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THE PYGMY RABBIT FROM UTAH TO MONTANA

By Reuel G. Janson



Pygmy Rabbit Habitat in Montana

Missoula, Montana

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Based on Pygmy Rabbit Studies by the Author in Utah and Idaho from 1938  
to 1946 with a Follow-up and Observations in Montana in 2001

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### ABSTRACT

The pygmy rabbit (Brachylagus idahoensis) is distributed intermittently in the Great Basin and adjoining areas. It has been found in eight western states and six major drainage systems. Because of its spotty distribution and retiring habits, it is one of our least known mammals. It was discovered in Idaho in 1890, found in Montana in 1918, and first reported in Utah in 1932. Its small size, short ears and tail, cranial characteristics and burrowing habits distinguish it from other American leporids. Throughout its range, the species is surprisingly constant in color, size and habits, and there are no subspecies. It is adaptable to a variety of habitats, but is dependent on sagebrush (Artemisia tridentata) for food and cover, and on deep, soft soil for burrows. This paper is based on the author's studies of the pygmy rabbit on two study areas in Utah and one in Idaho between 1938 and 1946; and limited observations in Montana and Utah in 2001. The initial studies resulted in a 435-kilometer southward extension of the known Utah range. Data were obtained on the life history, habitat, ecology and mortality of this species through the collection of specimens and field observations. The results were reported in two theses at Utah State University. The current status of the rabbit in the three-state area was ascertained through review of recent literature, visits and correspondence with state authorities, and a cursory follow-up visit to some former study sites. The recent information indicates that pygmy rabbit populations have declined in some areas largely because of human activities. Land development for construction, farming and range "improvement" for grazing has taken a toll of the sagebrush habitat the rabbit needs. In the three states where studies were made, the rabbit is the most threatened in Utah and the least, in Montana. Conservation of sagebrush lands is necessary for the continued existence of this species in the wild. A captive breeding program is being conducted by the Washington Department of Fish and Wildlife.

## ACKNOWLEDGMENTS

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## INTRODUCTION

Until recently, the pygmy rabbit, Brachylagus idahoensis (Merriam), was one of our least-known mammals. Because of its retiring habits and spotty distribution it was often over-looked by observers. It is, however, locally abundant in the Great Basin and adjacent areas. The author grew up in southwestern Utah, near the southern limits of the pygmy rabbit's range, and became acquainted with the rabbit soon after the first account of its occurrence in the state was published. His continuing interest in the subject resulted in the studies reported here.

This paper combines the results of two studies conducted by the author while attending Utah State University (then Utah State Agricultural College). One was a study of the pygmy rabbit done as a B.S. research project (Janson, 1940), and the other, a survey of Utah rabbits, was reported in an M.S. thesis (Janson, 1946).

The initial objectives of these studies were to obtain information concerning the distribution of the pygmy rabbit in Utah, to determine its habitat requirements and ecological relationships, to explore its reproductive cycle, to ascertain its diet, to investigate its behavior, and to evaluate the mortality factors affecting it. These objectives were at least partly met, and the outcome was reported in the two theses previously cited. Additional objectives of the current paper are to present information obtained since the original studies, to evaluate the status of the rabbit, to make recommendations for maintaining or enhancing the populations and to compile a bibliography of recent references.

### History and Classification

The pygmy rabbit was discovered near Goldburg, in the upper Pahsimeroi Valley of Idaho, in 1890 (Merriam, 1891). Its classification was controversial from the start. Merriam placed it in the genus Lepus, based on the misconception that the rabbit undergoes two annual molts, as in some hares, and gave it the specific name idahoensis. Miller (1900) established the name Brachylagus as a subgenus. Lyon (1904) raised that name to generic standing, based on unique cranial characters. Grinnell et al. (1930) demonstrated that there is only one annual molt. Nevertheless, the latter authors felt that the unique cranial features did not warrant generic status for Brachylagus, and assigned the rabbit to the genus Sylvilagus, where it remained until 1965.

In the meantime, a number of researchers added to the general knowledge of the pygmy rabbit. These were, by area, North America: Anthony (1913), Nelson (1909) and Hall and Kelson (1959); Montana: Goldman (1918) and Hoffinan et al. (1969); California: Grinnell et al. (1930) and Orr (1940); Utah: Stanford (1932), Janson (1940 and 1946), Durrant (1952) and Holt (1975); Nevada: Borrell and Ellis (1934) and Hall (1946); Oregon: Bailey (1936); and Idaho: Davis (1939).

Research into classification was resumed by Hibbard (1963) who did a detailed analysis of the dental patterns of lagomorphs, and concluded that the classification as Sylvilagus was incorrect. Kenner (1965), after a statistical analysis of cranial and dental characters, agreed and placed the rabbit back in the genus Brachylagus. This is a monotypic genus (containing no other species). Johnson and Wicks (1964) and Johnson (1968) determined that serum and hemoglobin patterns of pygmy rabbits are different from those of cottontails. Green and Flinders (1980a) concluded that "there is little basis for classifying pygmy rabbits as Sylvilagus." Thus, the controversy appears to be settled.

Recent research has focused on populations and habitat studies: Green and Flinders (1980b) and Wilde (1978) in Idaho; Lyman (1991) in Washington; Weiss and Verts (1983) in Oregon; and Rauscher (1997) in Montana. Concern over population status led to formulation of a recovery plan in Washington (Washington Department of Fish and Wildlife, 1995).

#### PROCEDURES

The data presented in this paper were gathered mostly between August, 1938 and December, 1941. The project was suspended during the war years, 1942-1945, and was concluded in May, 1946. Field work was performed in three main areas: the Quichapa Lake valley about 10 km southwest of Cedar City, Iron County, Utah; the Blue Springs Hills 16 km northwest of Tremonton, Box Elder County, Utah; and 8 km west of Dubois, Clark County, Idaho. Supplementary data were obtained at various locations including the foothills 3 km northwest of Clarkston, Cache County; Utah; west of Snowville and south of Grouse Creek, Box Elder County, Utah; and Beaverhead County Montana.

Field trips were made at intervals into the main study areas, and occasionally into other areas of potential pygmy rabbit habitat. Likely-looking areas were inspected on foot, and signs of pygmy rabbits (sightings, burrows, droppings or bones) were recorded. Specimens were

collected by shooting, digging them out of holes or running them down.. Some authors have reported good capture results by trapping, Wilde (1978), Green and Flinders 1979) and Rauscher (1997). Rabbits were measured, examined for parasites and diseased conditions; stomach contents were saved and analyzed; the breeding condition was noted; and skins were examined for evidence of molting. Study skins were prepared and distributed to various collections. Some rabbits were captured and kept in captivity for a few weeks for studies of behavior. Field notes were kept on habitat types, burrows, food plants, behavior, population density and predation. Data for Montana were obtained from specimens in the University of Montana Zoology Museum and several days of walking the sagebrush valleys of Beaverhead County.

## FINDINGS AND DISCUSSION

### Description of the Pygmy Rabbit

The pygmy rabbit (Figure 1) is the smallest North American rabbit. Its length varies between 10 and 12 inches (261-308 mm) and it weighs from 13 to 18 ounces (370-524 grams). In addition to small size, its distinguishing characteristics are: short legs,; short, broad ears; tail all brown and less than an inch (25 mm) long. The skull is unusual for its short length (about 50 mm), highly arched occipital region, shortened rostrum, very large tympanic bullae, and delicate supra-orbital processes. The color of the upperparts is an even grayish-brown, the underparts are white, and the nape and portions of the legs are rufous.

Standard measurements were taken of specimens while fresh, and some were weighed. These data are shown in Table 1. The average weight of 19 adults from Utah and Idaho was 419 grams (370-524). Eleven males averaged 397 grams (370-432), and eight females averaged 434 grams (415-524). Thus females were 14 percent heavier than males. Montana females (live-trapped weights) were heavier than those from other areas (Rauscher, 1997). Sexual size differences were also indicated by length measurements. The average length of 19 males was 275 mm (261-286), compared to 290 mm (269-308) for 31 females, a mean difference of 15 mm, or 5.4 percent. Other average measurements were: tail 18mm, hind foot 70 mm, and ear 51 mm. These measurements varied little between the sexes. Weights and measurements of pygmy rabbits in other studies are similar (Green and Flinders, 1980).

Specimens from all parts of the pygmy rabbit's range show little variability, and in spite of the rabbit's rather wide distribution, no subspecies are known. Little individual variation was noted in the rabbits collected during this study. A few specimens from each study area had a small tuft of black hairs in the tail. One March specimen from the Blue Springs Hills was a peculiar cinnamon color, and a wash of black-tipped hairs on the upper parts of two adults and one young rabbit was noted.

Table 1. Measurements of adult pygmy rabbits. Montana data mostly from Rauscher (1997)

| Area and sex                        | Number of Specimens | Ave. weight in grams* | Length  | Tail | Hind foot | Ear |
|-------------------------------------|---------------------|-----------------------|---------|------|-----------|-----|
| <u>Iron County, Utah</u>            |                     |                       |         |      |           |     |
| Males                               | 6                   | - (0)                 | 274 mm  | 17   | 67        | 52  |
| Females                             | 13                  | - (0)                 | 286     | 18   | 68        | 51  |
| <u>Box Elder and Cache counties</u> |                     |                       |         |      |           |     |
| Males                               | 8                   | 405 (6)               | 278     | 17   | 70        | 51  |
| Females                             | 8                   | 426 (5)               | 291     | 17   | 70        | 50  |
| <u>Clark County, Idaho</u>          |                     |                       |         |      |           |     |
| Males                               | 5                   | 388 (5)               | 272     | 19   | 70        | 52  |
| Females                             | 10                  | 479 (3)               | 295     | 19   | 71        | 52  |
| <u>Beaverhead County, Montana</u>   |                     |                       |         |      |           |     |
| Males                               | 17                  | 376 (17)              | 285 (1) | -    | 67        | 47  |
| Females                             | 20                  | 493 (12)              | -       | -    | 68        | 47  |

\* Gravid Montana rabbits, and gravid or lactating Utah and Idaho specimens, are omitted.

Three specimens from the newly-discovered range near Cedar City were submitted to the U.S. Bureau of Biological Survey in Washington, D.C. for examination in November, 1938 and March, 1939. They were examined by A.H. Howell who found them to conform to others of the species.

Young pygmy rabbits, no more than a month old, have a characteristic appearance which easily distinguishes them from the young of other rabbits. The eyes are noticeably smaller, the nose sharper, the ears more upright and the whole appearance better proportioned and less awkward than young cottontails or jackrabbits (Figure 2).



Figure 1. Pygmy rabbit at mouth of burrow near Quichapa Lake, Cedar City area, December, 1938.

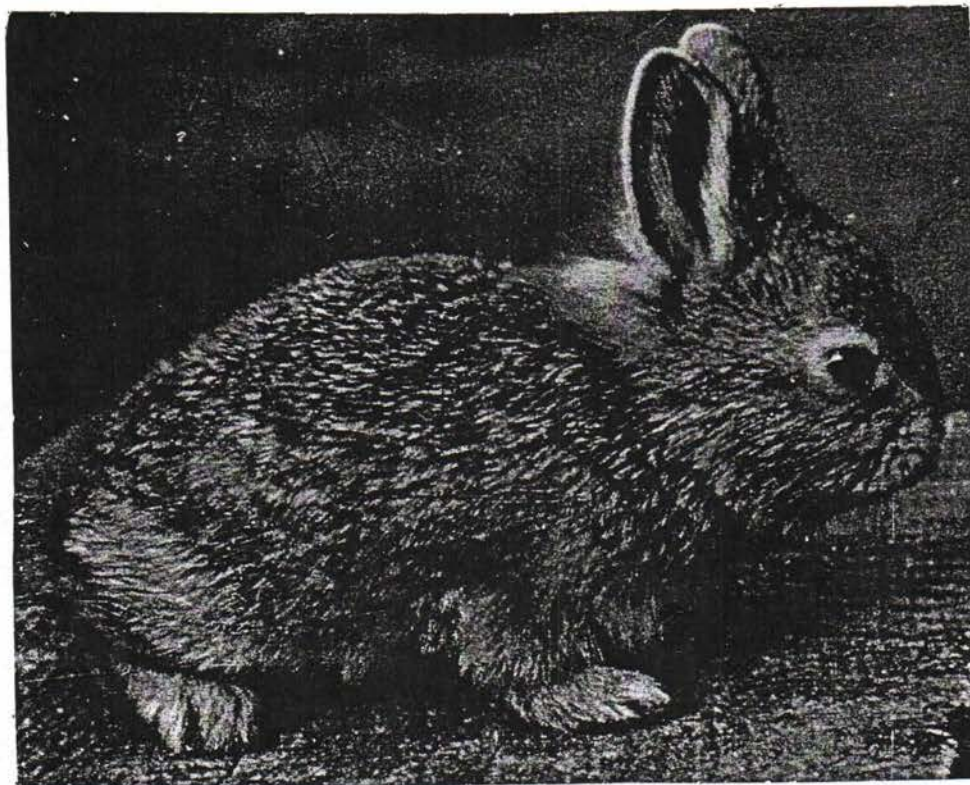


Figure 2. Young pygmy rabbit, four or five weeks old.

### **Pelage and Molting**

Because of a seasonal change in color and length of pelage, it was once thought that the pygmy rabbit undergoes two annual molts. Grinnell et al. (1930) demonstrated that only one annual molt occurs, and that subsequent color change is due to abrasion of the fur. Molting occurs during late summer and early fall. Davis (1939) reported Idaho specimens completing the molt as early as July 5. Borrell and Ellis (1934) found pygmy rabbits in complete fall pelage on July 22 in the Ruby Mountains region of Nevada. Grinnell et al. (1930) reported that molting occurs in September in northern California. In Iron County, Utah, I observed the beginning of molting in one specimen on September 13, 1938. A week later, a rabbit was taken in a more advanced stage. However, in 1941, a specimen on August 21 was in a stage of advanced molt with new hair growing in thickly over most of the body. Specimens collected on September 10 were still molting heavily. The posterior portion of the back appeared to be the first part of the body to attain new pelage. The molt then gradually worked forward until replacement of the fur was complete. In Oregon, Bailey (1936) noted that specimens taken September 16 had nearly completed the change to winter pelage, with summer pelage remaining only on the head and neck. Molting apparently occurs during a four-week period. After hair replacement, there is further increase in the length of hair and amount of underfur. In Iron County, Utah, the molt occurs in August and September, and its timing may vary somewhat from year to year, possibly in response to weather conditions. At higher latitudes and altitudes the molt probably occurs earlier.

The new fall pelage is buffy gray above (sometimes described as pinkish drab) and white below. By mid-winter, the fur is worn to silver gray with hints of sooty brown underneath. By spring, the upper parts are dark brownish gray. In specimens from southern Utah, the contrast between fall and spring colors was not as marked as in more northern regions. The fur is shorter and darker in winter specimens from Iron County than in those from northern Utah and southeastern Idaho. In all seasons, the nape and anterior portions of the legs are cinnamon buff. An adult male in the University of Montana Zoology Museum, collected Feb 6, 1977, from Beaverhead County, has long silver gray pelage. A young pygmy rabbit, found partly-eaten in a great horned owls nest near Dubois, Idaho, April 6, 1940, was a grayish buffy color with numerous black-tipped hairs that gave the pelage a blackish sheen lacking in most other rabbits.

The underparts of this rabbit were light grayish buff, and the nape and feet were pale buffy. The pelage was soft and more woolly than that of adults. A young Montana specimen in the University of Montana Zoology Museum, collected May 24, 1959, is similar, but lacks the black-tipped hairs.

### Distribution

The range of the pygmy rabbit is southern Idaho, southwestern Montana, east-central Washington, southeastern Oregon, northeastern California, central and northern Nevada, southwestern Wyoming and western Utah (Figure 3). Details of the range in Utah, eastern Idaho and Montana are also shown in Figure 3. These studies indicate that the Utah range extends across the northern edge of the state from Cache Valley to the Nevada boundary west of Grouse Creek, and from the Idaho boundary south along the west side of the Wasatch Mountains and southern plateaus to northern Washington County (Figure 4). Before settlement, the strip of land between the Wasatch Mountains and Great Salt and Utah Lakes probably supported pygmy rabbits but this area is so heavily developed now that no suitable habitat remains. Schantz (1947) recognized that study specimens collected near Cedar City extended the known Utah range 270 miles (435 km) southward. Since then, pygmy rabbits have been reported near Panguitch, Garfield County (Stephenson 1966) and in the Colorado River drainage on the Awapa Plateau near Loa in Wayne County (Pritchett et al. 1987). They were also found in Rich County and adjacent Wyoming (Green and Flinders 1980), Campbell et al. (1982) and Katzner (1994). Corridors of sagebrush along the Sevier and Bear River valleys probably allowed colonization of these areas by the rabbits. Holt (1975) reported them near Enterprise, and Toone (1994), from the Lytle Ranch, in Washington County. The species thus occurs in six major drainage systems: the Great Basin, the Columbia, the Snake, the Missouri, the Green and the Colorado. Throughout this region the species is limited to the sagebrush belt (Merriam's Upper Sonoran life zone and into the lower edge of the Transition zone) at altitudes from 1400 to 2380 meters.

Utah's north-south central mountain chain is a barrier confining many small mammals, including the pygmy rabbit, mostly to the western part of the state. The Pine Valley and Bull Valley mountains on the south, as well as the Lower Sonoran life zone conditions beyond, limit the southern distribution.

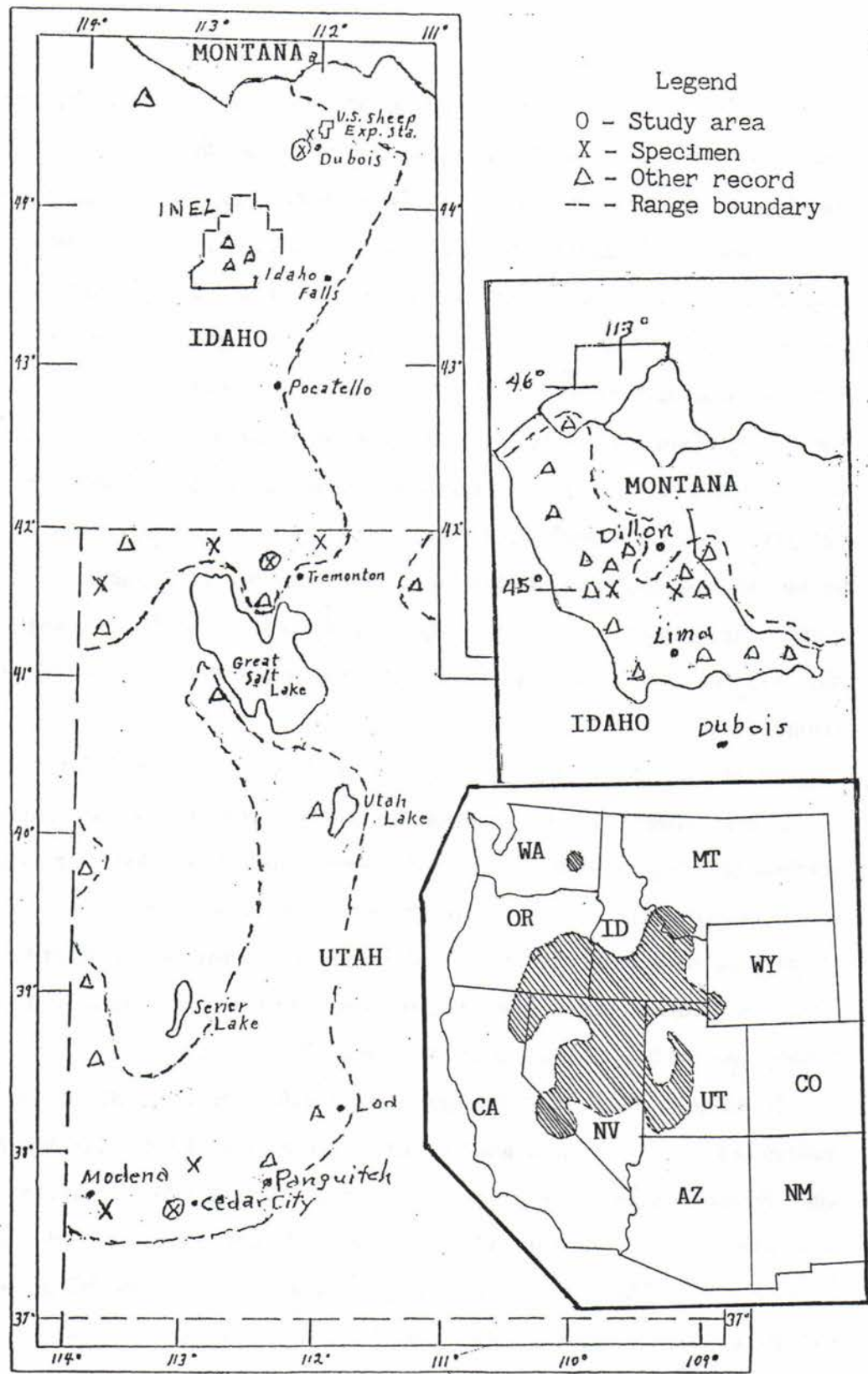


Figure 3. Study area locations; range of the pygmy rabbit in Utah, eastern Idaho and Montana; and national range. (the Montana range is adapted from Rauscher, 1997).

Durrant (1952) postulated that Pleistocene Lake Bonneville, which covered most of western Utah to a depth of 305 meters, greatly influenced the distribution and speciation of small mammals in western Utah. The effects were greater on relatively sedentary animals such as pocket gophers and kangaroo rats, but the distribution of the pygmy rabbit also appears to have been affected. Populations living below the maximum lake level ( 5200 feet or 1586 meters above sea level) would have been wiped out or forced to move to higher ground. Known pygmy rabbit locations are near, or well above, the the margins of the former lake. This is partly due to the scarcity of suitable habitat in the more arid lake basin, much of which consists of salt flats, playas, rugged desert mountain ranges and extensive areas of salt desert shrubs. However, there appears to be suitable sagebrush habitat in some upland areas where no pygmy rabbits have been found. Isolation may have prevented these areas from being repopulated. On the other hand, perhaps the rabbits are present but simply have been overlooked or unreported. For example, since this study, they were reported from the Lakeside Mountains just west of Great Salt Lake (Holt, 1975).

On the west, the Nevada range of the pygmy rabbit meets the Utah range west of Grouse Creek, and probably farther south. Holt (1975) reported pygmy rabbits from near Ibapah in southwestern Tooele County. Hall (1946) recorded the rabbit at Baker Creek just west of the Utah boundary. Janson (1946) received a report of its occurrence west of Trout Creek, Juab County, and collected specimens near Modena, Iron County. Both locations are very close to the Utah-Nevada border. The rabbits have also been reported at two locations in western Millard County and one in northwestern Beaver County (Holt, 1975).

To the north, the range of the pygmy rabbit extends across southern Idaho into the sagebrush valleys of southwestern Montana. Southern Idaho has been inhabited by pygmy rabbits at least since Pleistocene times. Fossil remains contemporary with early man and extinct ice-age mammals were found at Jaguar Cave in Indianhead Canyon, Lemhi County (Kurten and Anderson, 1972). Modern man "discovered" the rabbit in the upper Pahsineroi drainage in 1890 (Merriam, 1891). Whitlow and Hall (1933) reported taking five specimens near Pocatello (Schutt's Mine) in 1930. Davis (1939) collected one near Pocatello and two at Riddle (Owyhee County). Janson (1940) collected 15 specimens west of Dubois. The U.S. Sheep Experiment

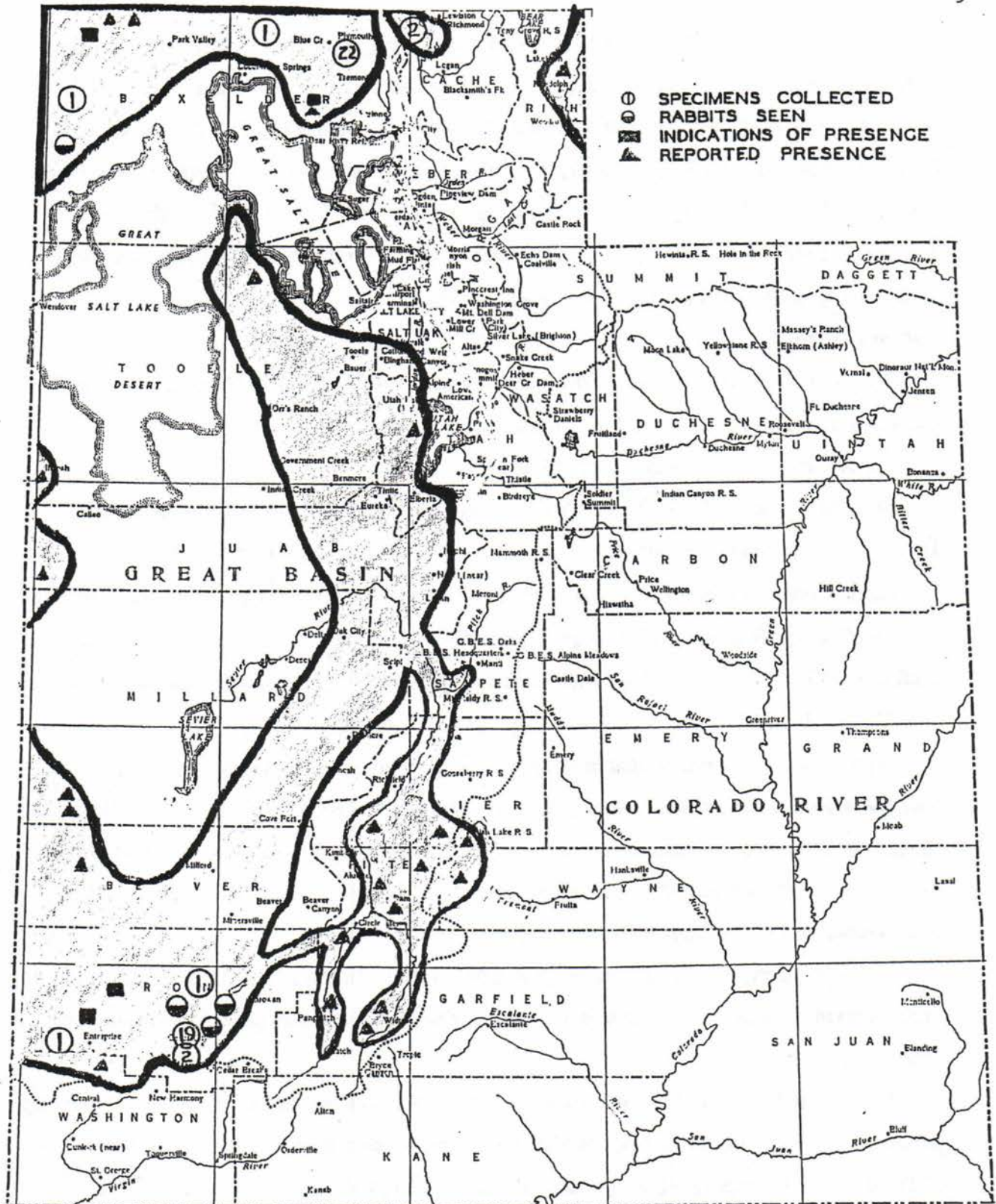


Figure 4. Probable distribution of the pygmy rabbit in Utah. Specimens and other records are the author's. Reported presence is from other sources.

Station north of Dubois, and the Idaho National Engineering Laboratory west of Idaho Falls were the locations of relatively recent pygmy rabbit studies (Green 1978) and Wilde (1978).

The rabbits have been found throughout the shrub-grassland ecosystem of Beaverhead County, and into the southwestern margins of Deer Lodge and Madison counties in Montana (Rauscher, 1997). The altitude of these areas varies between 1770 and 2000 meters. High mountains, coniferous forest, and scarcity of sagebrush and suitable soils probably limit the northward spread of the rabbit in Idaho and Montana.

### **Rabbit Locations**

Pygmy rabbits were collected during these studies at the following locations (Figures 3 and 4). The numbers collected are in parentheses:

Clark County, Idaho: 8 km west of Dubois (15) .

Box Elder County, Utah: White's Valley in the Blue Springs Hills 16 km northwest of Tremonton (22); 24 km west of Snowville (1) and 3 km south of Grouse Creek (1).

Cache County: In foothills 3 km northwest of Clarkston in Clarkston Creek "canyon" (3).

Iron County: East side of Quichapa Lake, 10 km southwest of Cedar City (19); 5 km southwest of Hamilton's Fort (2); 19 km southeast of Modena (1); 13 km northwest of Cedar City (2) and about 30 km north of Cedar City east of State route 130 (1).

Pygmy rabbits, or unmistakable signs of their presence, (burrows and droppings), were seen about 10 km west of Snowville, 5 km north of Lynn and 8 km north of Lucin in Box Elder County. In addition to the specimen collected, I saw five pygmy rabbits 3 km south of Grouse Creek. Postmaster Johnson at Grouse Creek told me that pygmy rabbits are plentiful in the brush along creeks and around fields.

In Iron County, pygmy rabbits, or their signs, were observed 1.7 km east of Enoch; on the southwest side of Little Salt Lake and 3 km northwest of Table Butte (about 10 km south of Lund).

In western Juab County, Will Parker, a Trout Creek Rancher, reported that there were sage grouse and "brush rabbits" in Pleasant Valley near the Nevada state line about 16 km southwest of Trout Creek. He was familiar with jackrabbits and cottontails so his "brush rabbits" were probably pygmy rabbits.

An observation west of Utah lake at the foot of the Lake Mountains in Utah County was reported by Lloyd Gunther (personal communication) who found a pygmy rabbit dead in a great horned owl's nest.

#### Additional Records:

Stephenson (1966) collected specimens in Garfield County at Lime Kiln Draw, 5 km north of Panguitch.

Holt (1975) reported specimens from the following locations:

Beaver County: Pine Valley, 24 km south of the Desert Range Experiment Station .

Box Elder County: 35 km west of Snowville; Yost; Gorge Creek, 5 km south of Yost; 16 km west of Strevell; 1.7 km west of Stevell and 6.4 km east of Lynn.

Garfield County: Circleville Canyon 27 km south of Circleville and Cottonwood Creek road 13 km north of Widtsoe.

Millard County: two areas, 10 km north and 19 km northeast of the Desert Range Experiment Station.

Piute County: 19 km south of Fish Lake; five km east of Greenwich; west side of Otter Creek Reservoir; five km east of Piute Reservoir and five km south of Circleville.

Sevier County: Sevier (26 km south of Richfield), and east side of Koosharem Reservoir.

Tooele County: Lakeside Mountains and five km south of Ibapah.

Washington County: Enterprise.

Katzner (1994) reported burrows and signs 6.9 km east of Laketown and a sighting between Randolph and Woodruff, 3.4 km west of mile marker 13 on State Route 16 in Rich County.

Fred Knowlton, (personal communication) reported seeing pygmy rabbits during the mid-1980's 12 to 16 km southwest of Snowville, Box Elder County . Pritchett, et al. (1987) reported one collected 16 km south of Fish Lake Ranger Station and sightings west of Loa in T28S, R1E, Secs. 3 and 14; also six live specimens and two skulls from Parker Mountain.

Toone (1994) reported the rabbits' occurrence at the Lytle Ranch in Washington County.

#### Physiography of Study Areas

The areas in which these studies were made are typical of the sagebrush valleys and plains of the Great Basin region. The climate and dominant vegetation are similar throughout the area encompassed by the eight degrees and 15 minutes of latitude (920 km) between the southern and

northern limits of the pygmy rabbits range. In all four areas, the winters are cold, and the summers are warm. The average temperatures in January and July are -5 and 23 degrees. The average annual precipitation is 30 cm, and the annual snowfall is about 100 cm. Temperatures can vary between -45 C in the north to 30 C in most areas. Snow depths often accumulate to more than 30 cm for extended periods in the north and at higher elevations. Study area elevations average 1525 meters, but range from 1400 to 2000 meters. Prichett et al. (1987) reported pygmy rabbits at 2379 meters on the Awapa Plateau near Loa, Utah. Individual study areas vary somewhat in climate, topography and biota.

The Quichapa (Cedar City) area is the southern-most, at 37 degrees 25 minutes north latitude. Its elevation is 1662 meters, and it is the warmest of the four areas, especially in the winter. The average January and July temperatures are -1 and 23 degrees C. The annual precipitation is about 30 cm; and annual snowfall is relatively light, about 76 cm. The topography consists of a wide, nearly flat valley with a playa (Quichapa Lake) in the lowest part. The soil is deep and soft with almost no rocks. Land use in 1940 was chiefly livestock grazing.

The Blue Springs area is 450 km north of Cedar City. Its elevation is about 1460 meters, the lowest of the study areas. The average temperature is -6 degrees C in January and 24 in July. The annual precipitation is the highest of the study areas, nearly 35 cm; and the annual snowfall is about 125 cm. The area consists of a series of rather steep rounded hills with narrow valleys between them. The soils are rather shallow and rocky. The valley bottoms are cultivated for dry-land wheat farming.

The Dubois area is 260 km north of Blue Springs. Its elevation is 1585 meters. Temperatures average -8 degrees C in January and 21 in July. The average annual precipitation is 25 cm, and annual snowfall is about 100 cm. The topography is a relatively flat plain with outcroppings of basaltic rock that rise five to 10 meters above the surrounding plain. Land use is chiefly grazing.

The center of the pygmy rabbit range in Montana is near Bannack in Beaverhead County, 210 km north of Dubois, Idaho. Elevations of the areas inhabited by pygmy rabbits vary from 1700 to 2000 meters. The Beaverhead area is relatively cold and dry. Temperatures average about -7 degrees C in January and 17 in July. Annual average precipitation is 30 cm, and annual snowfall is about 130 cm. The topography is characterized by fairly wide stream bottoms

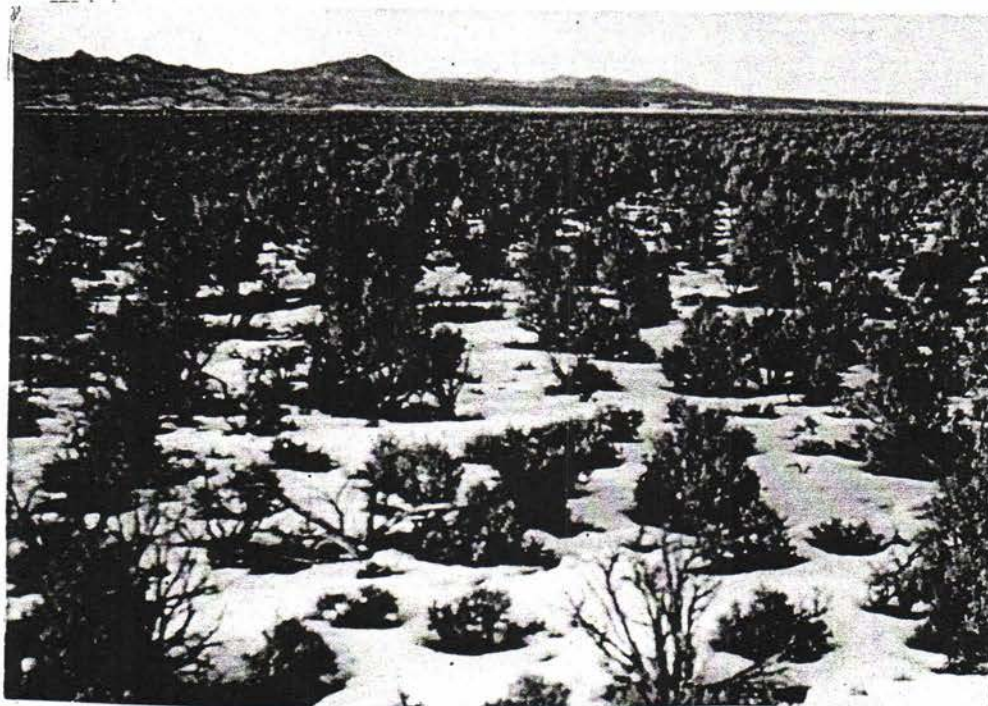


Figure 5 (top). Pygmy rabbit habitat near Cedar City, Utah, December, 1938.

Figure 6 (bottom). Pygmy rabbit and white-tailed jackrabbit in Blue Springs Hills habitat, Box Elder County, Utah, January, 1940.

between high mountain ranges. The valley bottoms are extensively used for irrigated pasture and hay production, while uplands are grazed by livestock. Preferred pygmy rabbit habitat is on alluvial fans and benches with adequate sagebrush cover and soft soils.

### Habitat

The pygmy rabbit is more dependent on sagebrush than are other rabbit species. Big sagebrush (Artemisia tridentata) on a deep, soft soil, seems to be its favored environment, although rocky areas may be used if adequate sagebrush and burrows dug by other animals are present. Crevices and holes among boulders in lava outcroppings are used in some areas. Other shrubs, often mixed with sagebrush in small quantities, are big rabbitbrush (Chrysothamnus nauseosus), little rabbitbrush (C. viscidiflorus), greasewood (Sarcobatus vermiculatus), spineless horsebrush (Tetradymia canescens) and prickly pear cactus (Opuntia sp.). Grasses and forbs were present in small amounts, and Russian thistle (Salsola pestifer) was common in all areas except the Beaverhead.

Other mammals significant in all areas as predators, competitors or buffer species were coyote (Canis latrans), long-tailed weasel (Mustela frenata), badger (Taxidea taxus), ground squirrels (Spermophilus spp.), least chipmunk (Tamias minimus), deer mouse (Peromyscus maniculatus) and other leporids. Characteristic birds observed in all areas, significant as predators or habitat indicators, were ferruginous hawk (Buteo regalis), rough-legged hawk (Buteo lagopus), red-tailed hawk (Buteo jamaicensis), golden eagle (Aquila chrysaetos), great horned owl (Bubo virginianus), raven (Corvus corax) and sage thrasher (Oreoscoptes montanus). Sage grouse (Centrocercus urophasianus) were present on all areas but Cedar City.

### Cedar City Area:

Each area also displayed some habitat differences. The Cedar City area (Figure 5) had more salt tolerant plants such as shadscale (Atriplex confertifolia) and alkali sacaton (Sporobolus airoides). The deep, soft soil allowed the rabbits to dig rather extensive burrow systems, sometimes on slight mounds having higher sagebrush than on the surrounding ground. The genesis of these mounds poses an interesting question: Did the rabbits select them as burrow sites because of the slight elevation and taller sagebrush, or have the mounds been raised by the activities of many generations of pygmy rabbits and other burrowing animals? Some rabbits were also found inhabiting burrows dug into a vertical bank above the east shore of Quichapa Lake.

Other mammals characteristic of the area were Townsend ground squirrel (*Spermophilus townsendii*), Ord kangaroo rat (*Dipodomys ordii*), black-tailed jackrabbit (*Lepus californicus*), mountain cottontail (*Sylvilagus nuttallii*) and the desert cottontail (*S. audubonii*). Birds observed, besides those common to all areas, were: turkey vulture (*Cathartes aura*), Swainson's hawk (*Buteo swainsoni*), prairie falcon (*Falco mexicanus*), American kestrel (*Falco sparverius*), burrowing owl (*Athene cunicularia*), Say's phoebe (*Sayornis saya*) and loggerhead shrike (*Lanius ludovicianus*).

#### **Blue Springs Hills:**

In the Blue Springs Hills (Figure 6), the pygmy rabbits live in a moister environment. The narrow valley bottoms are used extensively for dry-land wheat farming. As a result, most of the sagebrush is cleared from the valley bottoms. In the patches that remained, chiefly on the bases and sides of the hills, pygmy rabbits were quite abundant. Here they used old badger holes frequently, although holes dug by the rabbits themselves were also common. Vegetation other than sagebrush, especially grasses and forbs, grows quite abundantly in this area, but the pygmy rabbits were not found outside the patches of sagebrush. Other common plants were spineless horsebrush, bitterbrush (*Purshia tridentata*), snakeweed (*Gutierrezia sarothrae*), Giant wild rye (*Elymus condensatus*), smooth wheat grass (*Agropyron inerme*) and amaranth (*Amaranthus* sp.). On the cool, north slopes of the hills, there were a few patches of snowberry (*Symphoricarpos rotundifolius*) and chokecherry (*Prunus melanocarpa*) used as nesting sites by ferruginous hawks.

Mammals seen, in addition to those found in all areas, were: yellow-bellied marmot (*Marmota flaviventris*), Uinta ground squirrel (*Spermophilus armatus*), montane meadow mouse (*Microtus montanus*), porcupine (*Erethizon dorsatum*), White-tailed jackrabbit (*Lepus townsendii*), Black-tailed jackrabbit (*Lepus californicus*) and mountain cottontail (*Sylvilagus nuttallii*). Birds observed in winter and spring, besides those common to all areas, were: ring-necked pheasant (*Phasianus colchicus*), sage grouse (*Centrocercus urophasianus*) and sharp-tailed grouse (*Tympanuchus phasianellus*).

#### **Dubois Area:**

In the Dubois area (Figure 7), a portion of the Snake River Plain, some pygmy rabbits dug burrows in soft soil, but the majority were found at the bases of small knolls and ridges of lava rocks which rise about five meters above the surrounding plain. The rabbits made their holes



Figure 7. Pygmy rabbit habitat near Dubois, Idaho; March 1940.



Figure 8. Pygmy rabbit burrow under lava rocks, Dubois area, Idaho March, 1940. (note pygmy rabbit at lower right).

under the lava boulders, or in crevices between them, and fed among the surrounding sagebrush. Many rabbits were also found around abandoned farm buildings where their holes were in old cellars and foundation or under the floors of the houses. Large rock piles, too, were often inhabited by the rabbits.

Shrubs in the Dubois area, in addition to big sagebrush, were three-parted sagebrush (A. tripartita), little sagebrush (A. nova) and spineless horsebrush. Grasses noted in the early spring were Indian rice grass (Oryzopsis hymenoides) and spiked wheat grass (Agropyron spicatum). On the U.S Sheep Experiment Station, a few kilometers to the northeast, bitterbrush is common (Green 1978). He reported a vegetative composition of 19 percent bitterbrush, 19 percent big sagebrush, and six percent three-parted sagebrush. As in other areas, pygmy rabbits showed a preference for areas with higher average brush heights, 56 cm in areas with burrows, compared to 25 cm in unoccupied areas. Common grasses were Agropyron dasystachum, Poa nevadensis, other bluegrasses and Stipa comata. During my early spring studies, forbs were not in evidence, but common ones listed by Green (1978) were yarrow Achillea millifolia, balsamroot (Balsamorhiza sagitata), buckwheat (Eriogonum spp.), lupine (Lupinus caudatus) and Phlox spp.

Among mammals noted here were: spotted skunk (Spilogale gracilis), Townsend ground squirrel and desert wood rat, (Neotoma desertorum). The presence of these desert species indicated a dryer climate on my study area than on the Sheep Experiment Station, as did the absence of bitterbrush, Uinta ground squirrels and marmots which were reported by Green on the Sheep Station. Other leporids present on the study area were black-tailed jackrabbits and mountain cottontails. Representative birds seen in this area included the sage grouse and Swainson's hawk.

#### **Beaverhead Area:**

In Montana (Figs. 9 & 10), pygmy rabbits occupy areas of varied topography including alluvial fans, floodplains, plateaus, high mountain valleys and mountain slopes, but the preferred habitat is on gently sloping or level floodplains with adequate sagebrush and soils. (Rauscher, 1997). However, in the areas visited, I found that drainage bottoms with the deepest soils and tallest sagebrush (2 to 3 meters high) seemed to be avoided as burrow sites, while the higher ground with shorter sage on the edges of these areas, and on adjacent slopes, was preferred.

Perhaps this is an adaptation against the burrows being flooded during high run-off. Also, sagebrush leaves for food are less available to the rabbits in the stands of tall sagebrush. Patches and stringers of sagebrush in otherwise open areas are often important as burrow sites and movement corridors. In extensive areas of relatively low sagebrush, patches of higher sagebrush seem to be preferred as burrow sites. I often located burrows by visiting the low mounds with higher sagebrush. Rauscher (1997) reported a mean sagebrush height of 37.3 cm in burrow sites. However, there are local exceptions. On good habitat in upper Medicine Lodge Creek, sagebrush height of one meter was estimated at burrow sites, compared to one-half meter on surrounding ground.

Throughout the pygmy rabbit range in Montana, big sagebrush is the dominant plant, comprising about 22 percent of the canopy cover (Rauscher, 1997). Both species of rabbitbrush and spineless horsebrush are present in small amounts (3 percent). Grasses are relatively abundant (25 percent) and there are small amounts of forbs (6 percent).

Mountain cottontails and white-tailed jackrabbits commonly occur in the Beaverhead area. The cottontails use burrows, and may share them with pygmy rabbits. There is little, if any interaction between the jackrabbits and pygmy rabbits (Rauscher, 1997). The black-tailed jackrabbit has been recorded from several locations in the area, but is rare at present. It was not recorded by early observers, but was reported to be abundant in 1935-36 by W.L. Jellison (Hoffman, et al. 1969).

Badgers and Richardson ground squirrels (*Spermophilus richardsonii*) have an impact on the habitat because of their burrows. Both are able to dig in rocky soil, while the pygmy rabbit usually does not. Ground squirrel burrows are too small for rabbits, but many are dug up by badgers, thus making them large enough for the rabbits to use. Droppings of both ground squirrels and pygmy rabbits were found on some new badger mounds, indicating use by both animals. (Pygmy rabbit droppings can be distinguished from those of mountain cottontails by their smaller size).

An interesting feature of the montane valleys inhabited by pygmy rabbits in Montana is their seasonal use by other wild animals. Concentrations of winter droppings indicated heavy use of these areas for winter range by elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), white-tailed jackrabbits, and sage grouse. Antelope (*Antilocapra americana*) are present year-long



Figure 9. Pygmy rabbit habitat in Muddy Creek valley, Big Sheep Creek drainage, Beaverhead County, Montana, June, 2001.

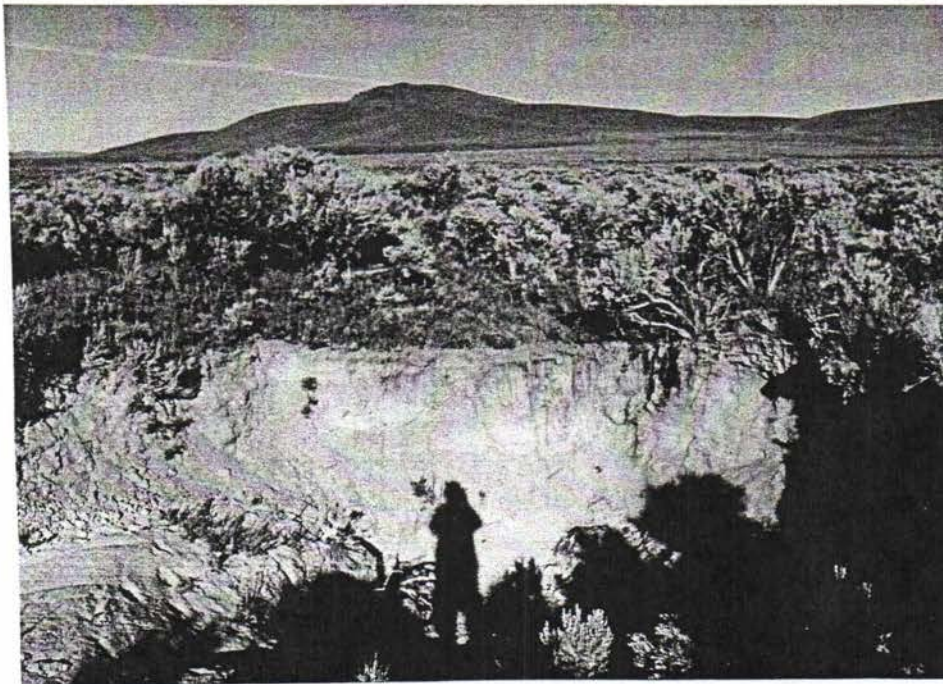


Figure 10. Soil profile in Badger Gulch, SW of Bannack, Beaverhead County, Montana, showing deep, soft soil like that at many burrow sites.

but tend to concentrate on lower sagebrush areas in the winter. As most of these animals eat sagebrush in the winter, they may compete with pygmy rabbits for food.

### Burrows

Where pygmy rabbits inhabit areas of deep, soft soil, they may dig extensive burrow systems which are used year after year. The rabbits excavate their own burrows (Figure 11) but freshly-dug ones are scarce, because there are usually enough old burrows to meet the needs of the population. They seem to be able to dig quite rapidly. Two new holes in the Cedar City area, 1.8 and 2.4 meters in length, had apparently been dug in a short time as indicated by the still moist ejected earth. The burrow systems are seemingly enlarged little by little with generations of use. From time to time, earth and debris are ejected from the tunnels, and new entrances added. Near Cedar City, most of the burrowing activity was noticed on mild winter and spring days. Where winters are more severe, most burrowing is done in the spring.

A typical burrow system in the Cedar City area (Figure 12) had multiple entrances, usually four or five and sometimes as many as 10. In more northerly areas there seemed to be a tendency toward fewer entrances. Wilde (1978) found that burrow entrances on the INEL Site in Idaho ranged from one to seven, with two being the most common. In Montana they averaged 2.25 per burrow system and ranged from one to five (Rauscher 1997). The entrances are usually fairly close together, being all contained in a diameter of from 3 to 5 meters. The burrow diameter varies between 100 and 130 mm, unless enlarged by badgers. Most of the burrows excavated by the author were quite shallow, the deepest being not more than about one meter below the surface, while the majority were from 50 to 75 cm. In addition to the main burrows, there were many short, shallow ones with only one or two entrances. These seemed to be used chiefly as emergency escape shelters. The tunnels in each burrow system were usually connected, but there were also some "blind alleys". It seems that these would be death traps in case of weasel attacks, but just the opposite may be the case. Weasels kill prey by biting the back of the skull (Leopold 1937), or by biting the neck or strangulation (Rauscher 1997). Rauscher suggested that when the rabbit is at the end of a tunnel, only the rear end is exposed, thus frustrating the weasel. This strategy would not work with badgers which frequently dig up rabbit burrows. To thwart badgers, the pygmies may avoid blind alleys, and escape through another entrance.

Burrows were apparently occupied by only one adult rabbit at a time, except during the breeding season. However, when alarmed, as many as three sought refuge in the same burrow. Rauscher (1997) found that the same rabbit may use several different burrows. During the breeding season (late winter and spring), pairs of rabbits were seen occupying the same burrow. Two of these pairs were collected, and in each case they were male and female.

The burrows are sometimes used by other small animals. Near Cedar City, I excavated a small tunnel branching from the main burrow. At its end, there was the nest of a kangaroo rat and the remains of its occupant which had been eaten by a weasel. On two occasions a weasel was captured in a rabbit burrow which the weasel had apparently used for shelter, as well as pursuit of rabbits. In the same area, two sagebrush lizards (*Sceloporus graciosus*) were found in a burrow about 15 cm under ground in early March. They were in a dormant condition, but when placed in the sunshine, they soon became active.

In the Blue Springs Hills, the same holes were often used by Uinta ground squirrels and pygmy rabbits. Old badger holes were also used by the rabbits. Mountain cottontails were common in the area and probably made use of the same burrows.

Near Dubois, Idaho, the pygmy rabbits often made their holes between, or under, lava boulders (Figure 8) and in old house foundations. In this area they did not burrow much as they were well-protected by the rocks which also made burrowing more difficult. Wilde (1978) noted a tendency for the rabbits to locate their burrows on the lee side of hills and lava outcrops where prevailing winds deposit more soil and snow. In these locations, the sagebrush is higher and the soil is deeper. Green and Flinders (1980a) reported that the rabbits also use badger and marmot burrows. Bradfield (1975) reported extensive use of subnivian tunnels to reach sagebrush food plants.

In Beaverhead County, Montana, the same burrows are sometimes used by pygmy rabbits, and mountain cottontails (Rauscher 1997). The pygmy rabbits also make use of holes dug initially by Richardson ground squirrels, and later enlarged by badgers (personal observation). During periods of deep snow, pygmy rabbits dig subnivian tunnels from their burrows to sagebrush food plants (Green and Flinders 1980a, Rauscher 1997). Sometimes these tunnels form networks under the snow and shelter the rabbits from avian predators and extreme weather (Katzner 1994).

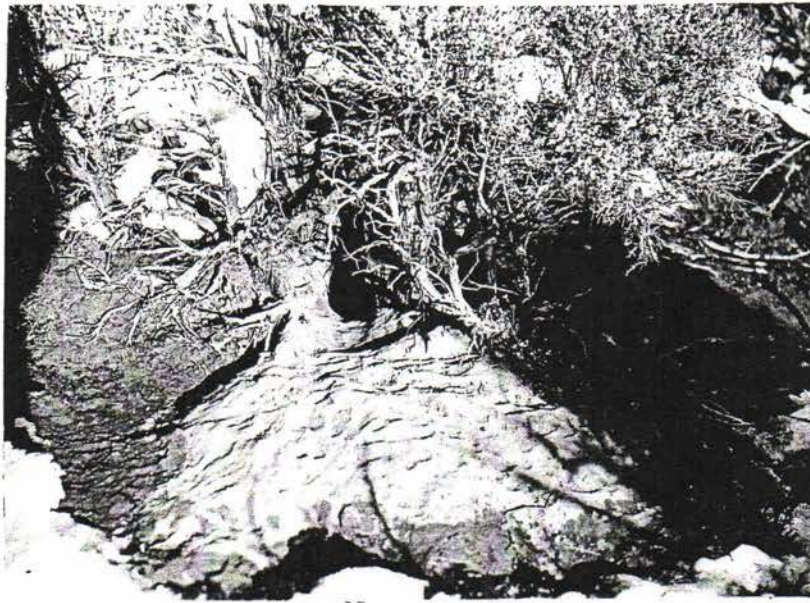


Figure 11. Pygmy rabbit burrow in Cedar City area, December, 1938.

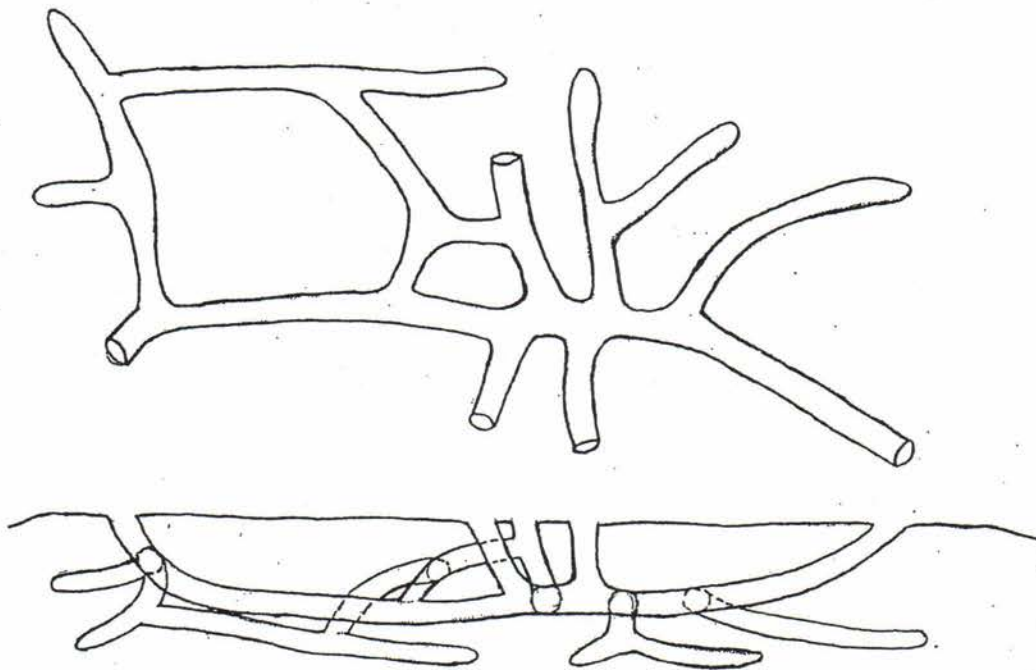


Figure 12. Plan and profile of an extensive pygmy rabbit burrow excavated in the Cedar City area. Scale 1:26.

No rabbit nests nor new-born young were found in the burrows excavated by the author. Other researchers also found no trace of nests or new-born young in burrows (Bradfield 1975) and doubted that they are used as birthing places (Wilde 1978). However, the Washington Department of Fish and Wildlife captive breeding program revealed that the young are born in a burrow in a nest of grass built by the mother (David Hays, personal communication).

### Food Habits

The food of the pygmy rabbit is primarily sagebrush leaves, except in the spring, when grasses are important. Examination of 32 stomachs from all areas, except the Beaverhead, revealed sagebrush leaves in 29. Three-parted sagebrush occurred in five of 11 from the Dubois area. Dry grasses occurred in three of the 32 stomachs, green grass in 10, and green forbs in four. The green grass occurred in all of 10 spring stomachs, and made up the bulk of the contents. Sagebrush was the main item in all 15 of the winter stomachs.

Supplementary observations of food habits were made by following tracks in the snow, and recording plants eaten. Plants clipped by rabbits near dens were also noted. These data confirmed that big sagebrush, or three-parted sagebrush near Dubois, were the plants most-heavily used. Leaves and twigs up to 7 mm in diameter were consumed. Other winter food plants included big rabbitbrush, little rabbitbrush, spineless horsebrush, smooth wheat grass, giant wild rye, and small amounts of Russian thistle and amaranth.

Green's study (1978) on the Sheep Experiment Station gave further evidence of the pygmy rabbits' reliance on sage brush for food. Fecal pellet analysis showed that sagebrush comprised up to 99 percent of their food in winter and 51 percent in summer. In spite of the fact that the quantity of bitterbrush nearly equaled big sagebrush, it made up less than two percent of the diet. Grasses made up 39 percent of their summer diet, and forbs, 10 percent. Wheatgrasses (*Agropyron* spp.) and Nevada blue grass (*Poa nevadensis*) were preferred food items. Green also found that the rabbits preferred grasses to forbs, and this selective use reduced grass cover and favored the increase of forbs in areas of pygmy abundance.

The switch to green vegetation in the spring tends to conserve sagebrush for winter food and is important for reproduction (Wilde, 1978). He concluded that green vegetation is the key to readiness for breeding in female pygmy rabbits. The author's observations indicated that they produce at least two litters during the time that grasses and forbs are the most succulent, and then

they cease to breed in the summer as the vegetation dries up. Second litters, conceived during the height of vegetative abundance, tended to have a greater number of young than first litters.

Captive rabbits ate almost anything they were given, including sagebrush, rabbitbrush, shadscale, greasewood, *Suaeda* sp., amaranth, orchard grass (*Dactylis glomerata*), downy brome (*Bromus tectorum*), common mallow (*Malva rotundifolia*), shepherd's purse (*Capsella bursa-pastoris*), and sweet clover (*Melilotus alba*). The following items were eaten with the greatest relish: alfalfa (*Medicago sativa*), dandelions (*Taraxacum officinale*), prickly lettuce (*Lactuca scariola*), garden lettuce, cabbage, carrots, and apples.

The rabbits do not seem to require free water. Their burrows are often located miles from the nearest water, and rainstorms are too infrequent to be dependable sources. Because of the normally low relative humidity, dew is not often available. When water was available in Quichapa Lake, it was less than 50 meters from inhabited pygmy rabbit burrows, yet no tracks were found in the mud between the burrows and the water. Captive rabbits appeared to thrive without water. Green vegetation apparently supplies their summer water requirements. In the winter, they have been observed to eat snow (Katzner, 1994).

### Behavior

Pygmy rabbits are both nocturnal and diurnal. They spend much of the day lying in forms in the shade of sagebushes near their burrows, and feeding at intervals. In the Blue Springs Hills, they were observed feeding on sagebrush at mid-day, and in all areas but the Beaverhead, the rabbits were commonly seen outside their burrows during the day. Evidence of nocturnal activity was furnished by numerous fresh tracks in snowfalls of the preceding evening, and by two pygmy rabbits found killed by great horned owls. Katzner (1994) found them to be active at any time of the day in the winter, but they spent the majority of the time resting in sheltered locations, i.e., forms under bushes, subnivian tunnels and subterranean burrows.

### Gait:

A characteristic of the pygmy rabbit is its low, scampering gait, in contrast to the longer, higher jumps of other rabbits. Their top running speed seems to be about 24 km per hour. They tire easily, and a few, found away from their holes, were chased on foot and caught. After a run of about 100 meters the rabbit was exhausted, and would sometimes stop and allow the pursuer to pick it up.

### Climbing:

Bailey (1936) reported that pygmy rabbits in Oregon occasionally climb into the tops of sage bushes to feed. Near Cedar City, I saw one jump from a bush at a height of 38 cm from the ground. Clipped twigs in the top of higher bushes indicated that they sometimes climb higher. Katzner (1994) reported them often climbing into bushes to feed. In some areas, standing on deep, packed snow enabled them to reach higher in the bushes to feed (Rauscher, 1997).

### Voice:

Like other rabbits, the pygmy has a loud, quavering squeal when captured. This is termed a distress call by Green (1978). In addition, it sometimes utters an alarm call somewhat resembling that of a pika (*Ochotona*), but much fainter. When pursued closely it often utters a faint squeak. Bailey (1936) noted that an adult pygmy uttered a scolding "quer, quer" as it tried to drive a smaller rabbit from its burrow. I heard a similar sound uttered by an adult pygmy rabbit as it drove a young black-tailed jackrabbit from its burrow. Near Dubois, several times during the night, a captive male uttered a series of chirping sounds which started rather high-pitched and ended on a lower note. They were similar to rock squirrel (*Spermophilus variegatus*) calls but not as loud and not as much of a whistle. Green (1978) postulated that the use of alarm calls may serve to alert other rabbits to danger, and thus indicate a higher degree of social organization than has been supposed.

### Tolerance:

Pygmy rabbits are sometimes very trusting. On each of several occasions a rabbit allowed me to approach within two meters as it sat at the mouth of a burrow. When approached slowly, it would run from the mouth of one burrow to another, repeatedly, before finally entering a burrow.

They are apparently somewhat territorial, at least in defense of their burrows. Most burrows that were dug out contained only one adult rabbit, except when others used them for escape, or during the breeding season. Some males that were collected had scars on their sides, indicating fighting with each other. On one occasion, in the Cedar City area, a half-grown black-tailed jackrabbit was observed to run into a burrow, and was immediately driven out by the pygmy rabbit occupant. Upon seeing me, the jackrabbit ran back into the hole, and sounds of growling and scuffling ensued until I dug them out. The pygmy was an adult male. The burrow also

contained a young pygmy, and in a separate branch, another adult male. Perhaps adults tolerate young pygmies in the same burrow, and even other adults if they are in separate tunnels.

In the Blue Springs Hills during January and February of 1940, soft snow provided an indicator of rabbit movements. In each of several holes, one rabbit appeared to be the sole occupant. This was tested by shooting a rabbit at each of three burrows on January 22, and returning to the area two weeks later. On the return trip, there was no evidence rabbits had been using any of the three burrows. By February 18, one of the burrows had been reoccupied, and by March 3, all of the burrows were being used.

Captive adult rabbits are very intolerant of each other in the same pen. At Cedar City, a nearly-adult male and an adult female were put in the same pen overnight. During the night, the female killed the male, ripping most of the skin from one side. The male had smeared blood around the pen while attempting to escape. The female was not injured, indicating the male had not fought back. Later, an adult female was placed in the pen with the same rabbit that had killed the male. The occupant immediately attacked the new-comer, biting and kicking with the hind legs, until they were separated. In the Dubois area a male and a female were put together, and then two females, but in both cases they fought so viciously that they had to be separated. On another occasion, an adult male pygmy rabbit was kept in the same pen with six young cottontails and one young pygmy for several weeks during late April and May. The adult pygmy made no attempt to harm the young ones, even though one of the cottontails occasionally nipped a mouthful of hair from him. One day the rabbits were not fed, and the adult pygmy began to chew the ears of the young rabbits. About half the length of several ears were consumed before the rabbits were fed dandelions and grass, whereupon the adult pygmy abandoned his carnivorous pursuits. The rabbits do not struggle much while being handled, and do not attempt to bite the handler.

#### **Home Range:**

The studies indicated that home range is very small. In the Blue Springs Hills, in January and February, tracks showed a radius of activity of only about 30 meters from the burrows. Burrows within 50 meters of each other were commonly connected by trails. Home ranges often overlap and some rabbits have more than one use area (Katzner 1994). Green (1978) citing studies by Wilde, et al. (1975) reported a radioed female that stayed within 20 meters of its burrow during

the winter. However, they also recorded a female moving 300 meters, and two males moving 200 and 500 meters. Rauscher (1997) reported fecal pellets at the base of a sagebrush 200 meters from the nearest burrow. Green (1978) relates a homing incident in which a young female escaped from captivity and returned 2.5 km to within 200 meters of where it was originally captured. Katzner (1994) monitored a male which moved 3.5 km in three days. Gahr (1993) reported travels of up to 1.2 km. In most cases, the longest movements were made by males seeking mates.

During severe winters the home range is sometimes restricted to islands of tall sagebrush standing above the surrounding snow-covered lower brush (Katzner, 1994). However, the use of subnivalian tunnels enables the rabbits to reach some distant sagebrush food plants. In the spring, with melting snow and the onset of the breeding season, the radius of activity increases considerably.

### Reproduction

#### Organic readiness:

Male reproductive readiness appears to be linked to lengthening daylight hours following the winter solstice (photoperiod), while female readiness is affected more by vegetative condition (Wilde 1978). During late December, the testes begin to enlarge and descend into the scrotum. On the INEL Site in Idaho, Wilde found testis descent completed by late January. By late February, testes reached an average length of 43 mm. He found that all females had copulated by March 19 in 1976 and March 7 in 1977. The first evidence of lactation was on April 4 in 1975, March 5, 1976 and February 20, 1977. These dates indicate earlier breeding than I found in the Dubois area in 1940, and dates of female breeding apparently fluctuated from year to year because of varying weather conditions. Wilde noted that 1977 was a drought year and vegetation green-up was earlier than in the two prior years.

A male with descended, enlarged testes (25 x 12mm) was collected on December 30, 1939, in the Cedar City area. However in other males collected at that time, the testes were small and abdominal. In females, the uteri were small and not convoluted, and the ovary sizes averaged 8 x 2 mm. A pregnant female was collected February 24, 1940.

In the Blue Springs Hills on January 22, 1940, a male with descended testes which measured 27 x 12 mm was collected. The ovaries and uterus of a female taken the same day had

not begun to enlarge. In females taken on March 4, the the uteri were much enlarged and folded, while the ovaries measured 10 x 3 mm. Two taken on this date contained small embryos within uterine swellings 7 mm in diameter.

A male collected from the Dubois area February 19, 1940, had enlarged testes (30 x 13 mm), but no females were collected until March 6. On this date, one was obtained in which the uterus was much enlarged and convoluted but contained no visible embryos. Likewise, females of March 17 were not yet pregnant. The first pregnant rabbit in the Dubois area was obtained on April 5. It contained five small embryos within uterine swellings 15 mm in diameter. Three females, collected April 13, were all pregnant with the first litter of the year. Three females collected on April 26 were all pregnant with their second litter.

In males, the testes and prostate gland showed a steady increase in size through the winter and spring. The maximum size was reached in March and April, when the testes attained a size of 45 x 20 mm, and the prostate gland measured 27 x 16 mm. (Figure 13). In females, the greatest size of ovaries, and of course, uteri, is attained during pregnancy. At this time, the ovaries measured about 15 x 6 mm. Females lag behind males which are physiologically ready to breed before the females.

The mammae number 10, five on each side. Two pair are pectoral, two pair abdominal and one pair inguinal. These are connected on two long mammary glands which meet on the median line when fully developed. They were measured on one lactating specimen, and each gland was 194 mm long x 37 mm wide x 3 mm thick.

#### **Mating And Litters:**

The mating season appears to be the only time that adult rabbits associate very closely. At this time, pairs were often seen feeding or sitting near burrows together, and taking refuge in the same burrow. This association probably continues only until after impregnation, and then the males are driven away. This was indicated by the observation that females containing embryos were alone when collected. Soon after the birth of the young, the females are receptive again, and mating occurs for the second litter. At times, the rabbits may associate in family groups. Near Dubois on April 26, two adults and what appeared to be their four young were seen sunning themselves on a small basaltic dome of rock. Upon becoming alarmed, they all ran into a hole under the rocks.

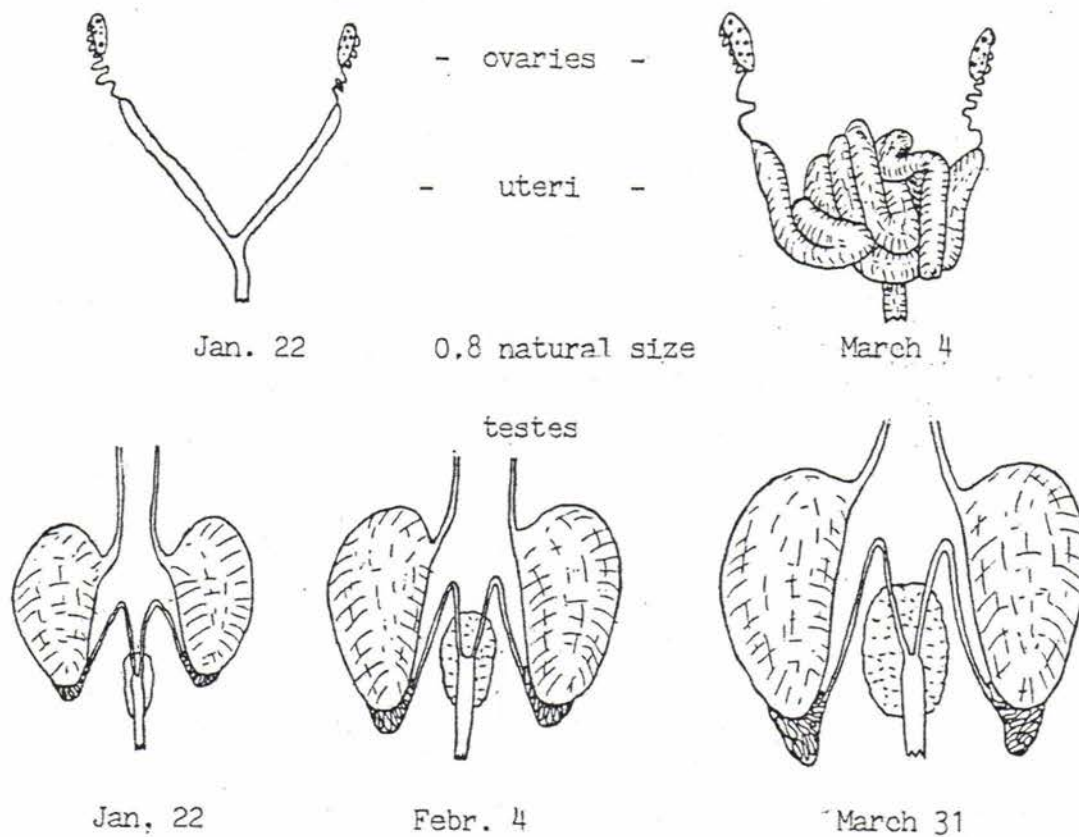


Figure 13. Reproductive organs of pygmy rabbits from Blue Springs Hills.



Figure 14. Adult pygmy rabbit with bot fly larva embedded under eye, Cedar City area, August, 1938.

The seasonal reproductive condition of females is shown in Table 2..

Table 2. Seasonal reproductive status of adult female pygmy rabbits

| Area & month                | Number examined | Barren | Gravid | Gravid & lactating | Percent pregnant | Number lactating | Litter No. |     |
|-----------------------------|-----------------|--------|--------|--------------------|------------------|------------------|------------|-----|
|                             |                 |        |        |                    |                  |                  | 1st        | 2nd |
| <u>Iron County, Utah</u>    |                 |        |        |                    |                  |                  |            |     |
| Febr.                       | 1               | 0      | 1      | 0                  | 100              | 0                | 1          | 0   |
| April                       | 2               | 2      | 0      | 0                  | 0                | 2                | 0          | 2   |
| Aug.                        | 3               | 3      | 0      | 0                  | 0                | 0                | 0          | 0   |
| Sept.                       | 3               | 3      | 0      | 0                  | 0                | 0                | 0          | 0   |
| <u>Box Elder County</u>     |                 |        |        |                    |                  |                  |            |     |
| Jan.                        | 2               | 2      | 0      | 0                  | 0                | 0                | 0          | 0   |
| March                       | 10              | 2      | 6      | 2                  | 80               | 0                | 6          | 2   |
| April                       | 6               | 0      | 0      | 2                  | 33               | 4                | 0          | 6   |
| <u>Clark County, Idaho</u>  |                 |        |        |                    |                  |                  |            |     |
| March                       | 3               | 3      | 0      | 0                  | 0                | 0                | 0          | 0   |
| April                       | 7               | 0      | 4      | 3                  | 100              | 0                | 4          | 3   |
| <u>Beaverhead, Montana*</u> |                 |        |        |                    |                  |                  |            |     |
| April                       | 1               | -      | 1?     | 0                  | ?                | 0                | 1?         | 0   |
| May                         | 11              | 0      | 3      | 7                  | 91               | 1                | 3          | 8   |
| June                        | 5               | 0      | 0      | 2                  | 40               | 3                | 0          | 5   |
| July                        | 6               | 5      | 0      | 0                  | 0                | 1?               | 0          | 1?  |
| Aug.                        | 4               | 3      | 0      | 0                  | 0                | 1                | 0          | 1?  |

\* Raw data from Rauscher, 1997

These data indicate that breeding is limited to late winter and spring.

Information concerning pre-natal litters is shown in Table 3. At least two litters per year were born. Wilde (1978) reported that three litters were born on the INEL site, and even though time and conditions permitted, additional litters were not produced. I found that first litters were somewhat smaller than second litters, averaging 5.7 fetuses per litter. Second litters averaged 7.1 fetuses. This agrees with findings for black-tailed jackrabbits in northern Utah, whose first litters were considerably smaller than second litters. This is probably an adaptation to lower availability of nutritious food during the early part of the breeding season (Janson, 1946).

Breeding occurred earlier in the southern part of the range than in the northern part. First litter breeding dates were: Cedar City, early to mid-February; Blue Springs Hills, early March; Dubois, mid to late March and Montana, April and May. The gestation period for the pygmy



In Montana, the breeding season is apparently somewhat later, in keeping with the higher latitude and later advent of spring weather. Rauscher (1997) reported a female (trap mortality) carrying seven fetuses on May 16, and a juvenile believed to be 10-14 days old was observed in late May. Another trap mortality on May 8 showed placental scars from an earlier litter. The last female to show signs of nursing was captured on June 19. A male I examined, in the University of Montana Zoology Museum, (UMZ 16423), collected February 6, 1977, had enlarged testes (35x11mm) indicating near-readiness for breeding. Rauscher (1997) reports a male with receding testes captured on June 9, and one with abdominal testes on July 7, indicating termination of the breeding season. In Idaho, Wilde (1978) noted regressing testes in early June, and no males with descended testes after June 10. He found few lactating females after July 1.

No nests or newly-born young of the pygmy rabbit were discovered. Davis (1939) obtained a parturient female and reported that the young, at birth, measure about 72 mm in rump-crown length and are born without hair and with their eyes closed. Wilde (1978) speculated that the young are not born in burrows, but the female scatters them in separate locations above ground. However, breeding observations of captive rabbits at the Oregon Zoo in 2001 and 2002, showed that the young are born naked in a nest of dry grass constructed by the female in a tunnel branching from the main burrow, or more commonly, in a separate burrow; and that the young leave the nest about 14 days after birth (David Hays, personal communication).

### Population Density

In areas of favorable habitat, pygmy rabbits may be quite numerous. On September 10, 1941, an area lying about 5 km southwest of Hamilton's Fort, Iron County, Utah, on which pygmy rabbit burrows were seen, was selected for census. This area measured approximately 182 meters on each of four sides, and contained 3.31 hectares. No rabbits were seen during an ordinary walk through the area. Then, by walking back and forth through the area on strips 18 meters apart, I saw six pygmy rabbits and 14 burrow systems. On the basis of rabbits seen, this was a density of 1.8 rabbits per hectare. Assuming that some were in burrows, and that there was an average of one rabbit per burrow system (a reasonable assumption based on excavation of burrows), there was a density of 4.2 rabbits per hectare. On another favorable area, along the

east side of Quichapa Lake, seven pygmy rabbits were counted in an hour using the strip count method. The estimated density was 8.6 rabbits per hectare.

Population density estimates in other states range from 0.22 rabbits per hectare in Washington (Gahr, 1993) to an unusually high density of 45 per hectare on ideal habitat in Idaho (Green, 1978).

Rauscher (1997) reported a density of 3.03 rabbits per hectare in good habitat in Montana during the summer of 1996. In June of 2001, I spent four days walking through some of this same habitat and saw no pygmy rabbits and very little recent sign. Old burrows and pellets were numerous. It was my impression that the population had experienced a considerable decline.

### **Mortality**

#### **Predation**

Weasels seem to be the principal predator of pygmy rabbits, being able to follow them into burrows. Four recent kills were found in the Cedar City area. In all cases, the dead rabbits were inside burrows, and were completely consumed except the feet, pieces of skin with fur, and contents of the digestive tract. After the kill, the weasel apparently stayed in the vicinity and revisited the corpse until it was entirely eaten. Usually, an accumulation of weasel dung was found near the remains. In one burrow, where the remains of two rabbits were found, the weasel had used the rabbits' fur to make a nest in a chamber of the burrow. It had apparently occupied the nest for some time, for the fur was packed so as to resemble felt. In another chamber, about a meter distant from the nest, there was an accumulation of about a liter of weasel dung. Many old remains of rabbits were found in other burrows excavated, and were commonly seen in the debris and earth ejected by the rabbits in cleaning out their burrows. A pygmy rabbit found in the Blue Springs Hills had been killed out in the open by a weasel and dragged about 200 meters to a burrow before being partially eaten. Wilde (1978), Katzner (1994) and Rauscher (1997) also named the weasel as a major predator. I found one coyote kill near the mouth of a burrow. Everything, including most of the hair, had been eaten or carried away. Data from Gaufin (1939), show pygmy rabbit remains in eight percent of coyote scats from the Dubois area (Table 4). Wilde (1978) found that up to 20 percent of pygmy rabbit burrows were dug up by coyotes, thus contributing to mortality by reducing shelter. Badgers dig up many pygmy rabbit holes, but as the rabbits are able to escape through other entrances, the badgers probably have limited success

catching them. Great horned owls may be a major avian predator. Two rabbit kills were found in the nests of the owls. Gaufin's data also show pygmy rabbit remains in about 10 percent of regurgitated pellets of Swainson's hawk, golden eagle and prairie falcon, and in 23 percent of the pellets of short-eared owls (Asio flameus). Remains were also found in the pellets of Marsh hawk (Circus hudsonius), burrowing owl, and red-tailed hawk. Near Modena, Utah, I flushed a Cooper's hawk (Accipiter cooperii) from a fresh kill. Davis (1939) found pygmy rabbit remains in the crop of a long-eared owl (Asio otis). Wilde (1978) flushed a marsh hawk from a freshly-killed rabbit. Katzner (1994) suspected a golden eagle in the death of a radio-collared rabbit.

Table 4. Frequency of rabbit occurrence in coyote droppings and raptor pellets (from Gaufin, 1939)

| Predator        | Number of droppings or pellets | Number of samples containing |                      |            |
|-----------------|--------------------------------|------------------------------|----------------------|------------|
|                 |                                | pygmy rabbit                 | blacktail jackrabbit | cottontail |
| Coyote          | 365                            | 30                           | 107                  | 128        |
| Swainson's hawk | 293                            | 32                           | 19                   | 42         |
| Golden eagle    | 70                             | 8                            | 21                   | 25         |
| Prairie falcon  | 13                             | 3                            | 0                    | 0          |
| Short-eared owl | 60                             | 14                           | 11                   | 24         |
| Marsh hawk      | 31                             | 1                            | 0                    | 1          |
| Burrowing owl   | 16                             | 1                            | 0                    | 0          |
| Red-tailed hawk | 3                              | 1                            | 0                    | 1          |
| Undetermined    | 109                            | 21                           | 6                    | 11         |

#### Parasites And Disease:

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 of 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 in length and 15 mm in diameter. They then leave the rabbit and pupate in the ground. The holes in the rabbit's skin heal and the rabbit seems to suffer no ill effects. Figure 14 shows an infested rabbit.

Fleas of the species Cediopsylla inaequalis were present on all specimens at all seasons. On some rabbits they were so numerous that as they crawled through the hair, it moved with a

waving motion. Davis (1939) also reported this phenomenon. At times these fleas lined the edges of the ears so thickly that the skin could not be seen. Wilde (1978) found two other flea species, Odontopsyllus dentatus and Orchopeas sexdentatus on pygmy rabbits in Idaho. During the spring and summer in the Cedar City area, larvae of an orange-colored mite, Trombicula, attached themselves to the rabbits. On portions of the body where fur is sparse such as the scrotum, belly and lower parts of the legs, they were so abundant they often formed orange patches on the skin.

Several species of ticks were found infesting pygmy rabbits. These included Dermacentor parumapterus, found in summer attached to the ears or head and engorged with blood; Haemaphysalis leporis-palustris, found as small ticks crawling in the fur in late summer and winter; and Ornithodoros sp. (nymphs), found in the ears of rabbits from Idaho in March. Stanford (1934) found nymphs of Dermacentor andersoni on pygmy rabbits from Promontory, Utah in July, 1931.

No tapeworms, either larval or adult, were found in the specimens examined. However, the following nematodes were collected from the digestive tract: Dermatoxys veligera, a roundworm about one inch long found in small numbers in the large intestines; and Nematodirus, long, extremely slender nematodes found in tangled masses in the small intestines.

No obviously diseased pygmy rabbits were seen in the course of these studies. Hall (1945) states that they are subject to tularemia. I found some complete skeletons above ground in an undisturbed condition indicating death from causes other than predation. It is likely that disease may periodically reduce the rabbit populations when they reach a high density.

It has long been known that some leporids are subject to wide population fluctuations. This seems to be true of the pygmy rabbit also. The populations of the study areas in Utah apparently suffered a decline between 1941 and 1946. A relatively severe winter in 1945-46 may have contributed to higher mortality. Weiss and Verts (1983) reported a marked population decline in Oregon between 1981 and 1983.

#### **Habitat Change:**

Long-term changes in climate and vegetation are probably involved in slow downward trends of some populations. Lyman (1991) postulated that a gradual decline in the pygmy rabbit population in Washington is largely due to a long-term change in the climate since the end of the

ice ages which has been reducing the amount of sagebrush. Butler (1972) stated that the pygmy rabbit population on the eastern Snake River plains of Idaho was higher prior to 7000 years ago, and has declined due to reduced grass and sagebrush cover.

### **Livestock Grazing**

Most Pygmy rabbit habitat is grazed in varying degrees. Observers differ about the effects. Green (1978) found that pygmy rabbits prefer grass to forbs in the spring and summer, and thus can affect the relative abundance of each group by reducing grass cover and fostering the increase of forbs. Since sheep prefer forbs and cattle prefer grass there is more competition between pygmy rabbits and cattle than between the rabbits and sheep. By inference, summer sheep range should provide better habitat for pygmy rabbits than summer cattle range. Chilson (1996) stated that grazing may improve sagebrush stands, and thus benefit the rabbits. Gahr (1993) reported higher pygmy rabbit populations on ungrazed areas. Pygmy rabbits did not inhabit Fossil Butte National Monument in Wyoming until after grazing was terminated in 1983 (Katzner 1994).

No attempt was made to measure grazing intensity on the study areas, but general observation indicated a relative scarcity of grasses and forbs on the Cedar City area as compared to the Blue Springs area. However, the ease of collecting specimens and frequency of observing rabbits was at least as good in the Cedar City area. Thus, a difference in the proportion of shrubs to herbaceous vegetation between the two areas, whether related to grazing or other causes, did not seem to affect pygmy rabbit populations. It is likely that grazing heavy enough to break down the sagebrush plants and reduce their density would be detrimental to pygmy rabbits.

### **Man's Developments**

Human activities are having a profound effect on pygmy rabbit populations in some areas. The elimination of sagebrush by developments such as housing, farming and pasture has reduced the rabbit's habitat. On grazing land, much of it public, sagebrush has been eliminated on a large scale, and the land planted to crested wheat grass. This has benefited cattle growers but has had a disastrous effect on native animals, including the pygmy rabbit, which are dependent on sagebrush for food and shelter. In Utah, much of the best habitat is privately owned and thus more prone to development. Pritchett, et al. (1987) reported that the Sevier River valley between Kingston and the Otter Creek Reservoir has been much disturbed and that one of the last large

patches of sagebrush had just been plowed and harrowed. This area is on the postulated dispersal route of pygmy rabbits from Iron County to the high Awapa Plateau of Wayne County.

In October, 2001, a revisit to some areas of the 1938-1946 studies in Utah showed a marked loss of pygmy rabbit habitat during the intervening years. In the Blue Springs Hills of Box Elder County, the stringers of wheatland have been expanded so that sagebrush is almost gone. The possibility that pygmy rabbits still exist there appeared remote. The foothills area near Clarkston, Cache County, also had undergone increased farming activity which has nearly eliminated the sagebrush. It is doubtful that pygmy rabbits still exist in Cache County.

Areas on the northwest outskirts of Cedar City which formerly supported pygmy rabbits have been taken over by residential and commercial developments. In the Quichapa Lake area, subdivisions now occupy some of the area east of the lake, and agricultural development has eliminated sagebrush west and south of the lake. Only a few old signs of pygmy rabbits could be found in the remaining accessible habitat. The area just east of the south half of the lake, where the densest pygmy rabbit population in 1938-1941 occurred, did not appear to be altered, but no access was found in 2001. This tract may still support pygmy rabbits. In sagebrush areas open to public access, there were good populations of black-tailed jackrabbits and cottontails, and many spent shotgun shells. Since most hunters probably don't distinguish between pygmy rabbits and cottontails, it is probable that some pygmies are shot by hunters.

#### **Status of the Pygmy Rabbit**

There seems to be no question that pygmy rabbit populations in Utah are low in some areas of former abundance. No rabbits nor recent signs were seen during my brief 2001 reconnaissance in the Cedar City area. A Bureau of Land Management biologist stated that he had not seen a pygmy rabbit for 20 years. Personnel of the Cedar City office of the Utah Division of Wildlife Resources reported only one recent sighting.

Of the three states studied, Utah's pygmy rabbit population appears to be the most at risk. The pygmy rabbit is classed as a protected nongame species in the state, but there seems to be little that can be done to halt the degradation of its prime habitat. However, fragmented populations may continue to hang on in remote areas of suitable sagebrush habitat which are less subject to development, particularly on public lands.

In Idaho, the pygmy rabbit is a game species, and is hunted along with cottontails and snowshoe hares from September through February. It has been given Heritage Program ranks of G5 (globally secure) and S3 (locally abundant in a restricted range in the state). The Idaho Falls nongame biologist for the Idaho Department of Fish and Game assured me that the pygmy rabbit's population status in Idaho is satisfactory. Nonetheless, recent road trips through southern Idaho indicate that much of the habitat has been lost since my 1940 study.

Of all the states with pygmy rabbits, Washington seems to be in the most danger of losing its population, which is isolated in a small area in the southeast portion of the state. Much of the sagebrush has been lost to farming and pasture, and the pygmy rabbit is listed as endangered. (Washington Dept. of Fish and Wildlife, 1995). The state has embarked on a captive breeding program to ensure the survival of the species (Lewiston Morning Tribune, Sept. 27, 2001, Lewiston, Idaho).

The Montana habitat has probably been the least affected by development although in some areas sagebrush has been reduced by "range improvement" methods such as herbicide application and burning to such an extent that the rabbits are barely surviving (Rauscher, 1997).

In spite of these local habitat alterations, the pygmy rabbit population in Montana appears to be secure. The historical range, with a few small exceptions, is still occupied by the species, and the large areas of sagebrush-covered public land should continue to provide suitable habitat. The pygmy rabbit is considered a Species At Risk by the U.S. Fish and Wildlife Service, and a Species of Special Concern by the Montana Natural Heritage Program and the Montana Department of Fish, Wildlife and Parks. The MNHP status code is G4,S2S3, indicating that it is apparently secure in its global range, but imperiled in its state range. The state ranking may be overly cautious given the findings of the Rauscher report (1997). In Montana, this rabbit is an unprotected nongame species. There are no legal restrictions on taking it at any time except for commercial uses, which are not allowed.

The effects of habitat destruction appear to be reversible. In Montana, pygmy rabbits have recolonized an area on which the sagebrush was burned in 1980 (Rauscher 1997). Disturbed habitat in Washington was recolonized by pygmy rabbits after sagebrush became re-established (Washington Dept. of Fish and Wildlife, 1995). These findings provide hope for the future of the

pygmy rabbit on lands where habitat has not been irreversibly destroyed, and which are available for recolonization efforts

### SUMMARY AND CONCLUSIONS

The pygmy rabbit is widely, but intermittently, distributed in the Great Basin and adjacent areas. It occurs in eight western states and six major drainage systems

The author studied pygmy rabbits on two main study areas in Utah, one in Idaho, and secured data at additional sites, between 1938 and 1946. Limited observations were also made in Montana, and on a return visit to some Utah sites in 2001. Initial findings of the studies resulted in a 435 km southward extension of the known range in Utah.

This is the smallest North American rabbit. The average weight of 19 adult Utah and Idaho specimens was 419 grams, while the average length of 50 specimens was 284 mm. Females were 14 percent heavier and five percent longer than males. Females from Montana (live-trapped) were heavier than those from other areas.

Pygmy rabbits undergo just one annual molt which occurs during early July to late September, and is completed in about four weeks. The dates of molting vary, and are apparently affected by weather, latitude and altitude. The color and length of the pelage vary seasonally because of wear. Throughout its range, the species is remarkably constant in morphology and habits, and there are no subspecies.

Pygmy rabbits inhabit areas of varied topography, including valleys, hillsides, alluvial fans, plateaus and edges of lava flows, mostly between elevations of 1400 and 2000 meters.

The climate of these areas is characterized by cold winters and warm summers. Average January and July temperatures are -5 and 25 degrees C., but are colder in the north and warmer in the south. Precipitation is scanty, averaging about 30 cm. annually, being less in the northern areas. The average annual snowfall is about 100 cm. but it melts more rapidly in the south, and accumulates to greater depths in the north, depending on elevation.

Big sagebrush on deep, soft soils is the favored habitat, with taller, denser brush preferred for burrow sites. Small quantities of rabbitbrush, greasewood, spineless horsebrush, bitterbrush, grasses and forbs are usually present.

Associated mammals are coyote, weasel, badger, ground squirrels, least chipmunk, deer mouse, jackrabbits and cottontail rabbits. The species vary somewhat among the different areas. Birds characteristic of the habitat include ferruginous hawk, rough-legged hawk, Swainson's hawk, golden eagle, sage grouse, great horned owl, raven and sage thrasher. Most of these are present, at least seasonally, on pygmy rabbit range. Much of the Montana pygmy rabbit habitat is used by winter concentrations of elk, mule deer, antelope, white-tailed jackrabbits and sage grouse which may compete for food.

Pygmy rabbits dig their own burrows but often use old badger and marmot burrows. Some burrows are quite extensive and have several entrances. Entrance diameters vary between 100 and 133 mm, and burrow depths are commonly between 50 and 75 cm. The burrows are usually occupied by only one adult rabbit at a time except during the breeding season, when they may be used by pairs. The burrows are sometimes used by other small animals, and they are frequently dug up by badgers. Near Dubois, Idaho, pygmy rabbits often used holes between, or under lava boulders and in old house foundations. During deep snow periods, they dig subnivian tunnels for shelter and access to distant food bushes.

Sagebrush leaves are the major food item, especially during the winter, when they comprise nearly 100 percent of the diet. In the spring, green grass makes up the bulk of the food, and is important for reproduction. Pygmy rabbits eat a variety of other plants depending on palatability and availability. Alfalfa, dandelions, prickly lettuce, garden lettuce, cabbage, carrots and apples were relished by captive specimens. Free water is not required, although they eat snow in the winter.

Pygmy rabbits are active at any time of the day or night, and spend most of their time alternately feeding and resting. They run with a scampering gait and have a top speed of about 24 kilometers per hour. They tire quickly and can be run down by a person. They frequently climb into sagebushes to feed, stand on packed snow to reach higher leaves and tunnel through deep snow to reach distant food sources.

They are quite vocal, having a loud squeal of distress when caught, an alarm call similar to a pika's call, a squeak when pursued, a scolding growl while repelling an interloper, and a series of chirping sounds similar to rock squirrel calls.

The rabbits are sometimes very trusting and allow close approach by an observer. They defend their burrows from intrusion by other rabbits, and adults fight fiercely with each other when two are confined together.

The home range is quite small, often within only a 30-meter radius of the burrow. but the rabbits occasionally move 200 or 300 meters. Males, seeking mates, sometimes move a kilometer or more.

The reproductive readiness of males is linked to lengthening daylight hours (photoperiod). During the winter, the testes descend into the scrotum, and grow to a maximum size (45 x 20 mm) by late March. Female readiness depends more on the availability of green vegetation, so they lag behind the males in organic development. Ovaries show a small size increase, but uteri grow dramatically from simple tubes to convoluted masses during late winter and early spring. Breeding occurs earlier in the south and at lower elevations. Gravid females were collected in late February in Iron County, early March in Box Elder County, Utah; and in early April near Dubois, Idaho. Evidence in Montana indicated breeding during late April and early May.

At least two, and not more than three, litters a year are produced. Prenatal litters averaged 6.4 young, and ranged from four to eight. First litters averaged 5.7 young, and second litters were somewhat larger (7.1). No nests or new-born young were found despite the excavation of burrows containing lactating females. However, recent observations of captive rabbits at the Oregon Zoo indicate that the young are born blind and hairless, in a nest, after a gestation period of about 24 days. Breeding terminated in late April or May in southern Utah, except at higher elevations, and by late May or June in southern Idaho and Montana.

Rabbits were frequently seen on the Utah and Idaho study areas, and population densities of 4.2 and 8.6 per hectare were estimated on two sites in Iron County, Utah. Populations in some areas declined between 1941 and 1946.

Most predatory mammals and birds prey upon the pygmy rabbit, but the weasel is the most efficient, as it is able to follow the rabbits into their burrows. Several recent kills were found. Other predators include coyote, badger, great horned owl, Swainson's hawk, golden eagle, prairie falcon and short-eared owl.

Pygmy rabbits are hosts to botfly larvae, several species of fleas and ticks, mite larvae and two species of intestinal nematodes. No diseased rabbits were found, but the discovery of some complete skeletons indicated death by causes other than predation.

Pygmy rabbit populations, as those of other leporids, fluctuate locally, and perhaps regionally, in response to environmental conditions, and are subject to long-term changes. In Idaho and Washington, a gradual decline has been attributed to climatic and vegetative changes since the end of the ice-ages. This has been accelerated recently by human activities.

The effects of grazing are not well known. Some grazing may be beneficial to pygmy rabbits. Grazing of sufficient intensity to reduce the sagebrush cover is detrimental.

The elimination of sagebrush by farming, construction and range "improvement" for grazing has reduced habitat and rabbit populations in Utah, and to a lesser extent in Idaho and Montana.

The legal status of the pygmy rabbit is a protected non-game species in Utah, a managed game species in Idaho, and an unprotected non-game species in Montana. Its population status is considered sensitive in Utah and satisfactory in Idaho and Montana.

The effects of some types of habitat alteration are reversible. Pygmy rabbits returned to sites in Montana and Washington on which sagebrush was re-established.

## RECOMMENDATIONS

1. The current condition of pygmy rabbit habitat and populations should be ascertained and monitored at intervals. This could probably best be done by state and federal wildlife agencies operating in each state. An example is the cooperative study conducted by the Montana Department of Fish, Wildlife and Parks and the U.S. Bureau of Land Management (Rauscher, 1997).

2. Follow-up studies should be made in areas where pygmy rabbits have been previously reported in order to determine changes in the habitat and populations. This could easily be done in areas where studies have pin-pointed active burrows by G.P.S. locations, but would require more searching where locations were described by mileage and direction from landmarks.

3. Agencies managing sagebrush lands in pygmy rabbit range should consider the welfare of the rabbit in their management and development plans. This would necessitate that they first determine whether the rabbits are present on or near the area in question.

4. Sagebrush removal projects should be carefully planned for the least impact on the rabbit populations. Complete removal of brush from large tracts should be avoided. Partial removal should be done in such a manner as to leave a mosaic pattern, with stringers of brush left for travel corridors between larger patches of brush.

5. Areas on which sagebrush has been removed should be allowed to revert to sagebrush cover before brush removal projects are carried out on adjacent areas. Pygmy rabbits have been found to recolonize areas where the habitat has not been irreversibly destroyed.

6. Grazing should be regulated to avoid overuse of the range and reduction of the sagebrush canopy. Moderate grazing may benefit the rabbits by maintaining the sagebrush canopy and providing spring grasses to stimulate rabbit reproduction. Livestock stocking rates may need to be adjusted to meet these ends.

#### LITERATURE CITED

- Anthony, H.E. 1913. Mammals of northern Malheur County, Oregon. Bull. Amer. Mus. Nat. Hist. 32:1-27.
- Bailey, V. 1936. Mammals and life zones of Oregon. North Amer. Fauna, 55:416 pp.
- Borrell, A.E. and R. Ellis. 1934. Mammals of the Ruby Mountains region of northeastern Nevada. J. Mamm., 15:12-44.
- Bradfield, T. 1975. On the behavior and ecology of the pygmy rabbit Sylvilagus idahoensis. M.S. Thesis, Idaho State Univ., Pocatello, 43 pp.
- Butler, B.R. 1972. The Holocene and Postglacial ecological crisis on the eastern Snake River Plain. Tebiwa, 15:49-63.
- Campbell, T.M.III, T.W. Clark and C.R. Groves. 1982. First record of the pygmy rabbit Brachylagus idahoensis in Wyoming. Great Basin Nat., 42:100.
- Chilson, P. 1996. Can cattle save the pygmy rabbit? High Country News. Apr. 29, 1996.
- Davis, W.B. 1939. The recent mammals of Idaho. The Caxton Printers, Caldwell, Idaho, pp. 363-366.

- Durrant, S.D. 1952. Mammals of Utah. Univ. Kansas Publ., Museum Nat. Hist., 6:1-549.
- Fisher, J.W. 1979. Reproduction in the pygmy rabbit in southeast Idaho. Unpub. Thesis, Idaho State Univ., Pocatello, 32 pp.
- Gahr, M.L. 1993. Natural history, burrow habitat and use, and home range of the pygmy rabbit Brachylagus idahoensis of Sagebrush Flat, Washington. M.S. Thesis, Univ. of Wash., Seattle. 125 pp.
- Gauvin, D.M. 1939. Collection and analysis of coyote droppings and raptor pellets for evidence of predation upon sage grouse. Unpub. Report, Files of Utah Coop. Wildlife Research Unit, Logan, Utah.
- Green, J.S. 1978. Pygmy rabbit and coyote investigations in southeastern Idaho. Ph.D. Dissertation, Brigham Young Univ., Provo, Utah. 88 pp.
- Green, J.S. and J.T. Flinders. 1979. Techniques for capturing pygmy rabbits. Murrelet 60:112-113.
- Green, J.S. and J.T. Flinders. 1980a. Brachylagus idahoensis. Mammalian Species 125:1-4.
- Green, J.S. and J.T. Flinders. 1980b. Habitat and dietary relationships of the pygmy rabbit. J. Range Mgmt. 33:136-142.
- Grinnell, J., J. Dixon and J.M. Linsdale. 1930. Vertebrate natural history of a section of northern California through the Lassen Peak region. Univ. California Publ. Zoology 35:553-562.
- Hall, E.R. 1946. Mammals of Nevada. Univ. of California Press. Berkeley and Los Angeles. pp. 614-618.
- Hall, E.R. and K.R. Kelson. 1959. Mammals of North America, Ronald Press, New York, 1:252-255.
- Hibbard, C.W. 1963. The origin of the P3 pattern of Sylvilagus, Caprolagus, Oryctolagus, and Lepus. J. Mamm. 44:1-15.
- Hoffman, R.S., P.L. Wright and F.E. Newby. 1969. The distribution of some mammals in Montana I. mammals other than bats. J. Mamm. 50:579-604.
- Holt, R.G. 1975. Taxonomy and distribution of cottontail rabbits, genus Sylvilagus, of Utah. Unpub. Thesis, Univ. of Utah, Salt Lake City, 173 pp.
- Janson, R.G. 1940. Distribution and life history studies of the pygmy rabbit Sylvilagus

- College, Logan. 44 pp.
- Janson, R.G. 1946. A survey of the native rabbits of Utah with reference to their classification, distribution, life histories and ecology. M.S. Thesis, Utah State Agri. College, Logan. 103 pp.
- Johnson, M.K. and R.N. Hansen. 1979. Coyote food habits on the Idaho National Engineering Laboratory. J. Wildl. Mgmt. 43:951-956.
- Johnson, M.L. 1968. Application of blood protein electrophoretic studies to problems in mammalian taxonomy. Syst. Zool. 17:23-30.
- Johnson, M.L., P.W. Cheney and T.H. Scheffer. 1951. Mammals of Grand Coulee, Washington. Murrelet 31:31-42.
- Johnson, M.L. and M.J. Wicks. 1964. Serum protein electrophoresis in mammals: significance in higher taxonomic categories. Pp. 681-694 in Taxonomic biochemistry and serology. The Ronald Press Co., New York.
- Katzner, T.E. 1994. Winter ecology of the pygmy rabbit (Brachylagus idahoensis) in Wyoming. Unpub. M.S. Thesis, Univ. Wyoming, Laramie. 109 pp.
- Kenner, G.H. 1965. Comparative osteology of rabbits of the genera Brachylagus Miller and Sylvilagus Gray. M.S. Thesis. Univ. of Utah, Salt lake City. 125 pp.
- Kurten, B. and E. Anderson. 1972. The sediments and fauna of Jaguar Cave: II - the fauna. Tebiwa 15:21-45.
- Leopold, A. 1937. Killing technique of the weasel. J. Mamm. 18: 98-99.
- Lyman, R.L. 1991. Late Quaternary biogeography of the pygmy rabbit Brachylagus idahoensis in eastern Washington. J. Mamm. 72:110-117.
- Lyon, M.W., Jr. 1904. Classification of the hares and their allies. Smithsonian Misc. Coll. 45:321-447.
- Merriam, C.H. 1891. Results of a biological reconnaissance of south-central Idaho. N. Amer. Fauna, 5:1-416..
- Miller, G.S., Jr. 1900. A new subgenus for Lepus idahoensis. Proc. Biol. Soc. Washington, 13:157.
- Nelson, E.W. 1909. The rabbits of North America. North Amer. Fauna, 29:1-314.
- Rauscher, R.L. 1997. Final Report. Status of the pygmy rabbit in Montana. Montana Dept.

- Rauscher, R.L. 1997. Final Report. Status of the pygmy rabbit in Montana. Montana Dept. of Fish, Wildlife and Parks. 19 pp.+ Appendices A and B.
- Pritchett, C.L., J.A. Wilson, M.P. Coffeen and H.D. Smith. 1987. Pygmy rabbits in the Colorado River Drainage. *Great Basin Naturalist*, 47:231-233.
- Schantz, V. 1947. Extension of the range of Brachylagus idahoensis. *J. Mamm.* 28:187-188.
- Stanford, J.S. 1932. Idaho pygmy rabbit; Brachylagus idahoensis (Merriam). *J. Mamm.* 13:79-80.
- Stanford, J.S. 1934. Some ectoparasites of Utah birds and mammals. *Proc. Utah Acad. Arts and Letters*, 11:247.
- Stephenson, S.N. 1966. Mammals of Paunsagunt Plateau region of Utah. *Great Basin Naturalist* 26:43-44
- Toone, R.A. 1994. Literature review for Category 2 candidate small mammals existing on or near lands administered by the USDI Bureau of Land Management in Utah. Unpub. report. Utah Natural Heritage Program. Salt Lake City. 96 pp.
- Weiss, N.T. and J.B. Verts. 1983. Habitat and distribution of pygmy rabbits (Sylvilagus idahoensis) in Oregon. *Great Basin Naturalist*, 44:563-571.
- Whitlow, W.B. and E.R. Hall. 1933. Mammals of the Pocatello region of southeastern Idaho. *Univ. California Publ. Zool.*, 40:235-275.
- Wilde, D.B. 1978. A population analysis of the pygmy rabbit (Sylvilagus idahoensis) on the INEL Site. Ph.D. Dissertation, Idaho State Univ., Pocatello, 172 pp.

