A SURVEY OF THE NATIVE RABBITS OF UTAH WITH REFERENCE TO THEIR CLASSIFICATION, DISTRIBUTION, LIFE HISTORIES AND ECOLOGY

by

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Approved:
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* Fish and Wildlife Service of the U. S. Department of Interior, Utah Fish and Game Department, Utah State Agricultural College and American Wildlife Institute cooperating.
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Rabbits and hares, both popularly referred to as rabbits, occupy a very prominent position in the wildlife of Utah. Over much of the state, they form the most conspicuous faunal group, and between the lowest portion of the state to above timberline on the highest mountains there are very few areas entirely devoid of their presence. There is great variation, however, in their abundance, both between localities and times. In some areas, rabbit populations often attain amazingly high numbers to the delight of sportsmen and the dismay of farmers.

Because of diversity of climate, topography, and vegetative types within the state, a great variety of animal species is anticipated. Such is the case with rabbits, for six species and ten sub-species of native forms, as well as an introduced one, are known to occur within the boundaries of the state.

Despite the abundance, widespread distribution, and comparative ease of observation, knowledge concerning rabbits is still relatively meager. To add to this sum of knowledge, the present study was undertaken. It was made possible by the grant of a fellowship to the writer in the Utah Cooperative Wildlife Research Unit. Under the fellowship studies were begun in October 1940 and continued until December 1941, at which time the project was suspended, because of the writer's entrance into military service. It was resumed in January 1946, and continued until May of the same year. Field work consisted of a series of field trips, by which it was endeavored to reach all portions of the state. As many specimens as possible were collected, and field notes pertaining to distribution, life history, food habits, behavior, numbers and economic importance of the various species were kept. Specimens were weighed; measured;
examined for parasites; their stomachs preserved for later analysis; their reproductive organs examined for evidence of breeding; and skins examined for progress of molting. Study skins were prepared of representative specimens.

Little has been written concerning the rabbits of Utah. In reports of early explorations, they received only passing mention or were entirely neglected. One of the earliest writers on the subject, Palmer (1897) gives considerable information concerning abundance, hunting and economic importance of jack rabbits in Utah and other western states between 1849 and 1897. Nelson's *Rabbits of North America* (1909) is a comprehensive treatise chiefly of classification and distribution. Barnes (1927) briefly describes each variety known to occur in Utah and includes notes on distribution and habits. The most thorough account available of all the rabbits of a large area is Orr's *Rabbits of California* (1940), which gives in great detail descriptions, relationships, distribution and life histories of California rabbits. East of the Rockies, rabbits assume more importance as game animals than in the west. Consequently, more literature concerning the eastern forms is available. Aldous (1937) Grange (1932) and Severaid (1945) have contributed much information on the life history of the eastern varying hares, while cyclic phenomena of this species have been intensively investigated by Green and Evans (1940) Chitty and Elton (1937, 1938, 1940), Soper (1921) and others.

Cottontails have been intensively studied in the eastern states. Some of the chief contributors to literature dealing with these rabbits are: Allen (1938), Dalke (1937), Gerstell (1935), Hamilton (1940), Haugen (1943), Hendrickson (1937), Schwartz (1942), Spinner (1940), and Trippensee (1936). In California, Ingles (1941) has written a thorough report on Audubon cottontails.
Vorhies and Taylor (1933) in southern Arizona have reported in detail concerning the life history and ecology of jack rabbits in relation to grazing.
Rabbits and hares, of course, are mammals. The order to which they are assigned has been designated Lagomorpha, meaning hare-like. This group includes hares and rabbits comprising the family Leporidae, and pikas forming the family Ochotonidae. The Lagomorphs resemble the rodents in possessing incisors fitting for gnawing. They are unlike them however in possessing a pair of rudimentary incisors immediately behind the functional pair.

Members of the family Ochotonidae are very small, have no external tail, have pads on the bottom of the feet, have broadly rounded ears; and do not have elongated hind legs. Members of the Leporidae are, in contrast, of larger size, have visible tail, bottoms of feet fully furred, ears long and narrow, and hind legs longer and stronger than front ones.

The family Leporidae is subdivided as follows:

Genus 1- Lepus—hares—born fully furred and eyes open.

Subgenus 1- Lepus—hares with two annual molts

Species found in Utah

1- Lepus townsendii townsendii Bachman, white-tailed jack rabbit

2- Lepus bairdii bairdii Hayden, Rocky Mountain snowshoe rabbit

Subgenus 2- Macrotolagus—hares with one annual molt

Species and subspecies found in Utah

3- Lepus californicus deserticola Mearns, Colorado Desert jack rabbit

4- Lepus californicus texianus Waterhouse, Texas jack rabbit

Genus 2- Sylvilagus—rabbits—born blind and nearly naked

Subgenus 1- Sylvilagus—cottontails
Species and subspecies found in Utah

5- *Sylvilagus nuttallii grangeri* (Allen), Black Hills cottontail

6- *S. n. pinetis* (Allen), Rocky Mountain cottontail

7- *S. audubonii arizonae* (Allen), Arizona cottontail

8- *S. a. warreni* Nelson, Colorado cottontail

9- *S. a. baileyi* (Merriam), Wyoming cottontail

Subgenus 2- Tapetiswamp rabbits— not found in Utah

Subgenus 3- *Brachylagus*-monotypic- pygmy rabbits

Species in Utah

10- *Sylvilagus idahoensis* (Merriam), Idaho pygmy rabbit

Positive identification of the forms of rabbits occurring in the state is not always easy. The cottontails especially, while easily distinguishable as a group, are, in a large area such as Utah which has received no careful taxonomic study, difficult to place in known sub-specific groups. It is my opinion based on the collection and examination of a few specimens from most areas of the state, that the ranges and relationships of Utah cottontails are but imperfectly known and could well be subjected to careful study. The same applies perhaps to a lesser degree to other rabbits of the state as well.

In the present survey, characteristics of form and skull, as set forth by Nelson (1909) and Orr (1940) which seemed best to fit specimens on hand, were used in identification.
ORIGIN

The most ancient rabbit known from North America was found in the rock formation known as the Duchesne River stage of the early Oligocene Epoch. This early ancestor of modern rabbits was quite unlike any existing today. Its generic name, *Uptonolagus*, is derived from the site of its discovery, near Myton in the Uintah Basin. In this area at present, white-tailed jack rabbits and cottontails occur more abundantly than in any other portion of the state. Apparently it has been for a great period of time a region favorable for rabbits.

Rabbits are common in the Upper Miocene formations, but are of different genera from any currently existing forms. In the Pliocene epoch species similar to those of today made their appearance.
DESCRIPTION

White-tailed Jack Rabbit

Western White-tailed Jack Rabbit, Lepus townsendii townsendii Bachman

Lepus townsendii Bachman 1839

*Lepus campestris* Merriam 1891

*Lepus campestris townsendii* Nelson 1909

This hare is known by the common name: mountain hare, white hare, white rabbit, and snowshoe rabbit. The latter is a misnomer, confusing it with the true snowshoe rabbit, *Lepus bairdii*.

The species is the largest of the Leporidae found in Utah. The weights of Utah specimens vary between five and ten pounds, with the females averaging somewhat larger than the males. Other distinguishing characters are the long ears, large hind legs and feet, comparatively long all-white tail; and seasonal change of color. In summer the pelage is grayish above and white beneath which changes to practically pure white in the winter.

The measurements of adult specimens collected in the northern half of Utah are tabulated below. Weights are given in grams; total length, lengths of tail, hind foot and ear from notch, in millimeters.

Table 1. Measurements of white-tailed jack rabbits from northern Utah.

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<th>Sex</th>
<th>Weight (grams)</th>
<th>Total Length (mm)</th>
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<th>Sex</th>
<th>Length Tail (mm)</th>
<th>Length Hind Foot (mm)</th>
<th>Length Ear (mm)</th>
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<td>38</td>
<td>94.6</td>
<td>80-120</td>
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Figure 1. Pair of white-tailed jack rabbits from the Uintah Basin, Feb. 8, 1946. Note larger female on the right.

Figure 2. White-tailed jack rabbit in worn summer pelage, Strawberry Valley, July, 1941.
From the data in Table 1 it will be noticed that females average somewhat larger than males in all measurements except length of ear. Occasionally stories are heard of a "mountain hare" as "large as a dog". Such cases must be exceedingly rare, however, for the largest of the 55 specimens weighed by the writer was 4456 grams or 9.8 pounds. This was a female collected near Heber, Wasatch County. That hares of this species may at times attain relatively enormous size is affirmed by Warren (1942) who reports a prairie hare, *Lepus townsendii campanius* of the Great plains region, weighing 40 pounds.

Summer Pelage: Upperparts light grayish with a suffusion of brown and black; front of fore-legs and tops of fore feet buffy gray; top of head brownish gray, front half of outside of ears dusky gray, posterior half white with a black tip; inside of ear dusky on posterior portion; ear bordered posteriorly with white and anteriorly with buff; orbital area and sides of nose buffy; breast dull drab; nape dingy gray, sometimes brownish; underparts, tops of hind feet, and all of tail white. Winter pelage: appears pure white at a distance; ears and head brownish; often brownish on back; under fur of upper parts salmon colored. Young: upper parts grizzled gray; tops of feet, abdomen, inner surface of legs, and under surface of tail white.

The skull is large, about 90 mm. in total length; arched dorsally; supraorbital plates large; distinct antorbital process; nasals short and wide, width more than half length; second premolar wider than first incisor; auditory bullae small.

Two complete annual molts are effected; a change from gray to white pelage in the fall, and from white to gray in the spring. The fall molt
probably begins in the latter part of October. A specimen collected at Logan on November 2, 1941, had new winter hair growing in copiously under the old summer pelage on the nose, base of ears, breast, throat, shoulders; back, sides and a spot on each side of the rump. Specimens collected in the early part of December were in full winter coat.

On March 3, 1946, 2 specimens collected near Cache Junction while still in winter coat, had summer pelage just coming in under it. Rabbits seen in late March were brown on head and back, with sides rump and legs still white. By April 23, 1940 and 1941, all seen appeared to be in full summer coat. Some individuals do not turn completely white in the winter. Some, especially in the Uintah Basin, were seen with considerable brown on the head, ears, and back. These individuals no doubt undergo a complete fall molt, but some of the new fur grows in brown instead of white.

Rocky Mountain Snowshoe Rabbit, *Lepus bairdii bairdii* Hayden

*Lepus bairdii* Hayden, 1869

The snowshoe rabbit is a small hare with very long hind legs, enormous hind feet, and rather short ears. Other common names are snowshoe hare and varying hare. Four Utah specimens averaged 1145 grams in weight (988-1285), the females being somewhat heavier than the males. Average measurements for six specimens are: total length, 454 mm. (410-451); tail vertebrae, 31 mm. (28-34); hind foot 138 (131-148); and length of ear from notch 76 mm. (70-82). For two males these measurements are: 417, 30, 134, and 72 mm., respectively. For four females they are 442, 31, 141, and 79 mm. These measurements are considerably less than those for *Lepus americanus*, the eastern and northern varying hare, famed for its great periodic population fluctuations.
Utah snowshoes also are somewhat smaller than the same subspecies in north central Idaho. Insufficient specimens have been collected from Utah to determine whether or not size differences exist in different portions of the state.

Color, summer pelage: upper parts grizzled brown to rufous brown, washed with blackish on back and rump; top of head and cheeks cinnamon; outside of ears brownish at base, blackish toward tip; inside of ears dark with white edging; fore-legs cinnamon; nape dusky brown; breast like sides; under parts white; hind feet white. In winter pelage, the rabbit is pure white, with black rimmed eyes and grayish on the ears. The young are less brown and more gray than the adults.

The color changes of the snowshoe rabbit result from two complete annual molts. The fall molt is accomplished by winter fur growing in under the summer pelage and then gradual shedding of the summer fur until the full white coat is revealed. The spring molt begins with the shedding of the long white guard hairs and breaking of the tips of the underfur. Shedding is gradually continued until the complete summer pelage, which has grown up under the winter fur is revealed. Grange (1932) made a detailed study of the pelages and molts of Lepus americanus phaeonotus in Michigan and Wisconsin. He found them beginning to assume winter pelage in late September but not completing the change until December 15 to early January. The spring molt was found to occupy the period from mid-March to June 21.

A specimen collected at Fish Lake in Sevier County, Utah on September 25, was well advanced with the fall molt, while one collected November 8, 1941 near Logan was in full winter coat. One near Fairview, San Pete County, on June 17 was losing its last remnants of winter fur.
Figure 3. Snowshoe rabbit from the Manti Natl. Forest, June 17, 1941.

Figure 4. Black-tailed jack rabbits: female, left; and male, right. From the vicinity of Snowville, March, 1946.
Black-tailed Jack Rabbits

Colorado Desert Jack Rabbit, *Lepus californicus deserticola* Mearns

*Lepus texianus deserticola* Mearns, 1896

*Lepus californicus deserticola* Nelson, 1909

This is a hare of medium size, averaging about 2200 grams or 4.8 pounds in weight and about 560 mm. or 22 inches in length. The hind feet are smaller and the ears larger than those of white-tailed jacks. The same gray pelage is worn throughout the year, there being but one annual molt. No color change except that due to abrasion and bleaching takes place. The tail is comparatively long, black on the upper side, and gray beneath.

The average measurements of 32 males from Box Elder and Cache Counties are: weight 2075 grams (1734-2500), length 554 mm. (505-595), length of tail vertebrae 87 mm. (75-110), length of hind foot 128 mm (121-136), length of ear from notch 123 mm. (113-134).

Twenty-five females from Box Elder and Cache Counties averaged as follows: weight 2386 (1962-2883), length 574 (535-615), length of tail vertebrae 91 (79-106), hind foot 130 (118-136), length of ear from notch 125 (118-134).

Eleven males from Iron County averaged: weight 2224 grams (1953-2477), length 558 (539-580), tail vertebrae 88 (75-102), hind foot 126 (123-130), ear from notch 127 (120-130).

Fourteen females from the same area in Iron County averaged: weight 2370 (1991-2733), length 568 (538-600), tail vertebrae 90 (82-97), hind foot 129 (121-135), ear from notch 126 (120-132).

From these data there appears to be little significant size difference between specimens from northern and southern Utah. Females averaged a little larger than males.
Pelage, Light phase: Upperparts ash gray, darkened by the black tips of guard hairs; sides of head and body paler than back; eye ringed with white or buffy; inside of ears gray edged with buff or white; outside of ears gray on front half, whitish on rear half with blackish patch at tip; nape pale cinnamon to grayish; top of tail and line down rump black; underside of neck buffy or fawn; no rump patch; underparts white; tops of hind feet whitish.

Dark phase: A strong brownish suffusion over all except narrow ventral white patch.

In the worn pelage of summer, the upper parts are considerably lighter and the fur shorter.

The young, even at birth, are minatures of the adult. The pelage however is more woolly.

The molt was observed beginning in mid-August in west-central Utah. Specimens taken in September and October were molting heavily, and one taken November 3 near Logan was still molting. The new hair apparently grows in a more or less regular pattern, beginning on the throat, top of head, nape, and shoulders. Next it comes in on the back, outside of legs and upper sides. The sides of the head, breast, lower sides, backs of hind legs and rump receive new hair next, breast, lower sides, while the fur of the abdomen comes in last.

The one annual molt of the black tail appears to take about twice as long for completion as the semi-annual molt of hares of the sub-genus Lepus.

Texas Jack Rabbit, Lepus californicus texianus Waterhouse

Lepus texianus Waterhouse, 1848
Lepus texianus griseus Mearns, 1896
Lepus texianus micropus Allen, 1903
Lepus californicus texianus Nelson, 1909

This subspecies, found in southeastern Utah, is said by Nelson to differ from *L. c. deserticola* chiefly in having a well-marked, pale gray rump patch; slightly darker color; less buff on sides, resulting in whiter underparts; and darker legs and ears.

No data was gathered concerning this race, as the writer was not able to visit its range.

Nuttall Cottontails

Cottontails are of small size as compared to the hares. They are easily distinguished by their shorter hind legs, small feet, short ears, rufous colored nape and legs, and short tail which is gray above and white below. The upperparts are grayish mixed more or less with buffy and darkened by a wash of black. There is but one annual molt.

The *nuttallii* group is characterized by short, well-furred ears; large, heavily-furred hind feet; and the following skull characteristics: supra-orbital processes small and slender, abruptly pointed anteriorly; palatine bridge lacking a postero-median spine; and bullae of medium size.

Black Hills Cottontail, *Sylvilagus nuttallii grangeri* Allen

Lepus sylvaticus grangeri Allen, 1885
Lepus perplicatus Elliot, 1903
*Sylvilagus nuttallii grangeri* Nelson, 1909

Measurements of 12 males collected from Cache and Box Elder Counties are averaged as follows: weight 765 grams (712-875), length 366 mm. (346-373), tail vertebrae 46 (40-58), hind foot 95 (92-98), ear from notch 62 (58-65).
Fourteen females from the same areas averaged; weight (7 averaged) 860 grams (739-996), length 377 (361-400), tail vertebrae 45 (41-50), ear from notch 64 (56-67). Females are thus seen to be the larger. Pelage: Top of head fawn color; back buffy, tinged with fawn and darkened by a wash of black. Sides of head paler and grayer; rump iron grays, forming patch lighter than rest; nape rufous; ears grayish edged with black; top of tail dusky brown above, white below; tops of hind feet white; front of forelegs cinnamon; throat ochraceous buff; chest and abdomen white.

Molts: Specimens collected in mid-August were well advanced in the molt, new hair coming in thickly on the back, sides and top of head. On October 10, areas of new hair growth had moved to the belly shoulders, rump, breast, under surface of neck, throat, chin, nape, and sides of head. By mid-November, molting was nearly complete. Skins examined at this time were prime, except a few with small molting areas on belly, rump, shoulders, breast, and throat. By early December, all skins were prime. Four months, August to November are occupied by the molt.

Rocky Mountain Cottontail, Sylvilagus nuttallii pinetis Warren

Lepus sylvaticus pinetis Allen, 1894

Sylvilagus nuttallii pinetis Warren, 1910

This is the largest race of the nuttallii group. According to Nelson (1909), it is distinguished from S. n. grangeri by the following characters: rump patch not as strongly defined as in grangeri; color darker; rufous of legs paler and duller; ears longer; no data were collected on this race which is said to occur in the higher mountains of southeastern Utah.

Audubon Cottontails

The audubonii group of cottontails possesses in contrast to the nuttallii group, longer ears which are more sparsely haired; slender hind
Figure 5. Comparison of Wyoming cottontail (above) and Black Hills cottontail (below). Both from vicinity of Altonah, Feb. 1946. Note larger size, longer ears, longer tail and lighter color of Wyoming cottontail.

Figure 6. Wyoming cottontail, Duchesne, Aug. 1941. Note long, sparsely-haired ears.
feet, not heavily-furred; supra-orbital processes broad, blunt or irregular at the anterior tip; palatine bridge with a postero-median spine; and bullae medium to large.

Arizona cottontail, Sylvilagus audubonii arizonae Allen

*Lepus* sylvaticus arizonae Allen, 1877
*Lepus* arizonae major Mearns, 1896
*Lepus* laticinctus Elliott, 1903
*Lepus* laticinctus rufipes, 1903
*Sylvilagus* audubonii arizonae Nelson, 1909

Distinguishing characters: size small, about 360 mm.; ears long and very sparsely haired; bullae large, over 13 mm.; skull small and light.

Average measurements of six males from Washington County are: weight 651 grams (609-708), length 355 mm (342-375), tail vertebrae 37 (31-50), ear from notch 74 (71-76).

Three females from the same area average: weight 688 grams (653-723), length 363 mm. (362-364), tail vertebrae 46 (41-52), hind foot 83 (80-85), ear from notch 75 (72-78). The females average slightly larger than the males.

Fresh pelage: Upperparts pale buffy gray, with wash of black; sides of head and body pale gray; iron gray rump patch; nape light rufous; top of tail similar to rump, under side white; outside of ears paler than back and edged with black at tip; front of forelegs cinnamon; tops of hind feet white; underside of neck drab to buff; belly white.

Worn pelage: paler, due to wearing away of black tips of guard hairs.
Juvenile: pale brownish gray; nape and legs pale.

Molts: Specimens from near Veyo, Washington County in mid-September were molting heavily.
Colorado cottontail, *Sylvilagus audubonii warreni* Nelson

*Sylvilagus audubonii warreni* Nelson, 1907

*Sylvilagus audubonii warreni* Miller, 1924

Distinguishing characters: Similar to *S. a. baileyi*; size smaller; upperparts darker, more brownish; grey rump patch more marked; nape and legs darker rufous; skulls not distinguishable from *baileyi*.

Measurements: The weights of two adult males are: 900 and 979 grams, lengths 370 and 377, tail vertebrae 43 and 48, hind feet of both 93, ear from notch 77 and 78. One female taken weighed 993 grams and measured 394, 48, 89, and 70 respectively in length, length of tail, hind foot, and ear from notch.

Fresh pelage: Upperparts dark creamy buff, heavily washed with black on the back; sides of head and body grayer; shading into buffy on flanks; outside of ears like back; nape light rufous; rump iron gray forming well-defined patch; top of tail like rump; front and sides of fore-legs rufous; tops of fore and hind feet white or buffy; back and outside of hind legs cinnamon; inguinal area buffy; underside of neck dark buff.

Molts: specimens collected in Emery County October 1, 1941 were molting heavily on the back, rump, shoulders, outside of legs, sides of neck, and top of head. Time and duration of molt of these cottontails probably coincides approximately with that of the Black Hills cottontail discussed previously.

Wyoming cottontail, *Sylvilagus audubonii baileyi* Merriam

*Lepus baileyi* Merriam, 1897

*Sylvilagus audubonii baileyi* Nelson, 1909

*Sylvilagus audubonii baileyi* Miller, 1924
Distinguishing characters: Largest cottontail found in Utah; differs from S. a. warreni in being lighter colored, and in having a poorly defined rump patch; rufous of the legs and nape paler. Both these races have a large skull with heavy molar series, heavy rostrum, large bullae, and broad zygomatic arch.

Three males taken from Duchesne and Uintah Counties averaged in weight 972 grams (900-1010). Other measurements were: length 398 mm. (394-405), tail vertebrae 49 (40-60), hind foot 96 (94-97), ear from notch 75 (70-77). Nine females taken from the same areas averaged: weight 1061 grams (914-1143), length 399 mm (387-420), tail vertebrae 49 (32-56), hind foot 96 (91-99), ear from notch 73 (71-76). Here, too, the females average a little larger than the males.

Fresh pelage: Long and thick; upperparts pale, creamy buff with light wash of black; sides of head and body paler than back; rump iron gray, not forming patch; top of tail like rump, under side white; outside of ear grayish white; nape light rufous; forelegs ochraceous buff; back and sides of hind legs dark buff; underside of neck buff.

Juvenile: darker and more Buffy brown.

Worn pelage: paler and grayer.

Molting: specimens collected in the Uintah Basin on August 1, 1941 had begun molting. New hair was coming in on the back, sides, rump, neck, and head.

Great Basin cottontails

Audubon cottontails found in the Great Basin desert areas of western Utah are difficult to place in any recognized race. They possess more similarity to the Colorado cottontail than any other form and after detailed taxonomic study will probably be placed either in the subspecies
S. a. warreni or in a new race. In size they are about the same as the Colorado cottontail.

Measurements: Three males from western Iron and Millard Counties averaged: weight 326 grams (869-990), length 396 mm. (390-400), tail 51 (46-55), hind foot 89 (87-91), ear from notch 79 (75-81). Three females from western Millard County measured: Weight 983 grams (888-1032), length 388 mm. (380-393), tail 52 (51-55), hind foot 88 (85-90), ear from notch 77 (74-82).

Pelage and skull characteristics are also similar to those of the Colorado cottontail.

Molts: Specimens taken in September in Millard and Iron Counties were molting heavily.

Pygmy Rabbits

Idaho Pygmy Rabbit, Sylvilagus idahoensis (Merriam)

Lepus idahoensis Merriam, 1891
Brachylagus idahoensis Lyon, 1904
Sylvilagus idahoensis Grinnell et. al., 1930

These are the smallest of American rabbits, measuring only between 10 and 12 inches in length. The ears, legs and feet are very short; the tail very inconspicuous and all brown. The color of the upperparts is an even grayish brown, the underparts white; the nape and portions of legs rufous.

Six males from Iron County averaged: Length 274 mm. (263-282), tail vertebrae 17 (13-23), hind foot 67 (65-70), ear from notch 52 (51-54).

Fourteen females from the same area measured: Length 286 mm. (269-308), tail vertebrae 18 (15-22), hind foot (64-73), ear from notch 51 (46-55).
Figure 7. The smallest and the largest of Utah rabbits: Pygmy rabbit, left; white-tailed jack rabbit, right. Blue Spring Hills, Box Elder Co., June, 1940.

Figure 8. Pygmy rabbit at mouth of burrow, near Cedar City, December, 1938.
Six males from Box Elder County averaged 405 (373-428) grams in weight, while the measurements for eight are: length 275 mm. (261-283), tail vertebrae 17 (15-19), hind foot 70 (66-75), ear from notch 51 (48-56). The average weight of 4 females from Box Elder and Cache Counties is 436 grams (415-456). Measurements of 8 females from the same area are: length 291 mm. (273-305), tail vertebrae 17 (15-19), hind foot 70 (67-74), ear from notch 50 (48-51).

From these data it appears that females averaged larger than males; and there seems to be a tendency toward larger size in the northern part of the state.

Davis (1939) describes the color of Idaho specimens at different seasons of the year as follows:

November: upperparts buffy gray; nape rich cinnamon buff; ears edged with buff, inside of concha clothed with white hairs; anterior surfaces of legs cinnamon buff; throat patch usually buff; abdomen clear white, often tinged with buff; tail rusty above and below. By midwinter (February) the fur has become so worn that upper parts are nearly silver gray, with a slight indication of sooty brown deeper color visible. By May, the upper parts are much darker, nearly sooty brown, with a mixture of white-tipped hairs; inside of ears gray rather than white; underparts plumbeous white. June specimens like those of May, but with new, grayish buffy hairs coming in thickly along the sides; old hair beginning to drop out on sides and flanks.

Molting: A specimen taken August 21, 1941 was in a state of advanced molt, new hair growing in thickly over most of the body. Specimens collected September 10, were still molting heavily.
DISTRIBUTION

White-tailed Jack Rabbits

Specimens were collected in the Blue Spring Hills and at Promontory in eastern Box Elder County; at Clarkston, Cache Junction and Logan in Cache County; near Heber and Strawberry Reservoir in Wasatch County; Diamond Mountain and Vernal in Uintah County; Altonah and Whiterocks in Duchesne County; and Fish Lake in Sevier County. Rabbits of this species were seen near Kalskowm and Randolph in Rich County; near Draper, Salt Lake County; near Price, Carbon County; at Fruits, Wayne County; the Aquarius Plateau and Panguitch Lake, Garfield County. Signs of their presence were noted in the Raft River Mountains, Box Elder County, and on Escalante Mountain, Garfield County. Nelson (1909) reports them from Kanab, Kane County. Their range, then, apparently extends completely across the northern part of the state in the Wasatch Mountains and west of Great Salt Lake in the West. It extends south through the mountains of central Utah to the southern extremity of the state (Figure 9).

Snowshoe Rabbits

Snowshoe rabbits are apparently found only in the Uintah and Wasatch Ranges, extending east nearly to Colorado and south to at least Boulder Mountain, Garfield County. Specimens were collected in Logan Canyon; in the Uintahs of Daggett and Uintah counties; east of Fairview, San Pete County; and at Fish Lake, Sevier County. These rabbits were seen in Weber Canyon; and on the mountain east of Salt Lake City. Signs of their presence were noted in Farmington Canyon; in the vicinity of Mirror Lake; in the mountains surrounding Strawberry Reservoir; and on Boulder Mountain, Garfield County. Barnes (1927) received a report from a
Figure 9. Probable distribution of white-tailed jack rabbits

LEGEND

- specimens collected
- rabbits seen
- indications of presence
- reported presence
Figure 10. Probable distribution of snowshoe rabbit in Utah

LEGEND

- specimens collected
- rabbits seen
- indications of presence
- reported presence

MAP OF UTAH WITH MARKINGS
reliable source of their presence in the mountains near Maryvale, Piute County.

Black-tailed Jack Rabbits

This species occurs throughout western Utah from Idaho to Arizona and from Nevada east to the Wasatch Range in the northern part of the state. South of Nephi, it is found through the intermountain valleys east to the Colorado state line, south of the Book Cliffs. These cliffs form the southern escarpment of the Tavaputs plateaus, attaining elevations of about 10,000 feet, which probably are barriers preventing the spread of blacktails northward into the Uintah Basin. The Colorado River is said to form the dividing line between the range of *Lepus californicus deserticolus* to the west and that of *Lepus californicus texianus* to the east. Specimens were collected at Clarkston and Logan, Cache County; Promontory, Blue Spring Hills, Howell, Snowville, Lynn, Grouse Creek and Lucin, Box Elder County; Fremont Island in Great Salt Lake; Otter Creek Reservoir, Piute County; Sevier Lake and Clear Lake, Millard County; Little Salt Lake, Summitt, Cedar City, Lund, Iron County; and about 30 miles southeast of Escalante, Garfield County. They were seen near Gold Hill and Vernon, Tooele County; Eureka, Utah County; Trout Creek and Levan; Juab County; Gunnison, San Pete County; Fillmore, Kanosh and the Desert Range Experiment Station, Millard County; Milford and Beaver, Beaver County; Melrose, and Newcastle, Iron County; Enterprise, Beaver Dam Wash and Leeds, Washington County; Hatch and Widstoe, Garfield County; Loa, Bicknell, and Hanksville, Wayne County. Long (1940) reports them abundant at Kanab.
Figure 11. Probable distribution of black-tailed jack rabbits

LEGEND
- Colorado Desert jack
- Texas jack rabbit

○ - specimens collected
× - rabbits seen
□ - indications of presence
△ - reported presence
Nuttall Cottontails

The Black Hills Cottontail is found most abundantly in Utah in the hills of the northern end of the state from which it extends west into Nevada and north into Idaho. It apparently extends south along the lower slopes of the mountains to the southern end of the state; and east along the lower slopes of the Uintahs into Colorado and Wyoming. Specimens were collected at Lynn, near Standrod, in the Blue Spring Hills, west of Snowville, all in Box Elder County; near Logan, Cache County; and near Altonah, Duchesne County. They were seen on Promontory Point, Little Mountain, Weber County, near Laketown, and near Heber. One seen near Panguitch Lake was probably this species. Nelson (1909) reports them from the Henry Mountains, Helper, Ogden, Nephi, Panguitch and Upper Kanab.

The Rocky Mountain cottontail, *S. n. pinetis* is probably found in the higher mountains of the northeastern part of the state. Benson (1935) reports a cottontail thought to be *pinetis* high on Navajo Mountain.

Audubon Cottontails

The Arizona cottontail, *Sylvilagus audubonii arizonae*, is restricted in Utah to the southwesterly corner of the state, chiefly Washington County, and is most abundant at elevations below 5000 feet. North of the Pine Valley Mountains it possibly intergrades into the larger form of *S. audubonii* found in the deserts to the north. Specimens were collected at Veyo, Leeds, and the Beaver Dam Wash. Presnall reports it from Zion and Bryce Canyons.

The Colorado cottontail *S. a. warreni* appears to occupy most of the desert plateau area of eastern Utah, south of the Book Cliffs, which apparently separate the range of *S. a. warreni* from that of *S. a. baileyi* found in Uintah Basin. Specimens were collected at Hanksville, 30 miles
Figure 12. Probable distribution of Nuttall cottontails in Utah

LEGEND
- Black Hills cottontail
- Rocky Mt. cottontail

○ - specimens collected
△ - rabbits seen
□ - indications of presence
△ - reported presence
Figure 13. Probable distribution of Audubon cottontails in Utah

LEGEND

- specimens collected
- rabbits seen
- indications of presence

- reported presence
- Arizona cottontail
- Wyoming cottontail
- Colorado cottontail
- Gt. Basin cottontail
southwest of Green River, and 20 miles southeast of Price. Nelson (1909) reports them from Ganesville and the Henry Mountains. Cary (1911) reports them abundant near Bluff City, San Juan County.

The Wyoming Cottontail is found in the Uintah Basin. Its range is divided from that of S. e. warreni by the Tavaputs Plateaus. Specimens were collected near Duchesne; near Vernal, in the Dinosaur National Monument near Jensen, at the state boundary southeast of Jensen, Uintah County; and near Altonah and Nyton, Duchesne County.

Cottontails found in the Great Basin desert areas of central and southern Utah present a taxonomic problem. In western Millard and Iron Counties cottontails of large size were collected, unquestionably belonging to the Audubonii group. Approaching the Pine Valley Mountains to the south and the Pavant Mountains to the east, they appear to decrease in size. They appear not to fit any recognized race, so for convenience they will be called Great Basin Cottontails in this paper.

Pygmy Rabbits

The range of the pygmy rabbit appears to extend through Utah west of the Wasatch Mountains from the Idaho boundary to the northern boundary of Washington County, chiefly between elevations of 4000 and 6000 feet. Specimens have been collected near Clarkston, Cache County; in the Blue Spring Hills, and at Grouse Creek, Box Elder County; and near Modena, Lund, Kanarraville, and Cedar City, in Iron County. They, or unmistakable signs of their presence, were seen near Snowville, Lund, Lucin, Promontory, and Parowan. A reliable report of their presence just west of Utah Lake and a somewhat questionable one of their occurrence just west of Trout Creek were received.
Figure 14. Probable distribution of pygmy rabbit in Utah

LEGEND

2 - specimens collected
× - rabbits seen
○ - indications of presence
△ - reported presence
Figure 15. Life zones of Utah

LEGEND
- Lower Sonoran Zone
- Upper Sonoran Zone
- Transition Zone
- Boreal Zone
- Alpine Zone

SCALE OF MILES

Legend:
- Salt Lake City
- Wellington
- Draper
- American Fork Canyon
- Utah Lake
- Wasatch Range
- Little Cottonwood River
- Provo River
- Ogden River
- Bear River
- Bear River Breaks
- Great Salt Lake
- Great Salt Lake Desert
- Utah National Park
- Yosemite National Park
- Grand Canyon
- Colorado River
- San Juan River
- Green River
- Yampa River
- Dolores River
- Rio Grande
- San Luis River
- Rio Grande de Chama
- Rio Grande del Norte
- Santa Fe River
HABITAT

White-tailed Jack Rabbit

In Northern Box Elder and Cache counties during the winter white-tails were found abundantly in hilly areas vegetated sparingly with sagebrush, *Artemisia tridentata*; bitter brush, *Purshia tridentata*; and giant wild rye, *Elymus condensatus*. In the summer they are more partial to the north slopes supporting patches of choke-cherry, *Prunus melanocarpa*; snowberry, *Symphoricarpos rotundifolia*; and mountain myrtle, *Pachystima myrsinites*. Patches of heavy sage seem to be avoided, and a more open type preferred. They are often common around the edges of wheat fields situated at the foot of hills, where they find cover in sage brush bordering the fields.

East of Logan they were jumped in areas between 7000 and 8000 feet altitude in a dense cover of snowbrush, *Ceanothus velutinus* with surrounding patches of aspen, *Populus tremuloides*; and alpine fir, *Abies lasiocarpa*.

In Wasatch County they were found inhabiting extensive areas of sagebrush at elevations ranging from 5500 to 8000 feet, while signs were seen at elevations of 10,000 feet on peaks supporting sparse vegetation.

In the Uintah Basin these rabbits were most abundant on sagebrush plateaus and slopes at about 7000 feet, but were also common on lower slopes supporting pinyons, junipers and serviceberry. They were also commonly found on the Basin floor at elevations around 5000 feet in a semi-desert type of greasewood, *Sarcobatus vermiculatus*; shadscale, *Atriplex confertifolia*; and other salt bushes. In this region they appeared to occupy the position filled by the *Lepus californicus* group found on the deserts and foothills of southeastern and western Utah.
Figure 16. Juniper and sagebrush habitat of white-tailed jack rabbit near Altonah, Duchesne County, Feb. 8, 1946.

Figure 17. Habitat of black-tailed jack rabbit and pygmy rabbit near Cedar City, Dec. 1938.
In the southern part of the state white-tailed jacks are found rarely, and then chiefly at elevations of 8000 to 11,000 feet. At Fish Lake they were common in high sage brush flats, while south of there they were met only occasionally in alpine fir timber with sagebrush flats, *A. cana* interspersed. Life zone distribution is from upper Sonoran to Alpine (Figure 15).

**Snowshoe Rabbit**

This species is found almost invariably associated with coniferous timber, although at times ranging away from it along streams bordered thickly with willows at high elevations. In northern Utah they are found in Douglas fir stands with an understory of snowberry, snowbrush, mountain myrtle, mountain ash, *Sorbus scopulina*, at elevations of about 5600 feet, through aspen, alpine fir and Engleman spruce to timberline. In the Uintahs, snowshoes are found commonly in lodgepole pine, and were noticed about unoccupied buildings such as C. C. C. barracks, under which they took refuge when startled.

Near Fish Lake they occupy areas with a cover of blue spruce, *Picea pungens*; aspen, willows, Douglas fir; and at higher elevations, alpine fir and Engleman spruce. Throughout their range these rabbits appear partial to dense windfalls, or thickets, in which they seek cover. Life zone distribution is principally Boreal (Figure 15).

**Black-tailed Jack Rabbits**

These hares are found in a wide variety of habitats in Utah, between 2500 and 8000 feet. They range through the lower Sonoran area of southwestern Utah with its vegetation of Joshua trees, *Yucca brevifolia*; cresote bush, *Covillea tridentata*; and Brigham tea, *Ephedra* spp., upward
through the pinyon juniper belt into the open stands of ponderosa pine. On the salt deserts of the Great Basin region, they occupy areas of shadscale and greasewood and extend through rabbitbrush and sagebrush types into the junipers and pinyons. They are very common in some of the sagebrush and rabbit brush covered valleys of the mountain regions in central and southern Utah. On the desert plateau of eastern Utah, blacktails are found occasionally in areas vegetated with black brush, Coleogyne; and Brigham tea, Ephedra nevadensia and E. viridis. In some of the greasewood flats adjacent to streams, they are more common. Life zone distribution is from the lower Sonoran to the Transition Zone (Figure 15).

Nuttall Cottontails

In the northern part of the state, Black Hills cottontails are found in hilly areas vegetated with sagebrush; rabbitbrush, Chrysothamnus nauseous and C. viscidiflous; giant wild rye; bitter brush and patches of choke cherry. In the foothills they extend upwards well into the pinyon-juniper belt with its associated shrubs; mountain maple, Acer grandidentatum and even into the Douglas fir and aspen. In the southern portion of the state this race appears to range through the foothill zones into the ponderosa pine belt.

S. n. pinetis is said to range still higher, from 7500 feet to over 10,000. Thus, it is frequently found in aspen, fir, and spruce stands. Both favor rocky situations. S. n. grangeri is rarely found away from rock piles, rocky outcroppings, or steep sided washes containing crevices and burrows in which it finds refuge. Old buildings often supplant natural shelters, and it is common to find several of these cottontails dwelling under an abandoned ranch house. Life zone distribution is from the upper Sonoran to the Boreal zone (Figure 15).
Audubon Cottontails

The Arizona cottontail, *S. a. arizonae*, seems to be predominately a lower Sonoran resident (Figure 15). It is found on the deserts of Washington County amid Joshua trees, various cacti, Brighan tea, creosote bush; and extends upwards into the junipers and pinyons with their associated evergreen oaks, *Quercus turbinella*; and quinine bush, *Garrya flavescens*. It seeks shelter readily in old burrows, or in crevices of rocky bluffs.

The Wyoming and Colorado cottontails inhabit similar situations. Washes and flats containing a cover of greasewood and salt bushes are favorite haunts. Eroded crevices in washes are frequently used as forms by both subspecies. Some of these cottontails are found too on higher ground supporting horsebrush, *Tetradymia axillaris*; hop sage, *Grayia spinosa*; four-winged salt bush, *Atriplex canescens*; and among boulders along rocky bluffs, upwards into the pinyon and juniper belt.

In western Utah a few Audubon cottontails were seen in the low, greasewood covered washes; but the majority were in the mouths of small, rocky canyons; or in the vicinity of boulders and rocky outcrops at the foot of buttes and hills. Vegetation in such areas consisted principally of *Atriplex canescens*, *Chrysothamnus nauseosus*, *Gutierrezia*, *Eurotia*, and *Emplectocladus fasciculatus*. At the Desert Range Experiment Station, where cover generally was scarce, cottontails were found inhabiting large drifts of tumbleweed piled against the fences in washes. Life zonal distribution of all Audubon cottontails in Utah, except *S. a. arizonae*, appears to be exclusively upper Sonoran (Figure 15).

Pygmy Rabbits

This rabbit appears to be more dependent upon sagebrush than any of the other species. Tall sagebrush on a loose sandy soil seems to be its
favored environment in Iron County. Some were found also in mixtures of sagebrush, rabbitbrush, and greasewood; and in sagebrush and four-winged saltbrush. In such areas these rabbits dig rather extensive burrow systems, in which they take refuge from danger. In the hills of northern Utah, they occupy the same habitats with white-tailed jack rabbits, black-tailed jacks, and Black Hills cottontails. In this area they are found frequently using old badger holes. Life zonal distribution is exclusively upper Sonoran (Figure 15).
HOME AND SHELTER

Forms are used extensively as shelter by all rabbits, while burrows are used chiefly by the cottontails and pygmy rabbits. Adult hares occasionally resort to burrows, to escape after being wounded, but normally their homes are merely hollowed out places under bushes known as forms. Pygmy rabbits are commonly regarded as the only North American rabbits which habitually dig their own burrows, although Orr (1940) reports Audubon cottontails in California digging burrows.

White-tailed Jack Rabbits

White-tailed jack rabbits make their forms in a variety of cover. On Diamond Plateau, east of Vernal, thirteen white-tails flushed, each from a form under sage brush, *Artemisia tridentata*. In Strawberry Valley, of eight forms, six were in *A. tridentata* and two in a combination of sagebrush and *Stipa*. In the Blue Spring Hills rabbits were flushed from forms in sagebrush and *Elymus*; snowberry, *Symphoricarpos*; and choke cherry. Near Altonah, these rabbits made their forms under junipers, juniper slash, pinyon, sagebrush, and *Purshia*.

These hares occasionally make use of burrows to escape from danger. On the Diamond Plateau one wounded by the writer crawled down a prairie dog hole, while wounded ones in the Blue Spring Hills were seen to seek shelter in old badger holes.

Snowshoe Rabbits

Snowshoe rabbits in Logan canyon during the winter commonly sought shelter under Douglas firs bent prostrate by snow; and in clumps of mountain willow. In the Uintah mountains they were jumped from dense windfalls of lodge pole pine, and were seen also living under abandoned
C. C. C. barracks. A nursing female, east of Fairview was flushed from wild gooseberry bushes, Grossularia.

Black-tailed Jack Rabbits

Black-tailed jacks utilize a wide variety of cover for their forms. On saline low lands, greasewood is a favored cover, while on better drained areas sagebrush and four-winged salt bush contain many forms. On the Colorado Desert of southeastern Utah forms of the black-tails were seen about equally in black brush, Coleogyne ramosissima, and Ephedra spp. In the dry hills south of Gold Hill, Tooele County, these rabbits were jumped from bushes of Grayia. Drifts of Russian thistle are commonly used as form cover in some area. Wounded black-tails often crawl into burrows of other animals to escape, and occasionally need not be wounded to do this. On a rabbit drive at Promontory, the writer observed apparently uninjured jack rabbits seeking refuge in old badger holes. Hardy (1945) reports instances of black-tails entering winter dens of the desert tortoise. The young customarily use burrows as readily as do cottontails.

Nuttall Cottontails

Nuttall cottontails favor outcroppings of rock, among which they have their holes. In areas inhabited by them where rocks are absent, old burrows of badgers and other burrowing animals constitute their chief refuge. Other favorite refuges are old buildings and stone walls.

Audubon Cottontails

Arizona cottontails depend partially upon thick clumps of desert vegetation, such as mesquite, whose thorns offer a measure of protection. Burrows and crevices in rock outcroppings and washes are also used habitually. Hardy (1945) states that they are commonly found in winter dens of the desert tortoise.
Audubon cottontails in southeastern and western Utah live in very similar situations. These are rough, rocky washes or small canyons with holes and crevices in the walls.

In the Uintah Basin some cottontails were found living on benchlands so bare that a mouse would be hard pressed to find cover. However, the prairie dog holes found commonly on such areas afforded the necessary concealment. In areas of better cover, many cottontails were found lying in forms in sage, juniper, or greasewood, and running to nearby burrows when danger threatened. In some areas of very dense greasewood cover, little recourse to burrows was made.

Pygmy Rabbits

In southern Utah, and other places where the rabbits inhabit areas of rather deep loose soil, they dig extensive burrows which they use year after year. These burrows are often found on slight mounds on which the sagebrush grows taller than on the surrounding ground. The rabbits excavate their own burrows, but freshly dug ones are scarce. This scarcity is probably due to the high mortality among the rabbits, and resulting stable population which has no need for more holes than already exist.

The rabbits are capable of digging quite rapidly. Two holes found, one about six feet long and the other eight, had been dug apparently within the space of a few hours, for the dirt at the entrances was still moist. The burrows are seemingly enlarged little by little with use by generations of pygmy rabbits. From time to time, earth and debris are evicted from the tunnels and new entrances added. In the Cedar City area most of the burrowing activity has been noticed to occur during mild winter days and early spring. In regions where the winters are more severe, burrowing is carried on mainly in the spring.
A typical burrow has several entrances, usually four or five, but sometimes as many as ten. The entrances are fairly close together, usually being all contained within a diameter of from ten to fifteen feet. The diameter of the entrances is about four or five inches, but the tunnels widen somewhat underground to form chambers, the deepest not exceeding three feet below the surface, and the others about two or two and one half feet.

Besides the main burrows, there are often found in areas frequented by the pygmies, short, shallow burrows with only one or two entrances. The rabbits seemingly use these only as a last resort.

Rabbit burrows seem to be occupied normally by only one adult rabbit, but when alarmed, as many as three may seek refuge temporarily in the same burrow. During the breeding season, the rabbits are commonly seen in pairs, both sexes apparently occupying the same burrow for a few days. On several occasions in the early spring, two rabbits were seen together occupying the same burrow. Two of these pairs were collected, and in each case one rabbit was a male and the other a female.

The burrows are often used as a base of operations by other small mammals, especially kangaroo rats. When the burrows are uncovered, often several small holes, too small for rabbits, are found branching from the main tunnel. In one that was follows to its end, the nest of a kangaroo rat and the remains of the occupant which had been eaten by a weasel were found. In the Blue Springs area, ground squirrels (citellus armatus) were very abundant. There both squirrels and pygmies apparently use the same holes to some extent.

In southeastern Idaho many were found inhabiting holes among the boulders of volcanic outcroppings, in stone walls, and in rock piles. In this area they were also found commonly about abandoned farm buildings
Figure 18. Freshly dug burrow of the pygmy rabbit, near Cedar City, Dec., 1939.

Figure 19. Adjacent entrances to pygmy burrow system in a cactus patch, near Cedar City, Dec., 1939.
where they had their holes in old cellars, foundations, and under the floors.

Forms under bushes similar to those used by other rabbits are used by the pygmies to lie in during the day.
FOOD

The results of stomach contents analysis of the six rabbit species occurring in Utah are summarized in Table 2. Because of the finely divided state of the food particles, only a few items could be identified. Lists of food plants were compiled chiefly from field observations obtained by following tracks in the snow and inspection of plants upon areas where rabbits were known to have been feeding. Identifications of plants, about which the writer was dubious, were performed by Professor A. D. Smith and Professor Bassett Maguire of the Utah State Agricultural College.

Table 2. Frequency of occurrence of various items in 201 stomachs of the six rabbit species native to Utah

<table>
<thead>
<tr>
<th>Items in Stomachs</th>
<th>snowshoe rabbit</th>
<th>whitetail</th>
<th>blacktail</th>
<th>Nuttall</th>
<th>Audubon cotton-tail</th>
<th>Fugmy cotton-tail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of stomachs examined</td>
<td>4</td>
<td>44</td>
<td>74</td>
<td>22</td>
<td>42</td>
<td>15</td>
</tr>
<tr>
<td>Grass &amp; sedge</td>
<td>3</td>
<td>38</td>
<td>52</td>
<td>15</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Unidentified weeds</td>
<td>4</td>
<td>15</td>
<td>6</td>
<td>3</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Polygonum</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salsola</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plantago</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amaranthus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unidentified seeds</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Sage brush</td>
<td>1</td>
<td>3</td>
<td>40</td>
<td>6</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Greasewood &amp; salt bushes</td>
<td></td>
<td></td>
<td>0</td>
<td>22</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Willows</td>
<td></td>
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</tr>
<tr>
<td>Wild rose</td>
<td></td>
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<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Cactus</td>
<td>6</td>
<td>1</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Juniper berries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unidentified roots</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Hay</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair</td>
<td>7</td>
<td></td>
<td></td>
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<tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Placentas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

White-tailed Jack Rabbit

The following list of food plants of the white-tail was drawn up from summer and winter observations in the field, supplemented by stomach analysis:

- **Juniperus utahensis** - Utah Juniper
- **Stipa sp.** - needle grass
- **Koeleria cristata** - Junegrass
- **Bromus tectorum** - downey brome
- **Agropyron smithii** - western wheat grass
- **Carex sp.** - sedge
- **Lupinus sp.** - Lupine
- **Medicago sativa** - alfalfa
- **Polygonum sp.** - knot weed
- **Opuntia sp.** - prickly pear cactus
- **Orthocarpous luteus** - owl clover
- **Plantago sp.** - plantain
- **Symphoricarpos sp.** - snowberry
- ** Gutierrezia sarothrae** - snake weed
- **Chrysothamnus nauseosus** - big rabbitbrush
- **C. viscidiflorus** - little rabbitbrush
- **Cirsium sp.** - thistle
- **Leonotodon taraxacum** - dandelion

Winter food in Box Elder and Cache Counties consisted principally of grasses, both the dried summers growth and the short green winter growth. Rabbits found near haystacks and wheatfields also had been eating large amounts of hay, waste grain kernels, and the green winter growth of grain. Browse plants were eaten in amounts probably varying inversely with availability of grasses and weeds. Twigs of sagebrush, rabbitbrush, and snakeweed were the ones most commonly eaten, and no doubt form a large proportion of food when deep snow covers grass and weeds.

In the Uintah Basin in early February dry grasses and weeds formed a major portion of the diet. Prickly pear cactus was also heavily eaten, and juniper berries were commonly found in stomachs. Usually, only the pulp of these was eaten but one rabbit, not so fastidious, had swallowed 23 of the stones as well. Other items present in small amounts were seeds
of plantain, sage brush twigs and leaves, roots and small unidentified seeds.

Hair from the rabbits themselves is frequently contained in the stomachs. It is undoubtedly swallowed while the rabbits are preening themselves.

The summer diet appears to consist largely of green grasses, sedge and weeds with small amounts of sage brush. In Strawberry Valley in July, rabbits were observed feeding in meadows on grasses, sedges, dandelions and polygonum; and upon open ridges and knolls where western wheat grass was the preferred food. On the Diamond Plateau near Vernal, in August white-tails had been eating western wheat grass, sedges, clover, and sage brush. Grain and alfalfa patches in the Uintah Basin had been heavily eaten in a strip about 10 yards wide bordering the patches and several trails usually criss-crossed them.

Snowshoe Rabbit

Field observations and stomach analysis (Table 2) during the winter showed snowshoes eating the following plants:

- Pinus contorta - lodgepole pine
- Pseudotsuga taxifolia - Douglas Fir
- Salix aculeifera - mountain willow
- Clematis sp. - clematis
- Odostemon repens - Oregon grape
- Amelanchier alnifolia - service berry
- Acer glabrum - dwarf maple
- Pachystina myrsinites - mountain laurel
- Ceanothus velutinus - snowbrush
- Symphoricarpos sp. - snowberry
- Artemisia tridentata - sage brush

Stomachs examined in June and August contained principally green grasses and weeds, while from November to February, needles and twigs of Douglas Fir were the chief items of diet in specimens from the Logan Canyon area.
Considerable damage frequently results to coniferous reproduction as a result of these rabbits clipping the leaders of young conifers. Baker, et al. (1922) report that all native conifers of the Wasatch Mountains are subject to snowshoe rabbit damage. These include in addition to the ones noted above; limber pine, *Pinus flexilis*; Engelmann spruce, *Picea engelmannii*, blue spruce, *Picea pungens*; alpine fir, *Abies lasiocarpa*; and white fir, *Abies concolor*. The writer noted lodgepole pines in the mountains north of Strawberry Valley highlined to a distance of 6 feet above the ground, to which height the rabbits are enabled to reach by the deep winter snow cover. Orr (1940) reports a snowshoe rabbit in California feeding upon manure in a roadway.

Black-tailed Jack Rabbit

Field observations supplemented by stomach analysis (Table 2) showed the following plants eaten by black-tailed jack rabbits.

- *Bilario* jamesii - galleta grass
- *Sporobolus airoides* - alkali sacaton
- *Bouteloua gracilis* - blue grama
- *Distichlis stricta* - salt grass
- *Agropyron cristatum* - crested wheat grass
- *Agropyron smithii* - western wheat grass
- *Polygonum sp.* - knotweed
- *Chenopodium sp.* - goose foot
- *Atriplex canescens* - four-wing salt bush
- *A. pusilla* - small scale
- *Sarcobatus vermiculatus* - greasewood
- *Dondia, sp.* - seep weed
- *Salsola pestifer* - Russian thistle
- *Bassia hyssopifolia*
- *Amaranthus sp.* - pig weed
- *Cloeome serrulata* - purple cloeome
- *Glycyr rhiza lepidota* - sand-bur
- *Opuntia sp.* - prickly pear
- *Harrubrium vulgare* - hoarhound
- *Chrysothamnus nauseosus* - big rabbitbrush
- *C. viscidiflorus* - little rabbitbrush
- *Iva axillaris*
- *Francoeria acanthocarpa* - bur sage
- *Artemisia tridentata* - sage brush
During the winter, woody plants and dry grasses apparently comprise the bulk of the black-tail’s food. Large amounts of sagebrush, greasewood, rabbit brush, and saltbushes are eaten. Between Snowville and the Raft River Mountains of Box Elder County, mound saltbush, shadscale and grasses are utilized so heavily during the winter, that by spring little more than the crowns of the plants remain. Other plants eaten in smaller amounts include prickly pear and Russian Thistle. A plot of crested wheat grass in the Oak Grove Forest Camp near Leeds, Washington County, was a favorite feeding ground for jack rabbits during the summer of 1939.

With the advent of spring, green grasses and weeds are eaten most heavily and from April to November often comprise 100 percent of the stomach contents. In agricultural areas, considerable quantities of alfalfa, growing grain and vegetable crops are consumed. Vaughn Madsen reports an entire patch of beans near Annabella, Sevier County, destroyed by these rabbits.

Eating of afterbirths was indicated by one April specimen, the stomach of which contained 4 or 5 placentas which had been swallowed without chewing. Whether or not this is a usual occurrence is not known.

Spring stomachs from the Blue Spring Hills often contained ticks which had probably been picked from the fur with the teeth and swallowed. Numbers found varied up to nine.

Nuttall Cottontails

In Box Elder and Cache Counties these cottontails were feeding on the following plants, as shown by field observations supplemented by stomach analysis (Table 2):

- *Agropyron* spp. - wheat grass
- *Salix* sp. - willows
- *Polygonum* sp. - knotweed
Grayia spinosa
Osostemon repens - Oregon grape
Furhia tridentata - bitter brush
Rosa sp. - wild rose
Prunus melanocarpa - choke cherry
Cutierrozia sarothrene - snake weed
Chrysanthemus nauseosus - rabbitbrush
Artemisia tridentata - sagebrush

In cultivated areas grain and alfalfa are eaten. Damage occasionally occurs to young fruit trees as a result of rabbits eating the bark.

During the winter when low growth is covered with snow, twigs of woody plants and large quantities of the bark of sagebrush, choke cherry, wild rose, willows and bitter brush are eaten.

In the spring and summer, green downy brome, other grasses, and weeds are heavily utilized.

Audubon Cottontails

Summer observations showed Wyoming and Colorado cottontails eating the following plants in eastern Utah:

Distichlis stricta - salt grass
Hilaria sp. - galleta grass
Cryzopes hymenoides - Indian rice grass
Sperobolus cryptandrus - sand dropseed
Sperobolus airoides - alkali sacaton
Bouteloua gracilllris - blue grama
Bromus tectorum - downy brome
Agropyron smithii - western wheat grass
Eleocharis sp. - spike rush
Carex spp. - sedge
Juncus balticus - wire grass
Chenopodium sp. - pig weed
Atriplex canescens - four-winged saltbush
A. nuttallii - mound saltbush
A. corrugata - mat saltbush
A. woffii
A. powellii
Sarcobatus vermiculatus - greasewood
dEndia sp. - seepweed
Salsola pestifer - Russian Thistle
Sophia sp.
Cleome lutes - yellow cleome
Rosa sp. - wild rose
Glycyrrhiza lepidota - sand bur
Sphaeralcea sp., - globe mallow
Opuntia sp. - prickly pear
Apoecynum cannabinum - dogbane
Chrysothamnus nauseosus - rabbit bush
Artemisia tridentata - sage brush
Tetradymia axillaris - horse brush

Considerable quantities of alfalfa and wheat are eaten by Wyoming cottontails in the Uintah Basin region.

During the winter they were found eating mostly grasses and weeds on areas where these are abundant, such as cultivated and pasture lands. On more arid and saline lowlands, these cottontails were feeding chiefly upon greasewood and saltbushes.

In western Utah, in late summer, Audubon cottontails were observed feeding upon:

Hilaria jamesii - galleta grass
Sporobolus airoides - alkali sacaton
Distichlis stricta - salt grass
Chenopodium sp. - pig weed
Atriplex canescens - four-winged salt brush
A. nuttallii - mound salt bush
Europia lanata - winter fat
Bassia hyssopifolia
Amaranthus sp.
Cleome serrulata - purple cleome
Gutierrezia sarothrae - snake weed
Artemisia tridentata - sage brush

Pygmy Rabbits

Winter food consists principally of sagebrush (Table 2). Small amounts of the following plants are also eaten:

Chrysothamnus nauseosus - rabbit brush
C. viscidiflorus - little rabbit brush
Tetradymia canescens - horse brush
Salsola pestifer - Russian thistle
Amaranthus sp.
Agropyron inerme - smooth wheat grass
A. spicatum - spiked wheat grass
Elymus condensatus - giant wild rye

Plants eaten in the spring are chiefly grasses, and some forbs.

Plants observed eaten in the late summer are:
Atriplex pusilla - small scale
Atriplex canescens - four winged salt bush
Agropyron smithii - western wheat grass
Artemisia tridentata - sage brush
Spharalcea sp. - globe mallow
Gutierrezia sarothrae - snake weed
Seasonal differences in size of testes and ovaries were found to coincide closely with sexual activity. In adults, these organs were of minimum size in fall specimens. During the winter months they expanded steadily until maximum volume was attained at the peak of the breeding season in the spring. After this time, testes assumed a shrunken flaccid character much in contrast to their previous firm, turgid appearance. Associated organs such as the prostate gland and epydidymus in males; the uterus and oviducts in females underwent corresponding variations in size.

For ease in comparing sizes of gonads, an index number consisting of the product of the length times the diameter of the testis or ovary, is used in subsequent tables (3, 4, 6, 7, 8) which illustrate the cycle of variation in size of testes and ovaries for the species dealt with. Insufficient measurements were obtained to plot the exact course of variation but in some species, enough were taken to illustrate the trend quite clearly. Considerable variation exists among different species as to time and duration of breeding. However, it can be said of all species found in Utah that breeding is limited to the period between January and August with the peak generally occurring from March until June. Altitude has considerable effect upon dates of breeding in those species whose range extends through several life zones. Thus white-tailed jack rabbits breed much earlier on the semi-desert habitat of the Uintah Basin, than in the sub-alpine areas of the Uintah and Wasatch Mountains. Due to the comparatively small latitudinal range of the state, dates of breeding show a lesser difference from south to north than from the low valleys to the high mountains.

In all species with the possible exception of those individuals living at very high altitudes, it was found that at least two litters,
with a very high probability of more per season, are raised. Furthermore, individuals of all species were found commonly suckling young of the previous litter while carrying well-advanced embryos of the succeeding litter. This is indicative of the occurrence of coitus and conception within a very short time subsequent to the birth of the preceding litter.

Resorption of foetuses has been noted in nearly all species. The presence of these smaller, abortive embryos with normal ones is possibly responsible for the belief of some observers that super-foetation has occurred. According to the following sequence of events as determined by Hammond and Marshall (1925) with domestic rabbits, super foetation is impossible: ovulation occurs about ten hours following coitus, and the ruptured follicles are transformed into corpora lutea. These increase in size as the embryos develop and prevent the development of additional follicles. Hence, during pregnancy, ovulation following coitus can not occur. However, after parturition the corpora lutea begin to decrease in size and ovulation may occur. Suckling does not prevent ovulation, at least until the 8th to 12th day. After this time, the does refuse to breed until the young are weaned.

Pseudopregnancy has been observed among snowshoe hares (Severaid 1945) and probably occurs among other wild rabbits as well.

**White-tailed Jack Rabbit**

Measurements of reproductive organs were procured for three months. The averages of these are presented in Table 3.
Table 3. Average measurements of testes, ovaries and products of these measurements for white-tailed jack rabbits

<table>
<thead>
<tr>
<th>Month</th>
<th>Testes</th>
<th>Ovaries</th>
<th>Testes</th>
<th>Ovaries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length</td>
<td>Diameter</td>
<td>Length</td>
<td>Diameter</td>
</tr>
<tr>
<td>November</td>
<td>38 m.m.</td>
<td>11 m.m.</td>
<td>11.5 m.m.</td>
<td>5 m.m.</td>
</tr>
<tr>
<td></td>
<td>418</td>
<td>58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>57</td>
<td>20.7</td>
<td>13.2</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>1180</td>
<td>86</td>
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</tr>
<tr>
<td>March</td>
<td>53.7</td>
<td>22.5</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>1280</td>
<td>220</td>
<td></td>
<td></td>
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</tbody>
</table>

White-tails were found beginning mating activity during the first week of February, 1946, in the Uintah Basin. On the sage and juniper covered slopes near Altonah, several trails, each made by two rabbits apparently travelling together, were noted in the snow. The writer followed one of these for several hundred yards to the spot where one of the hares crouched under low juniper boughs about 6 feet distant. It was collected and found to be the female. The track of the surviving rabbit led to a form under a small juniper about 150 yards from the female's. This rabbit was seen crouching in its form about 10 feet away and was collected. It was found to be a male. Tracks made by these rabbits indicated that copulation had occurred or had been attempted.

Similar trails were seen in the snow on the hills west of Cache Junction, on March 3, 1946, and a female collected from this area contained small embryos.

The earliest embryos were found in the Blue Spring Hills, Box Elder County on March 2, 1941. These were very small; as the diameter of the uterine swellings containing the embryos was but 14 mm.

Nine pre-natal litters were examined. The litters averaged 5.55 young, with extremes of four and eight. Gestation for this species is not known, but is probably near that for *Lepus americanus*, the gestation for which has been determined at 36 days (Grange 1932).
The latest litters were found at Strawberry Valley in July 1941. Of seven females collected there between July 17 and 28, six were suckling young. One of these contained embryos measuring 68 mm in rump-crown length, and the one not suckling, contained 5 embryos so near birth that their eyes were partly open.

The testes of the only male collected were in a shrunken and flaccid state. This fact, in conjunction with small proportion of pregnant females and large size of embryos in those pregnant, indicate closing of the breeding season in that area.

In the Uintah Basin during the first week of August, no pregnant females were collected, while most of the young seen were nearly equal in size to the adults. This indicates an earlier termination of the breeding season in the lower, semi-desert areas of the Basin than in the montane habitats of the state of which Strawberry Valley is an example.

Although considerable search was made for young in areas from which females known to be suckling young were collected, none were found. The only reference to nests found by the writer is by Orr (1940) who states,

The following account is given by Fry (1924, p. 174): 'It was on June 21, 1907, that we found a mother snowshoe rabbit (white-tailed jack rabbit) and her young on the north spur of Mt. Silliman in Sequoia National Park, elevation 10,400 feet. The mother had tunneled through some eighteen inches of crusted snow and built her bed on the ground under low willow bushes. When we approached, the mother rabbit bounded out on top of the snow, ran a few yards in a series of high jumps, then suddenly stopped and sat down high upon her haunches apparently in an effort to attract us from her young. We took the five young rabbits all gently from their nest, looked them over carefully, then returned them to the nest whence they came. When we were handling the young rabbits they uttered shrill squealing cries of fright and distress. In response to their cries the horrified mother ran hysterically around us uttering soft, weird, grunting sounds of emotional distress, and stamping her big padded hind feet hard down on the crusted snow with a great slapping effect. After we had taken our departure, and when away a distance of some hundred yards, the ever anxious mother was observed passing from sight under the snow to rejoin her helpless offspring!'
The young are born fully furred and with their eyes open. Five foetuses obtained from Strawberry Valley in July were covered with long, thick fur and some had their eyes open. It is believed these were within two or three days of birth. Their weights ranged from 91 to 114 grams, and they measured 169 to 176 mm in nose-to-tail length.

A young female collected July 28, 1941 at Strawberry Valley weighed 2130 grams and was 568 mm in length. Five young from Diamond Mountain near Vernal, on August 3, 1941, ranged in weight from 1839 to 2485 grams, with lengths from 538 to 608 mm. These were probably between four and five months of age.

Snowshoe Rabbit

Little information concerning breeding of this species was obtained. A female collected in Logan Canyon during late February contained no embryos, while no evidence of breeding in the vicinity was noticed at that time. Two females collected in June 1941 contained six small embryos each, and each was also suckling a litter of young.

A male, shot August 2, 1941, had testes measuring 30 mm long and 8 mm in diameter. They were in a shrunken and flaccid condition, indicating termination of sexual activity for the season.

These are the only American hares for which the gestation period has been determined. Grange (1932) found it to be 36 days for the Minnesota varying hares, *Lepus americanus phaeotus*, a form similar to our *Lepus a. bairdii*. Severaid (1945) found gestation of snowshoe hares in Maine to vary between 36 and 40 days.

Apparently no nest for the young is constructed. Orr (1940) reports three very young of the Washington snowshoe, found in a cavity about 2 feet long and six inches in diameter under a pine of brush, *(Ceanothus*
velutinus). No lining was present. Scheffer (1933) writing of the Washington snowshoe hare, states that the young are born well-furred, with the eyes open and are able to hop about. The same author examined nine litters whose average number of young was 4.2 with extremes of two and six.

Black-tailed Jack Rabbits

Because of wide spread distribution and greater abundance, more data was gathered for this than any other species. Average monthly measurements of reproductive organs are shown in the following table.

<table>
<thead>
<tr>
<th>Month</th>
<th>Testes</th>
<th>Ovaries</th>
<th>Length x Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length</td>
<td>Diameter</td>
<td>Length</td>
</tr>
<tr>
<td>September</td>
<td>42 mm</td>
<td>6 mm</td>
<td>15</td>
</tr>
<tr>
<td>October</td>
<td>40</td>
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<td>6</td>
</tr>
<tr>
<td>November</td>
<td>42.7</td>
<td>12.5</td>
<td>15.5</td>
</tr>
<tr>
<td>December</td>
<td>43.3</td>
<td>16.3</td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>50.1</td>
<td>19</td>
<td>17.7</td>
</tr>
<tr>
<td>February</td>
<td>54</td>
<td>16.6</td>
<td>16.3</td>
</tr>
<tr>
<td>March</td>
<td>55.1</td>
<td>19.8</td>
<td>21.4</td>
</tr>
<tr>
<td>April</td>
<td>55.2</td>
<td>19.8</td>
<td>22.7</td>
</tr>
</tbody>
</table>

Breeding among black-tail jacks begins earlier than for any other species. Near Lucin and Kelton, Box Elder County, in early January, 1941, buck rabbits were frequently observed pursuing the females, but embryos were not yet apparent in rabbits examined by the writer. At this time males were observed fighting with each other by Dean Hobson, who writes (unpublished report 1941) concerning nuptial antics:
The male pursues the female tirelessly in short low bounds both pausing frequently in the nuptial antics, on the alert for danger. Her trail is tortuous, having many sharp turns and cut-backs, and may lead around and around on certain bush in a small circle. Coitus is very brief, the male sometimes biting the loose skin on the nape of the female's neck. Frequent, vigorous battles between bellicose males are fought during the rut. The author chanced to observe several such fights in which the antagonists sat up on their hind feet and boxed with their fore feet, making frequent wild jabs with their heavier hind feet and emitting a dry throaty sound throughout. Some authors maintain these conflicts frequently end in death for one of the combatants, though I have never witnessed such a mortal combat.

On January 13, 1941, of 42 females examined by Hobson and the writer, near Lucin, none contained apparent embryos. On January 18, six of eight females collected near Promontory were pregnant. The average number per litter was two, with extremes of one and four. On January 31 near Lucin, Hobson reports 78 percent of 50 females pregnant, and on February 7, 82 percent of 50 contained embryos. The average number of foetuses per pregnant doe was 1.4, with extremes of one and three. Of seven females from Howell collected February 3, 1946, three were pregnant. These constitute the earliest breeding records.

Table 5. Summary of data concerning size of prenatal litters

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Females</th>
<th>Number Pregnant</th>
<th>Mean Size Litter</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number</td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>46</td>
<td>1.43</td>
<td>1-4</td>
<td>29 15 1 1</td>
</tr>
<tr>
<td>February</td>
<td>58</td>
<td>1.53</td>
<td>1-3</td>
<td>34 21 3</td>
</tr>
<tr>
<td>March</td>
<td>21</td>
<td>3.53</td>
<td>1-6</td>
<td>1 7 1 7 2 3</td>
</tr>
<tr>
<td>April</td>
<td>11</td>
<td>5.73</td>
<td>1-8</td>
<td>1 3 1 1 3 2</td>
</tr>
</tbody>
</table>

It is noticed that January and February litters are less than one third the size of litters taken during the spring. This is probably due primarily to the ovaries not being fully ready for maximum egg production
at the time when copulation occurs. At any rate it seems a fortunate adaptation for the species, in as much as a minimum drain on the vitality of the female is imposed at a time when climatic conditions and food scarcity are severe.

What little information concerning nesting of black-tails that was obtained indicates that nests may or may not be built. Vorhies and Taylor (1933) state that the young are customarily placed in nests, and Orr (1940) shares this opinion.

The writer is aware of two instances in which no nest was built. Near Cedar City on March 18, 1941 three very young jacks were found huddled together in a slight, unlined hollow under a greasewood bush. They were dead when found, possibly by starvation and exposure, but had not moved from the spot in which they had apparently been placed by the mother. On the other occasion 3 young were found huddled together on the ground in an alfalfa patch, with no trace of a nest. On the other hand, a well constructed nest containing five young was found by Professor George H. Kelker, near Dubois, Idaho, in April 1940. The nest was in a hollow under a sagebush, and was lined copiously with fur.

The young, as in other hares, are born clothed with long, soft fur, and with the eyes open. Four foetuses ready for birth were obtained near Snowville in April 1946. These, after lying gasping 2 or 3 minutes on the ground, crawled over to the dead mother and started searching for a teat. In two or three hours they were able to hop about, with ears erect, somewhat unsteadily, but in a rather lively manner. While still less than 12 hours old, one was observed cleansing its paws and face in the manner of a cat washing its face. These four ranged in weight from 80 to 87 grams. Their length from nose to tip of tail was approximately 170 millimeters.
The young apparently leave the nest, or place of birth, at an early age, but continue to suckle for some time. A young jack shot near Snowville on April 7 and weighing 325 grams, was still living largely on milk as shown by stomach contents which consisted of about 75 percent milk and 25 percent vegetation. A larger one, weighing 600 grams, collected the same day contained no milk in the stomach.

Nuttall Cottontails

Table 6. Average monthly measurements of reproductive organs of Nuttall Cottontails

<table>
<thead>
<tr>
<th>Month</th>
<th>Testes Length</th>
<th>Diameter</th>
<th>Ovaries Length</th>
<th>Diameter</th>
<th>Length x Diameter Testes</th>
<th>Ovaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>28</td>
<td>6</td>
<td>168</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>22</td>
<td>9</td>
<td>6</td>
<td>4</td>
<td>198</td>
<td>24</td>
</tr>
<tr>
<td>December</td>
<td>25.3</td>
<td>11</td>
<td>278</td>
<td></td>
<td>382</td>
<td>38</td>
</tr>
<tr>
<td>January</td>
<td>32.1</td>
<td>11.9</td>
<td>10</td>
<td>3.8</td>
<td>439</td>
<td>42</td>
</tr>
<tr>
<td>February</td>
<td>32.5</td>
<td>13.5</td>
<td>10.1</td>
<td>4.2</td>
<td>463</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>46.3</td>
<td>17.3</td>
<td>11</td>
<td>5</td>
<td>800</td>
<td>55</td>
</tr>
<tr>
<td>August</td>
<td>28</td>
<td>8</td>
<td>224</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Seven of eight females collected in the Blue Spring Hills, Box Elder County on March 30, 1941 were pregnant, five for the second time that season, for they were suckling young. Considering the gestation period 28 days as has been determined for eastern cottontails, this would place the first breeding dates in the last part of February or first of March. These dates probably vary according to weather. A female shot in the same area, March 2, 1946, showed no indication of sexual activity. At this time, there were still two feet of snow on the area and the weather generally cold and stormy, whereas, in 1941, the ground was nearly bare.
In all, 13 prenatal litters were examined. These contained on the average 6.62 young, and ranged from five to eight, with a frequency distribution as follows:

<table>
<thead>
<tr>
<th>Litters Contained</th>
<th>Young</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

Indication of late breeding was furnished by a female, collected in the Raft River Mountains in late August, which was still suckling young but contained no embryos. One of the young, about the size of a large meadow mouse was seen to run into a hole near by. The comparatively high altitude of the area may account for the late breeding of this example, which would certainly be abnormal at the altitude of the surrounding sage plains. Young collected near Blue Creek, Kelton and Lynn in late August nearly equalled adults in size, weighing from 537 to 620 grams, indicating an early termination of the breeding season in those localities.

A nest of the Black Hills cottontail was found April 3, 1940 near Logan, in a crevice of the foundation of an old building which was being torn down. It was composed of hay, lined with fur and contained 7 young whose weights ranged from 66.5 to 72.2. They were well-furred and their eyes had been open for some time, and they ate grass readily. It is believed they were about three weeks old. Orr (1940) cites three young from 40 to 47 grams in weight able to run about. The young at birth undoubtedly have the eyes closed, and are probably nearly naked, which is the case with eastern cottontails. Orr (1940 p. 108) concerning nesting reports,

A nest of this species containing four young was found on May 30, 1931, at an elevation of 9000 feet on the north side of Groom
Baldy, Lincoln County, Nevada (Hall, M.S.). It was situated at the southern base of a pinon pine on a ground surface composed of small rocks, pine needles and twigs. The nest consisted of a cup-like cavity lined with rabbit fur and dry grass. The top was covered over with fur, grass and a stick three-eighths of an inch in diameter, all of which the observer believed had been put there by the female.

One of the young weighed 74 grams and was 145 mm in length. Each of the young squealed when taken from the nest and refused to stay in it after being replaced.

Audubon Cottontails

The following table gives average monthly measurements of reproductive organs of these cottontails for six months of the year.

<table>
<thead>
<tr>
<th>Month</th>
<th>Testes Length</th>
<th>Testes Diameter</th>
<th>Ovaries Length</th>
<th>Ovaries Diameter</th>
<th>Length x Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>31.5</td>
<td>7.8</td>
<td></td>
<td></td>
<td>246</td>
</tr>
<tr>
<td>October</td>
<td>31</td>
<td>9</td>
<td></td>
<td></td>
<td>279</td>
</tr>
<tr>
<td>December</td>
<td>35</td>
<td>15</td>
<td>7</td>
<td>3</td>
<td>525 21</td>
</tr>
<tr>
<td>February</td>
<td>44.3</td>
<td>15.7</td>
<td>8.4</td>
<td>3.3</td>
<td>696 28</td>
</tr>
<tr>
<td>June</td>
<td>60</td>
<td>21</td>
<td></td>
<td></td>
<td>1260</td>
</tr>
<tr>
<td>August</td>
<td>28</td>
<td>9</td>
<td></td>
<td></td>
<td>252</td>
</tr>
</tbody>
</table>

Among Wyoming cottontails of the Uintah Basin in early February 1946, there was yet no evidence of sexual activity. A female collected in June contained four small embryos and was suckling young. Young seen at this time were of various sizes and represented at least two and probably three successive litters.

The oldest juveniles collected ranged in weight from 498 to 656 grams, and were judged to be between two and two and one-half months old. Others much smaller, representing later litters were seen.
When this region was visited again in early August, breeding appeared to have ceased, as no embryos were found, and most of the young nearly equalled the adults in size. An old nest of this species was shown me by Ranger Baldwin of the National Park Service at Dinosaur National Monument. It was a bowl-shaped cavity in the ground with a narrow opening, and was about 8 or 10 inches deep. He stated that in May it had contained a nest of bark and dry grasses lined with fur from the mother rabbit and had contained three young.

According to him the old rabbit would visit the young in the early morning and late afternoon, pull them out of the nest with her teeth, and lie down beside the nest while they suckled. Then she would put them back and cover the opening with grass and twigs. She guarded the nest vigilantly from small intruders. On one occasion a golden-mantled ground squirrel approached the nest too closely, whereupon the old rabbit rushed from near-by cover, seized the squirrel in its mouth and shook it vigorously, finally flipping it to one side.

Interesting data concerning the nesting of this cottontail was obtained from Henry Slaugh, State Game Warden at Vernal. He states that the height of the nesting season is in April and May, that the nests are placed in short burrows, one or two feet from the entrance, and are made of the bark of sagebrush, greasewood, or juniper, lined with fur. Seven is the greatest number of young he has seen in a nest. That the young of Audubon cottontails in California may sometimes be born in burrows is attested by Orr (1940).

On July 31, near Duchesne, a young Wyoming cottontail still suckling was collected. Its stomach contained half milk and half vegetation. It weighed 168 grams and was 225 mm in length. It was judged to be about a month old.
Great Basin Cottontails

Only two pregnant females of the great basin cottontails were collected. One from Clear Lake, Millard County on May 25, 1940, contained five half-developed embryos and was suckling young. The other, from the Desert Range Experiment Station in western Millard County, on September 25, contained three large living embryos and one in the process of resorption.

Pygmy Rabbits

Table 8. Measurements of reproductive organs of pygmy rabbits

<table>
<thead>
<tr>
<th></th>
<th>Testes</th>
<th>Ovaries</th>
<th>Length x Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>Length</td>
<td>Diameter</td>
<td>Length</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>24.5</td>
<td>10.5</td>
<td>257</td>
</tr>
<tr>
<td>January</td>
<td>25.5</td>
<td>10.5</td>
<td>3</td>
</tr>
<tr>
<td>February</td>
<td>31.5</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>38.7</td>
<td>18.7</td>
<td>16 x 4</td>
</tr>
<tr>
<td>April</td>
<td>39</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

In the vicinity of Cedar City, a pregnant female was collected on February 24, 1940. It contained four rather small embryos, indicating occurrence of fertilization about mid-February. On March 22, 1941, three young, probably not belonging to the same litter, were dug out of holes. These weighed 70, 100, and 117 grams, and were very active. Due to lack of comparative data, it is difficult to estimate their ages, but they were probably between two and five weeks. On April 7, 1939, two females were obtained which were suckling young, but did not contain embryos.

A better sample of embryos was obtained from the Blue Spring Hills. Here, the first embryos very small (7-8 mm) were noted on March 4, 1940.
Figure 20. Young black-tailed jack rabbits, 3 days old: Obtained by Caesarean delivery, April 7, 1946.

Figure 21. Young pygmy rabbit, believed to be five or six weeks old.
in two of four females collected. On March 31, one containing its second litter was taken. Five females taken March 30, 1941, all contained embryos varying from 11 to 63 mm in length. The average number of foetuses for the 14 pregnant females is 5.93 with extremes of four and eight. The frequency distribution of these follows:

2 litters contained 4 foetuses
2 " 5 "
6 " 6 "
3 " 7 "
1 " 8 "

Mammae: The mammae are ten in number, five on each side: two pair pectoral, two pair abdominal, and one pair inguinal. They are connected on two long mammary glands, not apparent usually, but during late pregnancy and lactation develop to large size. In a lactating female obtained March 31, they each measured 193 mm long, 37 mm wide and 3 mm thick, and met on the median line.

Other organs: The prostate gland of the male, usually inconspicuous, attains a length of 27 mm and width of 16 mm during March and April.

No nests or newly born young of the pygmy rabbit have been discovered. According to Davis (1939) a parturient female contained embryos measuring 72 mm in rump-crown length. These were naked and had the eyes closed. It is not known whether the young are born in burrows, or in surface nests. Several burrows from which lactating females were secured were excavated, but no trace of young was found.

By late August, the young have attained nearly full size. A young female obtained at this time measured 239 mm in length, as compared to 282 for adults.
GENERAL BEHAVIOR AND ACTIVITY

White-tailed Jack Rabbit

White-tails are chiefly crepuscular and nocturnal in habit. In Strawberry Valley the earliest activity was observed at sunset, when rabbits were seen feeding in meadows. They were seen active as late as 11 P.M., the latest hour the writer was in the field.

These hares range widely. Noland Nelson of the Utah Fish and Game Department informs me that he has tracked them on deep snow from haystacks, where they had been feeding, as far as 3.5 miles air-line to their forms.

The speed at which these rabbits are capable of running is excelled by few other animals. The prairie hare has been timed as high as 40 miles per hour (Cook 1927). Seton (1928) places them next to the antelope in the scale of speed.

They are not usually regarded as gregarious, yet the writer has noticed that often an area of only a few acres, there will be several rabbits formed-up in close proximity to each other, while for considerable distance around there may be no rabbits. Tracks made in the snow during the night on bare fields and knolls at times indicated that several rabbits had spent some time frolicking.

Considerable variation in flushing distance occurs. Some rabbits have been almost stepped on before they jumped, while others have flushed at distances over 100 yards. A close approach is usually allowed if the rabbits have not been previously alarmed, but once they have flushed, it is difficult to approach closely. In common with other rabbits, they tend to move in a large circle if pursued finally coming back near their starting points.
The gait is a characteristic series of high, stiff-legged bounds, giving the animal the appearance of bouncing over the ground as it runs.

When captured or wounded, white-tails often utter a loud quavering long-drawn out scream audible for several hundred yards.

Snowshoe Rabbits

Snowshoes shun the bright daylight, and are chiefly nocturnal or crepuscular. In the Uintah mountains, they were observed active about sunset.

They apparently have a small radius of activity. Grange (1932) found eastern varying hares to occupy a home range of not more than 10 acres.

Soper (1921) states that northern varying hares are very sociable. As many as 25 were seen frolicking and feeding together in the moonlight. The writer discovered two occupying the same windfall together in the Uintah Mountains.

These rabbits usually sit tight in their forms when in dense cover. Several times, the writer nearly stepped on top of a windfall before the rabbits flushed.

Deep snow is no handicap to them. With their enormous, stiffly-furred feet, they bound over the softest snow with ease.

Black-tailed Jack Rabbits

Black-tails probably are diurnal to a greater extent than the preceding species, however their greatest activity is from shortly before sunset to shortly after sunrise. They have been seen active by the writer at all hours of the night. Day light activity is chiefly in the morning before nine o'clock, and in the afternoon after four o'clock. Vorhies and Taylor (1933) observed them active at mid-day on cloudy days. Near Snowville the writer has seen them active in a light rain storm.
Daily range depends largely upon the distance between food and cover. Where both are together, little daily movement occurs. However, where feeding grounds and cover are widely separated several miles may be covered in their daily movements. Vorhies and Taylor (1933) found rabbits making a round trip of about 10 miles nightly from cover to feeding grounds and back.

Seasonal migration of rabbits apparently occur from hills to lower areas in the winter and vice versa in the summer. In the Blue Spring Hills of Box Elder County during the winter, very few black-tails were seen, while after the melting of the snow, they were quite numerous. In the hills north of Grouse Creek in the summer of 1941 rabbits were very numerous, but very few droppings were present. While on the near-by lowland areas, droppings were numerous but rabbits rather scarce. This would indicate that the lowlands were wintering areas for large concentrations of rabbits, which spread out to the hills with the melting of the snow.

These hares, with their comparatively small and narrow hind feet, are handicapped by deep, loose snow. The writer recalls that after an unusually heavy snowfall of over 12 inches near Cedar City, these hares would lie in their forms in clumps of sage until almost stepped upon, then they ran for nearest cover sinking deep into the snow which slowed them down considerably and make them easy targets.

They are gregarious to the extent that several will gather in an open area to feed. Whether or not they frolic as do snowshoe hares is not known.

When captured or wounded, they often give vent to a low, growling sound repeated several times which is usually followed by a loud quavering squeal. When fighting with each other, they also emit these growls.

One of the most conspicuous habits of these hares is their use of trails. In areas of abundance in the winter time, a network of trails extends in all
directions. These trails vary considerably in size and number of rabbits using them, just as the roads of man vary from highways to more paths. Main rabbit trails are well beaten paths in the snow which may be nearly a foot wide. After the snow melts, the trails are still used, but are not so apparent on the bare ground.

Their manner of running is characteristic, consisting of low rapid bounds, punctuated every few jumps with a longer, higher leap, apparently for observation purposes. At times, however, in thick cover, they will skulk, attempting to sneak away from the intruder without showing themselves. Available estimates of speed is between 30 and 35 miles an hour.

Nuttall Cottontails

All cottontails are probably chiefly nocturnal and crepuscular. Most of their daylight hours are apparently spent lying in forms, a few rods from their holes to which they run when alarmed. Frequently they sit motionless for long periods of time at the mouth of their burrows. One watched in the Blue Spring Hills, sat without a movement for a half hour. One collected near Cedar City was lying in the sunshine on a ledge of rock near its hole.

These cottontails probably have a rather restricted home range. Investigations of eastern cottontails have placed the range of females between one and two acres, and that of males somewhat higher.

Audubon Cottontails

Ingles (1941) found Audubon cottontails in California most active from sunset to 9:00 p.m., but there was also great activity all night long and during early morning. They were least active from 9:00 a.m. to 3:00 p.m. The writer observed Colorado cottontails in eastern Utah feeding at sunrise. Wyoming cottontails in the Uintah Basin were observed feeding at dusk.
Ingles (1941) found the home range of females to be about one acre, and that of males as much as 15 acres.

Extreme unwillingness of these cottontails to run across large open areas is sometimes shown. Near Vernal, a cottontail ran into a clump of greasewood about 8 feet in diameter at the edge of a wash with good cover. Away from the wash was a large clear area with only a dotting of bushes. The writer got between the rabbit and the wash to try to frighten it from the clump of brush. It dodged about the brush but wouldn't leave the protection of the clump of brush. Finally the writer tossed a rock at it, whereupon the rabbit dashed from the brush on the same side as the observer and ran for the cover of the wash.

Cottontails frequently thump loudly on the ground with their hind feet when very alarmed. The one mentioned above, while cornered in the clump of brush, thumped several times. Cottontails cornered in short holes or crevices were heard to thump in a similar fashion.

They are probably somewhat gregarious, for they often feed in groups. Near Cedar City in early autumn two were observed lying in the same form.

Pygmy rabbits

Pygmies are apparently both nocturnal and diurnal. Much of their time during the day is spent lying in the shade of sage bushes, near their burrows. In the Blue Spring Hills, they were observed feeding on sage brush about mid-day. Evidence of nocturnal activity was furnished by numerous fresh tracks in snow falls of the preceding evening, and by the two pygmy rabbits found killed by horned owls.

A characteristic of the pygmy is its low scurrying gait in contrast to the higher, longer jumps of other rabbits. Their running speed is
probably about 15 miles per hour. A few, found away from their holes were chased on foot by the writer and caught after a run of two or three hundred yards. After a chase of this distance the rabbit appeared quite exhausted.

Pygmies occasionally climb into the tops of sage bushes to feed from them. One was seen to jump from the bush at a height of 15 inches from the ground, near Cedar City.

Like other rabbits the pygmy has a loud quavering squeal when captured. In addition he sometimes utters a call somewhat resembling that of the pika, but much fainter. When pursued closely, it often utters a faint squeak of fright.

Pygmy rabbits are sometimes very unsuspicious. On several occasions the writer has been able to approach to within six feet of a rabbit while it sat at the mouth of its burrow.

Home range is very small. During the winter, track in the vicinity of holes indicates that the radius of activity was only about 30 yards from the burrows. In the spring, however, with the melting of the snow and the beginning of breeding, the radius of activity was lengthened somewhat.
Figure 22. Tracks of white-tailed jack rabbit

Figure 23. Tracks of pygmy rabbit
Most of the density figures in this paper were estimated by means of strip counts, on which the observer walked through the area as when hunting, making no attempt to maintain a straight line. The distance walked was estimated by either counting paces or by keeping time. The number of rabbits seen and their flushing distances were noted. Then multiplying the distance walked by twice the average flushing distance gave the area of the strip. As no attempt to maintain a straight line of travel was made, actual flushing distances, rather than perpendicular to line of travel, were used.

White-tailed Jack Rabbits

Density figures were obtained by means of strip counts. These are tabulated in Table 9.

Table 9. Density figures, with respect to locality and cover type, of white-tailed jack rabbits

<table>
<thead>
<tr>
<th>Location and type</th>
<th>Date</th>
<th>Area</th>
<th>Total Rabbits</th>
<th>Rabbits per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>sagebrush knolls and hollows east of Strawberry Reservoir</td>
<td>7-28-41</td>
<td>100 acres</td>
<td>5</td>
<td>.05</td>
</tr>
<tr>
<td>sagebrush plateau, Diamond Mountain, Uintah County</td>
<td>8-3-41</td>
<td>50</td>
<td>25</td>
<td>.50</td>
</tr>
<tr>
<td>rolling hills with sparse cover near wheat fields at Clarkston.</td>
<td>11-29-41</td>
<td>207</td>
<td>13</td>
<td>.06</td>
</tr>
<tr>
<td>juniper and sage benchland near Altonah, Duchesne Co.</td>
<td>2-3-46</td>
<td>40</td>
<td>11</td>
<td>.27</td>
</tr>
</tbody>
</table>

Residents of Altonah stated that white-tails in that area in 1946 were scarcer than in former years. The scarcity was attributed to light snowfall which did not drive the rabbits out of the mountains, and to a greater abundance of coyotes than formerly.
Snowshoe Rabbits

Small areas of favorable cover in Logan Canyon during the winter appear to support densities of one or two snowshoe rabbits per acre, but such abundance seems restricted to small areas.

Baker, et. al. (1922) report that in 1916 near the Cottonwood Nursery east of Salt Lake City, 15 snowshoes were killed on a strip of dense brush 400 yards long and 50 yards wide. This is a density of 3.7 rabbits per acre, and is less than the actual density, because of the escape of a few. No evidence of extreme fluctuations in numbers such as occur in eastern and northern forms was encountered.

Black-tailed Jack Rabbits

Jack rabbits were abundant in Utah even in the early days of pioneer settlement. Palmer (1897) reports that in the fall of 1849 a party of emigrants on their way from Salt Lake to California encountered a concentration of jack rabbits in Parowan Valley near Little Salt Lake. Here they held the first big rabbit hunt of which there is record. Rabbits ran in all directions, among the horses and cattle, and under the wagons so that the teamsters killed same with whips. All guns were put to use, and at the end of the hunt, five hundred dead rabbits were counted. Palmer reports further that between 1848 and 1870, rabbits were so abundant between the Jordan River and Great Salt Lake that during November and December parties of 4 to 6 hunters would kill 500 in a day. He states that between 1885 and 1895, 32 reported hunts were held in the following Utah counties: Beaver, Box Elder, Garfield, Iron, Millard, San Pete, Utah, and Wayne. From 50 to 8000 rabbits were killed on each hunt. It was estimated that over 61,000 rabbits were killed by such hunts from 1894 to 1896.
That jack rabbit numbers have not decreased greatly since early days in unsettled parts of the state is shown by the results of winter drives held by sportsmen. When these drives are well organized and properly conducted, they approach 100 percent effectiveness. Hence the number of rabbits killed is a reliable census estimate.

Table 10. Results of rabbit drives held in Box Elder County during the winter of 1940-41

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Hunters</th>
<th>Number of Rabbits Killed</th>
<th>Area Covered</th>
<th>Rabbits Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mi. north of Locomotive Springs</td>
<td>1-12-41 200 2000</td>
<td>1280 A. 1.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Grouse Creek</td>
<td>1-13-41 55 1500</td>
<td>640 2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 mi. west of Promontory</td>
<td>1-18-41 100 1400</td>
<td>800 1.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 mi. N. E. of Lucin</td>
<td>2-2-41 200 10000</td>
<td>825 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rose Bud Ranch near Lucin</td>
<td>2-23-41 133 4000</td>
<td>320 12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Promontory</td>
<td>2-5-39 65 2000</td>
<td>1300 1.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*This drive employed 55 C. G. C. boys, unarmed, to drive the rabbits into the V-shaped wings of a trap where they were clubbed to death. Actually only 150 rabbits were killed due to faulty construction which allowed the escape of 80 percent.

Densities such as those in Table 9 are not widespread, but apparently occur in limited areas where the rabbits congregate during the time the ground is covered deeply with snow. With the melting of the snow, the rabbits scatter far and wide.

Drives held in 1946 in the area west of Snowville were not as effective due to the small number of hunters participating. Here, also, was demonstrated the spotty distribution of areas of winter concentration. On February 3, 1946, a drive was held on low ground near the valley bottom by 50 hunters. After covering over a mile of ground and seeing no rabbits, the majority of the hunters left for home. Fifteen hunters, however,
proceeded to slightly higher ground three miles west, and killed about
900 rabbits in two or three hours.

Summer densities were estimated by strip counts, and were found to be
generally lower than densities obtained by drives in areas of winter con-
centration (Table 11).

Table 11. Population densities of black-tailed jack rabbits during times
of the year when snow is absent.

<table>
<thead>
<tr>
<th>Location and cover</th>
<th>Date</th>
<th>Area</th>
<th>Total Rabbits</th>
<th>Rabbits Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greasewood and sage brush wash north of Sevier Lake</td>
<td>9-2-41</td>
<td>21.8 A.</td>
<td>33</td>
<td>1.51</td>
</tr>
<tr>
<td>Sagebrush, Alter Creek Reservoir</td>
<td>9-24-41</td>
<td>65.4</td>
<td>46</td>
<td>.73</td>
</tr>
<tr>
<td>Sagebrush and service berry</td>
<td>6-21-41</td>
<td>29</td>
<td>18</td>
<td>.62</td>
</tr>
<tr>
<td>Sagebrush and greasewood flat 15 mi. N.W. of Cedar City</td>
<td>9-16-41</td>
<td>53.6</td>
<td>33</td>
<td>.61</td>
</tr>
<tr>
<td>Greasewood and sage flat adjacent to fields at Trout Creek</td>
<td>8-25-41</td>
<td>54.5</td>
<td>24</td>
<td>.44</td>
</tr>
<tr>
<td>Sagebrush valley bottom 2 mi. north of Kanarraville</td>
<td>9-10-41</td>
<td>27.3</td>
<td>11</td>
<td>.40</td>
</tr>
<tr>
<td>Greasewood Wash near Lucin (Lower Grouse Creek)</td>
<td>8-22-41</td>
<td>33</td>
<td>9</td>
<td>.27</td>
</tr>
<tr>
<td>Slope of Atriplex canescens and sage, Table Butte, Iron County</td>
<td>9-16-41</td>
<td>25.4</td>
<td>6</td>
<td>.24</td>
</tr>
<tr>
<td>Greasewood and sagebrush wash north west of Sevier Lake</td>
<td>9-1-41</td>
<td>34.8</td>
<td>8</td>
<td>.23</td>
</tr>
<tr>
<td>Greasewood, sage, and shadescale wash west of Yost.</td>
<td>8-20-41</td>
<td>23.5</td>
<td>5</td>
<td>.21</td>
</tr>
<tr>
<td>Sagebrush 15 miles south of Snowville</td>
<td>8-15-41</td>
<td>16.2</td>
<td>4</td>
<td>.21</td>
</tr>
<tr>
<td>Sagebrush and Purshia slope east of Washakie</td>
<td>8-14-41</td>
<td>72</td>
<td>15</td>
<td>.20</td>
</tr>
<tr>
<td>Sage and rabbitbrush hollow near Lynn, Box Elder County</td>
<td>8-20-41</td>
<td>54.5</td>
<td>8</td>
<td>.14</td>
</tr>
<tr>
<td>Greasewood river bottom on Muddy River near Hanksville</td>
<td>9-30-41</td>
<td>73</td>
<td>6</td>
<td>.08</td>
</tr>
<tr>
<td>Sage and purshia hill sides 6 mi. west of Portage</td>
<td>8-15-41</td>
<td>36</td>
<td>2</td>
<td>.06</td>
</tr>
<tr>
<td>Sage and greasewood hills 10 miles west of Kelton</td>
<td>8-16-41</td>
<td>131</td>
<td>5</td>
<td>.04</td>
</tr>
<tr>
<td>Enplectocladus and Atriplex, Desert Range Experiment Station</td>
<td>9-5-41</td>
<td>72</td>
<td>3</td>
<td>.04</td>
</tr>
<tr>
<td>Sagebrush flat 6 miles west of Snowville</td>
<td>8-15-41</td>
<td>36</td>
<td>1</td>
<td>.03</td>
</tr>
<tr>
<td>Covillea, Joshua tree, Ephedra in Beaver Dam Wash</td>
<td>12-29-40</td>
<td>96</td>
<td>3</td>
<td>.03</td>
</tr>
<tr>
<td>Grayia, Ephedra and Tetradymia Hillside S. of Gold Hill</td>
<td>8-23-41</td>
<td>58</td>
<td>2</td>
<td>.03</td>
</tr>
</tbody>
</table>
Whether or not black-tailed jack rabbits are truly cyclic is not known, but it is certainly true that their numbers are subject to great variation from time to time. Will Parker, rancher at Trout Creek, Juab County, expressed the belief that jack rabbits are cyclic, with population peaks occurring at five or six year intervals. According to him, 1940 was a peak year. A number of residents of northern Utah (Ogden and Lucin) who contend that jack rabbits are cyclic, state that the peaks occur at eight year intervals, but concur with the opinions of others that during the winter 1940-41, rabbits were at peak abundance. The writers observations are that during 1940-41 rabbits of all species over most of the state were much more abundant than during the winter of 1945-46.

Nuttall Cottontails

In Utah, north of Great Salt Lake, Black Hills Cottontail populations of greatest density are distributed as small islands in the sage brush covered hills and plains. The primary factor determining the location of a dense population is the presence of an outcrop of rocks, usually of volcanic origin. In one such area west of Snowville, not exceeding 3 or 4 acres, nine cottontails were shot and several more seen in a half hour.

Population densities of other areas are given in Table 12.

Table 12. Population densities of Black Hills Cottontails

<table>
<thead>
<tr>
<th>Location and cover</th>
<th>Date</th>
<th>Area</th>
<th>Rabbits</th>
<th>Rabbits Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagebrush, greasewood</td>
<td>8-16-41</td>
<td>.41 A</td>
<td>4</td>
<td>9.8</td>
</tr>
<tr>
<td>Grayia hillside among boulders 10 mi. west Kelton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sage, grayia, rabbitbrush</td>
<td>4-7-46</td>
<td></td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>hillside 15 mi. west Snowville among boulders</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basalt boulders, sage, purshia North Promontory</td>
<td>8-15-41</td>
<td>6.5</td>
<td>3</td>
<td>.43</td>
</tr>
<tr>
<td>Rabbitbrush and sage near Lynn</td>
<td>8-20-41</td>
<td>22</td>
<td>7</td>
<td>.32</td>
</tr>
</tbody>
</table>
Audubon Cottontails

In the Uintah Basin strip counts were employed in large expanses of greasewood flat. Along many narrow washes, however, total counts were applied with what are believed to be accurate results.

A visit to the Uintah Basin in February, 1946, showed cottontails to be scarcer than in 1941. Residents of Jensen were of the opinion that an increase in coyotes was the causative factor.

Table 13. Population densities of Wyoming Cottontails

<table>
<thead>
<tr>
<th>Location and Cover</th>
<th>Date</th>
<th>Area</th>
<th>Rabbits Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greasewood wash 5 mi west of Duchesne</td>
<td>7-31-41</td>
<td>77.8 A</td>
<td>15 .20</td>
</tr>
<tr>
<td>Greasewood wash 5 mi west of Duchesne</td>
<td>7-30-41</td>
<td>22.4</td>
<td>9 .40</td>
</tr>
<tr>
<td>Agricultural lands 6 mi S. E. of Vernal</td>
<td>8-4-41</td>
<td>32</td>
<td>18 .56</td>
</tr>
<tr>
<td>Greasewood and salt bush wash east of Vernal</td>
<td>8-5-41</td>
<td>3.3</td>
<td>3 .90</td>
</tr>
<tr>
<td>Greasewood Flat Dinosaur National Monument</td>
<td>8-5-41</td>
<td>39</td>
<td>36 .32</td>
</tr>
<tr>
<td>Greasewood and salt bush wash East of Vernal</td>
<td>8-5-41</td>
<td>1.9</td>
<td>2 1.00</td>
</tr>
<tr>
<td>Greasewood and salt bush wash East of Vernal</td>
<td>8-5-41</td>
<td>1.6</td>
<td>3 1.90</td>
</tr>
<tr>
<td>Greasewood Flat Dinosaur National Monument</td>
<td>8-5-41</td>
<td>4.9</td>
<td>12 2.40</td>
</tr>
<tr>
<td>Greasewood wash 10 mi. S. E. Vernal</td>
<td>8-6-41</td>
<td>14.4</td>
<td>74 5.20</td>
</tr>
<tr>
<td>Greasewood and salt bush wash 3 mi. East Vernal</td>
<td>8-5-41</td>
<td>3.7</td>
<td>36 9.70</td>
</tr>
</tbody>
</table>

Audubon cottontails in western Utah were most numerous in small rocky canyons or washes and on rocky hillsides. On such areas, population density was frequently high (Table 14).

Table 14. Population densities of Audubon Cottontails in western Utah

<table>
<thead>
<tr>
<th>Location and cover</th>
<th>Date</th>
<th>Area</th>
<th>Total Rabbits</th>
<th>Rabbits Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 mi. north Cedar Sage, rabbitbrush, grass covered hills</td>
<td>9-6-41</td>
<td>1.0</td>
<td>6</td>
<td>6.0</td>
</tr>
</tbody>
</table>
Table 14 (continued)

<table>
<thead>
<tr>
<th>Location and cover</th>
<th>Date</th>
<th>Area</th>
<th>Total Rabbits</th>
<th>Rabbits Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>West of Sevier Lake, Atriplex wash</td>
<td>9-3-41</td>
<td>1.8</td>
<td>7</td>
<td>3.9</td>
</tr>
<tr>
<td>Sage and atriplex near basalt outcappings Table Butte, Escalante Desert</td>
<td>9-16-41</td>
<td>2.2</td>
<td>7</td>
<td>3.2</td>
</tr>
<tr>
<td>Atriplex, rabbitbrush Tetradymia wash west of Sevier Lake</td>
<td>9-4-41</td>
<td>1.7</td>
<td>4</td>
<td>2.3</td>
</tr>
<tr>
<td>Atriplex, rabbitbrush Tetradymia wash west of Sevier Lake</td>
<td>9-4-41</td>
<td>1.9</td>
<td>3</td>
<td>1.6</td>
</tr>
<tr>
<td>Greasewood and sage flat near Trout Creek</td>
<td>8-25-41</td>
<td>4.4</td>
<td>3</td>
<td>.7</td>
</tr>
<tr>
<td>Greasewood and sage near lavatoutcrops Clear Lake</td>
<td>8-26-41</td>
<td>17.5</td>
<td>10</td>
<td>.6</td>
</tr>
<tr>
<td>Sage and greasewood north of Sevier Lake</td>
<td>9-2-41</td>
<td>8.5</td>
<td>4</td>
<td>.47</td>
</tr>
<tr>
<td>Greasewood and sage near lava outcrop Clear Lake</td>
<td>8-30-41</td>
<td>21.4</td>
<td>6</td>
<td>.28</td>
</tr>
</tbody>
</table>

Strip counts were applied to Colorado Cottontails in eastern Utah (Table 15). Like Audubon Cottontails in western Utah, Colorado Cottontails were most numerous in rocky washes and canyons.

Table 15. Population densities of Colorado Cottontails

<table>
<thead>
<tr>
<th>Location and cover</th>
<th>Date</th>
<th>Area</th>
<th>Rabbits</th>
<th>Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabbitbrush, Ephedra wash</td>
<td>10-1-41</td>
<td>7.3 A</td>
<td>9</td>
<td>1.2</td>
</tr>
<tr>
<td>20 mi. north of Hanksville</td>
<td>10-2-41</td>
<td>36.3</td>
<td>20</td>
<td>.53</td>
</tr>
</tbody>
</table>

Pygmy Rabbits

In small areas of favorable habitat, these rabbits are often quite numerous, but because of inconspicuous appearance and habits, they are often overlooked. On September 10, 1941, an area 200 yards square lying about 3 miles southwest Hamiltons Fort on which pygmy burrows were common was selected for counting. The writer walked through this area in an
ordinary manner first, and no pygmies were seen. Then by walking back and forth thru the area on strips 20 yards apart, 6 pygmies were seen, and 14 burrow systems counted. On the basis of rabbits seen, this would be a density of .75 per acre. Assuming that some were in burrows, and that there is on the average about one per burrow which has been the winters experience from excavating a number of them, there would be a density of 1.75 per acre. On another favorable area, along the east side of Quitchipah Lake about 8 miles southwest of Cedar City, using the strip count, the writer counted 7 pygmies in an hour, and estimated the density per acre at about 3.5 rabbits.

In the winter of 1946, pygmies appeared scarcer than in 1941. Several areas where these rabbits were common in 1941 were found to have none occupying them in 1946.
MORTALITY

White-tailed Jack Rabbit

No case of predation was found, but coyotes, foxes, bobcats and eagles probably take a toll. A golden eagle was observed chasing a white-tail in the Blue Spring Hills, but the rabbit dodged about so in the clumps of Purshia and sage, that the eagle, outmaneuvered, gave up the chase. Orr (1949) reports one in the Sierras killed by a pair of red foxes.

No evidence of disease was found among them.

Parasites: A number of tapeworms, nematodes, and ticks, were collected and sent to the U. S. Bureau of Animal Industry for identification. Unfortunately, due to priority work imposed by the war, these identifications have not yet been made.

These rabbits are often subject to infestation by tapeworm larvae which form huge watery cysts in the tissues and body cavity. A large female collected in the Uintah Basin contained in the body cavity four such cysts which exceeded the viscera in volume and probably added well over a pound to the weight of the animal. Otherwise the rabbit was in good shape and apparently not handicapped by its extra burden. A specimen from Strawberry Valley was infested with cysts in the body cavity, thigh and in the right eye which was apparently blind due to the cyst.

Other parasites were adult tapeworms from the small intestines; nematodes from the caecum; ticks found in the fur and attached about the head and ears; and a few fleas.

Snowshoe Rabbit

No evidence of predation or disease was found. Parasites collected from the few specimens obtained were: tapeworms from the small intestines
and nematodes from the large intestine. Davis (1939) reports a specimen from Idaho blinded by ticks attached to the eye-lids.

Black-tailed Jack Rabbit

These are heavily preyed upon by coyotes, hawks, golden eagles and horned owls. Table 16 from Gaufin's (1939) report in southeastern Idaho shows the incidence of predation upon various rabbit species.

A golden eagle in the Blue Spring Hills was noted to unsuccessfully pursue a black-tail jack rabbit which escaped by dodging around a bush until the eagle abandoned its pursuit.

Table 16. Frequency of occurrence of rabbits in coyote droppings and raptor pellets

<table>
<thead>
<tr>
<th>Predator</th>
<th>Total Samples Droppings or Pellets</th>
<th>No. Samples Containing</th>
<th>Pygmy Rabbit</th>
<th>Black-tail Jack Rabbit</th>
<th>Nuttall Cottontail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coyote</td>
<td>365</td>
<td>30</td>
<td>107</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>Swainson's Hawk</td>
<td>293</td>
<td>32</td>
<td>19</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Golden Eagle</td>
<td>70</td>
<td>8</td>
<td>21</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Prairie Falcon</td>
<td>13</td>
<td>3</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Short eared Owl</td>
<td>60</td>
<td>14</td>
<td>11</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Marsh Hawk</td>
<td>51</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Burrowing Owl</td>
<td>16</td>
<td>1</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Red-tail Owl</td>
<td>3</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Undetermined</td>
<td>109</td>
<td>21</td>
<td>6</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

Little evidence of disease was noted. One specimen from near Cedar City was very weak and died within an hour after being found. Autopsy by the U. S. A. C. Veterinary Department disclosed acute gastrites as the probable cause of death.

Severe epizootics among black-tailed jacks no doubt occur at times. References to such occurrences are common in literature, and several
persons were heard to report them. The cause of these diseases has not been definitely determined.

Parasites include ticks, tapeworms, cysticerci, adult tapeworms, nematodes, fleas, and *Cuterebrea larvae*.

**Nuttall Cottontails**

One case of weasel predation was discovered. Tracks in the snow east of Logan showed where the weasel had overtaken the rabbit and leaped on it. The weasel had been shaken off the first time but pounced on the rabbit again within two yards and after a brief struggle had killed it, dragged it into a snow tunnel under the bank of a canal and eaten a portion of its head and neck.

Instances of coyote predation were found in the Blue Spring Hills and on the mountains east of Cedar City. In these cases everything was consumed leaving only tracks, hair and blood on the snow to tell the story.

Hawks and owls take a number of cottontails. A marsh hawk was seen to chase a cottontail on sage and juniper covered hills west of Cedar. The rabbit eluded it by dodging around the junipers.

No evidence of disease was noted. Parasites are fleas, which at times infest these cottontails very heavily; *Cuterebrea larvae*; tapeworm cysticerci; adult tapeworms; nematodes and ticks.

**Audubon Cottontails**

Cases of coyote and hawk predation were noted in the Uintah Basin.

Diseased conditions observed during the late summer in the Uintah Basin were: presence of pus-filled nodules in the mammary glands of one female; running abscesses and sloughing of the hair and skin on the head of one specimen; and pus-filled boils on the back. Cary (1911) states
Figure 24. Cottontail killed by coyote, only hair and blood remaining. Vicinity of Altonah, Feb., 1946.

Figure 25. Pygmy rabbit with bot fly larva embedded below eye. Vicinity of Cedar City, Sept., 1938.
that in 1906 a severe epizootic occurred among Wyoming Cottontails in northwestern Colorado, following the previous year's peak of abundance, and greatly reduced their numbers.

Parasites included: fleas, Guterebra warbles; tapeworm cysticerci, adult tapeworms, ticks, and nematodes.

**Pygmy Rabbits**

Weasels are no doubt the principal enemy of these rabbits, being able to follow them into burrows. Four recent kills were found near Cedar City. In all cases the dead rabbits were inside burrows, and were completely consumed except for the feet, pieces of skin and fur, and contents of the digestive tract. After the kill, the weasel apparently stays in the vicinity and revisits the corpse until it is entirely eaten. Usually an accumulation of weasel dung is found near the remains. In one burrow was found the recent remains of two rabbits. The weasel had used the rabbit's fur to make a nest in a chamber of the burrow, and had apparently occupied it for some time, for the hair was packed so as to resemble felt. In a chamber about 3 feet removed from the nest was an accumulation of about a quart of weasel dung. Many old remains of rabbits were found in other burrows excavated, and were commonly seen in the debris and earth evicted by the pygmies in cleaning out their burrows.

A pygmy found in the Blue Spring Hills had been killed out in the open by a weasel and then dragged about a quarter of a mile to a hole before being partially eaten.

One coyote kill near the mouth of a burrow was discovered. Everything including most of the hair had been eaten. Data in Table 16 indicates that mortality due to coyotes is considerable.
Two kills by horned owls were found, both in nests of these birds. A number of parasites were obtained and identified. Bot fly larvae of the genus Cuterebra commonly infested rabbits near Cedar City in August and September, 1939. About half the rabbits examined during these two months were infested with from one to six larvae of various sizes. The grubs attain full size at 30 mm. length and 15 mm. diameter. They then leave the rabbit to pupate in the ground.

Fleas of the species Cediopsylla inaequalis are present on all specimens at all times of the year. On some rabbits they are so abundant that as they crawl through the hair, it moves with a waving motion. At times these fleas line the edges of the ears so thickly that the skin cannot be seen.

In the spring and summer, the larvae of a mute, Trombicula, orange in color, attach themselves to the rabbits. On portions of the body where the hair is sparse such as the scrotum, belly and lower parts of legs they are often so abundant as to form orange patches on the skin.

Several species of ticks were found infesting pygmy rabbits. These include:

Dermacentor parumapterus found in the summer attached to the ears or head and engorged tremendously with blood.

Haemaphysalis leporis-palustris found as small ticks crawling in the fur in late summer and winter.

Ornithodoros sp. (nymphs), found in the ear of rabbits from Idaho in March.

No tapeworms, either larval or adult were found in the specimens examined. However, the following nematodes were collected from the digestive tract:

[Further text may follow about nematode species found in pygmy rabbits.]
Dermatoxys veligera, a nematode about one inch long found in small numbers in the large intestine.

Nematodirus sp., long, extremely slender nematodes found in tangled masses in the small intestine.
ECONOMIC IMPORTANCE

Snowshoe Rabbit

In Utah, snowshoe rabbits are not sufficiently abundant to be of any importance for meat or fur. In areas of coniferous forest, however, they are numerous enough to damage forest reproduction. Baker et al. (1922) report damage to the native conifers: Douglas fir, alpine fir, white fir, Engelmann spruce, limber pine and blue spruce on the Wasatch and Manti National Forests. The following species introduced to those areas were also subject to rabbit damage: ponderosa pine, lodgepole, Jeffrey pine, jack pine, western white pine, Norway spruce, Austrian pine and Scotch pine. Damage consisted principally of rabbits clipping the leaders of young trees thus retarding growth and giving the tree a bushy shape. Trees up to 8 feet in height were damaged. Deep snow enables the rabbits to reach this height. It was found that rabbit-injured trees suffered a higher mortality than uninjured trees.

Jack Rabbits

Before the white man became well-established in Utah, the Piute Indians drew heavily upon the jack rabbit population for food and clothing. Near Cedar City, they used to assemble to take part in a big hunt each November. Thousands of rabbits were killed for their flesh and skins (Palmer 1897). The Navajos and Piutes of the Kaibab Plateau used to depend upon jack rabbits for food to a much greater extent than upon deer or other animals (Rasmussen 1941). The tribes of the Great Basin used jack rabbit skins for robes which were used as a cloak in the day and bed at night.

Palmer (1897) points out that jack rabbits are used as food to a greater extent than is generally realized. During the winter of 1894-95,
approximately 500,000 jack rabbits were sold for food in the markets of
the larger cities including Salt Lake City, San Francisco, Denver,
Chicago, New Orleans, St. Paul, St. Louis, Boston, New York and Washington
D. C. At that time rabbit carcasses sold on the market at prices ranging
from 75¢ to $3.00 per dozen, wholesale, and as high as 75¢ to $1.00 each
retail, in New York City.

Grinnell et. al. (1930) report several thousand rabbits shipped
weekly from Ravendale, California to San Francisco in 1925. They brought
prices of from $5.00 to $5.50 per dozen.

The skins are too weak to be used for furs but the hair of both
black-tailed and white-tailed jacks is suitable for felting. Whitlow
and Hall (1933) report:

According to a news item in the Salt Lake Tribune for
April 8, 1929:

'More than a half million black-tailed jack rabbit skins
were sold to hatters in the east by Idaho rabbit-catchers
during the past season. T. B. Murray, director for Idaho of
the rodent control division of the United States Biological
Survey reports.

From these $65,000 was received, the price per skin
averaging 15 cents.'

The sale of white-tailed jack rabbit skins to hatters, and carcasses
to fur farmers bring about $100,000 annually in North Dakota. Here skins
sold for about $1.60 per lb. in 1929 and 25¢ per lb. in 1939. About
1,000,000 skins are marketed annually (Saugstad 1939).

The meat of all rabbits occurring in Utah is very palatable, but
due chiefly to prejudice is not utilized as fully as it could be. The
fear of contracting tularemia no doubt also deters many people from
eating rabbit. This fear has some basis in fact for in 1939, there were
2,200 cases of tularemia with 150 deaths in the United States. Over
ninety percent of these cases were contracted by handling rabbits. However, studies in southern Illinois demonstrated that after the onset of freezing weather the incidence of tularemia was decreased from as high as 15 per 100,000 population to one per 100,000. The disease is carried by ticks, which leave the rabbits and hibernate in the fall. Infected rabbits die off, consequently tularemia incidence during the winter in a cold climate is very low or absent. Rabbits can be safely handled until the ticks emerge from hibernation in the spring and re-infect the rabbits. No indication of tularemia was found in any of the rabbits examined by the writer during all seasons of the year.

Jack rabbits, black tails especially, are frequently serious range pests. Vorhies and Taylor in southern Arizona worked out a set of forage consumption equivalents between jack rabbits and livestock. On the basis of total forage consumption they estimated that about 12 jack rabbits (Lepus californicus) are equivalent to one sheep, and 60 to one cow. However, allowing for plants eaten by rabbits and not by stock, they concluded that under range conditions, 30 rabbits are equivalent to one sheep and 148, to one cow. These figures probably would not be applicable to Utah ranges because of the different plant species present, with different palatabilities. Estimates of forage consumption by rabbits based only on amounts actually eaten are low, owing to the wasteful feeding habits. Feeding rabbits clip off long stems or leaves in rapid succession eating only a fraction of each before dropping it and clipping off another. Therefore forage wasted probably exceeds that eaten. This should be considered in estimating forage consumption.

Observations by the writer in the area west of Snowville indicate a very heavy winter utilization of plants by jack rabbits. By early spring
in areas of winter concentration of jack rabbits, grasses, salt bushes, and
sage and greasewood reproduction were commonly eaten down to the crowns of
the plants. This area in common with most of the semi-desert areas of
western Utah is used extensively as a cattle range and a winter range for
sheep.

In cultivated areas both jack rabbits and cottontails may damage crops.
In the Uintah Basin, the writer observed grain patches bordered with a
strip about 10 yards wide where white-tailed jack rabbits and Wyoming cotton-
tails had eaten the grain down to within a few inches of the ground. They
had also made numerous trails which criss-crossed in all directions through
the patch. Residents of Altonah stated that in winters of heavy snows,
white-tailed jack rabbits descended from the sage and juniper covered
foot hills into the cultivated areas in great numbers to feed from hay-
stacks. The stacks would often be undermined for distance of two feet,
giving them a "mushroom" appearance.

Will Parker rancher at Trout Creek, Juab County states that black tail
jack rabbits there do considerable damage to crops and come into haystacks
in large numbers in the winter.

Damage to crops in the early days must have been great. In February
1887 W. G. Nowers wrote concerning damage wrought by black-tailed jack
rabbits in Beaver County, Utah (Palmer 1897).

At times its ravages are enormous; sweeping down from the
bench lands and sage plains in myriads it devours entire fields
of cereals. Last year in this and adjoining counties on either
side its depredations amounted to several thousand dollars.
Last year some farmers in this county lost their entire crop of
small grain from this source alone. At Minersville, not more
than one-third of the crop was harvested; at Adamsville nearly
the total crop was taken; at Greenville one-half of the crop
was destroyed, and here (Beaver) about the same. This is also a
fair representation of the ravages in Iron County south of us.
Damage was done to alfalfa, melons, cabbage, carrots, cotton, sweet potato vines, young grain, grape vines, and orchard trees. Vaughn Madsen reports an entire patch of beans at Annabella, Sevier County, destroyed by these rabbits.

Cottontails

Cottontails, at times become sufficiently numerous to constitute range posts. Cary (1911) reports that in 1907 near Bluff, San Juan County, Colorado cottontails were at maximum abundance and had eaten off all the range grasses by June. Orchards are occasionally damaged during the winter by cottontails gnawing the bark of young trees.

In many states, cottontails are very important as game animals. In Utah however it has not been considered feasible to pass legislation controlling their hunting. Up to the present, hunting restrictions probably have not been desirable inasmuch as cottontails have held their own against the relatively few hunters. As population increases and more people hunt them, however, legislation protecting cottontails may become necessary. That Utah sportsmen are becoming interested in the game possibilities of cottontails is indicated by the fact that many of them are willing to go considerable lengths in order to hunt them and to improve hunting. Henry Slaugh, of Vernal, states that in the Uintah Basin during the winter months hunters frequently come from as far away as Salt Lake City to shoot cottontails.

In an effort to improve cottontail shooting near Salt Lake, the sportsmen of that area introduced several pairs of the Nebraska cottontail in 1937. In 1941 the writer checked the area at the mouth of Parleys canyon near the golf course, one of the areas in which these cottontails had been tiberated. Evidence of their having established themselves was found.
In Utah at the present time the management of rabbits is chiefly a problem in limiting numbers to reduce agricultural range and forest damage. Snowshoe rabbits, where numerous enough to cause damage to forest production, may be poisoned (Baker et. al. 1922).

Great numbers of black-tailed jack rabbits in western Utah are shot during winter drives, which although expensive in total amount of ammunition used, are not costly to any agency or group since the hunters participating do so chiefly for sport, and furnish their own ammunition. Control measures by certain agencies, as the Grazing Service and Fish and Wildlife Services, have been most successfully accomplished by poisoning with alfalfa baits.

For protecting a relatively small area, fencing is effective against jack rabbits. Palmer (1897) and Vorhies and Taylor (1933) report that a fence of two and one-half feet in height is sufficient to exclude black-tailed jack rabbits.

Much can probably be said on both sides for the advisability of permitting the increase of coyotes and other predators in order to control rabbits and rodents. To do this it would be necessary to determine whether or not the damage done to domestic and game would outweigh the benefits derived from the increased predation on rabbits and rodents.

If cottontails should attain importance in this state as game animals, it would of course be advisable to initiate management measures to insure continued good hunting. In areas where agricultural damage may result from their increase, the question as whether or not the benefits of the presence of rabbits would more than compensate for the damage to crops should be considered. The hunting season for cottontails would best be set during late fall or winter months to permit the rabbits unmolested breeding seasons,
to decrease spoilage of meat in hot weather, and decrease the incidence of tularemia. Also rabbits are fatter and in better shape during late fall and winter than in other seasons.

If it be deemed advisable to propagate cottontails to supplement natural increase, such a propagation program would be feasible. Dice (1929) and others have found it practicable to artificially propagate cottontails in the east.

Until the time, then, when popular demand for rabbits as game animals becomes more persistent, and the need for maintaining or building up their numbers arises, the policy of management need be to cut down numbers when necessary to curtail damage. Otherwise they should and probably will be unmolested except for the boys with 22 rifles, and the occasional hunter or group of hunters at times of the year when other hunting seasons are closed. Against such agencies of mortality, all native species of rabbits in Utah with their high reproductive potential are well able to hold their own.
SUMMARY

1. Within the borders of Utah are 6 native species of rabbits, 10 sub-species, and 1 introduced species.

2. Rabbits of one or more species are present in all life zones and in most habitats of the state.

3. Known distributions of the Snowshoe rabbit, Audubon cottontail, and pygmy rabbit have been considerably extended in Utah as a result of these studies.

4. Habitat requirements of the different species and the ability of different forms to adapt themselves to a variety of habitats, differs widely. The pygmy rabbit is the most restricted in habitat while black-tailed and white-tailed jack rabbits are the most versatile.

5. Hares use forms chiefly as shelter when adult, while the young commonly use holes. Adult cottontails and pygmy rabbits commonly use holes.

6. The pygmy rabbit is apparently the only Utah rabbit which commonly digs burrows.

7. The food of all rabbit species is almost exclusively vegetation, with grass and forbs predominating in spring, summer or fall, and with browse predominating in winter. Sagebrush is eaten to a greater extent by the pygmy rabbit than by other species.

8. The height of the breeding season is in the spring. Black-tailed jack rabbits are the earliest breeders, beginning in January. Breeding for all species is generally terminated by August. Dates of breeding vary with altitude and to a lesser degree with the latitude.

9. All Utah rabbit species are somewhat similar in actions and habits. Time of activity is much the same for all. The greatest activity occurs from late afternoon, through the night and early morning.
10. Home range varies from an acre or two for pygmy rabbits and cottontails to many square miles for jack rabbits.

11. The running speed of rabbits varies from about 15 miles per hour for the pygmy rabbit to 40 miles per hour for the white-tailed jack rabbit.

12. Rabbit populations are extremely variable. Between areas there may be a contrast of four or five per square mile to 12 per acre. Indications of cyclic behavior of populations exist.

13. All rabbits are subject to numerous predators, parasites and diseases. Evidence was obtained that epizootics sometimes follow extremely high population peaks and greatly reduce existing populations.

14. Rabbits are important in Utah chiefly as range and agricultural pests. Hunting for sport, meat, and skins is widespread.

15. Management measures consist principally of reduction of numbers to decrease crop and forage damage. Cottontails are potentially important game animals.
LITERATURE CITED


