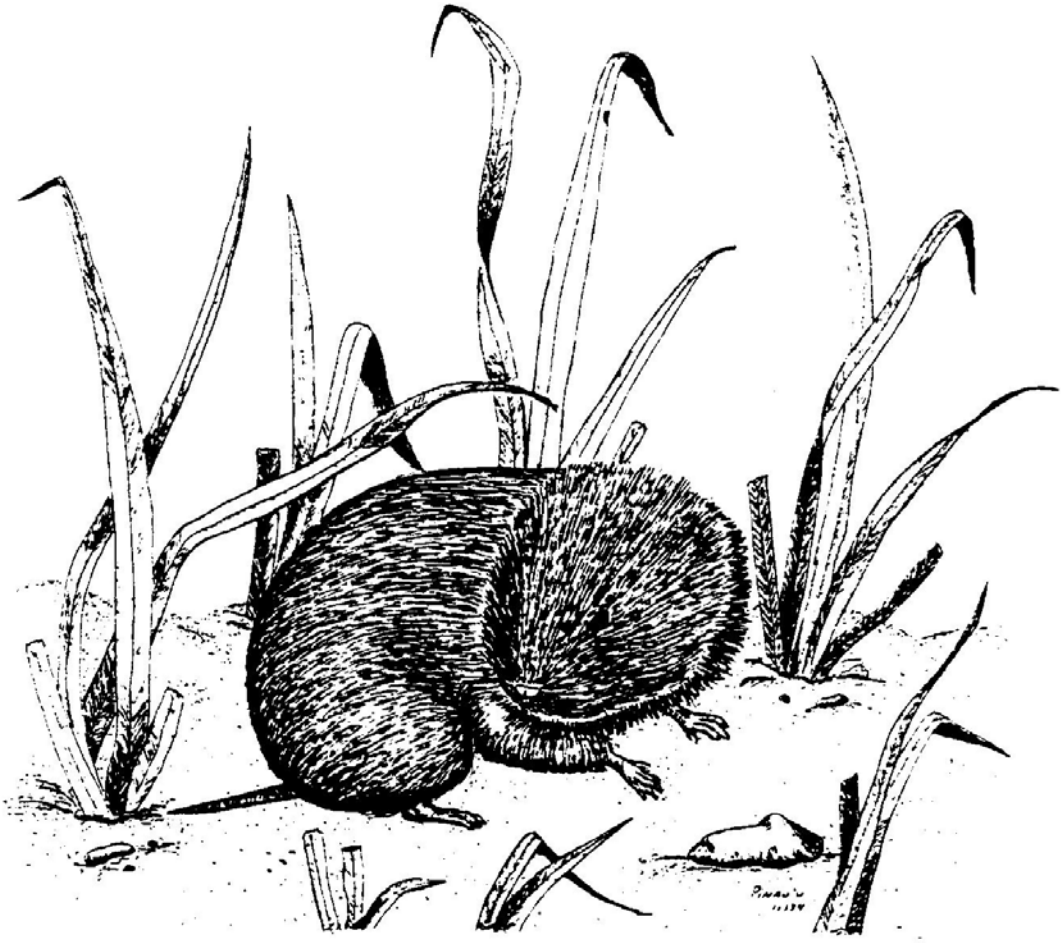
HUALAPAI MEXICAN VOLE INVESTIGATIONS ON THE PRESCOTT NATIONAL FOREST

Richard A. Winstead, Nongame Specialist
Johnathan R. Koehler, Wildlife Specialist
Jennifer L. Cordova, Wildlife Assistant
Region III, Field Operations Division



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INTRODUCTION

Following intensive field surveys by Spicer et al. (1985), the Hualapai Mexican vole (*Microtus mexicanus hualpiensis*, HMV) was listed as endangered by the U.S. Fish and Wildlife Service in 1987 (USFWS 1987). HMV is one of three subspecies of *Microtus mexicanus* found in Arizona, and is primarily known from the Hualapai Mountains. Other populations of Mexican voles have been located, but specimens have not yet been assigned to subspecies. Due to small sample sizes and difficulty in classifying specimens, the status and range of HMV have been in question since the last field evaluation by Spicer et al. (1985).

Known HMV distribution is limited to northwest Arizona. Voles collected in 1992 from the Bradshaw, Sierra Prieta, and Santa Maria Mountains on the Prescott National Forest (PNF) (Kime 1995) were shown by genetic evaluation to be similar to the HMV (Frey and Yates 1995). The PNF is seeking knowledge of vole habitat relationships, distribution, and population status because of the potential to extend the known range of the HMV into areas on the forest thought to be occupied by *M. m. mogollonensis* (Hoffmeister 1986). The PNF intends to assist the USFWS and Arizona Game and Fish Department (AGFD) in HMV recovery efforts by contributing resources to help determine population status of voles on the forest and by managing forest and rangeland habitats to sustain vole populations. The AGFD has a general mission to conserve, enhance, and restore wildlife resources and habitats in the state and a specific policy to promote the recovery of threatened and endangered wildlife and its habitat (AGFD 1999). To accomplish mutually beneficial objectives, the Forest Service and AGFD established a Challenge Cost-Share Agreement (0-01-97-0195).

Project objectives were:
1) to determine vole distribution on and near PNF,
2) to determine the taxonomic identity of voles found at these locations, and
3) to determine characteristics of habitats occupied by voles.

This report partially fulfills AGFD's obligation to report its findings by providing information on field techniques, number and description of voles captured, and habitat characteristics of occupied vole sites. Northern Arizona University, using AFLP and mitochondrial markers during genetic analysis, will determine taxonomic identity of voles. Their completion report is due February 2000.

METHODS

VOLE SITE SEARCHES

Project personnel identified potential vole habitats in mountainous areas and then intensively searched for vole signs within those potential habitats. Potential habitats included dry grassy areas on moderate to steep slopes with northern aspects and grassy meadows near permanent or intermittent water sources. Searches followed the guidelines developed by Kime (1994).

Detection of vole signs required close examination of the ground surface. Evidence of vole activity included runways, scat, grass clippings, burrow entrances, and observation of voles. Kime (1994) describes characteristics of runways, burrows, scat, and grass clippings.

When occupied vole sites were found, personnel collected coordinates at the approximate center of the site using a Global Positioning System (GPS) device. Locations were plotted later on a topographic map. Photographs showing general habitat and specific site characteristics were taken. New sites were named according to recognizable landmarks on topographic maps, but historical sites were not renamed. Site name, GPS coordinates (UTM), date, observer, photographs taken, type of sign observed, and general site description were recorded in field notes.

Population areas have been defined by groups of occupied sites within large geographic areas (e.g., Music Mountains, Sierra Prieta Mountains). Newly discovered sites were considered as additions to extant population areas if they were near historical sites, but new sites isolated from historical ones were treated as new population areas and named after a prominent landmark.

SITE CHARACTERISTICS

Vegetation measurements were taken to characterize cover and habitat components of sites occupied by voles. Because one size of sample unit will not adequately sample frequency for each form of vegetation, quadrats of different sizes were nested within each other (Higgins et al. 1994). Single sets of quadrats were used at each occupied vole site and had a common center point selected by field personnel as representative of the site. Quadrats were square and had lengths of 1 m (1-m^2 in area), 3.16 m (10-m^2), or 10 m (100-m^2). Following recommendations of Cain and Castro (1959:146), these were used to measure herbaceous plants, shrubs, and trees, respectively. Measurements and other information for each site were recorded on a standardized data form.

Canopy cover, the vertical projection of the crown of a plant onto the ground surface ignoring holes and minor gaps between branches (Hays et al. 1981), serves as a criterion for relative dominance within a community (Higgins et al. 1994). Canopy cover and height were measured for herbaceous plants and shrubs. Basal areas of trees also were measured.

Percent cover of grass and grass-like plants, forbs, bare ground, and litter was estimated by using cover classes (Hays et al. 1981). Plant species composition and type of substrate (soil, gravel, or rock) and litter (dead herbaceous, deciduous leaves, or conifer needles) were noted. Litter depth

was measured when present. Total length of vole runways within the 1-m^2 quadrat also was measured.

Mean diameter and height of all shrubs within the 10-m^2 quadrat were measured. Canopy area was calculated from mean diameter, which was derived from measurements of two diameters perpendicular to one another (Hays et al. 1981). Percent cover of shrubs is the sum of shrub canopy area divided by the total quadrat area.

The circumference of all trees within the 100-m^2 quadrat was measured and used to calculate basal area. Measurements were taken at a height of 2.5 cm. Because they may provide cover, brushpiles and logs within this quadrat also were measured. Brushpile diameters and heights were measured the same as shrubs. Log maximum circumference and length were measured and age of logs was estimated by classes of decomposition based on bark, twig, texture, shape, color and positional characteristics (Maser et al. 1979). Ages of brushpiles were estimated by bark characteristics alone.

Physical features of the environment are just as important as vegetation in determining animal abundance and distribution (Cooperrider 1986). Slope, aspect, and elevation are three important features that were measured from topographic maps once site locations were plotted. Slope is the angle between the horizontal and the plane of the ground surface and is expressed as percent (vertical rise/horizontal run X 100). Aspect is the downhill direction of a slope or the direction a slope faces. These were measured on maps by placing a ruler perpendicular to contour lines nearest to a plotted point. The number of contour lines gives vertical rise over a measured horizontal distance. The lay of the ruler indicates aspect which was recorded in degrees (e.g., north is 0º, east is 90º). Elevation was read directly from topographic map having 40 feet contour intervals.

Floristic composition of occupied sites was compared using coefficient of community and percentage similarity (Whittaker 1975:118). Coefficient of community expresses similarity in terms of presence and absence of plant species within pairs of sites. Percentage similarity is based on importance values of species within pairs of samples. Importance values for each plant species in this study were calculated as the percentage of sites it occurred on within each of 5 vole population areas.

All confidence intervals and means testing for this report used the probability of a Type I error as 0.10. Means were compared using Excel's Analysis ToolPak© (t-test assuming unequal variances). The null hypotheses were that means were equal; the alternative hypotheses, they were unequal.

SPECIMEN COLLECTION

Populations with highest priority for trapping were those that had earlier, but incomplete, genetic analyses. Next highest were historical, but untested, populations. Newly discovered populations received the lowest priority. The goal was to obtain a total genetic sample of 10 individuals from each population area, combining current samples with past samples.

Voles were captured with Sherman live-traps (23 x 8 x 9 cm) placed in runways. Trapping effort lasted until a target number of voles had been caught within a population area. Traps were baited with rolled oats mixed with peanut butter and had polyester batting added to prevent hypothermia of trapped animals (Kime 1994). Nearby sites were trapped concurrently with traps checked twice each day.

All small mammal captures were documented on standardized data forms. At each site, species, sex, weight (g), and lengths (mm) of right hind foot, right ear, tail, and total body were collected and recorded. Voles weighing 17 g or less were classified as juveniles, individuals weighing 18 to 25 g were classified as subadults, and individuals weighing 26 g or more were classified as adults. Reproductive status also was recorded (e.g., lactation, testes enlargement). Female voles showing evidence of pregnancy or lactation and individuals of non-target species were released unharmed at the capture site. Releases quickly followed the collection and recording of the necessary data.

Up to 10 individuals from each population area were euthanized and stored frozen for genetic testing. Carbon dioxide was used for euthanasia, conforming with recommendations of the American Veterinary Medical Association Panel on Euthanasia (Andrews et al. 1993) and the requirements of the Animal Welfare Act (7 USC 2131 et seq.).

Tags were attached to individual specimens and included specimen number, date and time of capture, sex and age, measurements, site name, and site coordinates. After tagging, specimens were placed in individual plastic bags and duplicate capture data were recorded on the outside of the bag using permanent ink. All bagged specimens were immediately placed in a waterproof container surrounded by ice. Upon arriving at the base camp, specimens were frozen.

RESULTS

VOLE SITE SEARCHES

From May 27 to July 20, 1998, field personnel found and evaluated 42 sites in the PNF vicinity (Figure 1). Occupancy was determined by presence of grass clippings (100% of sites), runways (95%), burrows (95%), and scat (93%) (Table 1). Free-ranging voles were observed only once during site searches.

Occupied sites were found at elevations ranging from 1579 to 2432 m ($0 = 2003 \pm 53$ m) and occurred on flat areas and on hillsides having 10 to 48 percent slopes ($0 = 22 \pm 3$ %). The flat areas (36%) were mostly associated with meadows and riparian areas and had no measurable aspects on topographic maps. Twenty-four percent of sites had north aspects (315°-45°), 19% had east aspects (45°-135°), and 17% had south aspects (135°-225°). Few sites (5%) were found on west aspects (225°-315°), likely the driest slopes in mountain ranges.

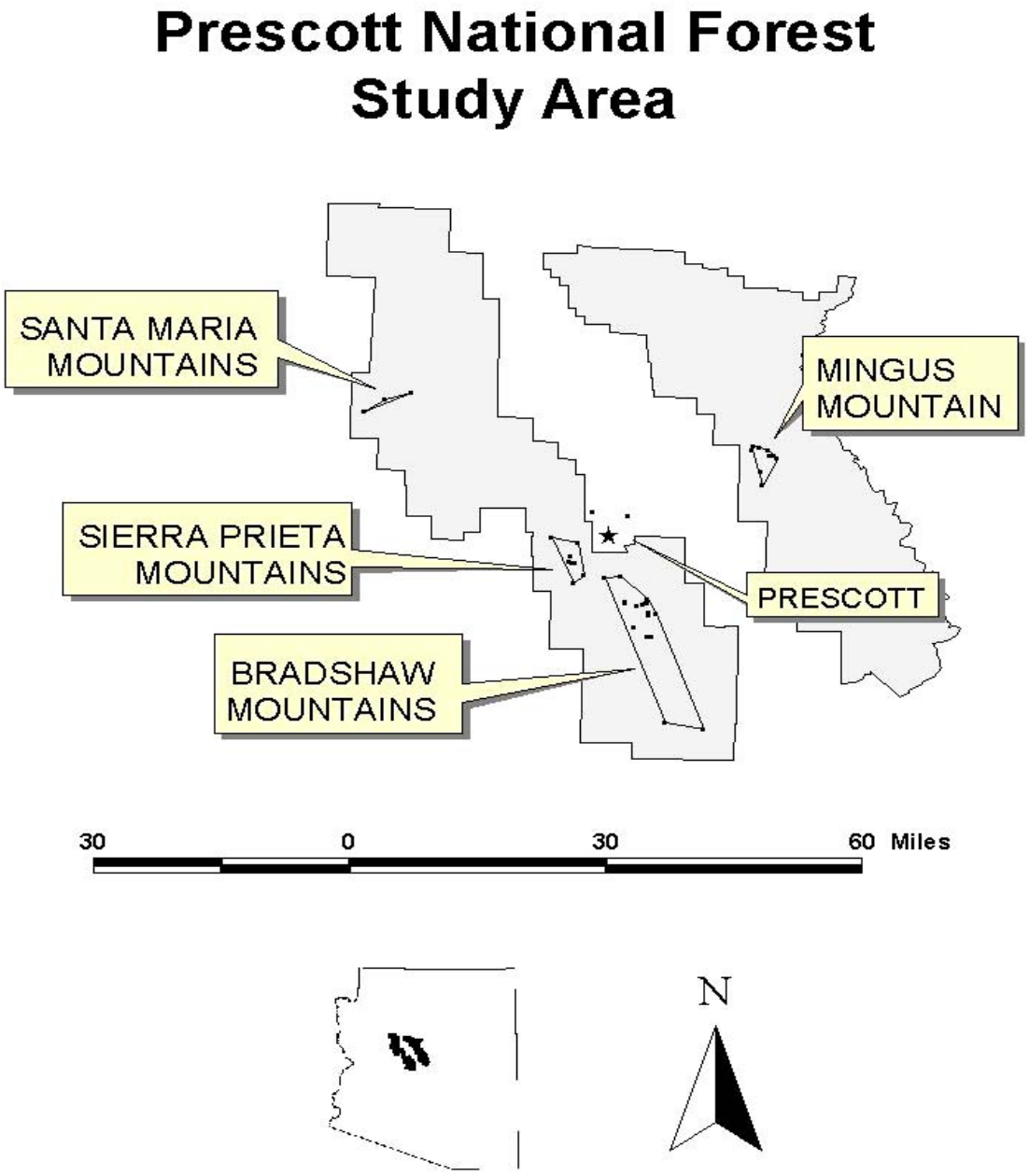

Figure 1. Vole population areas in and near Prescott National Forest.

Table 1. Occupied vole sites visited by AGFD in the Prescott National Forest, 1998.

Site Name	Township, Range, Section, Quarter, Quarter-quarter	Vole Sign[1]	Elevation (m)	Slope (%)	Aspect (°)
BRADSHAW MOUNTAINS (n=18)					
Five Corners, Lower	[redacted]	BCRSO	2069	20	350
Five Corners, Upper	[redacted]	BCRS	2097	15	150
Cattle Marsh	[redacted]	BCRS	1731	Flat	-
Goodwin (Beanbag)	[redacted]	BCRS	1695	Flat	-
Fuelbreak – Stand 16	[redacted]	BCRS	1935	10	330
Vole Road	[redacted]	BCRS	2100	20	130
Dandrea Ranch	[redacted]	BCRS	1975	30	120
Bullchip	[redacted]	BCRS	1951	44	5
Corral Spring	[redacted]	BCRS	1877	20	80
Lost Leaf	[redacted]	BCRS	2088	20	120
Borderline	[redacted]	BCRS	2222	30	280
Yarrow	[redacted]	BCRS	2063	10	60
Mount Union Tower	[redacted]	BCS	2432	30	200
The Furrows	[redacted]	BCRS	2121	39	350
The Graveyard	[redacted]	BCRS	2109	35	320
Spence Spring	[redacted]	BCRS	1780	35	50
Turkey Tank	[redacted]	BCRS	1935	Flat	-
Gold Lode	[redacted]	CR	1749	10	110
MINGUS MOUNTAIN (n=10)					
Butterfly Spring	[redacted]	BCRS	2255	15	145
Butterfly Spring, High	[redacted]	BCRS	2262	15	145
Elks Well	[redacted]	BCRS	2316	15	350
Meadowfinger	[redacted]	BCRS	2332	Flat	-
Powerline Tanks	[redacted]	BCRS	2164	Flat	-
Hickey Mountain Tanks	[redacted]	BCRS	2179	Flat	-
Mingus Springs Camp Tank	[redacted]	BCS	2060	10	340
Mingus Springs Camp	[redacted]	BCRS	1987	10	220
Birdtrap	[redacted]	BCRS	2188	Flat	-
Mingus Nature Preserve	[redacted]	BCRS	2298	Flat	-
PRESCOTT (n=2)					
Williamson Valley	[redacted]	CR	1591	15	200
Watson Woods	[redacted]	BCRS	1579	Flat	-
SANTA MARIA MOUNTAINS (n=3)					
Camp Wood	[redacted]	BCRS	1725	Flat	-
Paddock Place	[redacted]	BCRS	1798	Flat	-
Connels Gulch	[redacted]	BCRS	1768	Flat	-
SIERRA PRIETA MOUNTAINS (n=9)					
Four Corners	[redacted]	BCRS	2060	20	175
Catclaw	[redacted]	BCRS	2079	20	340
Camp Tepeyac, Lower	[redacted]	BCRS	2073	15	45
Camp Tepeyac, Upper	[redacted]	BCRS	2021	Flat	-
Indian Creek	[redacted]	BCRS	1817	48	10
Mount Francis Historic	[redacted]	BCRS	2109	25	280
Copper Creek	[redacted]	BCR	1646	Flat	-
Spruce-Porter Wash	[redacted]	BCRS	2048	20	50
Butte Creek	[redacted]	BCRS	1850	Flat	-

[1] Vole signs observed on-site: B=burrows, C=grass clippings, R=runways, S=scat, O=voles observed (excludes trapped animals).

SITE CHARACTERISTICS

Characteristics of occupied vole sites were measured and recorded between August 3 and August 25, 1998. Ground surface characteristics are given in Table 2. Most sites (86%) had soil substrates, but a few had a soil and rock mix. No sites had gravel or rock substrates. Litter was present at all sites and consisted of herbaceous material only (71%), herbaceous material combined with deciduous leaves (19%), deciduous leaves only (7%), or conifer needles (2%). The median for both substrate and litter cover was in the 6-25% category, with nearly all sites having <50% cover of each. Litter depth ranged from 1 to 5 cm ($\bar{0}$ = 1.9 ± 0.2 cm). Fifty-nine percent of sample quadrats contained vole runways ($\bar{0}$ = 100.5 ± 12.4 cm/m^2).

There were at least 22 species of grasses or grass-like plants, 32 forbs, 7 shrubs, and 13 trees identified in sample quadrats (Appendix A). Four grasses and 3 forbs were identified to genus only. Two trees, Gambel oak and New Mexico locust, were sometimes measured as shrubs if they were small, multi-stemmed, and growing in thickets. The most common species were western yarrow (36% of sites), Gambel's oak (33%), New Mexico locust (29%), an unknown brome (24%), Fendler ceanothus (21%), yellow nut-grass (21%), and an unknown geranium (21%). The remaining species occurred on less than 20% of the sites.

Sites showed little similarity in plant species composition. Only 414 out of 861 (48%) possible pairs had species in common. Of those, only 25 pairs had coefficients of community ≥0.50, i.e., half or more of species occurred at both sites. One pair from the Bradshaw Mountains had an identical composition of 3 species (1.0 coefficient of community).

The Bradshaw Mountains, Sierra Prieta Mountains, and Mingus Mountain were the most floristically similar population areas (36-50% similarity). The Santa Maria Mountains were less similar to the Bradshaw and Sierra Prieta Mountains (12-17% similarity). The Prescott area had the least similarity with any other population area (≤10% similarity).

All 42 sites had grass or grass-like cover present (Table 3). Thirty-eight sites (90%) had forb cover, 29 sites (69%) had shrub cover, and 22 sites (52%) had tree cover. Median grass cover was 50-75% with heights from 7 to 105 cm ($\bar{0}$ = 49.9 ± 6.1 cm). Median forb cover was 6-25% with heights from 5 to 135 cm ($\bar{0}$ = 45.7 ± 8.7 cm). Shrub cover ranged from 1 to 87% ($\bar{0}$ = 34.6 ± 8.1%) with heights from 31 to 457 cm ($\bar{0}$ = 98.0 ± 25.7 cm). Tree basal area was <1% ($\bar{0}$ = 0.2 ± 0.1%).

Characteristics of dead woody cover on occupied vole sites are given in Table 4. Thirty-six percent of the sites had logs and/or stumps present and 24% had brushpiles. Brushpiles provided 0.7 to 14.5% cover ($\bar{0}$ = 3.8 ± 2.1% cover) and all were old, having little or no bark left on stems. Logs and stumps provided 0.6 to 6.1% cover ($\bar{0}$ = 0.9 ± 0.6% cover). Most (69%) of the logs were middle aged or older (age classes 3 to 5).

Table 2. Substrate, litter and runway characteristics of occupied vole sites in the Prescott National Forest, 1998.

Site Name	Substrate		Litter			Runway Length (cm)
	% Cover	Type	% Cover	Type	Depth (cm)	
BRADSHAW MOUNTAINS						
Five Corners, Lower	25-50	Soil	6-25	Herbaceous	2	92
Five Corners, Upper	50-75	Soil	25-50	Herbaceous	1	-
Cattle Marsh	6-25	Soil	6-25	Herbaceous-Deciduous	2	-
Goodwin (Beanbag)	0-6	Soil	0-6	Herbaceous	1	100
Fuelbreak – Stand 16	0-6	Soil	6-25	Herbaceous	1	100
Vole Road	0-6	Soil	6-25	Herbaceous	2	180
Dandrea Ranch	25-50	Soil-Rock	6-25	Herbaceous-Deciduous	3	65
Bullchip	25-50	Soil	25-50	Herbaceous-Deciduous	2	90
Corral Spring	25-50	Soil	25-50	Herbaceous-Deciduous	1	35
Lost Leaf	25-50	Soil	6-25	Herbaceous	1	-
Borderline	50-75	Soil-Rock	0-6	Herbaceous	1	82
Yarrow	25-50	Soil-Rock	50-75	Herbaceous	3	-
Mount Union Tower	50-75	Soil-Rock	50-75	Deciduous	1	-
The Furrows	6-25	Soil	6-25	Deciduous	2	110
The Graveyard	25-50	Soil	25-50	Herbaceous-Deciduous	2	122
Spence Spring	0-6	Soil	6-25	Herbaceous	2	-
Turkey Tank	6-25	Soil	0-6	Herbaceous	1	35
Gold Lode	0-6	Soil	0-6	Herbaceous	1	-
MINGUS MOUNTAIN						
Butterfly Spring	6-25	Soil	6-25	Herbaceous	1	36
Butterfly Spring, High	0-6	Soil-Rock	0-6	Herbaceous	2	-
Elks Well	0-6	Soil	0-6	Herbaceous	2	-
Meadowfinger	6-25	Soil	25-50	Herbaceous	1	100
Powerline Tanks	25-50	Soil	6-25	Herbaceous	3	135
Hickey Mountain Tanks	50-75	Soil	25-50	Herbaceous	4	-
Mingus Springs Camp Tank	6-25	Soil	6-25	Herbaceous	2	-
Mingus Springs Camp	25-50	Soil	25-50	Herbaceous	2	100
Birdtrap	6-25	Soil	0-6	Herbaceous	2	180
Mingus Nature Preserve	6-25	Soil	6-25	Herbaceous	1	100
PRESCOTT						
Williamson Valley	6-25	Soil	0-6	Herbaceous	4	-
Watson Woods	0-6	Soil	6-25	Herbaceous-Deciduous	1	-
SANTA MARIA MOUNTAINS						
Camp Wood	6-25	Soil	25-50	Herbaceous	2	89
Paddock Place	25-50	Soil	25-50	Herbaceous-Deciduous	3	139
Connels Gulch	0-6	Soil	0-6	Herbaceous	1	-
SIERRA PRIETA MOUNTAINS						
Four Corners	75-94	Soil	6-25	Herbaceous	2	-
Catclaw	0-6	Soil	94-100	Coniferous	5	100
Camp Tepeyac, Lower	25-50	Soil	6-25	Herbaceous	2	55
Camp Tepeyac, Upper	0-6	Soil	0-6	Herbaceous	2	145
Indian Creek	50-75	Soil	50-75	Deciduous	2	82
Mount Francis Historic	25-50	Soil-Rock	6-25	Herbaceous	1	117
Copper Creek	0-6	Soil	0-6	Herbaceous	2	-
Spruce-Porter Wash	50-75	Soil	50-75	Herbaceous-Deciduous	2	-
Butte Creek	0-6	Soil	0-6	Herbaceous	1	124

Table 3. Vegetation cover characteristics of occupied vole sites in the Prescott National Forest, 1998.

Site Name	Grass		Forb		Shrub		Tree
	% Cover	Height (cm)	% Cover	Height (cm)	% Cover	Height (cm)	% Cover
BRADSHAW MOUNTAINS							
Five Corners, Lower	25-50	67	50-75	97	23.3	71.3	-
Five Corners, Upper	94-100	68	6-25	55	33.9	57.0	<1
Cattle Marsh	25-50	43	6-25	104	-	-	1.2
Goodwin (Beanbag)	50-75	39	50-75	33	-	-	<1
Fuelbreak – Stand 16	75-94	86	0-6	25	47.1	175.0	<1
Vole Road	94-100	83	0-6	-	31.4	59.5	<1
Dandrea Ranch	25-50	29	0-6	5	87.0	90.0	<1
Bullchip	50-75	95	0-6	30	26.9	68.0	<1
Corral Spring	25-50	78	50-75	68	66.6	74.0	-
Lost Leaf	75-94	105	0-6	-	26.9	54.0	<1
Borderline	50-75	44	6-25	39	57.9	126.7	<1
Yarrow	0-6	23	75-94	54	56.6	65.2	-
Mount Union Tower	6-25	16	6-25	27	43.9	99.0	-
The Furrows	6-25	63	75-94	11	17.5	86.0	<1
The Graveyard	50-75	27	6-25	44	39.9	78.5	<1
Spence Spring	75-94	44	6-25	60	-	-	<1
Turkey Tank	94-100	48	0-6	-	-	-	-
Gold Lode	94-100	25	0-6	130	1.0	64.0	-
MINGUS MOUNTAIN							
Butterfly Spring	50-75	63	25-50	60	2.4	31.0	<1
Butterfly Spring, High	0-6	66	6-25	64	4.5	59.5	-
Elks Well	94-100	86	0-6	40	-	-	-
Meadowfinger	6-25	42	50-75	16	2.2	62.0	<1
Powerline Tanks	25-50	36	50-75	27	-	-	-
Hickey Mountain Tanks	6-25	66	25-50	46	48.3	457.0	-
Mingus Springs Camp Tank	25-50	72	6-25	10	-	-	-
Mingus Springs Camp	6-25	83	6-25	54	9.4	111.0	-
Birdtrap	50-75	63	6-25	17	-	-	-
Mingus Nature Preserve	75-94	59	0-6	26	-	-	-
PRESCOTT							
Williamson Valley	75-94	80	25-50	135	30.2	300.0	-
Watson Woods	75-94	47	6-25	115	-	-	<1
SANTA MARIA MOUNTAINS							
Camp Wood	94-100	46	0-6	24	-	-	-
Paddock Place	50-75	23	25-50	48	1.5	123.0	1.2
Connels Gulch	75-94	26	0-6	-	-	-	-
SIERRA PRIETA MOUNTAINS							
Four Corners	0-6	7	0-6	12	14.4	95.3	-
Catclaw	0-6	31	6-25	17	73.8	56.6	<1
Camp Tepeyac, Lower	25-50	17	50-75	65	13.6	60.0	<1
Camp Tepeyac, Upper	94-100	35	0-6	45	1.8	73.0	-
Indian Creek	0-6	26	0-6	36	66.7	56.7	-
Mount Francis Historic	25-50	30	0-6	20	80.9	63.2	<1
Copper Creek	94-100	44	25-50	36	-	-	<1
Spruce-Porter Wash	0-6	17	0-6	5	78.4	31.0	<1
Butte Creek	50-75	50	25-50	37	16.3	95.0	<1

Table 4. Dead woody cover characteristics of occupied vole sites in the Prescott National Forest, 1998. Only sites with brushpiles, logs or stumps within quadrats are listed.

Site Name	Brushpiles		Logs and Stumps	
	% Cover	Bark Condition	% Cover	Age Class[1]
BRADSHAW MOUNTAINS				
Dandrea Ranch	4.7	Absent	1.2	5
Bullchip			<1	4
Corral Spring			<1	2
Borderline			<1[2]	3
Yarrow	7.5	Trace	<1[2]	1
Mount Union Tower			<1	3
The Graveyard	1.1	Absent	<1	5
Spence Spring			6.1	3
Turkey Tank			<1	2
MINGUS MOUNTAIN				
Mingus Springs Camp	14.5	Trace		
Birdtrap	1.8	Trace	<1	1
SANTA MARIA MOUNTAINS				
Paddock Place	2.8	Trace	1.8	3
SIERRA PRIETA MOUNTAINS				
Catclaw	1.1	Absent	<1	4
Camp Tepeyac, Lower	1.3	Trace	<1	4
Camp Tepeyac, Upper	<1	Trace		
Spruce-Porter Wash			<1	3
Butte Creek	2.1	Trace	<1	2

[1] 1 = bark intact, twigs present, intact texture, round shape, log elevated on support points; 2 = bark intact, twigs absent, intact to partly soft texture, round shape, log elevated but sagging; 3 = traces of bark, twigs absent, hard large pieces, round shape, log sagging near ground; 4 = bark absent, twigs absent, small soft pieces, round to oval shape, log on ground; 5 = bark absent, twigs absent, soft powdery texture, oval shape, log on ground (after Maser et al. 1979).
[2] no logs, stumps only.

SPECIMEN COLLECTION

Live traps were used from July 20 to November 6, 1998, and voles were captured at 10 out of 14 sites (Table 5). Twenty-nine voles were captured during 485.5 trap-days (16.7 trap-days per vole). Department personnel captured and retained 24 voles from the Prescott National Forest (PNF) area (7 from the Sierra Prieta Mountains, 3 from Mingus Mountain, 6 from the Bradshaw Mountains and 8 from Watson Woods). Five other voles were captured on Mingus Mountain and released.

Brush mice (*Peromyscus boylii*) also were captured in the Sierra Prieta (n = 4) and Bradshaw (n = 2) Mountains. All were released. In the Bradshaw Mountains, crewmembers were unable to identify one captured *Peromyscus* to species and another animal escaped before it was identified. An unknown number of deer mice (*Peromyscus maniculatus*) was caught and released at Watson Woods. Efforts to catch voles there were hampered because traps routinely caught this non-target species.

Table 5. Summary of trapping effort in the Prescott National Forest area, 1998.

Site	Dates	Hours	# Traps	Trap Days[1]	Captures[2]	Males			Female		Unknown	
						J	SA	A	SA	A	J	A
BRADSHAW MOUNTAINS												
Five Corners Lower	7/29-7/30	17.0	25	17.7	1/0/0/1			1				
Five Corners Upper	7/29-7/30	16.5	25	17.2	3/0/0/3			1	1	1		
Cattle Marsh	7/21-7/22	20.0	10	8.3	0/0/0/0							
Goodwin	7/21-7/22	20.0	30	25.0	2/0/0/2			1	1			
Turkey Tank	8/19-8/20	17.5	25	18.2	0/0/0/0							
MINGUS MOUNTAIN												
Butterfly Spring	7/20-7/21	20.0	10	8.3	0/0/0/0							
Mingus Nature Preserve	7/20-7/21	20.0	40	33.3	8/5/0/3		1[3]	3[4]		4[4]		
PRESCOTT												
Watson Woods	10/27-10/29	41.0	40	17.1	3/0/0/3			2		1		
Watson Woods	11/2-11/6	91.0	49	185.8	5/0/0/5			1		2	1	1
Watson Woods	11/4-11/6	45.0	8	15.0	0/0/0/0							
SIERRA PRIETA MOUNTAINS												
Catclaw	7/27-7/28	19.0	10	7.9	1/0/0/1				1			
Catclaw	8/3-8/6	66.0	10	27.5	1/0/1/0					1[5]		
Catclaw	8/3-8/4	17.0	10	7.1	0/0/0/0							
Camp Tepeyac Lower	8/4-8/6	50.5	10	21.0	0/0/0/0							
Camp Tepeyac Lower	7/20-7/21	24.0	10	10.0	4/0/0/4	2		1		1		
Camp Tepeyac Upper	7/20-7/22	48.0	10	20.0	0/0/0/0							
Camp Tepeyac Upper	8/6	4.0	5	0.8	0/0/0/0							
Mt. Francis Historic	7/27-7/28	18.0	5	3.7	0/0/0/0							
Cooper Creek	8/5-8/6	22.5	5	4.7	0/0/0/0							
Cooper Creek	8/4-8/6	47.0	10	19.6	1/0/0/1					1		
Spruce-Porter Wash	7/28-7/29	20.5	20	17.1	0/0/0/0							
Sum				485.5	29/5/1/23	2	1	10	3	11	1	1

[1] One trap-day equals 1 trap set for 24 hours. [2] Total caught/released/mortalities/collected live. [3] Released. [4] 2 released. [5] Trap mortality.

No significant differences in mean body lengths of adult male (n = 10), adult female (n = 11) and subadult female (n = 3) voles were observed. Body lengths were from 98 to 148 mm (0 = 128.2 ± 3.7 mm). Juvenile males (n = 2) were shorter, having lengths from 88 to 90 mm (0 = 89.0 ± 1.2 mm). No significant difference in mean tail length of adult male and females was observed. Tail lengths were from 26 to 38 mm (0 = 30.2 ± 1.1 mm). Subadult females had shorter tails, ranging from 26 to 28 mm (0 = 26.7 ± 0.9 mm). Juvenile males had the shortest tails (both 20 mm long).

Mean right hind foot length was not significantly different among adult males, juvenile males, adult females, and subadult females. Foot lengths were from 13 to 22 mm (0 = 19.0 ± 0.6 mm). No significant difference was observed in mean right ear length of adult male, adult female, and subadult female voles. Ear lengths were from 8 to 20 mm (0 = 12.4 ± 0.7 mm). No ear length measurements were taken from juvenile males.

Since body weight was used to assign individuals to age classes, we expected that there would be significant differences in mean weight. However, mean adult male and adult female weights were not significantly different. Adults weighed 26.5 to 48 g (0 = 35.9 ± 2.3 mm). Subadult females weighed 23.5 to 24 g (0 = 23.8 ± 0.2 mm). Both juvenile males weighed 13.5 g.

Few voles showed any sign of reproductive activity when captured. Only 3 of 11 (27%) adult females were lactating and 4 of 9 (44%) adult males showed some testicular enlargement. In the Bradshaw Mountains, one adult male had a torn ear and a subadult female had a broken top incisor. One subadult female from the Sierra Prieta Mountains had a heavy infestation of fleas. One juvenile (sex unknown) from Watson Woods was missing its right eye. An adult (sex unknown) from the same location apparently was sick because it was sluggish and was losing clumps of fur.

SUMMARY

Occupied Mexican vole sites were found primarily in moist flat areas such as riparian meadows or on moderate mountain slopes with mesic microclimates. Most sites had soil substrates with herbaceous litter. Grass cover was present at all sites. Most also had forb cover and many had shrub cover. Because occupied sites showed little similarity in plant species composition, species composition does not appear to be as important as the structural arrangement of those plants (i.e., availability of dense cover). Moderate to high-density grass, grass-like plants, or shrubs provided majority of the cover. Forbs, trees, or dead woody materials provided little cover on occupied sites.

A sufficient number of voles were collected from high priority areas to fulfill minimum needs for genetic analyses. However, 2 more are needed from the new Prescott population area. Juveniles and subadults were not well represented in our samples. Also, only about one-third of adults showed sign of sexual activity when trapped.

RECOMMENDATIONS

1) Survey other mountain ranges for potential vole habitat and collect specimens from selected areas for genetic analyses. Continue research involving genetic analyses of *Microtus mexicanus* to substantiate subspecific classifications and range boundaries of these subspecies within Arizona.

2) Specific habitat requirements for HMVs need to be determined. Include measurement of soil moisture and temperature, evaluation of habitat structural requirements, determination of fire history, and long-term monitoring of known HMV sites to clarify the role of succession in habitat suitability.

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Appendix A. Plant species found on occupied vole sites in the Prescott National Forest area, 1998.

Taxonomic Name	Common Name	Plant Present[1]					% Sites
		BR	MM	PR	SM	SP	
GRASSES AND GRASS-LIKES (n=18)							
Agropyron smithii	Western wheatgrass		X				5
Bromus inermis	Smooth brome	X					12
Bromus spp.	Brome	X	X			X	24
Carex eleocharis	Sedge					X	2
Carex spp.	Sedge	X	X			X	17
Cyperus esculentus	Yellow nut-grass	X				X	21
Dactylis glomerata	Orchardgrass	X					7
Elymus elymoides	Squirreltail	X	X			X	12
Equisetum laevigatum	Smooth scouringrush			X	X		5
Eragrostis curvula	Weeping lovegrass	X	X				19
Hordeum jubatum	Foxtail barley		X				10
Juncus spp.	Rush				X		2
Koeleria cristata	Prairie junegrass	X					2
Medicago sativa	Alfalfa	X					2
Phleum spp.	Timothy		X		X		5
Poa spp.	Bluegrass		X	X		X	12
Sorghum halepense	Johnson grass		X				2
Sporobolus spp.	Dropseed			X			5
FORBS (n=29)							
Achillea lanulosa	Western yarrow	X	X		X	X	36
Ambrosia psilostachya	Western ragweed		X				7
Arnica cordifolia	Heartleaf arnica	X					2
Artemisia frigida	Fringed sagebrush	X				X	10
Asclepias spp.	Milkweed	X	X				5
Aster spp.	Aster		X				2
Cirsium spp.	Thistle	X	X				5
Delphinium occcidentale	Western larkspur		X				2
Erigeron spp.	Fleabane		X				2
Geranium spp.	Geranium	X	X			X	21
Hypericum perforatum	St. Johnswort		X				5
Iris missouriensis	Rocky Mountain iris		X				2
Lepidium spp.	Pepperweed					X	2
Lotus spp.	Vetch	X					5
Lupinus spp.	Lupine	X	X		X	X	12
Medicago lupulina	Black medic	X	X		X	X	14
Melilotus officinalis	Yellow sweet clover	X	X	X		X	10

Taxonomic Name	Common Name	Plant Present[1]					% Sites
		BR	MM	PR	SM	SP	
FORBS CONTINUED							
Mentha spp.	Mint		X				2
Nepeta cataria	Catnip				X		2
Oxalis corniculata	Creeping woodsorrel	X					5
Portulaca oleracea	Common purslane	X				X	7
Ranunculus repens	Creeping buttercup				X		2
Rumex crispus	Curly dock	X	X	X		X	12
Salsola iberica	Russian thistle		X				2
Sphaeralcea coccinea	Red globe-mallow		X				2
Taraxacum officinale	Common dandelion		X				2
Thalictrum fendleri	Fendler's meadow-rue	X				X	14
Thlaspi spp.	Pennycress	X					2
Verbascum thapsus	Common mullein	X	X		X		12
SHRUBS (n=7)							
Amelanchier utahensis	Utah serviceberry	X					2
Ceanothus fendleri	Fendler ceanothus	X				X	21
Ribes inerme	Whitestem gooseberry				X		2
Rosa fendleri	Fendler's rose					X	2
Rosa spp.	Rose	X				X	5
Salix lasiolepis	Arroyo willow	X		X			5
Symphoricarpos rotundifolius	Roundleaf snowberry	X	X			X	19
TREES (n=13)							
Acer grandidentatum	Bigtooth maple	X					5
Fraxinus spp.	Ash					X	2
Juglans major	Arizona walnut	X				X	5
Juniperus deppeana	Alligator juniper	X				X	7
Juniperus monosperma	One-seed juniper	X					2
Pinus ponderosa	Ponderosa pine	X	X			X	17
Poplus angustifolia	Narrow leaf cottonwood	X			X		5
Populus tremuloides	Quaking aspen					X	2
Pseudotsuga menziesii	Douglas fir	X				X	5
Quercus gambelii	Gambel oak[2]	X	X			X	33
Quercus undulata	Wavy leaf oak	X					2
Robinia neomexicana	New Mexico locust[2]	X	X			X	29
Salix laevigata	Red willow			X			2

[1] BR = Bradshaw Mountains, MM= Mingus Mountain, PR = Prescott, SM = Santa Maria Mountains, SP = Sierra Prieta Mountains.
[2] Treated as a tree when large and having a single stem, otherwise treated as a shrub.