# Riparian Rodent Recovery Plan:
# Meadow Jumping Mouse, *Zapus hudsonius*
# &
# Arizona Montane Vole, *Microtus montanus arizonensis*

April 11, 2008

Photo: J. Morrison

Photo: D-L Crawford and C. Klinger



Prepared by:

Leland J. S. Pierce
Conservation Services Division
New Mexico Department of Game and Fish

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## EXECUTIVE SUMMARY

This is a Recovery Plan for two species of rodents found in riparian habitat in the State of New Mexico, the meadow jumping mouse, *Zapus hudsonius*, and the Arizona montane vole, *Microtus montanus arizonensis*, developed under the authority of the New Mexico Wildlife Conservation Act. The meadow jumping mouse is a federal candidate for listing and is listed as endangered in New Mexico. The Arizona montane vole is listed as endangered in New Mexico. The meadow jumping mouse has very large hindlegs and hindfeet, and a tail accounting for at least sixty percent of its total length. The mouse is orangish and slightly darker on the back than the sides. The Arizona montane vole has a blunt nose, small eyes, short legs, a small, sparsely haired tail and is generally brown in color. In New Mexico, the meadow jumping mouse is found in the San Juan, Sangre de Cristo, Jemez, and Sacramento Mountains, as well as potentially in Catron County adjacent to the White Mountains in Arizona, and along the Rio Grande and Rio Chama drainages. In New Mexico, the Arizona montane vole is found only in a small area in Catron County. Both species use high vegetation for protection from predators, and the meadow jumping mouse may climb through the upper portions of the vegetation, while the Arizona montane vole makes use of tunnel runways for movement. For the meadow jumping mouse, riparian areas with tall, dense vegetation, particularly sedges, with damp to wet soils constitutes good habitat, whereas good habitat for the Arizona montane vole also includes damp to wet soils, with tall vegetation such as grasses, forbs, and rushes. Necessary vegetation is not as tall for the vole as the jumping mouse, and the vole can make use of habitat around seeps where the jumping mouse does not. The presence of beavers is useful in maintaining habitat for both species. The meadow jumping mouse eats primarily seeds and insects, whereas the Arizona montane vole is a grass eater. The meadow jumping mouse may produce two litters per year in lower elevation but only one in montane populations. The Arizona montane vole is typical of voles in that it can produce three or more litters per year, depending upon the climate. The meadow jumping mouse hibernates up to nine months a year in montane populations, while the Arizona montane vole is active throughout the year. At present there appears to be no use of or demand for either the meadow jumping mouse or the Arizona montane vole, as there is no evidence that either species has been subject to either commercial or recreational collection. A chief economic use of the wet, grassy riparian areas favored by both rodents is for forage for livestock and large ungulates popular with hunters. The water that supports the riparian habitat favored by both rodents is also used for agriculture, as well as diversion for domestic and commercial development. Habitat alteration, such as removal of vegetation from ungulate grazing, loss of beaver, water diversion leading to drying out of habitat, and various recreational activities within the habitat are the chief threats to both species. The meadow jumping mouse has shown a sharp decline in recent years, up to 91 % in the Sacramento Mountain populations, while the status of the Arizona montane vole, beyond its very limited range, is currently unknown. An Advisory Committee was formed to develop the Recovery Plan, and met on January 15, 2008, at the Bosque del Apache National Wildlife Refuge, Socorro County, New Mexico, to formulate the management section. To recover the species, threats to the meadow jumping mouse and the Arizona montane vole, such as improper grazing and water use practices, will be managed to minimize negative impacts to habitat and environmental conditions necessary for population viability in both species. Habitat improvement by land managers and owners will be encouraged, with guidelines developed and funding for such work sought out. Through a cooperative process, private landowners, the State, and any federal stakeholders can work to further the survival of the two riparian rodents found on the stakeholder's property in a positive fashion for the meadow jumping mouse, Arizona montane vole, and the stakeholder.

# 1.0 Introduction

This is a Recovery Plan for two species of rodents found in riparian habitat in the State of New Mexico, the meadow jumping mouse, *Zapus hudsonius*, and the Arizona montane vole, *Microtus montanus arizonensis*, developed under the authority of the New Mexico Wildlife Conservation Act (WCA). The New Mexico Department of Game and Fish (NMDGF) is directed under the Act to develop recovery plans for species listed as threatened or endangered by the State [17-2-40.1 NMSA 1978]. Each recovery plan is to have the following components:

- a strategy to restore and maintain viable populations of the listed species and its habitat, to the extent that the species may be downlisted
- a strategy that mitigates adverse social or economic impacts resulting from recovery actions
- a strategy to identify social or economic benefits and opportunities
- a strategy to use existing resources and funding to implement the overall Recovery Plan.

As directed by the WCA, public information meetings were held on July 24 at the NMDGF northeast area office in Raton, NM, on July 26 at the NMDGF main office in Santa Fe, NM, on July 31 at the Civic Center in Alamogordo, NM, and on August 8, 2007 on the campus of Western New Mexico University in Silver City, NM at the initiation of the process, and an Advisory Committee was formed to develop the Recovery Plan. Please see Appendix 7.1 for listing of all public participation in the Recovery Plan. Members of the Advisory Committee met on January 15, 2008, at the Bosque del Apache National Wildlife Refuge, Socorro County, New Mexico, to formulate the management section of the Recovery Plan. Please see Appendix 7.2 for a list of committee members.

The organization of this Recovery Plan follows Graves (2002). Section 2 includes background information on the natural history, historical perspective, habitat assessment, and potential economic and social impacts of this Plan. Section 3 contains the goal for the recovery of the two riparian rodents, accompanying objective, issues affecting the recovery of the species, and the strategies for addressing those issues. The range of both species is broken into seven Management Units (MU; Figure 1); successful recovery of the species will depend upon meeting objectives within those MU's and statewide. The boundaries for MU's 1, 3, and 4 follow the mountain ranges for the Sangre de Cristo, San Juan, and Jemez Mountains respectively. MU 7 follows the southern half of the Sacramento Mountains, while MU 6 encompasses the San Francisco drainage from which the Arizona montane vole and potentially the meadow jumping mouse are found. MU 2 is composed of lowland habitat around the Rio Grande and Rio Chama down to where the Rio Grande empties into the Cochiti Reservoir, while MU 5 is composed of lowland habitat along the Rio Grande south of the reservoir.

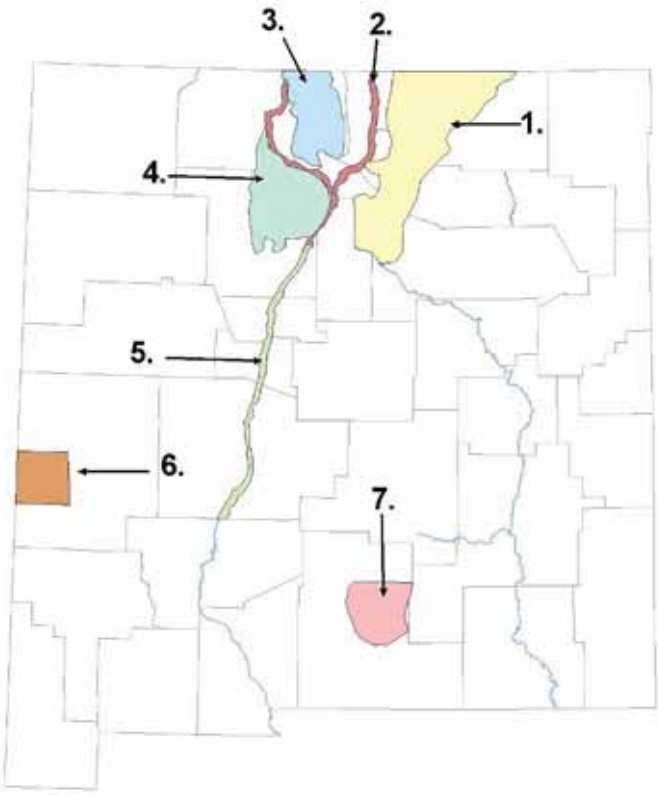


**Figure 1. Riparian Rodent Recovery Plan Management Units:**

1. **Sangre de Cristo**
2. **Upper Rio Grande-Chama**
3. **San Juan**
4. **Jemez**
5. **Middle Rio Grande**
6. **San Francisco**
7. **Sacramento**

## 1.1 RECOMMENDED CITATION

New Mexico Department of Game and Fish. 2008. Riparian rodent recovery plan: Meadow jumping mouse, *Zapus hudsonius*, and Arizona montane vole, *Microtus montanus arizonensis*. New Mexico Department of Game and Fish, Conservation Services Division, Santa Fe, New Mexico. 33 p.

## 1.2 ADDITIONAL COPIES

Additional copies of the Recovery Plan may be obtained from:

New Mexico Department of Game and Fish
P. O. Box 25112
Santa Fe, NM 87504
(505) 476-8101
http://wildlife.state.nm.us/conservation/index.htm

# 2.0 Background

Section 2.0 consists of background information on the distribution, status, habitat requirements, biology, and ecology of the two riparian rodent species. The section also includes economic and social profiles of the region within the range of each of the species. This information provides the basis for assessing current status, threats to persistence, and the most effective strategies for recovery of both the meadow jumping mouse and the Arizona montane vole.

## 2.1 NATURAL HISTORY

Where possible, information that pertains to both species is presented first, followed by the species-specific information that pertains to the meadow jumping mouse and then the Arizona montane vole. The information that is provided generally applies to either rodent at the species level, unless the subspecies is specifically referenced.

### 2.1.1 Taxonomy

General. Both species belong to the rodent order, Rodentia.
Meadow Jumping Mouse. The meadow jumping mouse (*Zapus hudsonius*) belongs to the family Dipodidae, which includes the jerboas, birch mice, and jumping mice (Holden and Musser 2005), although some mammalogists consider the jumping mice a distinct family (Zapodidae). *Zapus hudsonius* is one of three species of *Zapus* found in North America, and one of two species found in New Mexico. The western jumping mouse, *Z. princeps*, occurs in the Rocky Mountains of New Mexico; this species is not listed as endangered or threatened.
At present, eleven subspecies are recognized within the species *Z. hudsonius*. Two forms have been described from New Mexico, both within the Rio Grande Valley: *Z. luteus* from Española, Rio Arriba County (Miller 1911), and *Z. luteus australis* from Socorro, Socorro County (Bailey 1913); the latter form is now considered a synonym of *luteus*. Based on current understanding of this animal, all populations of meadow jumping mice in New Mexico are assigned to the subspecies *Z. hudsonius luteus*, the New Mexico meadow jumping mouse (Frey 2004, Hafner et al. 1981).

There is a long history of taxonomic confusion involving the two species in New Mexico (*Z. hudsonius* and *Z. princeps*), although work by Hafner et al. (1981) and Frey (2006) has helped clarify the relationships between these two similar mice.
Arizona Montane Vole. The Arizona montane vole (*Microtus montanus arizonensis*) belongs to the mice, rat, and vole family (Cricetidae), and is one of eighteen species of the genus *Microtus* found north of Mexico (Musser and Carleton 2005; Pugh et al. 2003). Currently fifteen subspecies are recognized within the species *M. montanus*, with *M. montanus arizonensis* and *M. m. fusus* found in New Mexico (Frey 2004, Pugh et al. 2003). The subspecies *M. m. arizonensis* was described by Bailey (1898) from Springerville, Arizona, and was first discovered in New Mexico at Centerfire Bog, Catron County, in 1978 (Hubbard et al. 1983).

## 2.1.2 Description

Meadow Jumping Mouse. This species of mouse can be recognized by having large hindlegs and hindfeet, and having a tail accounting for a minimum of sixty percent of its total length (Fitzgerald et al. 1994, Figure 2). The meadow jumping mouse has a white venter, and a dorsum that is orangish and slightly darker on the back than the sides. The tail is sparsely haired. Specimens in Arizona were 203 – 229 mm (8.0 – 11.8 in) total length, 123 – 141 mm (4.8 – 5.6 in) tail length, and 29 – 32 mm (1.1 – 1.3 in) hindfoot length (Hoffmeister 1986). In New Mexico, specimens were 194 – 235 mm (7.6 – 9.3 in) total length, 114 – 145 mm (4.5 – 5.7 in) tail length, and 28 – 34 mm (1.1 – 1.3 in) hind foot length (Frey 2005c). Upper incisor teeth have a distinct anterior groove and are orange. Female jumping mice have eight mammae.

**Figure 2. Meadow jumping mouse, illustrating the large hind feet indicative of the species. Photograph by Jennifer K. Frey.**

Distinguishing between the meadow jumping mouse and the western jumping mouse (*Z. princeps*) is difficult. While the meadow jumping mouse is orangish in color the western jumping mouse is more of a dull yellow-brown; the meadow jumping mouse also lacks a "racing stripe" of darker hairs on the dorsum and a white border to its ear, both prevalent in the western jumping mouse. The ranges of the two species likely only overlaps in New Mexico in the Sangre de Cristo and San Juan Mountain ranges (Frey 2004, 2005c).

Arizona Montane Vole. Like most voles, the Arizona montane vole has a blunt nose, small eyes, short legs, and a small, sparsely haired tail (Figure 3). A medium-sized vole, the species is generally brown in color, with pale sides and black hairs tipped with white on the venter (Hoffmeister 1986, Sera and Early 2003). The tail usually measures 30 – 39 percent of the length of the body, and is bicolored, black over gray (Hoffmeister 1986). In Arizona, specimens were 124 – 180 mm (4.9 – 7.1 in) total length, 34 – 48 mm (1.3 – 1.9 in) tail length, and 19 – 22 mm (0.8 – 0.9 in) hindfoot length (Hoffmeister 1986). In New Mexico, specimens were 109 – 181 mm (4.3 – 7.1 in) total length, 24 – 48 mm (1.0 – 2.0 in) tail length, and 15 – 23 mm (0.6 – 0.9 in) hindfoot length (Frey 2005a). Females have eight mammae.

Whereas voles can be easily distinguished from most other rodents by their blunt nose and short ears, differentiating between species of voles is more difficult (Frey 2005a, c). Two other species, The long-tailed vole (*M. longicaudus*), and the Mogollon vole (*M. mogollonensis*) occur in the same portion of New Mexico as the Arizona montane vole, and can be confused with the Arizona

montane vole. The long-tailed vole has a proportionately longer tail than the montane vole, accounting for one third or more of the long-tailed vole's total length, whereas the tail of adult Mogollon voles do not generally reach 35 mm (1.4 in) in length, unlike adult montane voles (Frey 2005c, Figure 8). The incisive foramina (paired longitudinal holes in the upper palate) of the montane vole is more constricted posteriorly than that of the Mogollon vole (Hoffmeister 1986).

**Figure 3. Montane vole. Photograph by Dolly-Lynn Crawford and Christy Klinger.**

## 2.1.3 Distribution

Meadow Jumping Mouse. **Historic**. Fossil records are known for this species from Kansas, Oklahoma, and Tennessee, with ancestral stock for the meadow jumping mouse likely stemming from *Z. sandersi rexroadensis* (Whitaker Jr. 1972). In New Mexico the species was reported from the San Juan, Sangre de Cristo, Jemez, and Sacramento Mountains, with localities also along the Rio Grande Valley between the Bosque del Apache National Wildlife Refuge and Espanola, the species likely having gained access to southern parts of the state during the glacial maxima no later than 10000 YBP (Findley et al. 1975, Hafner et al. 1981). New localities were added for the Rio Peñasco in the Sacramento Mountains, along the Rio Chama, and near Isleta, Española, and the Casa Colorada State Wildlife Area in the Rio Grande Valley, as well as for the Jemez Mountains (Morrison 1992). Relict populations are reported from the White and Mogollon Mountains in Arizona (Hoffmeister 1986). Recent work has determined the species to potentially have had a broad historical distribution in the southern San Juan Mountains region and adjacent river valleys, including the Chama and San Juan river drainages (MU's 3 and 2; J. Frey, personal communication).

**Current**. The meadow jumping mouse is a wide ranging species, occurring from Alaska to Labrador, southward to British Columbia, through Montana down to New Mexico, eastward through northern Oklahoma to Alabama and Georgia, and throughout the mid-western and eastern United States (Hall, 1981). Recent surveys throughout New Mexico determined the meadow jumping mouse to be persisting at 6 locations in the Jemez Mountains (MU 4), 2 in the Sangre de Cristo Mountains (MU 1), and 2 isolated populations in the Sacramento Mountains (MU 7), but overall populations of this species are in severe decline (Frey 2005b, see Section

2.2.2, Population Trends). The species has recently been discovered at Coyote Creek State Park, Mora County, as well as at Sugarite Canyon State Park, Colfax County (MU 1; Frey 2006). A report of the meadow jumping mouse occurring near Williams Lake in Taos County, within the Sangre de Cristo Mountain range, has not been confirmed in recent years (Hafner et al. 1981). The species might be found in Catron County, given the relict populations in the White Mountains in nearby Arizona (Frey 2004, Figure 4). The species was found at the Bosque del Apache National Wildlife Refuge (MU 5; Zwank et al. 1997).

Arizona Montane Vole. **Historic**. Fossil records for the montane vole (*Microtus montanus*) are known from Arizona, Colorado, Idaho, Kansas, Nevada, New Mexico, Oregon, Texas, Utah, and Wyoming, as well as Canada (Sera and Early 2003). Ancestral stock for the species likely stems from a lineage of *M. paroperarius – M. pennsylvanicus* or another New World lineage (Hoffmann and Koepple 1985, Zakrzewski 1985, Sera and Early 2003). The subspecies *M. m. arizonensis* is only known in Arizona from the White Mountains (Hoffmeister 1986). In New Mexico the Arizona montane vole was first found at Centerfire Bog in Catron County (Hubbard et al. 1983), and later in 1994 along Jenkins Creek, also in Catron County (Frey et al. 1995). All New Mexico localities of the Arizona montane vole lie within the drainage basin of the San Francisco River. Putative historic records of montane vole from Upper Nutria, McKinley County and other sites in Catron County outside of the San Francisco River drainage are apparently based on misidentified specimens of *Microtus* (Frey 2005a).

**Current**. The montane vole is also a wide-ranging species, occurring from British Columbia and Montana to east-central California, Arizona, and New Mexico (Hall, 1981, Sera and Early 2003). In New Mexico, the species is most widely distributed in the San Juan and Jemez mountains, but the subspecies *M. m. arizonensis* is geographically isolated from those more northern populations (Frey 2004, Findley et al., 1975, See Figure 5). Recent surveys confirmed that within New Mexico the Arizona montane vole likely only occupies a triangle of 14.5 by 19.3 by 16.9 km (9.0 by 12.0 by 10.5 mi), from Jenkins Creek in Catron County, south along the Arizona border, and east to Centerfire Bog (Frey 2005a, see Section 2.2.2, Population Trends, Figure 4).

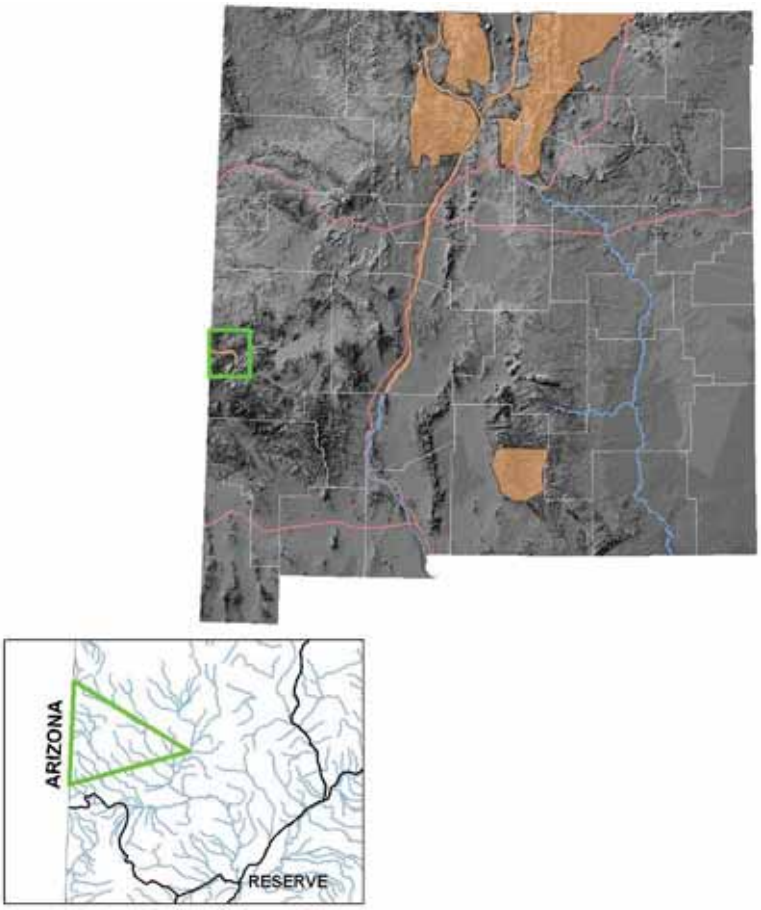


**Figure 4. Current distribution of Meadow jumping mouse (tan shading) and Arizona montane vole (green square) in New Mexico. Smaller figure proposed range (green triangle) for the Arizona Montane Vole in Catron County, NM (Frey 2005a).**

**Figure 5. Overall range for the montane vole (*Microtus montanus*), with the separation of the Arizona montane vole from the overall population (Patterson et al. 2005).**

## 2.1.4 Required Habitats

General. Both species of rodents are found in riparian areas that have moist to very wet soils, dense vegetation cover, and usually some form of free-flowing water nearby. A majore aspect of their life history is the vegetation components of the habitat, and less the aquatic aspects (J. Frey, personal communication).
Meadow Jumping Mouse. This species is found in moist grasslands and meadows, often along edges of marshes and near free-flowing water (Quimby 1951, Whitaker 1963, Morrison 1990, Frey 2005b). Within New Mexico, it is restricted to complex riparian habitats, with a key habitat component typically being tall sedges (J. Frey, personal communication). Cover from vegetation allows the mice to move freely without being seen from above by a predator, and very good habitat was deemed those areas with very dense vegetation cover over 0.9 m (3.0 ft) high, with

grasses and forbs dominating the areas where the species was found (Morrison 1989, 1990, Frey 2005b). The meadow jumping mouse has been found above 2100 m (> 6890 ft) in the Jemez and Sacramento Mountains, and at 1200 – 1515 m (3937 – 4971 ft) in the Rio Grande Valley, in all cases within 0.0 – 45.7 m (0.0 – 150.0 ft) of permanent, free-flowing water (Morrison 1990). In the Rio Grande Valley, Morrison (1992) also found the species in irrigation waterways adjacent to agricultural fields. In their study at Bosque del Apache National Wildlife Refuge, Zwank et al. (1997) had the highest capture rates in wetlands in spring, canals and drains in summer, and woodlands in fall. Slopes from roads down to canals were good sites for hibernacula and nests, although mowing and frequent inundation would render such sites uninhabitable (Zwank et al. 1997). Beaver dams and some human-made dams on streams can produce suitable habitat for this species in montane areas, particularly at the most upstream portion of the impoundment where sediment deposition and periodic inundation creates moist soil conditions and herbaceous plant growth (Frey 2006). These conditions were observed at meadow jumping mouse sites at Sugarite Canyon State Park (Frey 2005b). Of note, habitat for populations found in montane regions is likely not the same as for those found in the Rio Grande Valley and such differences warrant further investigation (J. Frey, personal communication).


**Figure 6. Meadow jumping mouse habitat, Jemez Mountains. Note dense stand of sedges and beaver pond and lodge in background Photograph by Dr. Jennifer K. Frey.**

Arizona Montane Vole. In New Mexico, this species was found first at Centerfire Bog in Catron County, in a wet sedge (*Cyperus* spp.) and grass meadow with small patches of cattail (*Typha latifolia*; Hubbard et al. 1983). A subsequent survey found the vole at the upper end of a mesic meadow surrounded by ponderosa pine (*Pinus ponderosa*), and the individual caught was found within microhabitats having significantly higher soil moisture and vertical cover of graminoid (grass) vegetation than surrounding microhabitats (Frey 2005a). Mean stubble height at capture sites was 245.80 mm, SD 67.98 (9.68 in, SD 2.68). One key difference between the Arizona montane vole and the meadow jumping mouse is the former makes use of habitats dominated with rushes (*Juncus* spp.) whereas the latter does not (J. Frey, personal communication). The species can make use of habitat from springs, seeps, and drainages (J. Frey, personal communication). Elevation for the species ranged from 2100 – 2630 m (6890 – 8629 ft; Hubbard et al. 1983, Frey 2005a).

**Figure 7. Arizona montane vole habitat, Catron County. Photograph by Dr. Jennifer K. Frey.**

## 2.1.5 Food Habits

Meadow Jumping Mouse. This species primarily eats seeds and insects. Examination of stomach contents of over seven hundred specimens of meadow jumping mice taken in the state of New York revealed a variety of foods taken (Whitaker 1963). Shortly after hibernation, most foods were insects, with roughly 20 % of the stomach contents being seeds. As the season progressed, more seeds were taken as they became available, particularly grass seeds (*Phleum*, *Anthoxanthum*, *Poa*, *Cerastium*, *Rumex*, *Dactylus*, *Potentilla*, *Oxalis*, *Echinochloa*, *Ulmus*, and *Asclepias* spp.), as well as a fungus (*Endogone* spp.; Whitaker 1963). Fruits, snails, and millipedes are also taken (Fitzgerald et al. 1994, Hoffmeister 1986). Of note, the meadow jumping mouse subspecies, *Z. h. luteus*, may have differing food habits from other subspecies, and warrants further research (J. Frey, personal communication).
Arizona Montane Vole. This species is primarily an herbivore, with up to 85 % of diet coming from leaves and forbs (Vaughn 1974). Grasses account for a small percentage of diet, as do fungi (Sera and Early 2003). In winter more grasses may be taken, as well as bark and twigs, when forbs are less palatable.

## 2.1.6 Behavior

Meadow Jumping Mouse. Although primarily nocturnal or crepuscular, the meadow jumping mouse is also occasionally diurnal in their activity. The species may only be active for four to seven months of the year (Quimby, 1951; Whitaker, 1963). In New Mexico, meadow jumping mice are generally active four to five months (Morrison, 1990), although this activity season may be even shorter at high elevation sites (J.K. Frey, personal communication). For a population studied at Fenton Lake in 1986, the activity period for the species was from mid-June to the first week of October, females emerging from hibernation later than males, and with all but one jumping mouse being captured at night (Morrison 1987). This population seemed more active during cool, wet days, than warm, dry ones. Only young that reach adult size by the time of hibernation survive the winter, with the last two weeks prior to hibernation spent building up fat reserves. The meadow jumping mouse doesn't cache food for the winter (Fitzgerald et al. 1994).

Meadow jumping mice are generally solitary in nature and docile (Whitaker 1963, 1972). Although mostly silent, the species will make some chirping and clucking noises, and will drum their tails when excited (Whitaker 1963).
Arizona Montane Vole. The use of runways under vegetation cover (see Section 2.1.8, Movement) allows the species to be active both diurnally and nocturnally (Hoffmeister 1986). During the heat of summer the voles show a bimodal activity pattern, avoiding the hottest periods of the day (Drabek 1994). Montane voles do not hibernate, and are somewhat active in winter, foraging under snow that is not too hard (Hoffmeister 1986).
Montane voles are territorial, with intense male-male agonistic events occurring just after snowmelt, when territories are established (Sera and Early 2003, Jannett 1980). Males mark territories with urine and feces along portions of their runways.

## 2.1.7 Reproductive Biology

Meadow Jumping Mouse. Reproduction is poorly understood for the species. Females seem to have two litters per year and sometimes three, with four to seven embryos, although only one breeding attempt was identified during studies of a montane population in New Mexico in 1986 (Quimby 1951, Morrison 1987). In the same montane New Mexico population, males had fully developed testes by July, and the peak reproductive period for females was between the third week of July and the third week of August (Morrison 1987). Gestation is 17 to 21 days and weaning 28 to 30 days. Such a long time for gestation and weaning may preclude a second litter in montane populations (Morrison 1987). The young are naked at birth.
Arizona Montane Vole. Reproduction in the montane vole (*Microtus montanus*) has been studied at various localities outside of New Mexico, but little research has been done on populations of the Arizona montane vole. Breeding in the montane vole begins after the spring snowmelt, in April or May, and continues as late as November (Sera and Early 2003, Negus et al. 1992). Females do not exhibit regular estrus cycles, and ovulation is stimulated by contact with males, particularly if enough copulations have been attempted (Sera and Early 2003, Davis et al. 1974, Kenney and Dewsbury 1977). Montane voles breed during their first year after birth. During sexual encounters the male will attempt to contact the female's head or nape, and the female will rear up and slap at the male with her forepaws and a boxing match may ensue before the female accepts copulation (Pierce et al. 1991).
Litter size in the montane vole ranges from 1 – 5 or more in certain cases, with 3 – 4 normally produced in a well-studied population in Utah (Sera and Early 2003, Negus et al. 1986). Litter size increases with each subsequent litter, with 2 – 10 pups per litter (Sera and Early 2003). In New Mexico, a specimen was found with five embryos (Frey et al. 1995). Neonates are born hairless and toothless with eyes and ears closed and toes fused. The eyes open around ten days, and toes separate around 10 to 12 days (Shapiro and Insel 1990). Males and females have separate nests and therefore do not share parental care (Sera and Early 2003, Jannett 1980). Maternal care consists of nursing, brooding, grooming, and retrieval of pups (McGuire and Novak 1986). Unless the population is at a very high density, female montane voles abandon the nest when the pups are fifteen days old to begin making the next nest (Jannett 1978).
In Utah, the first cohort, born usually in May, grow rapidly and are sexually mature within five weeks, living for approximately six months (Negus et al. 1986). A second cohort matures within eight weeks and lives approximately seven months. The third cohort overwinters and is not sexually mature until the following spring, living typically twelve months. A fourth cohort usually does not survive the winter. Vole populations will fluctuate greatly not only from year to year, but in between cohorts, often in response to environmental conditions such as rainfall or drought (Negus et al. 1992).

## 2.1.8 Movement

General. Both species tend to be nocturnal in their activity, although Arizona montane vole is often active during daylight hours. The species differ significantly in how they move through their densely vegetated habitat.

Meadow Jumping Mouse. The meadow jumping mouse typically crawl over or through the high herbaceous vegetation within their preferred habitat, or make short hops on the ground (Fitzgerald et al. 1996). When threatened the species is capable of leaping and may alter course in mid-flight by using its long tail as a rudder. Individuals observed after release from trapping studies would quickly retreat to thick cover, then remain still (Morrison 1987). Meadow jumping mice are good climbers and swimmers, and can dig. The mouse does not make much use of vole runways, nor do they construct runways themselves (Fitzgerald et al. 1996). They may avoid voles, which are competitively aggressive.
Arizona Montane Vole. Like most voles, the montane vole constructs tunnels or runways through the grasses and herbaceous vegetation in which they live, and this allows them to move throughout their habitat without being seen by visual predators (Pugh et al. 2003). Narrow runways crisscrossing through dense stands of grass or sedge are a characteristic sign that voles are present. The montane vole also constructs globular-shaped nests off of the runway networks (Sera and Early 2003). The montane vole is capable of swimming. Voles tend to move at a run (Pugh et al. 2003).

### 2.1.9 Predators

Meadow Jumping Mouse. A variety of predators may potentially take the meadow jumping mouse, including hawks, owls, weasels (*Mustela* spp.), skunks, badgers (*Taxidea taxus*), and foxes (Fitzgerald et al. 1996, Whitaker 1963). Snakes, particularly garter snakes (*Thamnophis* spp.) are important predators (J. Frey, personal communication).
Arizona Montane Vole. As with the meadow jumping mouse, a variety of predators take the montane vole, including northern harriers (*Circus cyaneus*), rough-legged hawks (*Buteo lagopus*), kestrels (*Falco sparverius*), burrowing owls (*Athene cunicularia*), great horned owls (*Bubo virginianus*), long-eared owls (*Asio otus*), weasels, and coyotes (*Canis latrans*; Sera and Early 2003, Negus et al. 1986). Snakes, particularly garter snakes (*Thamnophis* spp.) are important predators (J. Frey, personal communication).

## 2.10 Associated Species

Meadow Jumping Mouse. Aside from a potential overlap in the Sangre de Cristo and San Juan Mountains, the meadow jumping mouse likely does not associate with the western jumping mouse (*Zapus princeps*) in New Mexico; the latter species tends to occur at higher elevations (Frey 2004). Recent surveys in the Jemez Mountains in New Mexico (MU4) captured American water shrews (*S. palustris*), montane shrews (*S. monticolus*), bushy-tailed woodrats (*Neotoma cinerea*), Mexican woodrats (*N. mexicana*), deer mice (*Peromyscus maniculatus*), long-tailed voles (*M. longicaudus*), montane voles (M*. montanus*), golden-mantled ground squirrels (*Spermophilus lateralis*), and Colorado chipmunks (*Neotamias quadrivittatus*; Frey 2005b). Surveys in the Sangre de Cristo Mountains (MU 1) captured deer mice, meadow voles (*Microtus* pennsylvanicus), long-tailed voles, western jumping mice, water shrews, western harvest mice (*Reithrodontomys megalotis*), long-tailed shrews (*Sorex* spp.), prairie voles (*M. orchrogaster*), white-footed mice (*Peromyscus leucopus*), and ermine (*Mustela erminea*; Frey 2006). Surveys in the Sacramento Mountains (MU 7) captured New Mexico shrews (*Sorex neomexicanus*), Mexican woodrats, deer mice, western harvest mice, long-tailed voles, and mogollon voles (*M. mogollonensis*; Frey 2005b). At Sugarite Canyon State Park (MU 1), meadow jumping mice were found in close association with meadow voles, and these two species may compete for habitat use at this location (J.K. Frey, personal communication).
Arizona Montane Vole. Mogollon and long-tailed voles also occur in the same area as the Arizona montane vole. Recent surveys for the montane vole captured golden-mantled ground squirrels, cliff chipmunks (*N. dorsalis*), gray-collared chipmunks (*N. cinereicollis*), Mexican woodrats, brush mice (*P. boylii*), canyon mice (*P. crinitus*), deer mice, piñon mice (*P. truei*), Osgood's mice (*P. gratus*), northern rock mice (*P. nasutus*), western harvest mice, and cottontail rabbits (*Sylvilagus* spp.; Frey 2005a). At Flannigan Spring, a very small, high quality patch of habitat for the species,

only *M. montanus* was captured, suggesting it may exclude *M. mogollonensis* from small, monotypic habitat (J. Frey, personal communication).

**Figure 8. Museum specimens of three voles species found in range of Arizona montane vole. From the top: long-tailed vole (*Microtus longicaudus*), Arizona montane vole (*M. montanus arizonensis*), and Mogollon vole (*M. mogollonensis*). Photograph by Dr. Jennifer K. Frey.**

## 2.2 HISTORICAL PERSPECTIVE

### 2.2.1 Habitat Trends

Both rodents are found in riparian ecosystems, which are defined as an assemblage of plant, animal, and aquatic communities whose presence can be either directly or indirectly attributed to streams or rivers (NMDGF 2005, Kauffman and Krueger 1984). An estimated one third of the wetlands – including riparian ecosystems – that once existed in New Mexico have been lost from habitat conversion, water diversion and withdrawal, drought, invasive species, improper restoration efforts, improper grazing, fire, and other issues (NMDGF 2005, Durkin et al. 1996, Dahl 1990), with improper defined as those practices that reduce long-term plant and animal productivity (NMDGF 2005). Recent surveys determined that the declines seen in populations of the meadow jumping mouse were due to an almost utter lack of habitat (Frey 2005b); in many cases the wet, grassy areas were no longer present in historic localities, likely from water no longer being present and pressure from ungulates, including cattle and elk. In areas lacking complex wetlands created by numerous beaver dams, the meadow jumping mouse likely cannot persist under improper grazing pressure (J. Frey, personal communication). Flooding following fire can lead to erosion, thus rendering the habitat unsuitable for the meadow jumping mouse (Frey and Malaney in litt.). Further exacerbating the situation is that the remaining suitable habitat is fragmented and is often separated by miles of unsuitable habitat that prevents movement of animals between suitable patches. Habitat connectivity has been determined to be very important for maintaining genetic diversity, in jumping mice in particular (Frey 2005 a, b, Vignieri 2005). Fragmentation may occur through various activities, such as residential and

commercial development, road construction, improper grazing, mowing of habitat along canals and ditches, and human recreational activity, such as off-road vehicle use and development of stream-side trails and camping sites for various outdoor activities (Frey 2005b). In addition, increased human use of dwindling water supplies may further increase the rate of habitat loss, given the dependence of the habitat on a sustained water supply. Activities such as diversion of water for commercial and residential use, capping of springs, and removal of beavers can all reduce the availability of water to the point the habitat will no longer support a viable population of either species (Frey 2005a, b, Morrison 1992).

Changes in climate may adversely affect the composition of riparian ecosystems through increased or decreased flooding events and severity, increased frequency and severity of drought, and loss of biodiversity (NMDGF 2005). Drought is a particular threat to the two species, given the dependence of their respective habitats on sustained water availability. The trend for the average temperature in July in New Mexico, when both rodents are active, has been for an increase of 0.83° C (1.5°F) per decade over the last twenty years (National Climatic Data Center, National Environmental Satellite, Data, and Information Service, http://www.ncdc.noaa.gov/oa/ncdc.html).

**Figure 9. Former meadow jumping mouse habitat, Sacramento Mountains, based on historic surveys. Note fish structure in middle bottom of image, an indication that a perennial stream was formerly present. Photograph by Dr. Jennifer K. Frey.**

Meadow Jumping Mouse. The meadow jumping mouse is known from U.S. Forest Service Lands, New Mexico State Park properties (including one owned by the City of Raton and Managed by State Parks), U.S. National Wildlife Refuge properties, private properties, the San Juan Pueblo, Isleta Pueblo, Mescalero Apache lands, and potentially other local, state, federal, and tribal properties throughout the State of New Mexico.

Arizona Montane Vole. The Arizona montane vole is known from private and U.S. Forest Service properties.

## 2.2.2 Population Trends

Meadow Jumping Mouse. Recent surveys for the meadow jumping mouse indicate declines in populations, in some instances quite severe (Frey 2005b). No remaining habitat was found at the single historic locality in the San Juan Mountains (MU 3). Within the Jemez Mountains, the Rio Cebolla, Seven Springs area, and Fenton Lake have remaining populations, but much of the habitat is reduced due to intensive grazing from livestock and wildlife, lack of beavers to provide wet meadows, and human recreation activities (MU 4; Frey 2005b). No meadow jumping mice were caught in the Rio de las Vacas drainage, where the species was known historically, as the area now lacks the riparian vegetation favored by the species. Overall, the species was not caught at 67% of historic localities surveyed within the Jemez Mountain range (Frey 2005b). Likewise, of four confirmed localities, the species was caught in only one of three sites surveyed (33%) in the Sangre de Cristo Mountains, with one new population discovered in 2006 (MU 1; Frey 2006).
The species was not found in 91% of historic localities surveyed within the Sacramento Mountains during recent surveys, and appeared to be persisting at only two isolated sites; few of the historic localities had sufficient habitat to support populations of the meadow jumping mouse (MU 7; Frey 2005b). Further work is needed to determine population status and trends in the lowland habitat along the Rio Chama and Rio Grande (MU's 2 and 5; J. Frey, personal communication, NMDGF files).
Arizona Montane Vole. Prior to surveys in 2004, the vole was known from two localities in Catron County: Jenkins Creek and Centerfire Bog. A recent, intensive survey only led to the capture of a single specimen at Jenkins Creek (Frey 2005a). The Centerfire Bog area was inaccessible and not sampled, although some habitat appears to persist here. However, the Arizona montane vole was captured at four new localities during 2004: Flanagan Spring, Romero Creek, SA Creek, and the confluence of the San Francisco River and Stone Creek (Frey 2005a). Thus, the species does persist at several localities in the San Francisco River drainage, although fluctuations in numbers of voles and the suitability of habitat at these various sites likely makes predictions about population trends difficult.

### 2.2.3 Use and Demand Trends

At present there appears to be no use of or demand for either the meadow jumping mouse or the Arizona montane vole, as there is no evidence that either species has been subject to either commercial or recreational collection. Both species are periodically collected in small numbers by mammalogists and other researchers, working under scientific permits issued by New Mexico Department of Game and Fish and applicable land management agencies.

### 2.2.4 Past Management

General. Both riparian rodents were identified as species of greatest conservation need under the Comprehensive Wildlife Conservation Strategy-New Mexico (NMDGF 2005).
Meadow Jumping Mouse. The New Mexico State Game Commission approved listing meadow jumping mouse as threatened in 1983 (Jones and Schmitt, 1997). The species was then approved to be up-listed to endangered in 2006 (NMDGF 2006). In Arizona, the mouse is considered a species of concern (AZDGF 1996). The New Mexico meadow jumping mouse (*Z. h. luteus*) was added to the candidate for federal listing under the U. S. Endangered Species Act in 2007 (USFWS 2007).
Arizona Montane Vole. The New Mexico State Game Commission approved listing the Arizona montane vole as endangered in 1979, shortly after its discovery in the state (Jones and Schmitt, 1997). This subspecies has no special status in Arizona (J. Underwood, Arizona Game and Fish, personal communication).

## 2.3 ECONOMIC AND SOCIAL IMPACTS

### 2.3.1 Economic Profile

The meadow jumping mouse is potentially found in Bernalillo, Catron, Colfax, Lincoln, Los Alamos, Mora, Otero, Rio Arriba, San Miguel, Santa Fe, Sandoval, Socorro, Taos, and Valencia Counties, while the Arizona montane vole is found only in Catron County. The following tables provide a profile of human population and economic metrics for each county.

| County | 2006 Population (Estimated) | 2000 Population | Percent Change | Persons/Sq. Mile (2000) |
|---|---|---|---|---|
| Bernalillo | 615,099 | 556,678 | 10.6% | 477.4 |
| Catron | 3,476 | 3,543 | -1.9% | 0.5 |
| Colfax | 13,514 | 14,189 | -4.8% | 3.8 |
| Lincoln | 21,223 | 19,411 | 9.3% | 4.0 |
| Los Alamos | 19,022 | 18,343 | 3.7% | 168.3 |
| Mora | 5,151 | 5,180 | -0.6% | 2.7 |
| Otero | 62,744 | 62,298 | 0.7% | 9.4 |
| Rio Arriba | 40,949 | 41,190 | -0.6% | 7.0 |
| San Miguel | 29,325 | 30,126 | -2.7% | 6.4 |
| Sandoval | 113,772 | 89,908 | 25.6% | 24.2 |
| Santa Fe | 142,407 | 129,292 | 10.1% | 67.7 |
| Socorro | 18,240 | 18,078 | 0.9% | 2.7 |
| Taos | 31,832 | 29,979 | 6.2% | 13.6 |
| Valencia | 70,389 | 66,152 | 6.4% | 61.9 |
| | | | | |
| New Mexico | 1,954,599 | 1,819,046 | 7.5% | 15.0 |

**Table 1. Human Population data for counties within range of meadow jumping mouse and Arizona montane vole. Data from U. S. Census Bureau (http://www.census.gov/).**

| County | Per Capita Income | Main Industries |
|---|---|---|
| Bernalillo | $31,160 | Health Care, Retail, Accomodation, Professional, Adminstration |
| Catron | $17,504 | Construction, Retail, Health Care, Accomodation, Agriculture |
| Colfax | $22,496 | Accomodation, Health Care, Retail, Construction, Administration |
| Lincoln | $21,381 | Accomodation, Health Care, Construction, Education, Recreation |
| Los Alamos | $51,027 | Administration, Education, Health Care, Accomodation, Retail |
| Mora | $17,142 | Health Care, Construction, Administration, Retail, Agriculture |
| Otero | $20,292 | Accomodation, Administration, Retail, Health Care, Education |
| San Miguel | $21,130 | Health Care, Retail, Accomodation, Construction, Adminstration |
| Sandoval | $25,468 | Manufacturing, Retail, Education, Construction, Accomodation |
| Santa Fe | $34,448 | Administration, Retail, Accomodation, Health Care, Education |
| Socorro | $20,186 | Education, Accomodation, Health Care, Retail, Administration |
| Taos | $23,031 | Accomodation, Education, Retail, Construction, Education |
| Valencia | $22,968 | Unavailable |

**Table 2. Per capita income and main industries (based upon projected employees) for counties within the range of the meadow jumping mouse and Arizona montane vole. Data for income from New Mexico Economic Development Department, http://www.edd.state.nm.us/), and data for main industries from Labor Analyses Statistics and Economic Research of the New Mexico Department of Workforce Solutions, http://www.dws.state.nm.us/).**

| County | Farms, 2002 | Head of Cattle, 2006 |
|---|---|---|
| Bernalillo | 618 | 7,000 |
| Catron | 206 | 26,000 |
| Lincoln | 343 | 29,000 |
| Los Alamos | 6 | |
| Mora | 410 | 20,000 |
| Otero | 622 | 10,000 |
| San Miguel | 565 | 36,000 |
| Sandoval | 347 | 10,000 |
| Santa Fe | 460 | 10,000 |
| Socorro | 388 | 34,000 |
| Taos | 453 | 5,000 |
| Valencia | 718 | 15,000 |

**Table 3. Number of farms in 2002 and head of cattle in 2006 for counties within the range of the meadow jumping mouse and Arizona montane vole. Data from the New Mexico Department of Agriculture, http://nmdaweb.nmsu.edu/).**

## 2.3.2 Economic Use of Habitat

A chief economic use of the wet, grassy riparian areas favored by both rodents is for forage for livestock and large ungulates popular with hunters. Within the State of New Mexico the cattle industry was estimated to have generated US $968 million gross for 2005 (New Mexico Department of Agriculture, http://nmdaweb.nmsu.edu/). During the 2005 – 2006 big game season, the NMDGF sold 85,000 licenses for deer and elk, and US $2.8 million were spent through the Habitat Stamp Program for enhancing wildlife habitat, including riparian enhancements (NMDGF files).

The water that supports the riparian habitat favored by both rodents is also used for agriculture. In 2005, crop based industries for the State of New Mexico was valued at 622 million dollars (New Mexico Department of Agriculture, http://nmdaweb.nmsu.edu/). In the Sacramento Mountains, many springs are also capped and diverted for agricultural and household use (J. Frey, personal communication).

Recreational activities in preferred habitat include fishing, hunting, hiking, camping, and off-road vehicle activities.

## 2.3.3 Sociological Factors

Habitat preservation is the main issue for recovery of the various populations of the meadow jumping mouse and the tiny population of the Arizona montane vole; conserving the species may require modification of livestock and wildlife (e.g., elk and deer) grazing practices, as well as water distribution practices. One social misgiving would be for private property to be negatively impacted by the discovery of the species on that land. Currently the New Mexico meadow jumping mouse is under candidacy status for listing as threatened or endangered under the U.S. Endangered Species Act (USFWS 2007), while the Arizona montane vole is not under any such consideration. New Mexico State recovery plans are by definition implemented to improve the status of the species and, if successful, would aid in precluding listing. A successful recovery plan would also lessen the cost of any future environmental considerations (ECONorthwest 2002). Even if federal listing did occur, safe harbor agreements and federal funding would still be available to aid private landowners (L. Thompson, Western Colorado Field Office, US Fish and Wildlife Service, personal communication). Further, the New Mexico Wildlife Conservation Act has no provision for restricting private property use to protect any species. Therefore, through a cooperative process such as this Recovery Plan, private landowners, the State, and any federal stakeholders can work to further the survival of the two riparian rodents found on the landowner's

property in a positive fashion for the meadow jumping mouse, Arizona montane vole, and the landowner.

# 3.0 Management Strategy

Section 3.0 consists of a goal, objective, issues and strategies for the recovery of the meadow jumping mouse and the Arizona montane vole, following Graves (2002). A goal is a general, unlimited statement expressing a desired future outcome, whereas the objective is a quantitative, measureable, and time-limited restatement of the goal. Objective parameters are intermediate outcomes that will foster the stated objective. Issues are situations that are expected to impede the attainment of the objective or are opportunities that may enhance rather than obstruct success of the recovery plan implementation. Strategies are the broad approaches to employ to overcome a problem or take advantage of an opportunity. Most strategies herein apply to both the meadow jumping mouse and the Arizona montane vole, but not all, and therefore each strategy has a section noting the species to which the strategy pertains (a checked box).

## 3.1 MANAGEMENT GOAL AND OBJECTIVE

Goal: Ensure the long-term persistence of natural densities of the meadow jumping mouse and Arizona montane vole within their respective natural ranges in New Mexico, thereby contributing to the maintenance of the biological diversity in the State.

Objective: That by 2015, the populations and distribution of the meadow jumping mouse and Arizona montane vole are sufficient to ensure their persistence within New Mexico.

Objective Parameters:

Habitat protection measures implemented immediately in watersheds where populations of meadow jumping mouse are in imminent danger of extirpation.

Both species no longer meet the definition of endangered or threatened under the New Mexico WCA:

- Multiple populations within each management unit are secure enough such that no single event threatens the species within those units
- Species habitat is secure enough such that populations within each management unit face no known, significant threats

Historical and potential watersheds investigated for presence of populations and potential habitat.

Monitoring standards have been developed and a system for survey/monitoring data management is in place.

## 3.2 MANAGEMENT ISSUES AND STRATEGIES

### 3.2.1 Issue 1-Threats to Habitat

*Riparian areas are limited and have been identified as the most threatened habitat in the state (NMDGF 2005). Loss of habitat and fragmentation from improper grazing and diversion of water supporting the habitat can lead to extirpation of both species of riparian rodents, particularly the meadow jumping mouse. Other threats to the well being of habitat for both species include drought, the effects of climate change, commercial and residential development, some recreational activities, and forest fire and subsequent flooding. Lastly, the removal of beaver has*

*highly negative consequences for both species, particularly the meadow jumping mouse, as beaver dams create and maintain habitat.*

Strategy 1. Maintain existing wildlife habitat enclosures and develop additional enclosures where appropriate to prevent habitat disturbance around most of the perennial stream for known populations, to allow for improvement and expansion of current populations, to reduce population fragmentation, and to improve local metapopulation conditions.
- ☒ Meadow Jumping Mouse
- ☒ Arizona Montane Vole

Strategy 2. Use best grazing management practices to maintain perennial water flow which supports mesic habitat, reduce erosion of streambeds and loss of associated riparian vegetation, and to allow for riparian dispersal corridors among existing populations.
- ☒ Meadow Jumping Mouse
- ☒ Arizona Montane Vole

Strategy 3. Develop best management practices for reducing the impact of recreational activities, such as off-road vehicle use and high-density camping, on habitat of known populations.
- ☒ Meadow Jumping Mouse
- ☒ Arizona Montane Vole

Strategy 4. Develop best management practices for mowing within proper habitat.
- ☒ Meadow Jumping Mouse
- ☐ Arizona Montane Vole

Strategy 5. Develop best management practices for water use (e.g., diversion, impoundments, etc.) to maintain proper habitat.
- ☒ Meadow Jumping Mouse
- ☒ Arizona Montane Vole

Strategy 6. Develop best management practices for all activities within riparian areas to preserve proper habitat under various climatic conditions, including but not limited to drought.
- ☒ Meadow Jumping Mouse
- ☒ Arizona Montane Vole

### 3.2.2 Issue 2-Habitat improvement

*The presence and maintenance of quality habitat are of utmost importance in the recovery of the meadow jumping mouse and the Arizona montane vole. Resources are available for habitat improvement for repatriation, restoration, and maintenance of populations and metapopulations; the use of such resources will allow stakeholders to pursue their own goals while maintaining efforts to recover the meadow jumping mouse and Arizona montane vole. For the meadow jumping mouse, riparian areas with tall, dense vegetation, particularly sedges, with damp to wet soils constitutes good habitat, whereas good habitat for the Arizona montane vole also includes damp to wet soils, with tall vegetation such as grasses, forbs, and rushes. Necessary vegetation is not as tall for the vole as the jumping mouse, and the vole can make use of habitat around seeps where the jumping mouse does not. The presence of beavers is very useful in maintaining habitat for both species.*

Strategy 1. Identify and prioritize areas for habitat restoration.
- ☒ Meadow Jumping Mouse
- ☒ Arizona Montane Vole

Strategy 2. Identify and prioritize areas for potential repatriation.
- ☒ Meadow Jumping Mouse
- ☐ Arizona Montane Vole

Strategy 3. Promote development of beaver dams or install log barriers, check dams, gabion structures, or similar obstructions to help impound water to create new habitat within appropriate areas.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 4. Develop guidelines for land managers and landowners to refer to for improving known and potential habitat, to be refined as more knowledge on the species becomes available.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 5. Identify and improve upland habitat near riparian areas important to the species.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 6. Develop protocols for establishment and management of beavers for development of suitable habitat.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 7. Develop strategies for use of funding opportunities, including but not limited to the Federal Farm Bill, State Wildlife Grants, and State and Federal Land Owner Incentive Programs to aid land managers and landowners in improving known and potential habitat.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 8. Develop protocols for improving known potential habitat on New Mexico Department of Game and Fish properties.

☒ Meadow Jumping Mouse
☐ Arizona Montane Vole

### 3.2.3 Issue 3-Management

*The meadow jumping mouse is known from U.S. Forest Service Lands, N. M. State Park properties, U.S. National Wildlife Refuge properties, private properties, and potentially other local, state, federal, and tribal properties throughout the State of New Mexico, including properties managed by the NMDGF. The Arizona montane vole is known from private and U.S. Forest Service properties. Coordination of efforts will allow such entities to pursue their own goals while maintaining efforts to recover the meadow jumping mouse and Arizona montane vole.*

Strategy 1. Create a statewide recovery-working group of stakeholders and managers to coordinate efforts, develop partnerships, and develop agreements as necessary among interested parties.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 2. Develop monitoring and inventory programs for populations and habitat, including mapping, data management and sharing, specimen collection, and protocols for responding to trends seen in such programs.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 3. Identify and secure funding to promote the goals of this recovery plan.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 4. Provide technical guidance and assistance to interested landowners in conserving current or repatriated populations on their properties.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 5. Identify and prioritize areas for potential repatriation and populations from which to repatriate the species.

☒ Meadow Jumping Mouse
☐ Arizona Montane Vole

### 3.2.4 Issue 4- Need for Information on Biology and Natural History of the Meadow Jumping Mouse and the Arizona Montane Vole

*Much of the biology and natural history of the meadow jumping mouse and the Arizona montane vole is not well understood. It is important to gather such information to improve the success of recovery efforts.*

Strategy 1. Conduct additional surveys for species in potential habitat.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

Strategy 2. Support research into the biology and natural history of the meadow jumping mouse and Arizona montane vole, to determine the population dynamics necessary to sustain the species in New Mexico, including but not limited to the following:

Meadow Jumping Mouse

- Population viability
- Metapopulation models
- Population interaction with grazing activities
- Population movements through genetic methods
- Reproductive biology
- Fitness
- Hibernation biology
- Habitat structure
- Predation
- Diet
- Dispersal

Arizona Montane Vole

- Population viability
- Metapopulation models
- Population movements through genetic methods
- Fitness
- Habitat Structure
- Dispersal
- Reproductive Biology
- Predation
- Diet
- Winter Biology

Strategy 3. Support research into the best practices for repatriating the species to appropriate habitat.

☒ Meadow Jumping Mouse
☐ Arizona Montane Vole

Strategy 4. Support research to assess the impact of climate on the species.

☒ Meadow Jumping Mouse
☒ Arizona Montane Vole

# 4.0 Implementation Schedule

Section 4.0 contains the Implementation Schedule for the Recovery Plan. Section 4.1 identifies specific tasks to be carried out to meet the strategies identified in Section 3.2 (Management Issues and Strategies). Unless otherwise stated, all tasks apply to both the meadow jumping mouse and the Arizona montane vole. Section 4.2 presents a suggested time-line for the Implementation Schedule. Anticipated costs, including staffing, for these tasks will be addressed in an Operational Plan, to be developed following final approval of the Recovery Plan by the New Mexico State Game Commission

## 4.1 IMPLEMENTATION SCHEDULE TASKS

4.1.1 Reduce and remove threats to habitat

1. Identify populations that require wildlife habitat enclosures to improve habitat for the meadow jumping mouse
2. Develop necessary agreements
3. Maintain or develop wildlife habitat enclosures for meadow jumping mouse populations
4. Develop best management practices for maintaining habitat for both species

4.1.2 Improve habitat

1. Develop habitat survey guidelines
2. Develop relationships and any necessary agreements with stakeholders to allow surveys of potential habitats
3. Survey for habitat for improvement
4. Survey for habitat for repatriation of the meadow jumping mouse
5. Develop guidelines for the use of beavers for improving and maintaining meadow jumping mouse habitat
6. Conduct outreach for use of beavers for improving and maintaining meadow jumping mouse habitat
7. Develop guidelines to inform land managers and owners of what constitutes quality habitat
8. Conduct outreach for use of funding opportunities for land managers and land owners interested in improving habitat

**4.1.3 Develop and maintain high levels of cooperation and coordination between stakeholders and interested parties.**

1. Formulate a riparian rodent recovery team
2. Develop population survey guidelines
3. Develop relationships and any necessary agreements with stakeholders to allow surveys of populations
4. Develop guidelines for monitoring populations
5. Develop strategies for responding to trends found in monitoring populations
6. Develop guidelines for data management
7. Develop agreements for data sharing concerning surveys of the meadow jumping mouse and Arizona montane vole
8. Identify potential funding sources
9. Acquire funding for the Recovery Plan

**4.1.4 Support research into the biology and natural history of the meadow jumping mouse and Arizona montane vole**

1. Support research into the natural history of the meadow jumping mouse and Arizona montane vole
2. Identify parties interested in conducting research on the biology of the meadow jumping mouse and Arizona montane vole

3. Identify priorities for research on the biology of the meadow jumping mouse and Arizona montane vole
4. Develop guidelines for population trend analyses and metapopulation modeling
5. Identify parties interested in population trend analyses and metapopulation modeling of the meadow jumping mouse and Arizona montane vole

## 4.2 IMPLEMENTATION SCHEDULE TIME-LINE

| Time Frame | Habitat Improvement | Population Monitoring | Coordination | Research |
|---|---|---|---|---|
| 1st Half 2008 | Maintain and develop existing exclosures to protect MU 7 meadow jumping mouse habitat | Survey known areas, determine new areas to survey | Commission approval; Formation of Recovery Team | Prioritize needs; identify interested parties |
| 2nd Half 2008 | Prioritize areas for habitat restoration; develop best management practices; investigate funding sources to aid in habitat improvement | Survey known and new areas; collect natural historical information | Develop guidelines, strategies, agreements, and information sharing; Develop operation plans and measures of success | Identify funding sources |
| 1st Half 2009 | Develop best management practices; investigate funding sources to aid in habitat improvement | Survey known and new areas; collect natural historical information | Outreach for use of beavers for meadow jumping mouse habitat; out reach for potential funding | |
| 2nd Half 2009 | Update best management practices; investigate funding sources to aid in habitat improvement | Survey known and new areas; collect natural historical information | Update Guidelines; Annual Report | Summarize latest information |
| 1st Half 2010 | | Survey known and new areas; collect natural historical information | Outreach | Develop protocols for any necessary repatriation |
| 2nd Half 2010 | Update best management practices; investigate funding sources to aid in habitat improvement | Survey known and new areas; collect natural historical information | Update Guidelines; Annual Report | Summarize latest information |
| 1st Half 2011 | | Survey for status | Outreach | |
| 2nd Half 2011 | Update best management practices; investigate funding sources to aid in habitat improvement | Survey for status | Update Guidelines; Annual Report | Summarize latest information |
| 1st Half 2012 | | Survey for status | Outreach | |
| 2nd Half 2012 | Update best management practices; investigate funding sources to aid in habitat improvement | Survey for status | Update Guidelines; Annual Report | Summarize latest information |

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# 6.0 Approvals

# 7.0 Appendices

## 7.1 HISTORY OF PUBLIC PARTICIPATION

24 July 2007, Raton, NM: Public meeting to announce the initiation of a Recovery Plan for the meadow jumping mouse (*Zapus hudsonius*) and Arizona montane vole (*Microtus montanus arizonensis*). 1 attendee + 5 NMDGF employees.

26 July 2007, Santa Fe, NM: Public meeting to announce the initiation of a Recovery Plan for the meadow jumping mouse (*Zapus hudsonius*) and Arizona montane vole (*Microtus montanus arizonensis*). 2 attendees + 6 NMDGF employees.

31 July 2007, Alamogordo, NM: Public meeting to announce the initiation of a Recovery Plan for the meadow jumping mouse (*Zapus hudsonius*) and Arizona montane vole (*Microtus montanus arizonensis*). 2 attendees + 2 NMDGF employees.

8 August 2007, Silver City, NM: Public meeting to announce the initiation of a Recovery Plan for the meadow jumping mouse (*Zapus hudsonius*) and Arizona montane vole (*Microtus montanus arizonensis*). 2 attendees + 2 NMDGF employees.

August 2007: Formed Advisory Committee.

October 2007: Advisory Committee review of background of Recovery Plan.

15 January 2008, Bosque del Apache National Wildlife Refuge Center, NM: Meeting of Advisory Committee to develop management section of Recovery Plan for the Boreal Toad. 5 attendees + 3 NMDGF employees. In attendance: Steve Cary (NM EMNRD), Jennifer Frey (NMSU), Charles Gobar (USFS), Eric Hein (USFWS), Jason Malaney (UNM), Renae Held (NMDGF), Jim Stuart (NMDGF), Leland Pierce (NMDGF).

January – February 2008: Advisory Committee review of proposed management section and subsequently final draft of the Recovery Plan.

February 2008: Internal NMDGF review of draft of Recovery Plan

March 2008: Public review of draft of Recovery Plan

## 7.2 LISTING OF INTERESTED PARTIES AND MEMBERS OF ADVISORY COMMITTEE

Active participants on the Riparian Rodent Recovery Plan Advisory Committee in **Bold**:

Arizona Department of Game and Fish-**Jared Underwood**
New Mexico Energy, Minerals, and Natural Resources Department, Mining Division-Linda Delay
New Mexico Energy, Minerals, and Natural Resources Department, State Parks Division-**Steve Cary**
New Mexico State University/Private-**Dr. Jennifer K. Frey**
Private-**Rebecca Piper-Perry**, Rex Wahl
U. S. Fish and Wildlife Service-**Eric Hein**

U. S. Forest Service, Santa Fe National Forest-**Charles Gobar**
U. S. Geological Survey, University of New Mexico-**Dr. Ernie Valdez**
University of Nebraska, Kearney-Dr. Keith Geluso
University of New Mexico-**Dolly Lynn Crawford,** Natalie Gwen Dawson, **Jason Malaney**