloua gracilis	<1	<1	<1	<1	<1	<1	3	4	1	—
Other grasses	<1	<1	4	3	2	<1	4	7	2	<1
Unidentified grasses	<1	<1	<1	<1	<1	—	<1	2	1	<1
Total grasses	18	57	7	72	77	69	57	63	57	24
Forbs:										
Medicago-Melilotus	6	12	40	22	14	9	7	5	14	49
Kochia scoparia	2	<1	8	<1	2	4	6	11	1	5
Physalis sp.	11	2	—	—	—	—	1	5	11	5
Chenopodium album	13	2	<1	—	—	—	<1	<1	—	—
Plantago purshii	<1	<1	—	<1	<1	4	9	—	—	<1
Eriogonum annuum	2	5	—	—	—	—	<1	<1	2	1
Other forbs	4	2	<1	3	4	11	12	9	6	—
Unidentified forbs	4	2	3	1	2	3	7	5	6	2
Total forbs	43	26	52	27	23	31	43	36	40	62
Shrubs:										
Opuntia humifusa	38	4	4	<1	—	—	—	—	<1	3
Artemisia filifolia	—	12	34	—	—	—	—	—	—	6
Other shrubs	—	1	2	—	—	—	—	—	—	—
Total shrubs	38	17	40	<1	—	—	—	—	<1	9
Seeds	1	<1	2	—	—	—	—	<1	4	5

smaller amounts during the remainder of the study (Table 2). Although needleandthread occurred in 28% of the stomachs examined, it made up only 3% of the yearly diet (Table 3).

Prairie sandreed was eaten mainly in late spring and summer, although very small amounts were eaten at other seasons. This grass was 10% of the diet of jackrabbits in early August. It comprised 2% of the yearly diet and occurred in 24% of the stomachs examined.

Blue grama and cheatgrass brome (*Bromus tectorum*) were the other grasses that made up at least 1% of the yearly diet. Grasses and grass-like plants that constituted less than 1% of the yearly diet included: *Andropogon hallii, Buchloe dactyloides, Carex heliophila, Distichlis stricta,* and *Sorghum vulgare.*

Forbs

Roughly 9% of the vegetation on the study area was forbs, but they made up 39% of the yearly diet of the black-tailed jackrabbit. Forbs were eaten most frequently during summer and early fall.

Alfalfa was the second most important food item in the diet. It made up 18% of the yearly diet and occurred in 52% of the stomachs examined (Table 3). Rabbits ate alfalfa throughout the year, but it was most important in late fall, winter and early spring. This forb comprised 40% of the diet in February when the ground was covered with snow and was 49% of the diet in November 1966 (Fig. 1, Table 2). When snow covered the vegetation on the study area, jackrabbits ate alfalfa hay that had been fed to cattle and they dug through the snow to obtain green growth near the bases of the alfalfa plants.

Alfalfa, as used in this paper, includes yellow sweetclover and white sweetclover as well as alfalfa. The diagnostic characters of these species were so similar that all were recorded as alfalfa. In most cases, alfalfa was probably the major component of the group.

Summer cypress constituted a part of the diet in all seasons although it was most important in February when snow covered the shorter vegetation and from May through August when it was green and succulent. This forb comprised 11% of the diet in August (Table 2). It accounted for 4% of the yearly diet and occurred in 36% of the stomachs examined (Table 3).

Groundcherry (*Physalis* sp.) was preferred during late summer and fall but was not eaten during winter or spring. This plant comprised 11% of the diet in September 1965 and 1966. The leaves were eaten in minor amounts, but the fruits were relished and eaten as long as they were available. Groundcherry constituted 4% of the yearly diet and occurred in 28% of the stomachs examined.

Table 3. Occurrence and composition (in percent) of food items in yearly diet of the black-tailed jackrabbit.

Plants	Occurrence	Composition
Agropyron smithii	72	22
Medicago-Melilotus	52	18
Kochia scoparia	36	4
Festuca octoflora	28	8
Sporobolus cryptandrus	28	8
Physalis sp.	28	4
Stipa comata	28	3
Opuntia humifusa	24	5
Calamovilfa longifolia	24	2
Artemisia filifolia	20	5
Bromus sp.	20	2
Chenopodium album	12	2
Plantago purshii	12	1
Eriogonum annuum	8	1
Bouteloua gracilis	5	1
Unidentified forbs	56	4
Seeds	20	1

Lambsquarters (*Chenopodium album*) made up 13% of the diet in September 1965, but decreased to 2% by December 1965 (Table 2). During the remainder of the study it was eaten infrequently and in small amounts. It was 2% of the yearly diet and occurred in 12% of the stomachs examined.

The diet contained 9% of wooly indianwheat in late June although it was eaten only in very small amounts during the rest of the year. This forb comprised 1% of the yearly diet and occurred in 12% of the stomachs examined.

Annual buckwheat (*Eriogonum annuum*) was the only other forb that made up at least 1% of the yearly diet, but the following forbs were eaten in amounts less than 1% of the yearly diet: *Artemisia ludoviciana, Astragalus* sp., *Asclepias* sp., *Conyza canadensis, Cryptantha* sp., *Descurainia* sp., *Erigeron* sp., *Evolvulus nuttallianus, Gaura coccinea, Lepidium densiflorum, Mentzelia nuda, Portulaca* sp., *Psoralea tenuiflora, Salsola kali, Sophora sericea, Sphaeralcea coccinea, Tradescantia occidentalis,* and *Tribulus terrestris.*

Shrubs

Shrubs comprised roughly 2% of the vegetation on the study area and were 10% of the yearly diet of the jackrabbit. They were most important in the fall and winter.

Pricklypear was the most important food item in September 1965, when it was 38% of the diet (Fig. 1, Table 2). It was eaten mainly in the fall and winter, but utilization of this species decreased after September. The ripe fruits were relished and were eaten whenever they were available, whereas the pads were eaten in lesser amounts. Pricklypear comprised 5% of the yearly diet and occurred in 24% of the stomachs analyzed (Table 3).

Sand sagebrush was eaten during late fall and winter. This shrub was first detected in the stomach contents in December 1965, when it constituted 12% of the diet. It accounted for 34% of the food eaten in February when snow covered most of the vegetation on the study area. This shrub was not eaten during the spring or summer but appeared in the diet again early in November 1966. The yearly diet included 5% sand sagebrush which occurred in 20% of the stomachs examined.

Soapweed (*Yucca glauca*) eaten in very small amounts, was the only other shrub to appear in the stomach contents.

Seeds

Seeds appeared in the stomach contents primarily during the fall and comprised 4% of the diet in September 1966 (Table 2). They made up 1% of the yearly diet and occurred in 20% of the stomachs analyzed.

Discussion

Diet

Only two plants served as staple foods for black-tailed jackrabbits, although many other plants were eaten seasonally or in small amounts. The staples, western wheatgrass and alfalfa, were eaten throughout the year and showed similar trends of importance in the diet (Fig. 1). Preference for the green regrowth of these plants was high during seasons when most of the vegetation was dormant or dead and was low when other green grasses and forbs were plentiful.

After forbs in the sandhill pastures matured and became unpalatable, jackrabbits shifted their feeding activities to an area along a draw where western wheatgrass was a common component of the vegetation. Most jackrabbits that were collected in late fall and winter had been feeding in these areas or in alfalfa fields that bordered the draw. Utilization of alfalfa fields was most apparent in February when snow covered the short vegetation and was least apparent in the spring and summer when rabbits probably fed on sweetclover and alfalfa in old fields and on other forbs and grasses in the native pastures. The amounts of western wheatgrass and alfalfa in the diet decreased after the spring period, and they were replaced by species that have their maximum growth in the summer.

The apparent importance of alfalfa in the diet of the jackrabbit was influenced by the sampling method. Each sample was made up of some jackrabbits that had access to alfalfa and some whose home range probably did not include a source of alfalfa. As a result, most samples included a few jackrabbits that had eaten almost entirely alfalfa

Table 4. Jackrabbits with more than and less than 50% alfalfa[1] in the diet on all sampling dates.

Sampling dates	More than 50% alfalfa		Less than 50% alfalfa	
	No. of animals	Percent alfalfa	No. of animals	Percent alfalfa
September 28	3	92	22	6
December 1	6	77	19	4
February 8	14	65	11	12
April 1	8	71	17	5
April 29	4	68	21	8
May 20	4	66	21	4
June 29	3	63	22	3
August 1	1	60	24	3
September 23	3	84	22	8
November 11	15	88	10	5

[1] Alfalfa includes white sweetclover, yellow sweetclover as well as alfalfa.

and a larger number that had eaten alfalfa in small amounts or not at all (Table 4).

About 60% of the yearly diet of the jackrabbit was made up of plants that were eaten in small amounts or were preferred only at a particular time of the year. Seasonal foods were usually available in the preferred stage of maturity for short periods. Sixweeks fescue, while it was in a green vegetative stage, was the second most important item in the diet in late April. Utilization of this grass more than doubled after it had developed an inflorescence, making it the most important constituent of the diet in late May. It became unpalatable and disappeared from the diet in August. Sand dropseed was eaten in large amounts only after it had flowered, and utilization decreased sharply before November when it had matured and the seed had shattered. Pricklypear and groundcherry were relished only when their fruits were ripe in late summer and fall. Sand sagebrush was preferred and eaten only after its leaves began to fall in November. Currie and Goodwin (1966) reported a similar trend on utilization of big sagebrush in Utah. Blue grama and prairie sandreed were preferred only during the summer, although they were the two most abundant plants and were available throughout the year.

The diet of jackrabbits on the study area appeared to be influenced by the changing availability of some plants. Vorhies and Taylor (1933) indicated that the availability of food materials has much to do with feeding habits of jackrabbits. In September 1965, both lambsquarters and pricklypear were consumed in large amounts, but in September 1966, lambsquarters was not eaten and pricklypear was eaten only in small amounts. Lambsquarters, an annual, was plentiful in the summer of 1965, whereas it was seldom observed in the pastures in 1966. Pricklypear plants were laden with fruits and appeared vigorous in September 1965, but by December the pads had shriveled and remained in this condition until the study was terminated in November 1966. Few fruits were produced in September 1966, which probably accounted for the small amount of this plant in the diet at that time. To get an accurate estimate of the plants eaten by jackrabbits, their diets should be investigated over a period of several years.

Preference

The preference for a plant species shown by jackrabbits seemed to be governed by the kinds, the quantity and the condition of the plants present (Bear and Hansen, 1966). Hayden (1966) suggested that the selection of food material in desert areas was strongly influenced by the environment and the necessity of maintaining a water balance. Succulent grasses and forbs were preferred by jackrabbits during my study. Seasonal preferences for certain plants also could have been influenced by the amount of energy the plant yielded to the animal. Although no energy determinations were made, rabbits may have been harvesting high energy foods when they consumed the seeds of sixweeks fescue and sand dropseed and the fruits of groundcherry and pricklypear.

Preference indices, computed for the most common food items, varied throughout the year for each species. Forbs were more highly preferred than were grasses, and seasonally important foods received higher preference indices than those plants eaten in all seasons. The preference index for western wheatgrass varied from 6.5 in December 1965, to 0.8 in August 1966. Preference indices for some of the seasonally important foods at the peak of their utilization was: lambsquarters, 131.0; pricklypear, 94.5; annual buckwheat, 27.5; groundcherry, 26.5; sixweeks fescue, 6.9; sand dropseed, 6.6; prairie sandreed, 0.7; and blue grama, less than 0.1.

Because jackrabbits probably move over a large area while feeding, preference indices are only an approximate measure of true preference. Botanical composition of the vegetation was taken only at the kill site, and it was possible that the jackrabbit had eaten elsewhere.

Grazing Relationships

Competition.—Seasonal diets of cattle have been investigated on the Eastern Colorado Range Station (Dahl, unpublished data) and Reppert (1960). Both found that blue grama, prairie sandreed, and needleandthread comprised most of the yearly diet of cattle. Western wheatgrass and sunsedge (*Carex heliophila*) formed an important part of the diet in early spring. Sand dropseed, sand bluestem (*Andropogon hallii*), and forbs were eaten in smaller amounts in summer.

Competition for food between jackrabbits and cattle was greatest in early spring when both animals preferred green forage. Western wheatgrass, needleandthread, and sunsedge initiated growth early and were preferred by both classes of animals. At this time of the year green forage was at a premium and any consumer that removed it was competing with cattle.

Although jackrabbits and cattle ate some of the same species during the summer, they did not eat them in similar proportions. Cattle ate large amounts of blue grama, prairie sandreed, and sand bluestem, whereas jackrabbits ate mostly forbs and sand dropseed.

Competition was probably slight during fall and winter when cattle ate needleandthread and blue grama and jackrabbits relied on western wheatgrass, forbs, and shrubs.

Effects on rangeland.—Jackrabbits probably influence secondary succession on old fields and denuded ranges and decrease the longevity of reseeded forage stands on rangelands. Brown (1947) reported that over a period of 6 months jackrabbits deposited 12.75 lb/acre of sand dropseed seed in fecal pellets on an abandoned field. He also found that the digestive processes of the jackrabbit increased the viability of the seed from 4.2% to 31.3%. The feasibility of using grass–alfalfa mixtures on reseeded rangelands was investigated at the Eastern Colorado Range Station (Dahl et al., 1967). Sand dropseed invaded the reseeded pastures and increased as the amount of intermediate wheatgrass (*Agropyron intermedium*) decreased. Data presented in the present paper indicate that alfalfa, sand dropseed, and possibly intermediate wheatgrass (not distinguished from western wheatgrass) are preferred foods of the jackrabbit. Perhaps jackrabbits concentrated on areas seeded with a grass–alfalfa mixture and disseminated sand dropseed seed while feeding, thus contributing to the invasion of the species.

Conclusions

The major foods in the diet of the black-tailed jackrabbit were western wheatgrass, alfalfa, sixweeks fescue, sand dropseed, pricklypear, and sand sagebrush. The diet followed definite seasonal trends that were influenced by forage maturity and availability. Grasses made up 50% of the yearly diet and were most frequently eaten during early spring and summer. Forbs constituted 30% of the yearly diet and were preferred during summer and early fall. Shrubs were 10% of the yearly diet and were eaten primarily during fall and winter. Forbs were preferred over grasses and seasonally important foods received higher preference indices than those that were eaten in all seasons.

Competition for food between jackrabbits and cattle was greatest in early spring when both animals preferred green forage. At other times they ate some of the same foods but not in the same proportions, so competition was not great for the plants that were preferred by cattle.

Jackrabbits probably decrease the longevity of reseeded forage stands on rangelands and influence secondary succession on old fields and denuded ranges. When a grass–alfalfa mixture is used to reseed rangelands, it is possible that jackrabbits concentrate on seeded areas and disseminate the seeds of less desirable grasses and forbs while feeding, thus contributing to the invasion of these species.

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