

## SAGEBRUSH VOLE

### *Lemmiscus curtatus*

#### Description

Early biological survey accounts and research referred to the sagebrush vole as pygmy vole, pallid vole, sagebrush meadow mouse, pygmy field mouse, or variations on these names (Cary 1911; Hall 1928; Miller 1930).

The sagebrush vole is a small, short-tailed rodent with a dense, soft, relatively long pelage. Hairs are dark gray at their bases and a paler or ashy gray at their ends. The dorsal pelage is buff-gray to gray with paler sides; ears and nose are often tinged with buff; venter is silver gray to buff; and feet are light gray to pale buff. Posterior soles are well-haired as is the tail, which is indistinctly bicolor with a dusky line above and silvery white to buff below. The vole molts twice a year. Summer pelage is slightly darker than winter pelage (Carroll and Genoways 1980).

Total measurements range from 100 to 142 mm, including tail length of 16 to 30 mm. The hind foot measures 14 to 18 mm; the ear measures 9 to 16 mm. Adult voles weigh between 17 to 38 g. This vole is readily distinguished from other voles by its relatively pale coloration, the conspicuous lack of a dorsal stripe, and its short tail, which is roughly the same length as the hind foot (Carroll and Genoways 1980).

Six subspecies are recognized. One subspecies, *L. c. levidensis*, occurs in Colorado and the Wyoming Basins, and west into southern Idaho. Generic synonyms have included *Lagurus* and *Arvicola* (Carroll and Genoways 1980).

#### Life history & behavior

Sagebrush voles are most active in the hours around dusk and dawn, and do not hibernate. They are thought to breed year-round throughout their range, producing three to four litters per year. Reproduction may be suppressed during unfavorable conditions (James and Booth 1952). Gestation lasts about 25 days and results in 4 to 6 young per litter, born blind and without fur. By day 21, young are weaned, independent and building their own nests. Males and females are capable of breeding at about two months of age (Carroll and Genoways 1980).

Sagebrush voles are strictly herbivorous, consuming flowers, leaves and stems of grasses, sagebrush, rabbitbrush, winterfat, mustards, and legumes, but rarely mature seeds of grasses (Carroll and Genoways 1980). In Colorado, greasewood was eaten (Miller 1930). In Utah, three pinyon pine seeds were found in the mouth of a sagebrush vole (Presnall 1937, cited in Carroll and Genoways 1980). Sagebrush may be a more important food item in winter than in summer (Mullican and Keller 1986). Sagebrush bark is used extensively in lining nests (Mullican and Keller 1987), as are grasses.

James and Booth (1952), Miller (1930), Cary (1911) and others have described the sagebrush vole as a colonial species. A tagging and dispersal study in southeast Idaho by Mullican and Keller (1986) suggested that sagebrush voles are solitary or occur in pairs, at least during the summer months. The authors found no evidence on their study sites of colonial social structure, such as food caching or common burrow systems, (Mullican and Keller 1987). Sagebrush voles sometimes use abandoned burrows of other rodents, such as pocket gophers. Miller (1930) found sagebrush voles sharing a burrow "to a considerable extent" with red desert pocket mice in Moffat County, Colorado.

## Population trends

No comprehensive long-term census effort has been performed in Colorado or rangewide.

Dramatic short-term local population fluctuations may be common.

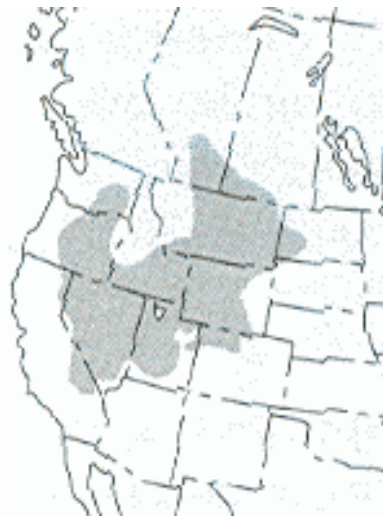
Long-term population trends of the sagebrush vole in Colorado and rangewide are undocumented. Local numbers may cycle dramatically, increasing in mild winters or with increased summer or fall precipitation, and decreasing in response to extremely hot periods, drought, or disease cycles. Unfortunately, only anecdotal reports or short-term studies exist for the sagebrush vole, and such assertions are largely unsupported by replicated studies and must be held with caution.

A comprehensive literature review by Dobkin and Sauder (2004) suggested that sagebrush voles were absent from many locations they were expected occupy in the Great Basin and Columbia Plateau. Although sagebrush voles are notoriously difficult to capture, the review raises concerns about the status, distribution, and habitat requirements of sagebrush voles throughout their range.

## Range

In spite of significant sagebrush habitat loss rangewide, the sagebrush vole remains extant in the states where it historically occurred.

Overall range map reproduced from Fitzgerald et al. (1994) by permission.



The range of the sagebrush vole encompasses the Great Basin, the Columbia Plateau, the northern Great Plains steppe of Montana, southern Alberta and Saskatchewan, and the western Dakotas, and the Wyoming Basins into northwestern and north-central Colorado. No data exist documenting historic continental-scale shifts in distribution of this species. Pleistocene occurrences are known from in New Mexico, well outside present range (D. Armstrong, pers. comm.).

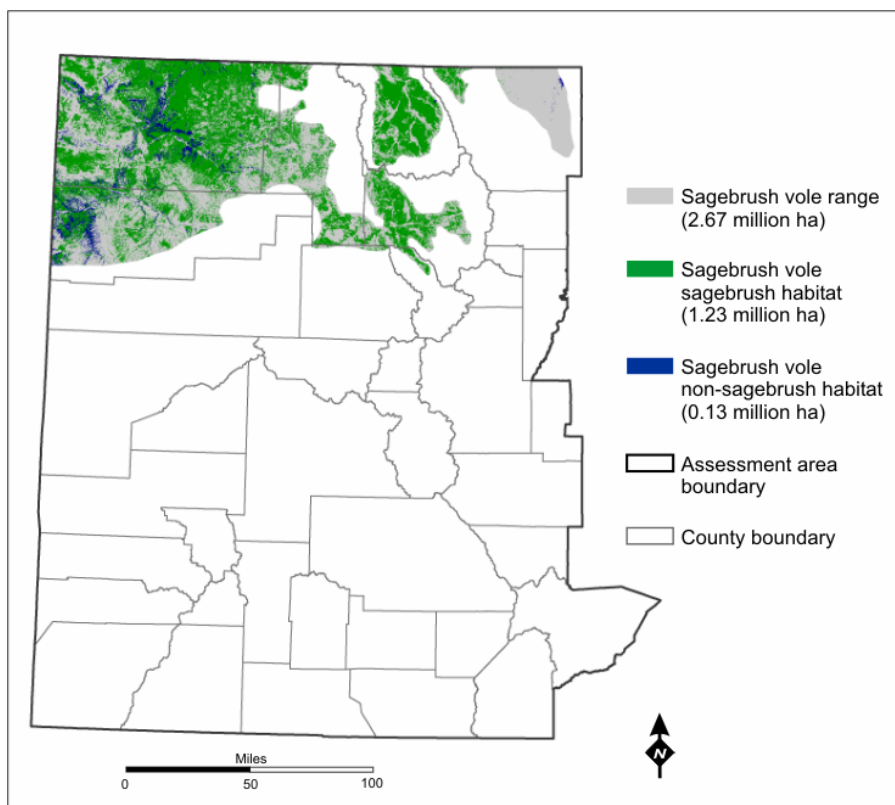
Given that sagebrush voles are strongly tied to sagebrush shrubsteppe habitat across their range, and that this habitat has undergone significant decline in the last century (Knick and Rotenberry 2002), it is possible that the range and distribution of the sagebrush vole has declined accordingly.

### Colorado distribution patterns & abundance

Sagebrush voles are thought to occur in appropriate habitat below 12,400 feet (Carroll and Genoways 1980). In Colorado, most records are from below 9,000 feet (D. Armstrong, pers. comm.).

The total estimated area of sagebrush vole range in the Colorado sagebrush assessment area is 2.67 million ha, with an estimated 1.36 million ha of suitable habitat.

Common associates are white-tailed prairie dog, Merriam's shrew, pronghorn, least chipmunk, and greater sage-grouse (Fitzgerald et al. 1982).



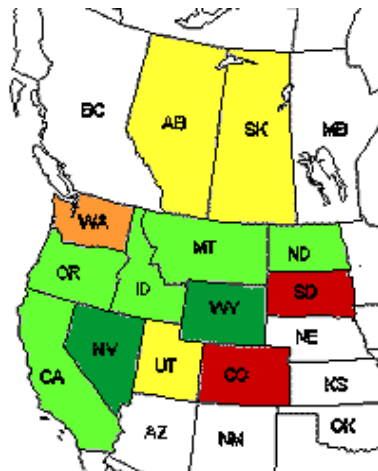
Sagebrush voles occur in northwestern Colorado in appropriate habitat, with likely centers of abundance in Moffat County and North Park. Specimens have been taken in Routt, Moffat, Rio Blanco, Larimer, and Grand Counties (Cary 1911; Fitzgerald et al. 1982; Miller 1930). The distribution of the sagebrush vole has probably not changed significantly in Colorado since European settlement, but recent analysis of woodrat middens in Haystack Cave near Gunnison indicate sagebrush voles inhabited the shrubsteppe of the Gunnison Basin during the late Pleistocene (WSC 1998).

No density estimates are available for Colorado populations. Fitzgerald et al. (1994) remarked that sagebrush voles seem uncommon in any locality, but this perception may be due to lack of information. Densities of some species of voles are thought to fluctuate dramatically depending on environmental factors. One 13-month study in southeastern Idaho (Mullican and Keller 1986) found breeding densities of sagebrush voles ranged between 4 and 10 per ha, but it is unknown whether these densities or this range of densities are typical. Capture rates for this study were significantly higher than for other studies conducted in the Columbia Plateau or Great Basin regions.

## Conservation status

Ranked G5/S1: demonstrably secure rangewide, Colorado population critically imperiled (NatureServe 2004).

The sagebrush vole has no legal status in Colorado or any other state.



The S1 ranking in Colorado reflects that sagebrush vole is at the edge of its range in Colorado, where data regarding its population status are lacking. This species is fully tracked by the Colorado Natural heritage Program (CNHP 2004).

- S1: Critically imperiled
- S2: Imperiled
- S3: Vulnerable
- S4: Apparently secure
- S5: Secure

Map courtesy of NatureServe (2004).

## Habitat

Habitat characteristics that influence presence and abundance of sagebrush voles are poorly understood.

In the Colorado sagebrush assessment area, about 1.36 million ha of suitable habitat exists for sagebrush vole, 1.23 million ha of which is sagebrush shrublands (see figure in Colorado Distribution Patterns and Abundance).

Cover provided by *Artemisia* shrubs and native bunchgrasses appears to be important to sagebrush voles, both for habitat structure and forage.

Sagebrush voles were captured less often in non-sagebrush habitats

Sagebrush voles are closely tied to sagebrush habitats, especially where big sagebrush co-dominates with native bunchgrasses. Most experts consider the sagebrush vole a sagebrush obligate.

Habitat characteristics that influence presence and abundance of the sagebrush vole are poorly understood. Anecdotal reports hold that sagebrush voles prefer big sagebrush (*Artemisia tridentata*) shrubsteppe. The literature shows they use a variety of other woody *Artemisia* as well. In central and eastern Washington sagebrush voles were captured in big sagebrush and black sagebrush (Hall 1928), big sagebrush/bluebunch wheatgrass (Rickard 1960; O'Farrell 1972); and stiff sagebrush/bluegrass associations (Rickard 1960). In south-central Utah, they were taken in a black sagebrush/fringed sagebrush community (Zou et al. 1989). In southern Idaho, Mullican and Keller (1986) trapped sagebrush voles in big sagebrush/bluebunch wheatgrass with a rabbitbrush component, and Keller and Johnson (1983) and Reynolds and Trost (1980) trapped them in big sagebrush with various understories of bluebunch wheatgrass, crested wheatgrass, bottlebrush squirreltail, and Indian ricegrass. Hanley and Page (1981) captured sagebrush voles in dwarf sagebrush/Idaho fescue in northeast California. Sagebrush voles were taken in low numbers in Colorado's Dinosaur National Monument in the 1980s in "sagebrush-grasslands" (M. Bogan, pers. comm.).

Little is known about the specific physiognomic characteristics of the shrub community preferred by sagebrush voles. Review of the literature suggests that a wide range of habitat structure is suitable, but not necessarily equally preferable. Hall (1928) noted that in eastern Washington, most specimens were taken in scattered sagebrush with uniform height of about 2.5 feet and where lower branches were near the ground. In Idaho, canopy cover of big sagebrush, when reported, ranged from 17 to 29 percent, and cover of bunchgrasses was high (Mullican and Keller 1986; Reynolds and Trost 1980). The average sagebrush shrub height on Mullican and Keller's study plots was 60 cm. Harris (1984) captured sagebrush voles at a stabilized low sand dune site in eastern California with less than 10 percent total vascular vegetative cover, dominated by rabbitbrush with big sagebrush and horsebrush and a sparse understory of milkvetch and Indian ricegrass. Miller (1930) captured sagebrush voles in Colorado near Two Bar Spring in Moffat County on a sandy

than in sagebrush habitats, and some seemingly suitable sagebrush habitats were unoccupied (Dobkin and Sauder 2004).

Burrow entrances are typically located at the base of big sagebrush shrubs (Mullican and Keller 1987).

Minimum or optimum patch size for the sagebrush vole is unknown.

Topography of sagebrush vole habitat is typically flat or gently rolling.

Home ranges of sagebrush voles in southeastern Idaho were well under 100 square meters. Home ranges of males were generally larger than those of females, with very little overlap between home ranges of males (Mullican and Keller 1987).

flat “at the mouth of a dry gully issuing from the cedar hills” and “scantily covered with sagebrush and greasewood.” Mullican et al. (2004) captured one sagebrush vole in South Dakota sagebrush shrubsteppe where percent grass cover and number of live shrubs was lower, and percentage of bare ground and dead shrubs was higher than on 34 other sites where the vole was not captured.

Sagebrush voles are captured on occasion in bunchgrass communities without a shrub component in Idaho, Washington, and Oregon (Dobkin and Sauder 2004, reviewing others), but these localities are likely not far from sagebrush (Mullican 2004, pers. comm.). Sagebrush voles have also been captured at very low rates in Nevada bluegrass/sedge in east-central California, curl-leaf mountain mahogany/western needlegrass in western Nevada (Dobkin and Sauder 2004, reviewing others), and in “upland riparian,” chained pinyon-juniper, greasewood, and “cold desert shrubland” in Colorado’s Piceance Basin (Fitzgerald et al. 1982, reviewing others). Cary (1911) observed them in the “sand hills east of Walden, North Park,” their runways beneath the lowest branches of large clumps of rabbitbrush. He also noted a “large colony” occupying a grassy swale at Elk Springs (Moffat County), with runways extending out “a considerable distance into the surrounding sage plain.”

In studies or reviews cited in the preceding paragraphs, sagebrush voles were not captured in fescue grasslands; aspen; ponderosa pine; Douglas-fir forest; spruce/fir; cedar/hemlock; shadscale/Indian ricegrass; black greasewood/Great Basin wildrye; unstable dunes with black greasewood, horsebrush, and rabbitbrush of about 5 percent cover; or rimrock.

It is important to note that none of these studies captured sagebrush voles in sufficient numbers to provide statistically significant correlations between vole occurrence/abundance and vegetation physiognomy or community types. Sagebrush voles were consistently the rarest species trapped relative to other rodents collected during the same studies. Sagebrush voles are notoriously difficult to trap, requiring hundreds, sometimes thousands of trap-nights to capture a single animal. Capture rates of sagebrush vole for studies reviewed by Dobkin and Sauder (2004) ranged from 5 animals per 100 trap-nights to one animal in 10,000 trap-nights. When Mullican and Keller (1987) made foam injection casts of a burrow in southeastern Idaho, they found a nest chamber lined with materials the voles had collected from nearby live traps, raising the question “are they really rare or merely adroit?”

## Threats & sensitivities

Sagebrush makes up an estimated 90 percent of sagebrush vole’s suitable habitat in Colorado; threats to sagebrush vole habitat are a significant concern.

In the Colorado sagebrush assessment area, where sagebrush makes up about 90 percent of the sagebrush vole’s suitable habitat, threats to sagebrush are major concerns. The sagebrush vole’s sagebrush habitat in the assessment area is at risk of four widespread threats modeled in the Colorado sagebrush conservation assessment and strategy: pinyon-juniper encroachment, encroachment by invasive herbaceous plants, residential development, and energy development.

Residential development probably poses the lowest risk of the four threats, with less than 1 percent of the sagebrush vole’s sagebrush habitat at high risk, 1 percent at moderate risk, and 12 percent at low risk. About 87 percent of the sagebrush vole’s sagebrush habitat is at no risk of residential development

See [Chapter 6](#) for more detail about habitat estimates and predictive threats modeling for sagebrush vole in the assessment area. [Chapter 4](#) presents rule sets for threats modeling in sagebrush habitat.

Livestock grazing potentially has a negative influence on sagebrush vole populations.

Low intensity infrequent fires in shrublands probably have little direct effect on sagebrush vole populations.

Whether or how invasions of exotic herbaceous vegetation affect the sagebrush vole is unknown.

based on our predictive model. Residential development threats to sagebrush in sagebrush vole range are fairly scattered, with hot spots around Craig, Steamboat Springs, and Granby.

Pinyon-juniper encroachment risk is also relatively low. Our predictive model estimated 19 percent of the sagebrush vole's sagebrush habitat is at high risk of pinyon-juniper encroachment, 4 percent is at moderate risk, and 78 percent is at low or no risk.

Risk of energy development is broadly moderate in the sagebrush vole's sagebrush habitat. About 73 percent of the sagebrush vole's sagebrush habitat is at moderate risk of energy development in the Colorado sagebrush assessment area, 20 percent is at low or no risk, and 8 percent is at high risk. Energy development can result in destruction, degradation, and fragmentation of habitat via mechanisms described in [Chapter 2](#). The effects of shrubland habitat fragmentation and perforation on sagebrush vole populations have not been studied. Roads, especially divided highways, are likely major barriers to dispersal of small mammals. Sagebrush habitat at highest risk of energy development is scattered throughout the western-most counties in the assessment area, with larger hot spots in sagebrush vole range clustered in Rio Blanco County.

Over 99 percent of sagebrush vole's sagebrush habitat is at some degree of risk of encroachment by invasive herbaceous plants. Our model predicts 26 percent at high risk, 18 percent at moderate risk, and 55 percent at low risk. Sagebrush habitat at moderate or high risk of invasive herbaceous plant encroachment in sagebrush vole range is mostly broadly scattered across the western-most counties at lower elevations. Moffat and Rio Blanco counties contain the largest contiguous patches of sagebrush habitat at high risk.

Little is known about the sagebrush vole's response to grazing, range management practices, or habitat degradation in sagebrush shrubsteppe, and virtually nothing is known for Colorado.

Dobkin and Sauder's (2004) comprehensive review of literature on the sagebrush vole for the Columbia Plateau and Great Basin suggested that livestock grazing has a negative influence on sagebrush vole populations, based on presence/absence and apparent abundance based on capture rates in grazed and ungrazed shrubsteppe. Sagebrush voles do occur (capture rates were relatively low) in shrubsteppe grazed by cattle (Dobkin and Sauder 2004) and by sheep (Mullican et al. 2004), and anecdotal accounts exist of sagebrush voles using cavities or runways dug or eaten into cow chips as escape or feeding stations where vegetative cover is lacking (Hammer and Maser 1969). Cattle may compress soils and trample burrows of sagebrush voles, and compete with them directly for herbaceous forage. Livestock grazing is associated with the introduction of exotic plants and potentially influences structural or floristic shifts in the plant community. How such shifts might affect sagebrush voles is unknown.

Sagebrush vole responses to chemical or mechanical sagebrush range treatments are largely undocumented. In south-central Utah, black sagebrush/fringed sage plots were treated with herbicide or mechanical shredding, and selected plots were reseeded with a grass-forb-shrub mix (Zou et al. 1989). Sagebrush voles were absent from all plots except control plots

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and reseeded herbicide plots in the growing season following treatment. The estimated average density of voles was higher on control plots. The toxicity effects to sagebrush voles of herbicides applied to sagebrush are unknown. Equipment used for mechanical treatments may destroy sagebrush vole burrows.

The effect of fire in shrubsteppe on sagebrush voles is unknown. Low intensity, patchy, infrequent fires in shrublands probably have little effect on sagebrush vole populations, except where native grasses are replaced by exotic graminoids or forbs. Hot, frequent ground fires would affect sagebrush voles during the year of the burn by removing all grass material (forage and cover). Similarly, complete burn-off of woody shrubs would remove vertical habitat structure preferred by sagebrush voles.

Whether or how invasions of exotic herbaceous vegetation affect the sagebrush vole is unknown. Dobkin and Sauder (2004) noted that sagebrush voles were absent, or at least not captured, in areas completely converted to Russian thistle or crested wheatgrass. One individual was captured in 10,000 trap nights in sagebrush-cheatgrass in south-central Washington. In Oregon, tender stems and leaves of cheatgrass, bulbous bluegrass, and other non-native grasses were eaten by sagebrush voles before seedheads matured (Maser et al. 1974, cited in Carroll and Genoways 1980).

The effects of shrubland habitat fragmentation and perforation on sagebrush vole populations have not been studied. Roads, especially divided highways, are likely major barriers to dispersal of voles. No data are available regarding the effects on sagebrush voles of agricultural conversions of sagebrush shrubsteppe. Such conversions are assumed to result in direct habitat loss, especially where crops are irrigated. Dry, well-drained soils and fairly flat terrain seem to be a requisite for this species (James and Booth 1952).

According to pellet analyses reviewed by Carroll and Genoways (1980), owls are among the most important predators of sagebrush voles. Sagebrush vole remains were present in pellets of burrowing, short-eared, long-eared, pygmy, and great-horned owls. Others reported predation by bobcat, coyote, fox, long-tailed weasel, rattlesnake, and in one instance, loggerhead shrike. Sagebrush voles host a variety of fleas and were considered a primary reservoir of sylvatic (bubonic) plague in Washington state in the 1950s (James and Booth 1952); this association has not been reported in Colorado (Fitzgerald et al. 1982).

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### **Research needs**

No comprehensive baseline population estimates or trend data exist across any part of the species' range. Cycles of sagebrush vole populations are still poorly understood. Whether or not sagebrush voles undergo annual or multi-annual fluctuations in numbers has not been definitively established (Mullican and Keller 1986, 1987). Contradictions exist in the literature regarding the social structure of sagebrush voles. Detailed studies of habitat requirements and responses to habitat degradation are lacking.

## Management issues

The apparent spatial and temporal variability of sagebrush vole distribution across its range suggests the need for caution when interpreting the vole's responses to habitat conditions. The sagebrush vole is a potential indicator of habitat integrity in sagebrush ecosystems (Fitzgerald et al. 1982). That potential will remain unfulfilled until a better understanding of the natural history and ecology of the species in Colorado is established.

The apparent rarity of this species, and/or its ability to elude capture further confounds our ability to manage and monitor it with confidence. The potential effort and expense of a statistically powerful population census, let alone a long-term trend estimate, using standard trapping methods, explains why so little is known about sagebrush vole populations.

The effects of research activities on local sagebrush vole populations are undocumented, although mortality rates are likely high. Snap-traps, which kill the sampled fraction of the population, are often the method of choice for a rodent census.

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