ECOLOGY OF OWENS VALLEY VOLE

A Thesis

by

FLETCHER CHRIS NELSON

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2004

Major Subject: Wildlife and Fisheries Sciences

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Approved as to style and content by:

Nova J. Silvy (Co-Chair of Committee)	Roel R. Lopez (Co-Chair of Committee)
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ABSTRACT

Ecology of Owens Valley Vole.

(May 2004)

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Little current data exist concerning the status and ecology of Owens Valley vole (OVV; *Microtus californicus vallicola*), despite its California Department of Fish and Game listing as a Species of Special Concern. No formal studies have been undertaken to understand the ecology of OVV or other small mammal species occurring in mesic-vegetative communities in Owens Valley, California. I investigated the relative abundance of small mammal species in mesic-plant associations of Owens Valley, OVV distribution, and OVV use of vegetative types as habitat. Low OVV capture rates decreased the efficiency of systematic trapping surveys. Live trapping and sign surveys yielded contradictory results. The distribution of OVV was associated with irrigation and microhabitat features such as waterways, fence lines, and brush patches. The distribution and use of vegetation types by OVV was similar to that of the California vole (*M. californicus*).

DEDICATION

For Mom

ACKNOWLEDGMENTS

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INTRODUCTION

Information concerning small mammal ecology in Owens Valley of California is scarce. Studies to date have focused primarily on taxonomy (Bailey 1898,1915; Elliot 1903; Hollister 1913, 1914; Grinnell 1922; Hall and Dale 1939; Lidicker 1960) or on species occurring in xerophytic-plant associations (Kenagy 1973*a*,*b*; Brown 1973; Brown and Lieberman 1973; Matson 1976). Mesic associations comprise approximately 26,880 ha (approximately 20%) of the total area of Owens Valley. These mesic areas, including riparian corridors, meadows, and agricultural lands, are subject to more intensive and concentrated use (i.e., livestock grazing, recreation) than drier areas.

Mesic environments are likely to support small mammal communities different from those of xeric communities. The distribution of one small mammal species, Owens Valley vole (OVV; *Microtus californicus vallicola*), may be restricted to mesic-vegetation types. The Sierra Nevada and the Mojave Desert isolate OVV from other California vole subspecies (Hall 1981). California Department of Fish and Game (CDFG) had listed OVV as a Species of Special Concern (CDFG 2001).

The first collection and description of OVV was in 1898, by Bailey (1900), who gave the subspecies its taxonomic designation. Bailey distinguished OVV from the California vole (*M. californicus*) by its comparatively darker pelage, smaller auditory bullae, more abruptly truncated occiput, and a loop on the fourth triangle of the middle upper molar. Kellogg (1918) noted uniform convexity in dorsal profile, narrow interpterygoid fossa, and heavy maxillary roots as distinguishing characteristics.

This thesis follows the style and format of Journal of Wildlife Management.

Current knowledge about OVV is entirely limited to historical collection records. The University of California, Berkeley's Museum of Vertebrate Zoology holds 108 specimens. All were collected between 1912 and 1957. Although a considerable body of literature exists regarding California vole ecology (Krebs 1966, Lidicker 1980, Ford and Pitelka 1984, Tamarin 1985), its applicability to OVV populations is questionable. Climate, vegetative communities, topography, elevation, and plant association distribution patterns differ substantially between typical California vole study sites (i.e., coastal and inland Mediterranean annual grasslands) and collection locations for OVV.

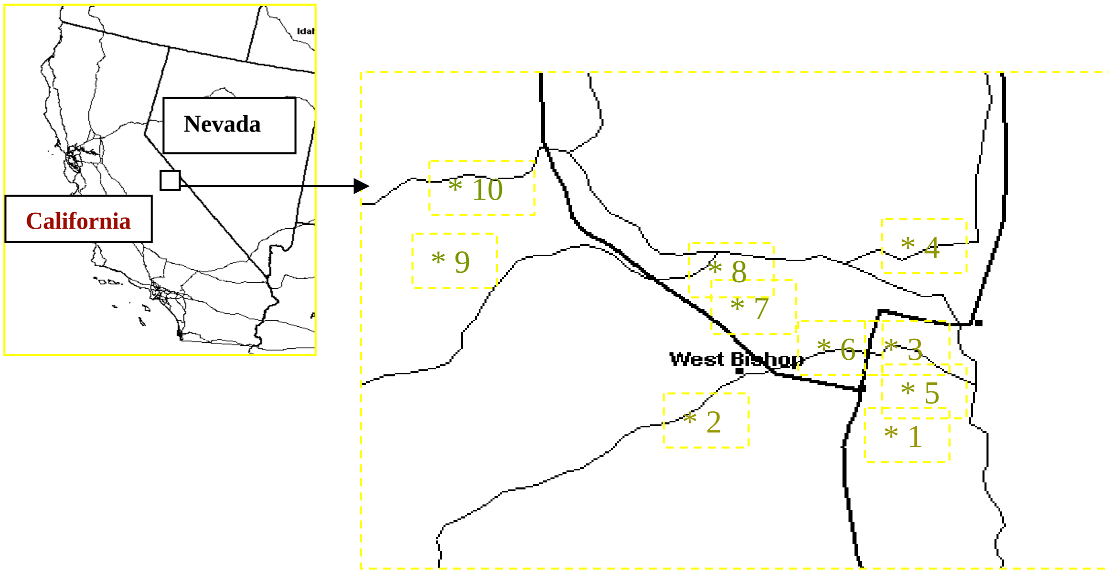
In order to better understand the ecology of OVV, I studied the relative abundance of small mammal species, including OVV, in mesic-plant associations of Owens Valley, California. I placed special emphasis on the distribution of OVV in Owens Valley and the vegetation types used by OVV as habitat.

STUDY AREA

Owens Valley lies between the Sierra Nevada and Inyo-White Mountain ranges in eastern California. The steep elevational gradient of the valley supports several cold- and warm-desert plant communities. These shrublands are interspersed with riparian communities associated with the Owens River and its tributaries, natural wetlands, and irrigated and non-irrigated agricultural land. The study was restricted to the vicinity (within 24 km) of Bishop, California, located at the northern end of Owens Valley (Fig. 1). The climate of the region is characteristic of the southern Great Basin, with low (136 mm) precipitation occurring primarily in winter and spring. Annual precipitation has been lower than average since 1999 (Fig. 2). Normal January and July average temperatures were 3°C and 21°C, respectively. Elevation at study sites was between 1,250m and 1,400m.

There were 6 plant communities represented in the study area (Fig 1). They were: (1) Rabbitbrush meadow, (2) Great Basin riparian forest, (3) Rush/sedge meadow, (4) Native meadow, (5) Great Basin riparian scrub, and (6) Irrigated pasture. Two study sites (sites 1 and 5) were selected in Rabbitbrush meadow communities. Dominant plant species in the Rabbitbrush meadow sites were rubber rabbitbrush (*Chrysothamnus nauseosus*), saltgrass (*Distichlis spicata*), and alkali sacaton (*Sporabolus airoides*).

In Great Basin riparian forest communities, 2 study sites were selected (sites 2 and 4). Plant species composition was highly variable between the 2 sites. Site 2 had a relatively dense canopy dominated by red willow (*Salix laevigata*) and Gooding willow (*S. goodingii*), black locust (*Robinia pseudoacacia*), and water birch (*Betula occidentalis*). The understory was sparse to dense, with dominant species coyote willow



Rabbitbrush Meadow

Riparian Forest

Riparian Scrub

Rush/Sedge Meadow

Irrigated Pasture (ungrazed)

Irrigated Pasture (grazed)

Fig. 1. Study area with study sites and photographs of vegetative cover types (sites 1 and 5 consisted of Rabbitbrush Meadow, sites 2 and 4 consisted of Riparian Forest, sites 3 and 7 consisted of Rush/Sedge Meadow, site 6 consisted of Irrigated Pasture [ungrazed], site 8 consisted of Riparian Scrub, and sites 9 and 10 consisted of Irrigated Pasture [grazed]), Owens Valley, California, 2002. Coordinates (UTM) for study sites are available at Los Angeles Department of Water and Power, Bishop Office, Bishop, California, USA.

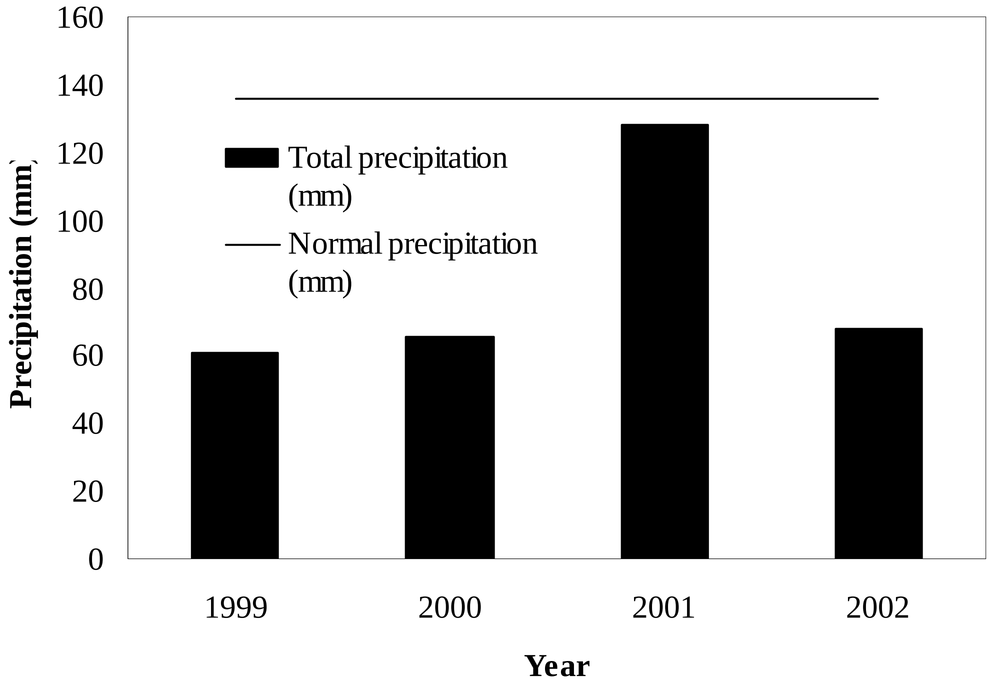


Fig. 2. Normal versus annual precipitation, Owens Valley, California, 1999–2002.

(*S. exigua*) and Wood's rose (*Rosa woodsii*). The herbaceous layer was sparse to dense, depending on canopy and understory density, and was dominated by beardless wildrye (*Leymus triticoides*) and saltgrass. Site 4 had a relatively open canopy of Fremont's cottonwood (*Populus fremontii*), red willow, and Gooding willow. With increasing distance from water, the dominant understory shrubs transitioned from coyote willow, to Wood's rose (*Rosa woodsii*) and rubber rabbitbrush, to saltbush (*Atriplex* spp.). The dominant herbaceous species was saltgrass.

Two sites were studied in Rush/sedge meadow communities (sites 3 and 7): Species composition was highly variable between sites. Sedges (*Carex* spp.) and rushes (*Juncus* spp.) occurred at site 3, but beardless wildrye, glue licorice (*Glycyrrhiza* *lepidota*), and milkweeds (*Asclepias* spp.) were most prevalent, perhaps due to efficient irrigation. Site 7 lacked developed irrigation (i.e. ditches) and was dominated by sedges, rushes, and saltgrass. Both meadows were used for grazing livestock, but at the time of trapping, the sites remained ungrazed since the prior growing season.

One site was selected in the Native meadow community (site 6): This site was sporadically irrigated via natural waterways, and dominated by dense growth of beardless wildrye. The Great Basin riparian scrub community also was represented by 1 site (site 8). A dense canopy of shrubby red willow and Gooding willow and occasional thickets of coyote willow were restricted to the immediate vicinity of the stream at this site. Rubber rabbitbrush was the dominant species within the remainder of the riparian corridor, with patches of Wood's rose and common reed (*Phragmites australis*) interspersed. Herbaceous cover was sparse to dense and dominated by saltgrass. Beardless wildrye was present in open areas subject to occasional flooding.

Two sites were selected in Irrigated pasture (sites 9 and 10). The distinction between Irrigated pasture, Native meadow, and Rush/sedge meadow was somewhat arbitrary. In general, Irrigated pasture was subject to more intensive management (i.e. irrigation and grazing) and had been seeded in the past with exotic grasses (e.g. bluegrass [*Poa* spp.] and orchardgrass [*Dactylis glomerata*]), resulting in variable species composition between individual pastures. At the time of trapping, site 9 had been grazed to short (<10 cm) stubble, and grasses were unidentifiable. Site 10 had not been grazed since the prior growing season. This site supported a dense graminoid growth, including muhly grass (*Muhlenbergia* spp.), *Poa* spp., orchardgrass, beardless wildrye, and sedges, as well as the annual forbs chicory (*Cichorium intybus*) and milkweeds.

METHODS

Selection of Study Sites

I used the Los Angeles Department of Water and Power (LADWP) geographic information system (GIS) database to generate a randomized list of potential survey sites. Vegetation layers in LADWP's GIS are based on an inventory conducted by the agency between 1984 and 1987. The inventory encompassed approximately 91,863 ha of valley floor. This area was divided into over 2,000 parcels of relatively homogeneous vegetative associations based on Holland's (1986) plant community classifications.

I used the LADWP GIS to exclude non-target plant communities and parcels of insufficient area, and generated a list of suitable parcels in random order. Some potential sites were discarded due to disparities between their classification under the vegetation inventory and their current vegetative community (i.e., considerable succession or disturbance had occurred). I excluded other sites due to presence of livestock or close proximity to areas of human activity.

Trapping

Trapping was conducted in order to assess the presence and relative abundance of rodents from July 2002 to November 2002. Although there were considerable changes in temperature during this period, animal activity, as assessed through trapping and sign observation, appeared stable throughout the season. During summer months, traps were opened only at night (3 nights); during the fall traps were left open day and night (3 nights, 2 days). Trapping was stopped in November due to rising frequency of cold weather mortalities.

At most sites a standard 100 X 100-m grid with traps at 10-m intervals was established. At the 3 riparian sites, 60 – 250-m transects were placed along the waterway in order to sample the corridor. All traps used in the study were large (7.6 X 8.9 X 22.9 cm) Sherman live-traps (H. B. Sherman Traps, Inc. Tallahassee, Florida, USA). Traps were baited with plain rolled oats initially, but rolled oats and peanut butter were used later in response to low OVV captures. All captured animals were identified to species, sexed, measured, marked, and released. Data from systematic trapping, using the number of new individuals captured per 100 trap-nights, were used to establish an index of abundance for each species.

In response to low OVV capture rates, a limited amount of supplemental trapping was conducted at site 3 to explore the effectiveness of alternative baits and trapping methods. The use of alternative baits, including carrots, celery, and cut alfalfa did not increase OVV captures. Two experimental pitfall arrays were established, but both of were unsuccessful. Pitfall arrays were impractical, due to the density of perennial rhizomes at the site and disturbance to vole runways. The direct placement of traps at locations of vole activity was relatively effective, and this method was used in all subsequent trapping sessions. Supplementary traps were placed on or near suspected OVV runways and burrows.

Sign Survey

Because of low OVV captures, surveys of OVV sign (burrowing, feces, grass clippings, grazing, and runways) also were used to obtain additional information on OVV distribution. Presence/absence data were collected for OVV sign within a 1-m radius of each trap location. Sign that may have been attributable to other small mammal species (i.e. burrows and grazing) was considered only if associated with sign distinctly characteristic of OVV activity (i.e. runways and feces). OVV fecal pellets were readily distinguishable from those of other small mammal species by their large size, crescent shape, and coarse texture. Both old and recent OVV sign was considered as long as it was distinguishable from that of sympatric species.

Vegetation Data

To confirm the general vegetative community classification at each site, a line-intercept-vegetation survey was conducted at each site. Except in riparian sites, 2 (100m) line transects were placed in a perpendicular pattern with the axis in the center of the trapping grid. In riparian sites, vegetation transects followed the linear trapping transects. Contacts with living plant species, mulch, and bare ground were recorded at 1-m intervals. Only first contacts were counted, except in riparian areas, where both canopy and first understory species were recorded. For surveys conducted after the growing season, vegetation from the prior growing season was considered a first contact with living matter. All other standing matter was recorded as litter.

Additional vegetation data were collected at vole capture sites. A 10-m transect was run in each of the 4 cardinal directions with the trap location as the starting point. Height and species of first contacts were recorded at 10-cm intervals from 0–3 m, and at 0.5-m intervals from 3–10 m. Differences between interval length at different distances from trap locations were meant to be a compromise between data collection requirements and labor constraints. I considered the immediate radius (0–3 m) of the trap location to be of greater importance than the surrounding area (3–10 m), but wished to represent the entire 10-m radius.

RESULTS

Small Mammals

Four species (Table 1) of small mammals were captured: western harvest mouse (*Reithrodontomys megalotis*), deer mouse (*Peromyscus maniculatus*), OVV, and little pocket mouse (*Perognathus longimembris*). Little pocket mouse was present only at site 4, and was captured in a saltbush/saltgrass association. Western harvest mouse was absent only from site 9, a heavily grazed irrigated pasture. Native meadow and grazed irrigated pasture had the lowest small mammal abundance, and riparian scrub the highest.

Table 1. Index of abundance (number/100 trap nights) for small mammal species, Owens Valley, California, 2002.

		Species				
Site (plant community)	Trap nights	Western harvest mouse	Deer mouse	Owens Valley vole	Little pocket mouse	All species
1 (Rabbitbrush meadow)	300	2.67	3.33			6.00
2 (Riparian forest)a	300	4.33	4.67			9.00
3 (Rush/sedge meadow)	300	1.33	1.33	0.33		3.00
4 (Riparian forest)a	180	2.78	1.67		0.56	5.00
5 (Rabbitbrush meadow)	300	4.00	0.33			2.17
6 (Native meadow)	600	0.33		0.17		1.00
7 (Rush/sedge meadow)	300	1.33		0.33		1.67
8 (Riparian scrub)b	300	11.33	7.00	0.67		19.00
9 (Irr. pasture, grazed)	300		1.00			1.00
10 (Irr. pasture, ungrazed)	300	1.33	0.33	1.33		3.00
All sites	3180	2.70	1.79	0.28	0.03	4.81

a Great Basin riparian forest b Great Basin riparian scrub

Owens Valley Vole

Sign surveys (Table 2) indicated past or contemporary OVV presence at all sites. Lack of correlation between sign indexes and OVV captures (Pearson correlation coefficient = 0.309, P = 0.386) may be due to the consideration of old sign in my surveys as well as low susceptibility to capture.

I encountered difficulties in capturing OVV. Only 2 OVV were trapped in the first 1,980 trap-nights, which included 900 trap-nights at 2 sites (3 and 6) with conspicuous vole activity. Fresh feces, grass clippings, burrowing spoils, and extensive runways were conspicuous at both sites. Sign indexes at sites 3 and 6 were 64% and 23%, respectively.

Table 2. Percentage of trap locations with OVV sign present, Owens Valley, California, 2002.

	Site (vegetative community)									
	1 (Rabbitbrush meadow)	2 (Riparian forest)[a]	3 (Rush/sedge meadow)	4 (Riparian forest)[a]	5 (Rabbitbrush meadow)	6 (Native meadow)	7 (Rush/sedge meadow)	8 (Riparian scrub)[b]	9 (Pasture ungrazed)	10 (Pasture grazed)
% sign	8	4	64	6.7	3	23	12	31	9	10

[a]Great Basin riparian forest [b]Great Basin riparian scrub

Microhabitat

Both plant species composition and height varied between and within sites at capture locations (Table 3). Small sample size (n = 8) for systematic capture locations prohibited statistical analysis of microhabitat selection. However, observations made in the field while selecting directed trapping locations and conducting sign surveys indicated microhabitat selection within general plant associations. Sign of vole activity was concentrated around irregular features of the study site, such as shrubs, patches of dense herbaceous vegetation, fence lines, and waterways.

Sites with the highest sign indexes (sites 3, 6, and 8) had high beardless wildrye cover (43%, 84%, and 20%, respectively). At capture sites, only “unidentified grass species” comprised a higher percentage (23%) than beardless wildrye (12%).

Table 3. Vegetative characteristics at OVV capture locations, Owens Valley, California, 2002.

Site	Number of captures			Percentage				
	Direct	Grid	Total	Bare ground and litter	Grasses	Forbs	Woody	Mean Height (cm)
3 (Rush/sedge meadow)	0	1	1	0.0	42.4	57.6	0.0	67
6 (Native meadow)	2	1	3	28.7	61.1	4.2	6.0	28
7 (Rush/sedge meadow)	2	1	3	4.0	45.7	2.3	48.0	57
8 (Riparian scrub)[a]	3	2	5	6.2	60.8	4.3	16.8	32
9 (Pasture, grazed)	6	0	6	0.8	97.1	2.3	0.0	12
10 (Pasture, ungrazed)	1	3	4	0.0	81.2	18.8	0.0	29
Mean			3.7	6.6	64.7	14.9	11.8	37.5

[a] Capture location percentages <100 due to water counts at capture sites.

At sites 6, 7, and 8, OVV activity was high in and around shrubs. At site 7, all OVV capture locations were on the periphery of an isolated Wood’s rose thicket. All fresh sign in the meadow was concentrated around this shrub. Likewise, OVV activity was high in Wood’s rose and common reed at site 8. Runways typically extended short distances into surrounding grass and connected neighboring shrubs.

In irrigated pasture (sites 9 and 10), OVV activity was conspicuous in patches of dense herbaceous vegetation and along fence lines. At site 9, livestock grazing had reduced most of the grasses to short stubble, and OVV activity was high in 4 patches of un-grazed rushes. Patch diameter ranged from 4-10 m. One complex of runways and burrows was located entirely in stubble. Both woody vegetation growth and OVV activity were high along a fence with a parallel irrigation ditch.

Vole activity appeared to be concentrated near waterways (e.g., natural stream courses, irrigation ditches, and former Owens River meanders) when available. Whether OVV activity was actually higher near waterways and other site features could not be determined, as activity may simply be more conspicuous in the absence of dense grass.

DISCUSSION

Average annual precipitation in Owens Valley has been below normal since 1998. Populations of all small mammal species were likely depressed due to drought conditions at the time of the study. Drought may explain the presence of old OVV sign in currently unoccupied sites. In wet years with high plant production, these sites may be occupied by OVV dispersing from adjacent areas. Beatley (1969) and Ernest et al. (2000) noted that drought resulted in depressed small mammal populations in arid regions.

Irrigation, as might be expected in an arid environment, is a primary factor in OVV distribution. Except in one case, all sites in which OVV were captured were irrigated. Site 8 (riparian scrub) was not artificially irrigated, but flooding from the creek provided some natural irrigation, and allowed the persistence of dense herbaceous patches. Irrigation not only increases overall herbaceous vegetation density, it also encourages the growth of beardless wildrye, which requires intermediate levels of moisture. Cockburn and Lidicker (1983) and Ostfeld et al. (1985) showed that California voles preferred patches of beardless wildrye to other microhabitats. In my study, sites with the highest sign indexes also had high beardless wildrye cover.

OVV use of microhabitat “islands” such as shrubs, fence lines, and rush patches deserves consideration in the development of management plans. The importance of cover in microtine population dynamics is well documented (Birney et al. 1976, Getz 1985). It is likely that OVV used patches of cover as refuge when macrohabitat quality was diminished through land uses such as mowing or grazing (Hovland et al. 1999) or seasonal and inter-annual changes in herbaceous vegetation density.

Although Church (1966) concluded that California vole "is a species dependent on free water," other microtine rodents (e.g., sagebrush vole [*Lemmiscus curtatus*], Mexican vole [*M. mexicanus*]) are known to occur in arid habitats and murid rodents can rely on green vegetation to meet water requirements (Getz 1985, Mullican 1986). Seven OVV capture locations were either a considerable distance (>200m) from a reliable water source, or isolated from water by discontinuities in vegetative cover. Thus, OVV living near waterways were probably not seeking free water. They may be responding to increased overall grass production, to the higher dietary water content, or to the dominance of preferred forage species (i.e., beardless wildrye) near water.

Comparing relative OVV abundance between vegetative communities through livetrapping may be impossible. The number of captures/100 trap-nights was probably an unreliable index of OVV population abundance, due to differences in individual trap avoidance which cannot be estimated nor corrected for. Lack of correlation between OVV activity and OVV captures suggested that trap avoidance may be inversely related to food availability. Thus capture numbers may be lower at sites with relatively high resource availability and OVV density, and higher at sites with low resources and low OVV density.

Although high susceptibility to livetrapping is one reason for the popularity of microtine species (i.e., California vole and meadow vole [*M. pennsylvanicus*]) as ecological study subjects, I encountered difficulty in capturing OVV. Researchers studying the sagebrush vole, a species associated with Great Basin shrub-grassland plant communities, also have reported inconsistency in trapping success (Moore 1943, Allred 1973). Low susceptibility to trapping probably resulted in gross under-representation of actual OVV abundances. For example, OVV activity at site 6 was high and very conspicuous, but 600 nights of trapping yielded only 3 captures. Directed trapping increased the number of captures, but this method is biased and has limited applications. Chitty and Kempson (1949) recommend prebaiting traps. In my study, OVV capture rates increased on second and third trap nights, suggesting that OVV do in fact avoid entering newly placed traps. Prebaiting should be tested in any subsequent OVV studies.

Attempts to estimate vole abundances from sign indexes have yielded mixed results. Sign index reliability is sensitive to changes in population density (Lidicker 1973), seasonal changes in sign production (Village and Myhill 1990), and difficulties in distinguishing between old and fresh sign (Redpath et al. 1995). Furthermore, sign indexes probably need to be “calibrated” for separate species due to differences in habitat and sign production. Although sign indexes are an unreliable means of estimating vole abundance, they could provide other data relevant to resource managers. In Owens Valley, old and new sign is easily distinguished, and sign can be a reliable indicator of current presence or absence. Sign surveys conducted at the same time each year could reveal inter-annual trends in abundance, if not actual point estimates of abundance.

CONCLUSION

The results of my study suggest that OVV ecology is more likely to be closely related to California vole ecology than not. In the absence of costly OVV studies, land managers should be able to make informed decisions concerning OVV conservation through judicious extrapolation from the existing large body of knowledge about California voles. Considering that even though small mammal populations were likely at relatively low levels due to droughty conditions, OVV were still present in most mesic vegetative communities, current management practices seem appropriate. Care should be taken regarding irrigation decisions, and establishment of annual sign index surveys is advisable.

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