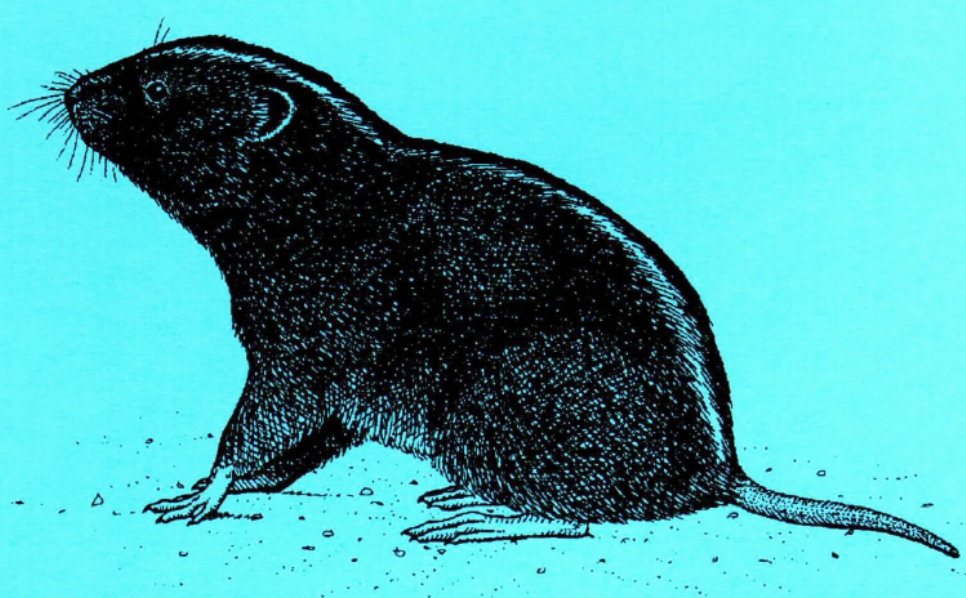
U.S. Fish & Wildlife Service

Recovery Plan for the Amargosa Vole

(Microtus californicus scirpensis)



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AMARGOSA VOLE
(*Microtus californicus scirpensis*)

RECOVERY PLAN

September, 1997

U.S. Department of the Interior
Fish and Wildlife Service
Region One, Portland, Oregon

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The primary author of this plan is Theodore A. Rado, formerly of the U.S. Fish and Wildlife Service in Sacramento, California. Mr. Rado is now self-employed as an environmental consultant. Lynn Wilson Oldt of the Ventura, California, Field Office edited the plan to meet the guidelines established by the 1988 amendments to the Endangered Species Act. Carl T. Benz of the Ventura Field Office modified the text and recovery tasks to incorporate new data. Clark Roberts of the Carlsbad Field Office created the maps for this plan.

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EXECUTIVE SUMMARY OF THE RECOVERY PLAN FOR THE AMARGOSA VOLE

CURRENT STATUS: This species was federally listed as endangered with critical habitat in 1984.

HABITAT REQUIREMENTS AND LIMITING FACTORS: The Amargosa vole is a rodent with a highly localized range in the central Mojave Desert of California. This species is closely associated with, and dependent upon, wetland vegetation present in disjunct "pockets" along an isolated riparian segment of the Amargosa River. Historical and current threats to the species and its habitat include conversion of wetlands for farming, diversion of surface or groundwaters, intermittent flooding, and introduction of exotic plant and wildlife species.

RECOVERY OBJECTIVE: The goal of this plan is to stabilize and protect existing populations and habitat so that this species may be reclassified to threatened.

RECOVERY CRITERIA: Development of delisting criteria for the Amargosa vole is not possible at this time due to a paucity of information relating to the species' biology and management requirements. The Amargosa vole may be downlisted to threatened status when extant (existing) wetland habitats and water sources for perpetuating these areas are secured and managed to maintain stable or increasing vole populations.

ACTIONS NEEDED:

(1) Secure all extant wetland habitats, while focusing priority on "upland" areas containing "core" vole populations. Secured lands will be managed to maintain viable vole populations and maximize habitat conditions through protection of spring sources and control of exotic and/or competitive species and incompatible uses.

(2) Survey the population and obtain basic life history information.

(3) Quantify habitat characteristics and determine temporal and spacial patterns of use.

(4) Complete genetic analyses. Genetic information is needed from contemporary and historic populations.

(5) Enhance Amargosa vole populations and habitat. This may include reintroduction of the vole into historic habitat.

(6) Monitor habitat trends.

(7) Develop a public outreach program.

RECOVERY COSTS ($1,000's):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Need 7	Total
1998	35	25	20	25	0	0	12	117
1999	36	25	20	15	0	0	7	103
2000	20	25	20	15	1	0	3	84
2001	25	25	20	0	1	0	3	74
2002	5	25	25	5	9	0	3	72
2003	5	0	0	0	0	0	3	8
2004	5	0	0	0	0	0	3	8
2005	5	0	0	0	0	0	3	8
2006	5	0	0	0	0	0	3	8
2007	5	0	0	0	0	0	3	8
2008	5	0	0	0	0	0	3	8
2009	5	0	0	0	0	0	3	8
Total Cost:	156	125	105	60	11	0	49	506

DATE OF RECOVERY: The interim goal of securing wetland habitats and water sources could possibly be met as early as 1998 if water sources can be readily secured. Downlisting of the Amargosa vole from endangered to threatened could possibly be met as early as 2003 if reintroduction of the vole into historic habitat is not necessary to ensure population viability. A delisting target date cannot be projected at this time.

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Part I. INTRODUCTION

A. BRIEF OVERVIEW

The Amargosa vole (*Microtus californicus scirpensis*) is a desert subspecies of the widely distributed California vole (*Microtus californicus*). The Amargosa vole historically inhabited a highly localized and isolated wetland of the central Mojave Desert in extreme southeastern Inyo County, California, near the Inyo-San Bernardino County line. It depends upon, and is closely associated with, wetland vegetation dominated by bulrush (*Scirpus olneyi*). The Amargosa vole was listed as a California State endangered species on September 2, 1980 (Title 14 California Administrative Code, Section 670.5) and as a Federal endangered species with critical habitat on November 15, 1984 (49 Federal Register (FR): 45160). Reasons for listing included loss of historical habitat, rechannelization of water sources needed to perpetuate habitats, and pumping of groundwater. Based on the high degree of threat and low full recovery potential, the Amargosa vole has been given a recovery priority of 6, meaning that it is a subspecies under high threat with a low recovery potential.

B. TAXONOMY

Information addressing the taxonomic history of the genus *Microtus* is available from Tamarin (1985). The Amargosa vole is one of 17 subspecies of the California vole (Hall 1981). The taxon was originally described as a distinct species, *Microtus scirpensis*, based on seven specimens collected near Shoshone (Bailey 1900). Kellogg (1918), in revising the *californicus* species group within and adjacent to California, reassigned the scientific name *Microtus californicus scirpensis*, and provided the vernacular name "Amargosa meadow mouse". This

is the currently recognized scientific name in the literature (Hall and Kelson 1959, Hall 1981).

C. DESCRIPTION

As with other congeners (those belonging to the same genus), the overall appearance of the Amargosa vole is a stout-bodied, almost cylindrical, compact mouse. The comparatively short tail, small rounded ears, and short legs easily distinguish it from most other small mouse-like rodents. The Amargosa vole averages 8 inches (20.3 centimeters) in total length. Tail length averages about 2 ½ inches (6.3 centimeters). Coloration is "bright" brown, ranging from cinnamon buff to "buckthorn" brown (Kellogg 1918). Distinguishing characteristics include the "bright" pelage coloration, and a small skull with comparatively large zygomatic width (Kellogg 1918).

D. HISTORICAL DISTRIBUTION

The historical range of the Amargosa vole, although never completely documented, apparently was limited to wetland "pockets" extending from the desert community of Shoshone, Inyo County, to the Amargosa Canyon, Inyo County, California. The largely subterranean Amargosa River and an associated series of small tributary springs maintain an isolated 10-linear mile (16 kilometer) stretch of perennial surface water. Associated wetland vegetation is dominated by bulrush, cattails (*Typha* spp.), and saltgrass (*Distichlis spicata*).

The type specimens (specimens from which the description of the species was based) of the Amargosa vole were collected in 1891 from a small "tule" marsh near the community of Shoshone (Bailey 1900). Subsequent to the marsh being burned for several years and used as a hog pasture, unsuccessful trapping attempts to obtain additional voles led to the erroneous conclusion that the subspecies was extinct (Kellogg 1918). In the 1930's, additional trapping efforts to relocate specimens were successful near Shoshone and approximately 4 miles (6.4 kilometers) farther south along the Amargosa River near the community of Tecopa Hot Springs (Bleich 1979a). Trapping inventories of extant wetland

"pockets" between 1977 and 1988 documented additional Amargosa vole sites along the Amargosa River drainage, extending from a tributary spring 0.5 mile (0.8 kilometer) north of Tecopa Hot Springs, south for approximately 3.5 miles (5.6 kilometers) to the northern end of Amargosa Canyon (Gould and Bleich 1977, Bleich 1979b, Rado and Rowlands 1984, Murphy and Freas 1989).

E. CRITICAL HABITAT

Critical habitat, as defined by section 3 of the Endangered Species Act (16 U.S.C. 1531 *et sec.*), as amended (Act), and at 50 CFR Part 424, includes: 1) the specific areas, within the geographic area occupied by a species at the time of its listing in accordance with the provisions of section 4 of the Act, on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection; and 2) specific areas outside the geographical area occupied by the species at the time it is listed which are determined to be essential for the conservation of the species.

Amargosa vole critical habitat (49 FR 45160) encompasses an area of 4,520 acres in southeastern Inyo County, California: T20N R7E Sec.4, 5, N½ and SE¼ Sec.9, NW¼ Sec.10, SW¼ SW¼ Sec.15, E½ Sec.16, NW¼ Sec.22; T21N R7E S½ Sec.28, S½ and NW¼ Sec.29, Sec.32, 33 (Figure 1). Within these areas, the major constituent elements that are known to require special management considerations or protection are marsh vegetation (primarily bulrushes of the genus *Scirpus*), springs, and some open water along the Amargosa River, which provide escape cover and an adequate food supply.

Critical habitat consists of all extant vole populations and significant areas of potential habitat from just north of Tecopa Hot Springs to the northern Amargosa Canyon, just south of Tecopa. The type locality (where the type specimen was found), near Shoshone, is not within critical habitat. No information exists suggesting that critical habitat boundaries should be revised.

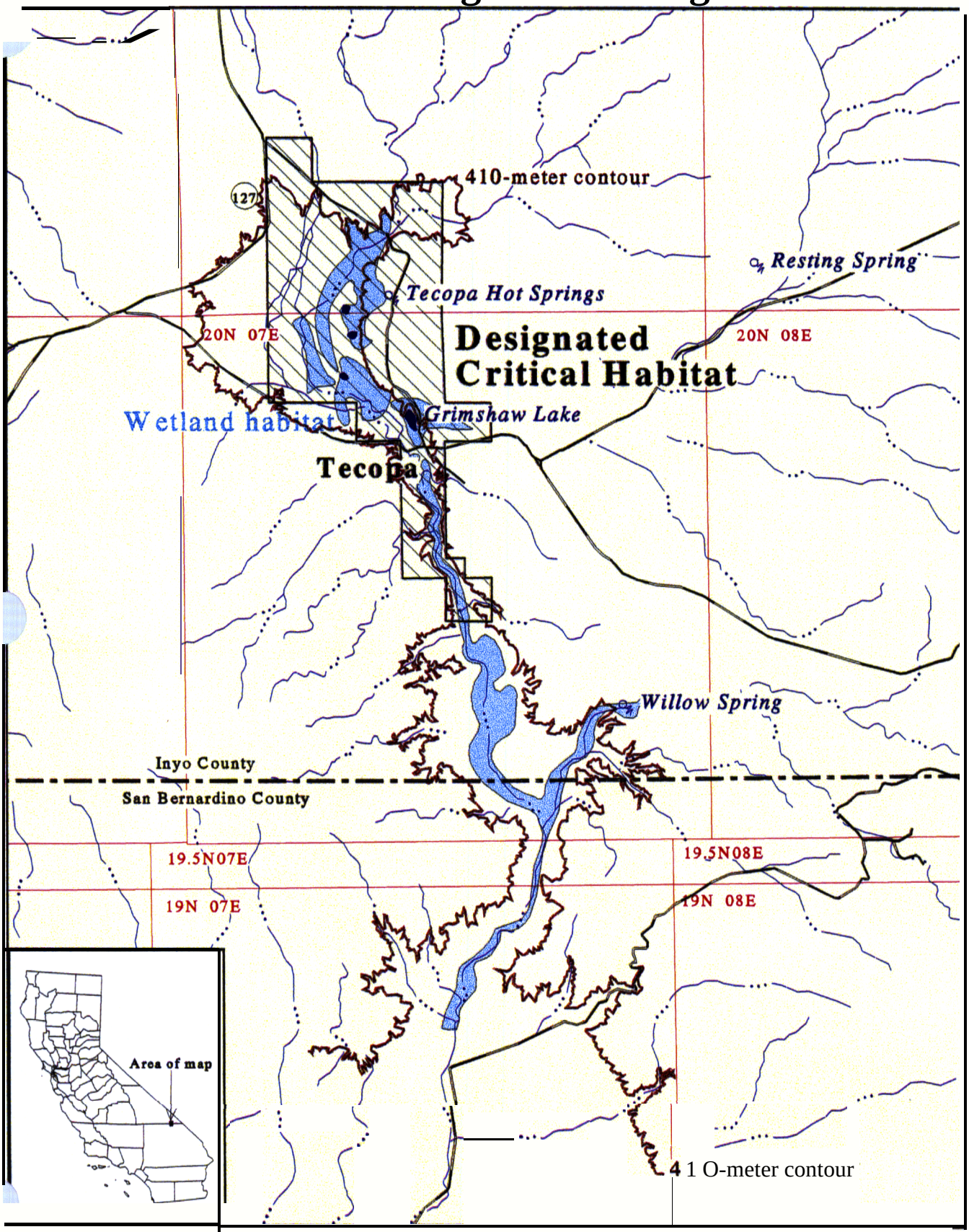
F. DISTRIBUTION AND POPULATION TRENDS

The current distribution of the Amargosa vole extends discontinuously from a tributary spring site located in the SW¼ NE¼ of Sec.33, T21N R7E; south to the SW¼ SW¼ of Sec.15, T20N R7E, San Bernardino Baseline Meridian. The distribution of this rodent appears to coincide principally with isolated bulrush-cattail "pockets" that are not subjected to regular inundation during heavy summer thunderstorms. Although the precise area of wetland habitats in the Tecopa Lake Basin and Amargosa Canyon has not been determined, such areas do not exceed 500 acres each (Figure 1). Amargosa voles have recently been live-trapped in wetland habitats from the following localities: T21N R7E, Sec.33; T20N R7E Sec.4, 5, 9, 15, San Bernardino Baseline Meridian (Bleich 1979b, Rado and Rowlands 1984, Murphy and Freas 1989). Wetland habitats above 1,370 feet (410 meters) elevation (upland) are not susceptible to inundation by seasonal flooding; habitats below 1,370 feet (410 meters) elevation (lowland) are vulnerable to flooding.

Occupied habitat patches above 1,370 feet (410 meters) elevation include the marsh created by the developed warm spring east of Tecopa Hot Springs Road immediately north of the community of Tecopa Hot Springs on land administered by the Bureau of Land Management (BLM). These occupied patches also include the narrow tule marsh running through the Tecopa Hot Springs County Park west of Tecopa Hot Springs road, and the tule marsh on both sides of Tecopa Hot springs Road east of the railroad grading and immediately north of the community of Tecopa on lands administered by BLM. The property owned by The Nature Conservancy is expected to provide additional secure habitat for voles (Murphy and Freas 1989). These habitat patches will be the focus of initial recovery efforts to achieve the interim recovery objective.

The Amargosa River drainage, extending downstream for approximately 5 linear miles (8 kilometers) from the southernmost documented Amargosa vole locality, has been inventoried unsuccessfully for the species (Rado and Rowlands 1984, Rado 1985). A narrow but almost continuous band dominated by cattails and bulrush existed at the time of these surveys. Prior investigators hypothesized

Figure 1. Designated critical habitat and wetland habitat within range of Amargosa vole



Source: 49 FR 45160 and USDI Bureau of Land Management 1983a, 1983b.
Digital data: BLM, USFWS, and Teale Data Center.

that these habitats are intermittently submerged by flash flood waters through the Amargosa Canyon. Thus, although the habitat is seemingly favorable, the flooding creates an unstable situation that may limit vole dispersal and colonization (Rado and Rowlands 1984, Murphy and Freas 1989).

No population trend information is currently available for this rodent. Loss of the type locality, plus the heavy flooding of low-lying portions of its extant habitats in 1983 and subsequent low rate of trapping success (Rado and Rowlands 1984) suggest that Amargosa vole populations may be in decline.

G. LIFE HISTORY

Aside from existing information consisting almost exclusively of field inventories (i.e., presence/absence) for the species' occurrence (Gould and Bleich 1977, Bleich 1979b, Rado and Rowlands 1984, Murphy and Freas 1989), no other information on the Amargosa vole is available. However, the life history of the Amargosa vole is probably similar to that of the California vole (*M. californicus*), from which the following information is derived.

The California vole typically inhabits grasslands, although it also occupies wetlands (Getz 1985). Voles are primary consumers and often the principal herbivores within occupied habitats (Rose and Birney 1985). They may excavate an extensive underground network of runways and tunnels (Wolff 1985), and in dense cover frequently develop extensive surface runways (Taitt and Krebs 1985).

The inability to concentrate urine and conserve water is a major reason for the vole's distributional restriction to mesic and wetland habitats (Getz 1985); voles are poorly adapted to conserve water and lack other physiological or morphological characteristics to allow them to tolerate high temperatures (Rose and Birney 1985). California voles require regular intake of large amounts of water, meeting or exceeding 10 percent of body weight per day (Batzli and Pitelka 1971).

California voles are active throughout the year. Activity usually occurs in

daylight hours during winter months, although animals may become crepuscular and nocturnal through the summer (Madison 1985). Grasses and forbs chiefly are consumed, as well as seeds (Heske, et al. 1984). Grasses in the genera *Hordeum*, *Bromus*, and *Lolium* were included as food items in a central California vole population (Gill 1977), although those green succulent plants most abundant in occupied habitats are probably consumed in the greatest amounts (Zimmerman 1965). When seasonally available, green emergent vegetation comprises the bulk of the diet; grass seeds predominate in the diet during the summer and autumn (Batzli and Pitelka 1971).

California vole home range size is typically small. Krebs (1966) noted the tendency of the species to "remain in a restricted area." Dispersal distances of up to 400 feet (120 meters) were recorded for a comparatively small proportion of the marked California voles during this 1966 study. Madison (1985) has reiterated the tendency for this rodent species to remain within a confined area, stating that, "...a vole can move across its entire [home] range within a few seconds, certainly in less than 1 min[ute]."

Social systems of California voles reportedly range from monogamy to polygamy (Wolff 1985). Reproduction may occur at any time of year, but is primarily influenced by factors such as temperature and precipitation that determine availability of food and water (Hoffmann 1958, Seabloom 1985). In central California, vole populations peak during the spring and begin declining in late summer (Hoffmann 1958). The California vole population in late summer usually consists predominantly of adults. Juveniles are most abundant during the winter and spring (Batzli and Pitelka 1971).

The California vole's life expectancy is short. During a one year study, Krebs (1966) estimated the average longevity of adult males and adult females at about 8 weeks and 12.5 weeks, respectively. Predators include birds, snakes, and mammals (Pearson 1985).

Reproductive maturity is reached when females attain a weight of 0.9-1.1 ounces (25.5-31.1 grams) and males a weight of 1.2-1.4 ounces (34-39.6 grams)

(Hoffmann 1958). Vole nests are composed of dried grass and may be placed above or below ground (Wolff 1985). In central California, litter size increases from about three at the beginning of the breeding season in the fall, to a peak of about six in the spring (Hoffmann 1958). Mean litter size for the species is 4.7 (Nadeau 1985). Young are born after a gestation of 21 days, and are weaned after 14 days (Nadeau 1985).

Seasonal population fluctuations during a 2-year grassland study ranged from 4 to 64 animals per acre (Krebs 1966). The species also undergoes 2- to 4-year cyclic irruptions (Batzli and Pitelka 1971). Lidicker (1973) examined such an irruption between 1959-1963, where California vole populations ranged from a low of 20 to a high of 632 per acre. Causes of subsequent population "crashes" are not well understood, but could be related to food quality and availability (Batzli and Pitelka 1971). Cyclic vole population explosions may result in intensive interspecific competition for available resources (Heske, et al. 1984).

H. HABITAT DESCRIPTION

The Amargosa vole has been found in isolated wetland habitats where bulrush is a dominant perennial overstory species. These form discontinuous narrow bands along the Amargosa River, broken by more "characteristic" desert vegetation dominated by creosote bush (*Larrea tridentata*), burrobush (*Ambrosia dumosa*) and desert holly (*Atriplex hymenelytra*). Perennial tributary spring sources interspersed along this section of the Amargosa River additionally create mesic habitat "islands" of cattails and bulrush, ranging in size from less than 1 to over 5 acres. Gould and Bleich (1977) located five individual voles in five separate areas where bulrush densities ranged from "moderate" to "high." Four of the five sites were on slopes of less than 20 percent. The remaining site was on level ground. Bleich (1979b) subsequently captured 14 voles at a single site within "moderate" density bulrush habitat on level ground. Virtually all known trapping sites (six of seven) were closely associated with standing perennial surface water. No estimates of plant species composition were provided in these studies. Rado and Rowlands (1984) later described the vegetational composition at two sites where the Amargosa vole was captured. Information obtained using

the releve method (Mueller-Dombois and Ellenberg 1974) included estimates of vegetational cover by canopy height. A successful vole trapping site in Amargosa Canyon was dominated by an overstory of bulrush, arrow weed (*Pluchea sericea*), seep-weed (*Suaeda torreyanna*), quailbush (*Atriplex lentiformis*), and southern reed (*Phragmites australis*). Understory vegetation included yerba mansa (*Anemopsis californica*) and saltgrass. Saltcedar (*Tamarix ramosissima*) was introduced at some point in the past and has recently become extremely dense in areas considered suitable vole habitat in northern Amargosa Canyon. Constituent vegetation at another vole site approximately 3 miles to the north in the Tecopa Lake Basin consisted of a less diverse plant assemblage dominated by an overstory of bulrush and an understory of yerba mansa, saltgrass, and reeds (*Juncus* sp.) (Table 1).

I. HISTORICAL AND CURRENT THREATS

Loss or degradation of habitats used by the Amargosa vole is an important reason for the species' decline. The type locality "tule" marsh at Shoshone was burned and subsequently used for hog farming after the discovery of this rodent (Kellogg 1918). Spring flow at this locality has also been diverted and channelized to allow for swimming pool construction. Development of additional spring sources near Tecopa Hot Springs, with associated land modifications for buildings and parking lots, has contributed to further wetland degradation and loss.

Construction of the Tonopah and Tidewater Railroad line, bisecting the Tecopa Lake Basin in 1906-1907, may have significantly altered historical ponding patterns on the basin floor, resulting in the loss of wetland pockets or the creation of additional wetland areas by retention of surface waters along the railroad embankment. The subsequent construction of the Tecopa Hot Springs Road and the Old Spanish Trail Highway may have similarly affected the area.

Table 1. Plant species composition at Amargosa vole sites in Amargosa Canyon and Grimshaw Lake Areas of Critical Environmental Concern[1/]

Height Class feet (meters)	Species	Percent Cover Amargosa Canyon[2/]	Tecopa Basin[3/]
0 - 0.81	*Anemopsis californica*	10-20	1-5
(0 - 0.24)	*Distichlis spicata*	5-10	60-80
	Frankenia grandiflora		<1
	Juncus sp.	<1	1-5
	Haplopappus acradenius		<1
	Nitrophila occidentalis	<1	<1
0.81 - 1.6	*Carex* sp.	20-40	
(0.24 - 0.48)	*Cirsium mohavensis*	<1	
1.6 - 3.2	*Juncus cooperi*		<1
(0.48 - 0.96)	*Suaeda torreyanna*	5-10	
3.2 - 6.4	*Atriplex lentiformis*	10-20	
(0.96 - 1.92)	*Pluchea sericea*	5-10	
	Scirpus olneyi	10-20	20-40
	Typha domingensis	<1	
6.4+	*Baccharis glutinosa*	<1	
(1.92+)	*Phragmites australis*	1-5	
	Salix nigra var. *vallicola*	<1	
	Number of Species	14	8

[1/]Adapted from Rado and Rowlands (1984).

[2/]Amargosa Canyon (SW¼ SW¼ Section 15, Township 20 North, Range 7 East).

[3/]Tecopa Lake Basin (SW¼ NE¼ Section 33, Township 21 North, Range 7 East).

When federally listed, much of the habitat was privately owned. Burning, grazing, and spring development had greatly modified or eliminated suitable habitat. Competition from introduced species was identified as a contributing factor in the decline of the Amargosa vole. Currently, the BLM, California State Lands Commission, and The Nature Conservancy administer most of the marsh habitat of the Amargosa vole. Burning and livestock grazing are no longer a threat with possibly the one exception of trespass cattle impacts to potential habitat in northern Amargosa Canyon.

The development and exploitation of subterranean water sources for geothermal energy production, which has been considered for portions of the area (U.S.D.I. Bureau of Land Management 1984), could also result in further habitat alteration or loss. Both public and private lands in the Tecopa Lake Basin have the potential for future geothermal energy development. Other sources of water exploitation include pumping for domestic consumption by residents of the communities of Shoshone, Tecopa and Tecopa Hot Springs or for commercial/investment development and operation. A plan to develop a resort hotel with golf course in this area has been proposed but subsequently withdrawn. Aside from very localized potential for development within the communities of Tecopa and Tecopa Hot Springs, opportunity for short-term development within Amargosa vole habitat is low. Alteration of substantial portions of the range of this rodent could occur, however, if appreciable water development is permitted or economically feasible geothermal resources are discovered in the area.

Many non-native species of wildlife and plants have been introduced into the area (Rado and Rowlands 1984, Murphy and Freas 1989). Vole populations may be subject to interspecific competition with the house mouse (*Mus musculus*), a species that forms a dominant component of the marsh rodent fauna (Gould and Bleich 1977, Bleich 1979b, Rado and Rowlands 1984, Murphy and Freas 1989). Predation by domestic cats (*Felis catus*) (especially those owned by recreationists visiting Tecopa and Tecopa Hot Springs for extended periods during the winter months) and feral cats could result in significant mortality. The human population in the area varies annually from a summer low of approximately 250 residents to a high of 3,000 winter visitors (U.S.D.I. Bureau of Land Management

1983a). The influx of people may correspond to that period of time when vole populations are at an annual low. Camping and parking areas heavily utilized during the winter are located next to upland bulrush marshes occupied by voles.

The introduction and establishment of tamarisk into the Amargosa River drainage may be diminishing vole habitat quality through replacement of bulrush and other native wetland plants. In areas not exposed to regular flooding, salt exuded from tamarisk leaves prevents the perpetuation of a lower canopy flora which may provide a critical source of food and cover for local vole populations (DeLoach 1991). Tamarisk currently is widespread along the northern portion of Amargosa Canyon, but only lightly established elsewhere within the range of the Amargosa vole.

Previous investigators have recorded a variety of sympatric native rodent species at vole locations, including deer mice (*Peromyscus maniculatus*), harvest mice *(Reithrodontomys megalotis*), and desert woodrats (*Neotoma lepida*) (Gould and Bleich 1977, Bleich 1979b, Rado and Rowlands 1984, Murphy and Freas 1989). Such species could limit vole population numbers due to competition for food or other resources or their ability to more opportunistically use wetland habitats subject to periodic habitat inundation or other alteration.

Pesticide applications may include use of rodenticides and herbicides near the communities of Tecopa and Tecopa Hot Springs. The current extent of pesticide applications within the geographic range of the Amargosa vole is unknown. Many pesticides commercially available could directly and indirectly affect this species, however. Herbicide used in saltcedar eradication may also affect voles if they occur in close proximity and if herbicide is not used correctly.

Intermittent but extensive inundation of lowland habitats occurs within the major portion of potentially occupiable areas of Amargosa vole range. Flooding may pose a serious threat because voles are not capable of readily climbing emergent vegetation (Rose and Birney 1985). Summer rain storms may completely submerge marsh habitats for periods of up to two weeks. For example, a 1984 inventory of a previously occupied lowland site (Bleich 1979b)

failed to confirm the presence of the animal after prolonged flooding (Rado and Rowlands 1984). Negative survey results led investigators to speculate that "...perpetuation of Amargosa vole populations over an extended period of time could heavily depend upon the continued stability of a relatively small proportion of bulrush-dominated habitats which are located on higher ground not susceptible to flooding. Such sites could serve as points from which re-establishment into lower-lying areas may take place during normal or dry periods. Their relative scarcity should mandate a very high level of protective management" (Rado and Rowlands 1984). Preferred plant species composition and density or food availability in themselves are inadequate to ensure long-term persistence. The notable difference between vole presence and absence within similar habitats is the vulnerability of an area to flooding. Only habitat above 1,370 feet (410 meters) in elevation remains secure for the vole during extreme flooding and highwater (what is locally called the "30 year floods") (Murphy and Freas 1989).

The often small (i.e., less than 5 contiguous acres) size and disjunct distribution of wetland habitats in the Tecopa Lake Basin increase the likelihood of extirpation of constituent vole populations through intermittent flooding, inbreeding depression, etc. "Corridors" of wetland habitats, such as spring overflow channels which would link such sites, are essential for maintaining vole gene flow and affording the opportunity for adjacent populations to recolonize affected sites. Flooding, watertable drawdown, spring flow alteration, or long-term shifts in weather patterns towards increasing aridity may result in the loss of wetland "pockets" and/or "corridors".

The U.S. Army Corps of Engineers has been involved with review of specific projects that potentially could affect wetland habitats utilized by the Amargosa vole. The California Department of Transportation and the County of Inyo have been similarly involved as permitting agencies for local area projects, including maintenance of area roads adjacent to the Tecopa Lake Basin.

J. CONSERVATION EFFORTS

Amargosa vole habitat is located on Federal, State, and private lands.

Wetland habitats occupied by the Amargosa vole are primarily situated on BLM lands in two contiguous "blocks" totaling approximately 1,250 acres. One site is 700 acres around the vicinity of Tecopa, including several upland bulrush-cattail marsh "pockets". The other site is 550 acres near Tecopa Hot Springs, including a significant portion of extant lowland marshes. The BLM, recognizing the environmental sensitivity of this area, designated two Areas of Critical Environmental Concern, including portions of the Tecopa Lake Basin and the Amargosa Canyon, as a part of the California Desert Plan Program (Figure 2) (U.S.D.I. Bureau of Land Management 1980). Management plans for each area were completed in 1983 (U.S.D.I. Bureau of Land Management 1983a, 1983b).

Management prescriptions for the 1,000-acre Grimshaw Lake Area of Critical Environmental Concern include measures to limit vehicular access and mineral development, maintain wetland vegetation and water flow, and monitor Amargosa vole populations. Management prescriptions for the 8,300-acre Amargosa Canyon Area of Critical Environmental concern include similar protective actions. Implementation of these actions has included a live-trapping survey of both areas for the Amargosa vole (Rado and Rowlands 1984). The BLM has completed many of these actions but administrative actions identified in the plan for long-term protection of wetland habitats and water sources, monitoring of vole populations and land acquisition within the Amargosa Canyon remain (Tom Egan, Bureau of Land Management, pers. comm., 1993). Table 2 summarizes respective management plan actions relevant to the Amargosa vole.

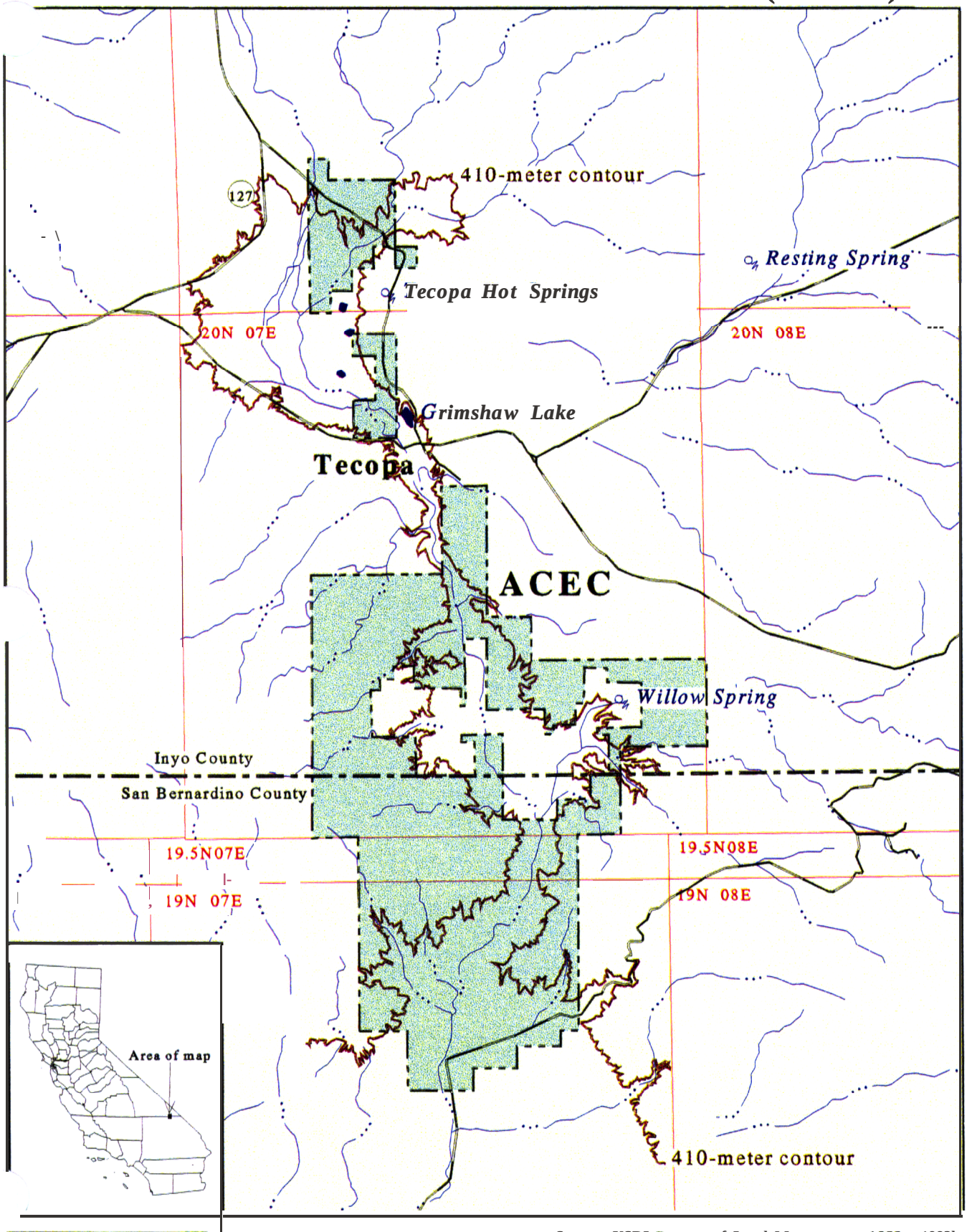
The State of California owns a single section of land (Section 16) in the northern end of Amargosa Canyon. This State section includes an approximately 1-linear mile (1.6 kilometers) segment of the Amargosa Canyon, bordered by a 10-100 foot (3-30 meter) band of cattail-bulrush vegetation. This 640-acre parcel is undeveloped. The State currently has no plans to alter extant wildlands. The BLM has entered into a cooperative agreement with the State Lands Commission for management of these lands.

The Nature Conservancy, a non-profit conservation organization, has acquired a 160-acre parcel in the SE¼ of Section 4 of Township 20 North, Range

7 East, within the southernmost of these two blocks of private land. The Nature Conservancy's parcel includes a major tributary spring supplying water to the basin, and a portion of an approximately 5-acre upland bulrush-dominated marsh. Fresh vole sign was found within this marsh in November and December 1987 and animals were captured in the adjacent tule marsh administered by the BLM in the NE¼ of Section 9 of Township 20 North, Range 7 East (Murphy and Freas 1989).

Two additional private areas of habitat remain, one that includes approximately 400 contiguous acres near Tecopa Hot Springs and another area of land in northern Amargosa Canyon. The site within the canyon historically included extensive meadows and now is used for cattle grazing. This area of private land is a high priority acquisition parcel for the BLM, and may be valuable as a secure site for habitat enhancement and reintroduction of the vole.

Figure 2. Amargosa Canyon and Grimshaw Lake Area of Critical Enviromental Concern (ACEC)



Source: USDI **Bureau** of Land Mann**gement 1983a,** 1983b. **Digital** data; BLM, USFWS, and Teale Data Center.

Table 2. Management tasks specified for wetland habitat and Amargosa vole protection in the Grimshaw Lake and Amargosa Canyon Areas of Critical Environmental Concern Management Plans[1/]

Management Prescription	Mgmt. Plan[2/]		Action	
	A	G	Completed	Pending
(1) Remove tamarisk	X	X		X[3/]
(2) Acquire private lands	X	X		X[4/]
(3) Develop cooperative landowner agreements	X	X		X[5/]
(4) Restrict vehicles	X	X	X	
(5) Rebuild vehicle barricade	X		X	
(6) Construct interpretive signs	X	X		X
(7) Monitor wetland habitats	X	X		X[6/]
(8) Conduct general vole survey	X		X	
(9) Monitor vole populations	X	X		X
(10) Mineral withdrawal		X		X
(11) Identify spring water reserves		X		X

[1/]Source: adapted from Bureau of Land Management (1983a, 1983b).

[2/]"A"=Amargosa Canyon Area of Critical Environmental Concern Management Plan;
"G"=Grimshaw Lake Area of Critical Environmental Concern Management Plan

[3/]Tamarisk removal has proceeded on private lands in central Amargosa Canyon, south of known vole habitat. No control has taken place within the range of this species.

[4/]The Nature Conservancy has acquired 160 acres in Township 20 North, Range 7 East, Section 4, San Bernardino Baseline Meridian, for protective management. The BLM has acquired Grimshaw Lake wetlands in Township 20 North, Range 7 East, Section 9.

[5/]The Nature Conservancy is independently attempting to acquire private lands in vole range.

[6/]Baseline data on vegetation composition and water quality was obtained in 1983-1984 by the Bureau of Land Management and in 1989 by The Nature Conservancy.

Part II. RECOVERY

A. OBJECTIVE

The objective is to minimize the threats that imperil the Amargosa vole so that the species can be downlisted to threatened status. The Amargosa vole may be proposed for downlisting when populations of the vole and the wetland ecosystem upon which they are dependent within the ancient Tecopa Lake Basin and within Amargosa Canyon are secure and self-perpetuating. (Minimum population size and period of stability or growth for populations will be determined based upon monitoring and to some extent, the genetic analyses).

Recovery efforts should occur on the following five sites: Public lands administered by the BLM in the Grimshaw Lake and Amargosa Canyon Areas of Critical Environmental Concern; State lands in the northern portion of Amargosa Canyon; The BLM lands south of Tecopa Hot Springs; and private lands containing vole habitats. Water sources required to perpetuate these areas, and corridors necessary for maintaining genetic exchange between otherwise isolated vole populations should be secured and managed. Secured wetland habitats should be collectively managed to meet or exceed a minimum viable Amargosa vole population size. Specific information on the Amargosa vole life history, genetics, and habitat requirements is necessary to determine the characteristics of a self sustaining population and its habitat. Priority for securing lands and for maintaining "core" vole population numbers should focus on upland (>1,370 feet, 410 meters) wetland sites deemed crucial for recolonizing, more than ephemeral lowlands (≤1,370 feet, 410 meters) sites subject to periodic inundation.

The interim goal is to secure vole populations in wetlands above 1,370 feet (410 meters) elevation. Tasks to achieve the interim goal include securing habitat and the water sources for maintaining these wetlands, and minimizing threats from introduced species.

Specific delisting criteria for the Amargosa vole cannot be developed at this time because of a paucity of information on the species' biology and management requirements. Recovery tasks to rectify these information deficiencies include collection of data to determine the number of individuals and habitat size necessary to maintain self-perpetuating Amargosa vole populations. Delisting criteria for the Amargosa vole will be developed at a date following the retrieval of this information.

B. NARRATIVE

1. Implement short-term actions critical for the near-term survival of the Amargosa vole.

The immediate and long-term survival of the species appears to depend on the persistence of vole populations occupying habitat patches above 1,370 feet (410 meters) elevation. All populations and associated wetlands are small and vulnerable to rapid changes from altered groundwater and spring outflows, exotic vegetation and animals, natural and introduced predators, and floods. Extant populations and habitats need to be protected.

11. Identify Amargosa vole habitat and source water on private, The Nature Conservancy, State, and Federal lands.

Current distribution of vole habitat throughout historic range needs to be mapped. Habitats, groundwater, and spring water sources should be catalogued according to ownership or leaseholder.

111. Identify Amargosa vole habitat.

Vole habitat throughout historic range should be mapped and catalogued according to ownership. This effort should include precise delineation of wetlands and elevation contours.

112. Identify groundwater sources and springs.

All groundwater and spring water sources, and springs

essential to maintaining vole habitat need to be identified by location and ownership or leaseholder. This information should be included on maps developed for Task 111.

12. Implement measures to secure extant populations and non-occupied habitats; foremost, those above 1,370 feet (410 meters) in elevation and habitats protected against flooding by the historic railbed grading for the Tonopah and Tidewater railroad line.

Habitat patches above the 1,370 feet (410 meter) elevation and behind the railbed grading are not inundated by periodic flooding. Populations in these areas persist during critical flooding years and probably act as feeder stock for repopulating habitats of lower elevation that are exposed to flood waters. Seasonally flooded lowland habitats probably act as a corridor for gene exchange among upland populations. Immediate actions need to be taken to secure upland habitat patches and lowland habitat patches.

121. Secure water sources and water rights for groundwater and springs critical to maintaining and enhancing upland habitats and lowland habitats.

The diversion and channelization of springs have greatly modified or eliminated suitable habitat. Existing water sources must be secured to protect wetlands. Further development of the water sources critical to maintaining these wetlands could result in the extirpations of the vole. Water development that may result in the adverse modification of vole habitat needs to be prohibited. Water rights to ground water and spring outflows maintaining these habitats need to be secured to ensure protection of the wetlands.

122. Protect wetland habitats from geothermal development.

Geothermal development may result in diminishing the quantity and quality of water available to vole habitat.

1221. Identify geothermal ownership that can affect upland and protected lowland habitats.

Geothermal ownerships in areas that may affect vole habitat need to be identified.

1222. Remove geothermal development that has adverse effects on wetlands from current and future leasing.

Geothermal development that will likely affect vole habitat needs to be removed from current and future operation.

123. Remove tamarisk from upland and protected lowland habitats.

The exotic tamarisk can quickly invade wetlands, out-compete native vegetation, contribute to water loss and can reduce standing water levels. Tamarisk needs to be removed from vole habitat. Prior to tamarisk removal, the necessary authorization and permits must be obtained.

124. Maintain integrity of the Tonopah and Tidewater railbed to prevent flooding of existing protected lowland habitats.

The existing historic railbed protects some habitat from major flooding. If the railbed is breached, flood waters can eliminate vole populations in these otherwise protected habitats. The railbed needs to be monitored for possible breaching and reinforced where weaknesses are found.

125. Prevent further loss of habitat or water quality by road construction, maintenance, or other construction activities.

Road construction or maintenance can directly and/or indirectly affect vole habitat by crushing vegetation, covering habitat with material, impounding or altering spring flow, etc. Construction activities need to be managed to ensure habitat is not adversely modified.

13. Identify threats to the Amargosa vole and/or habitat.

Competition with introduced house mice, predation by domestic and feral cats, invasion by the exotic tamarisk, and groundwater depletion are all considered serious threats. Because of the small size of the extant vole populations and habitat, all potential threats (e.g., invasion by the exotic southern reed, cattle grazing in northern Amargosa canyon) and measures to protect the vole need to be identified. (The effect of some threats on the population may not be readily known and should be studied. These studies will be completed under Task 51.)

14. Develop Interim Management Plan to Protect Habitats.

After completing Task 13, and based on the best available information, develop an interim management plan for the immediate, short-term protection of the vole. The plan should identify action items to minimize loss of vole habitat; especially water sources, competition with introduced plant and animal species, predation, and other identified threats. The BLM should explore the option of acquiring the Modine property with the private landowners. This would help protect additional habitat areas for the vole.

15. Implement Interim Management Plan.

Responsible trust resource agencies and organizations need to obtain adequate funding to fully implement the management plan (Task 14).

2. Population Surveys and Assessment.

Basic life history information needs to be acquired to increase the opportunity for long-term effective management of Amargosa vole populations and habitats. Available information has been restricted primarily to initial collection and a series of general inventories of wetland habitats between Shoshone and the Amargosa Canyon. A comprehensive survey, comprising visual and focused trapping effort over all occupied, as well as potentially occupied, habitat should be conducted.

21. Estimate population size of all habitat patches using capture/mark/recapture.

A survey and handling protocol needs to be developed. Survey effort should include historic sites. Animals captured should be permanently marked with a subcutaneous passive integrated transponder (PIT) tag and released.

22. Obtain demographic data on the Amargosa vole to determine abundance, distribution, natality, mortality, recruitment, dispersal distance, and rate of population change.

The dynamic nature of populations causes them to change in size, number and location through time. The status of vole populations, including survivorship and effective breeding population size, needs to be monitored.

23. Collect tissue samples from all new captured animals.

At a minimum, a tissue sample (e.g., hair, ear clip) will be taken from each individual upon first capture for subsequent genetic analysis. When possible, and per established protocol, a sample of blood should be collected for genetic analysis of blood protein groups. Also, there are new, less invasive techniques, such as fecal analysis, that should be explored as other potential means of extracting genetic information.

24. Collate and analyze data annually.

All data should be synthesized and analyzed annually. A summary report should be distributed to all Federal and State agencies with trust resource responsibilities.

3. Habitat Surveys and Assessment.

A thorough description of habitat distribution and a detailed assessment of habitat requirements of the vole is necessary to design habitat enhancement plans.

31. Quantify habitat characteristics around animal capture sites.

Each precise point of capture of the vole will be marked for

subsequent quantification of habitat parameters. Biotic and abiotic components need to be characterized and evaluated. The habitat characterization should include, but not be limited to, floristic composition, distance from nearest water, soil type, soil compaction, soil moisture content, and gradient.

32. Determine temporal and spacial patterns of habitat use.

Amargosa vole population size and distribution fluctuates seasonally and many vole populations have relatively predictable, long-term cyclic patterns. To design an effective habitat management plan, it will be important to understand contemporary habitat use patterns, population size and distribution.

33. Evaluate habitat condition annually.

A systematic inventory of extant wetland habitats, extending from Shoshone to the Amargosa Canyon, needs to be undertaken. Each habitat patch should be mapped and characterized based on the findings of Task 31. Habitat conditions on secured (i.e., Federal, State and The Nature Conservancy lands) and unsecured (i.e., remaining private lands) Amargosa vole habitats should be evaluated annually. Monitoring measures should gauge effects of both natural and human-induced actions and success of recovery tasks.

331. Tecopa Lake Basin and the Amargosa Canyon.

Vegetation surveys, hydrological studies, and human disturbance evaluations will all need to be conducted to evaluate habitat quality. Assessment of the impact of seasonal flooding to vole habitat suitability, especially in the area between Tecopa Hot Springs Road and the railroad grade as well as within the Amargosa canyon will be necessary. Assessment of tamarisk encroachment in the Grimshaw Lake area and the Amargosa canyon will be necessary. A review of the cooperative efforts between the various land owners and administrators in the area should assist in isolating areas of conflict, prevent duplication of

effort, and help determine methods of efficient habitat management.

332. Shoshone area.

Vegetation surveys, hydrological studies, and human disturbance evaluations will all need to be conducted to evaluate habitat quality and population reestablishment efforts. A review of the cooperative efforts between the various land owners and administrators in the area should assist in isolating areas of conflict, prevent duplication of effort, and help determine methods of efficient habitat management.

34. Develop management protocols for enhancing extant habitat and rehabilitating historical habitat sites.

Based on data obtained from Tasks 31-33, management protocols should be developed. This process will be ongoing with management protocols evolving as new information becomes available.

341. Analyze habitat data.

Data obtained from Tasks 31-33 should be analyzed to determine essential habitat characteristics, variations in habitat types, optimal habitat parameters, natural changes in habitat, and other factors necessary to define optimal habitat, monitor trends, and manage for optimal habitat conditions.

342. Develop management protocols for enhancing extant habitat and rehabilitating historical habitat sites.

Management protocols should be developed and modified as new information is available. A report of Amargosa vole habitat status should be submitted annually to Federal and State trust resource management agencies.

4. Genetic Analysis.

Amargosa vole genetics information is necessary to complete recovery

criteria and develop sound recovery tasks.

41. Genetic analysis.

The degree of genetic differentiation within and among Amargosa vole populations can be used to determine the degree of gene flow, relative levels of inbreeding, and changes in inbreeding over time. Samples should be obtained from all Amargosa voles captured in the field and from museum specimens. Necessary permits should be obtained from the U.S. Fish and Wildlife Service and California State Lands Commission. A variety of sampling and testing methodologies are available. A protocol describing the sampling procedures and appropriate methodologies (e.g., mitochondrial DNA, nuclear DNA, electrophoretic) needs to be developed and implemented. These studies may provide information critical for identifying necessary recovery actions.

42. Evaluate progress toward recovery objective.

The genetics information will be used to determine if recovery objectives and management actions (such as Task 5) need to be modified.

5. Enhance Amargosa Vole Populations and Habitat.

Enhancing existing habitat and restoration of lost or degraded habitats to a quality that will support "target" Amargosa vole population levels may include: tamarisk removal and control, protective fencing of wetland habitats, rehabilitation or creation of previously degraded habitats and vole dispersal corridors, control of house mice to reduce competition (if necessary), removal of feral cats to reduce predation, restricting application of rodenticides or herbicides near wetland habitats, creation of additional upland bulrush pockets not subject to regular inundation, and introduction of voles into these created habitats. Implementation of management measures to restore or enhance habitats or to "boost" vole populations will be contingent upon initial field test results.

51. Determine effects of natural and anthropogenic threats including flooding, spring water flow and flux, vegetational changes, fire, exotic intrusion (plant and animal), pesticides/rodenticides, and

groundwater/watershed alteration.

Task 13 requires resource agencies to identify threats to vole populations and their habitat while task 14 requires development of an interim management plan to protect the vole based on the best available information. In some cases, the effects of threats to vole populations and habitats still need to be determined to implement appropriate long-range management actions. A focused long-range management plan needs to identify threats that require immediate and specific action to prevent extinction, those threats that are not immediate but will require prolonged management action, and those threats that are of small consequence.

52. Implement effective habitat/vegetation manipulation that enhances vole habitat and minimizes adverse effects on other sensitive native species.

Management of habitat may be necessary to maximize vole population size. Such action should include protection against water withdrawal, fire, and/or tamarisk removal. Restoration of historic habitat should attempt to duplicate biotic and abiotic conditions that characterize high quality vole habitat. Prior to habitat manipulation, surveys should be conducted for rare or endangered species.

53. Reduce or eliminate competitive faunal species.

Selective techniques to control predators (native and feral) and eliminate or/control non-native competitive species should be implemented. Techniques should not adversely modify habitat or result in the accidental killing or harming of the vole.

54. Establish additional Amargosa vole populations.

Species with a patchy distribution will be less vulnerable to demographic and environmental stochasticity if patches are numerous, large and interconnected. The need and location for additional vole populations should be based on the genetic analysis findings. Reintroductions should occur only in historic habitat.

541. Determine if establishment or rehabilitation of habitat is necessary.

It may be necessary to translocate individual animals from extant populations into other areas of historic habitat where bulrush marsh pockets appear favorable for colonization by this species. Alternatively, creation of new "upland" sites in the Tecopa Lake Basin or Shoshone area may afford the opportunity for successful establishment of vole populations into previously unstable habitats.

542. Locate site(s) for experimental translocation of voles.

Selection of reintroduction sites should be based on an analysis of species inventory results, an assessment of habitat condition and rehabilitation potential, current and anticipated threats, and opportunity for long-term management of habitats for the perpetuation of the subject Amargosa vole population.

543. Complete habitat rehabilitation or protective measures, if necessary, prior to reintroducing voles.

Reintroduction sites may need restoration or protection measures to maximize the viability of the reintroduced vole populations. Measures could include flood protection, vegetation restoration, fencing to exclude domestic dogs and cats, elimination/control of predators and competitors, and the posting of informational signs.

544. Obtain voles for translocation program.

Amargosa voles may be live-trapped from an extant population site deemed large enough to accommodate removal of several animals. Alternately, smaller numbers of individual animals may be obtained from one or more extant populations and used to captively rear additional animals for later release.

545. Introduce voles into the site(s).

Relevant literature should be reviewed to determine the

initial optimum number and demographic composition of voles in a translocated population and the optimal environmental conditions for reintroduction. An experimental reintroduction plan will be developed detailing the translocation procedures and subsequent research/ monitoring design. All necessary permits will need to be obtained from the relevant regulatory and management agencies before actual translocation occurs.

546. Monitor success of the vole population at each transplant site.

Ability of translocated animals to survive and reproduce, and for the vole population to increase within the area of reintroduction should be evaluated for at least two consecutive years to gauge program success. Development of additional management recommendations to facilitate increased opportunity for successful reintroductions should also be an integral component of this evaluation program.

547. Continue with transplant program if necessary or feasible.

If experimental translocation results show a high probability for the successful establishment of additional vole populations, an extended program may be instituted within the area.

55. Develop map of habitat and population trends.

As enhancement efforts progress and evolve, the status of Amargosa vole habitat and population trends should be documented and mapped. The maps will illustrate species status and the extent of habitat manipulation and land use trends. An annual report should be submitted to Federal and State trust resource management agencies.

6. Monitor Habitat Trends.

The status of the Amargosa vole, implementation of recovery tasks, and the effectiveness of recovery tasks can be assessed only by routine monitoring. Modifications of recovery plan objectives may be required as additional

information obtained through implementation of plan tasks becomes available. Such modifications may include adjustment of minimum vole population density levels required to maintain a viable population size. Accumulation of this information should also provide for quantification of specific delisting goals.

61. Develop monitoring protocol and conduct yearly small mammal and vegetation surveys.

A protocol for small mammal and vegetation surveys should be developed (and may be adopted from above tasks). The protocol should include, but not be limited to, survey methods, season, handling procedure, measurements, and disposition of specimens. The necessary Federal and State permits will be acquired.

62. Update map of habitat and population trends.

Data should be synthesized and analyzed in a report form. Raw data should be digitized onto maps of Amargosa vole habitat. All information should be reported annually to Federal and State trust resource agencies.

63. As necessary, modify management plans.

New data should be incorporated into the management plans. Modify plans as necessary.

7. Establish a public outreach program.

An effective public information program should be developed to increase awareness and understanding of the Amargosa vole recovery efforts. Interested parties should be continually involved in and updated on all aspects of this recovery effort so that conflicts can be identified and resolved as soon and as much as possible.

71. Establish a public outreach program.

Develop educational materials such as signs, talk shows and brochures to inform the public about Amargosa vole recovery efforts and to help identify hazards to the species survival on unprotected lands.

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Part IV. IMPLEMENTATION SCHEDULE

This implementation schedule outlines recommended actions and estimated costs associated with the recovery of the Amargosa vole. It is a guide for meeting the objective discussed in Part II of this recovery plan. This schedule indicates task priorities, numbers, and descriptions; duration of each task; responsible agencies; and estimated costs. These actions, when accomplished, should bring about the recovery of the Amargosa vole and protect its habitat. Estimated monetary needs for all parties involved in recovery are identified and, therefore, this schedule reflects the total estimated financial requirements for the recovery of this species.

In the implementation schedule, tasks are arranged in priority order. The assigned priorities are defined as follows:

Priority 1 - An action that must be undertaken to prevent extinction or to prevent the Amargosa vole from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be undertaken to prevent a significant decline in the Amargosa vole population distribution or size, or habitat quality, or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to meet the recovery objective.

The following terms and abbreviations are used in the implementation schedule:

Task Duration:

Continuous	=	The action will be implemented continually once begun.
Ongoing	=	Currently being implemented and will continue until no longer necessary for recovery.

Responsible Party:

BLM	=	U.S. Bureau of Land Management
FWS	=	U.S. Fish and Wildlife Service
BRD	=	U.S.G.S. Biological Resources Division
NPS	=	U.S. National Park Service
CDFG	=	California Department of Fish and Game
TNC	=	The Nature Conservancy
*	=	Lead Agency

Other:

Total Cost	=	Projected cost of task from start to finish; does not include costs identified as TBD.
TBD	=	To Be Determined at a later date

Part IV. Implementation Schedule for the Amargosa Vole

Priority No.	Task No.	Task Description	Task Duration Years	Responsible Party	Total Cost	COST ESTIMATES ($1,000'S)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
		Needs 1: Critical Action for Near-term Survival								
1	111	Identify vole habitat	2	BRD* BLM CDFG TNC	4 4 2 2	2 2 1 1	2 2 1 1			
1	112	Identify groundwater sources and springs	2	BRD* BLM CDFG TNC	4 4 2 2	2 2 1 1	2 2 1 1			
1	121	Secure groundwater and springs critical to maintain and enhance upland and protected lowland habitats	2	BLM* CDFG TNC NPS	TBD TBD TBD TBD	TBD TBD TBD TBD	TBD TBD TBD TBD			
1	1221	Identify geothermal ownership that can affect habitat	1	BLM*	TBD	TBD				
1	1222	Remove geothermal threats	1	BLM*	TBD	TBD				
1	123	Remove tamarisk from upland and protected habitats	Continuous	BLM* TNC BRD	125 TBD TBD	20 TBD TBD	20 TBD TBD	20 TBD TBD	25 TBD TBD	5 TBD TBD
1	124	Maintain integrity of historic railbed to prevent flooding of protected lowland habitats	Continuous	BLM	TBD	TBD	TBD	TBD	TBD	
1	125	Prevent further loss of habitat or water quality by construction activities	Continuous	BLM*	TBD	TBD	TBD	TBD		

Priority No.	Task No.	Task Description	Task Duration Years	Responsible Party	Total Cost	COST ESTIMATES ($1,000'S)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
1	13	Identify threats to the vole	1	CDFG* BLM	2 1	2 1				
1	14	Develop interim management plan	1	BLM* CDFG FWS	2 1 1		2 1 1			
1	15	Implement interim management plan	3	BLM* TNC	TBD TBD			TBD TBD	TBD TBD	TBD TBD
		Subtotal costs needs 1			156	35	36	20	25	5
		Needs 2: Population Surveys and Assessment								
1	21	Estimate population size of all habitat patches	3	CDFG* BLM TNC FWS BRD	30 9 9 6 3	10 3 3 2 1	10 3 3 2 1	10 3 3 2 1		
1	22	Obtain demographic data	5	CDFG* BLM TNC FWS BRD	20 6 6 4 2	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	10 3 3 2 1	10 3 3 2 1
2	23	Collect tissue samples	5	BRD* BLM CDFG TNC FWS	TBD TBD TBD TBD TBD	TBD TBD TBD TBD TBD	TBD TBD TBD TBD TBD	TBD TBD TBD TBD TBD	TBD TBD TBD TBD TBD	TBD TBD TBD TBD TBD

Priority No.	Task No.	Task Description	Task Duration Years	Responsible Party	Total Cost	COST ESTIMATES ($1,000'S)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
2	24	Analyze population data	5	BRD*	10	2	2	2	2	2
				BLM	5	1	1	1	1	1
				CDFG	5	1	1	1	1	1
				TNC	5	1	1	1	1	1
				FWS	5	1	1	1	1	1
Subtotal costs needs 2					125	25	25	25	25	25
Needs 3: Habitat Surveys and Assessment										
2	31	Quantify habitat characteristics	3	BLM*	6	2	2	2		
				CDFG	3	1	1	1		
				TNC	3	1	1	1		
				FWS	3	1	1	1		
				BRD	3	1	1	1		
2	32	Determine temporal and spacial patterns of habitat use	5	BRD*	4	0	0	0	2	2
				BLM	2	0	0	0	1	1
				CDFG	2	0	0	0	1	1
				TNC	2	0	0	0	1	1
				FWS	2	0	0	0	1	1
2	331	Evaluate habitat conditions of Tecopa Lake Basin and Amargosa Canyon	5	BLM*	10	2	2	2	2	2
				CDFG	5	1	1	1	1	1
				TNC	5	1	1	1	1	1
				FWS	5	1	1	1	1	1
2	332	Evaluate habitat conditions of Shoshone Area	5	CDFG*	5	1	1	1	1	1
				BLM	5	1	1	1	1	1
				FWS	5	1	1	1	1	1

Priority No.	Task No.	Task Description	Task Duration Years	Responsible Party	Total Cost	COST ESTIMATES ($1,000'S)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
2	341	Analyze habitat area	5	BLM*	10	2	2	2	2	2
				CDFG	5	1	1	1	1	1
				TNC	5	1	1	1	1	1
				FWS	5	1	1	1	1	1
				BRD	5	1	1	1	1	1
2	342	Develop management protocol	5	BLM*	2					2
				CDFG	1					1
				TNC	1					1
				FWS	1					1
Subtotal costs needs 3					105	20	20	20	20	25
Needs 4: Genetic Analysis										
2	41	Genetic Analysis	3	BRD*	40	20	10	10		
				FWS	6	2	2	2		
				CDFG	6	2	2	2		
				BLM	3	1	1	1		
2	42	Evaluate progress toward recovery objective	Continuous	FWS	0					
				BLM	0					
Subtotal costs needs 4					60	25	15	15	0	5
Needs 5: Enhance Vole Population and Habitat										
2	51	Determine effects of threats	3	BLM*	3			1	1	1
2	52	Implement habitat/vegetation enhancement	Continuous	BLM*	TBD					TBD
				CDFG	TBD					TBD
				TNC	TBD					TBD
				FWS	TBD					TBD
2	53	Reduce competitive fauna	Continuous	CDFG*	TBD					TBD
				BLM	TBD					TBD
				TNC	TBD					TBD
				FWS	TBD					TBD

Priority No.	Task No.	Task Description	Task Duration Years	Responsible Party	Total Cost	COST ESTIMATES ($1,000'S)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
2	541	Determine if establishment of rehabilitation of habitat is necessary	1	FWS* BLM CDFG TNC	2 2 2 2					2 2 2 2
2	542	Locate site(s) for experimental translocation of voles	1	BLM* CDFG FWS	TBD TBD TBD					
2	543	Complete habitat rehabilitation prior to reintroducing voles	2	BLM* CDFG FWS	TBD TBD TBD					
2	544	Obtain voles for translocation	3	BRD* BLM CDFG FWS	TBD TBD TBD TBD					
2	545	Reintroduce voles	3	BRD* BLM CDFG FWS	TBD TBD TBD TBD					
2	546	Monitor success of reintroduction	2	BRD* BLM CDFG FWS	TBD TBD TBD TBD					
2	547	Continue with translocations as necessary	Continuous	CDFG* BLM FWS	TBD TBD TBD					
Subtotal costs needs 5					11	0	0	1	1	9
Needs 6: Monitor Habitat Trends										

Priority No.	Task No.	Task Description	Task Duration Years	Responsible Party	Total Cost	COST ESTIMATES ($1,000'S)				
						FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
2	61	Develop monitoring protocol and conduct yearly small mammal and vegetation surveys	Continuous	CDFG* BLM FWS	TBD TBD TBD					
2	62	Update map of habitat and population trends	Continuous	BLM* CDFG FWS	TBD TBD TBD					
2	63	Modify management plans	TBD	BLM* CDFG FWS	TBD TBD TBD					
Subtotal costs needs 6					0	0	0	0	0	0
Needs 7: Develop public Outreach Program										
2	71	Develop a public outreach program	Continuous	BLM* CDFG FWS	18 5 5	10 1 1	5 1 1	1 1 1	1 1 1	1 1 1
Subtotal costs needs 7					49	12	7	3	3	3
TOTAL COSTS					506	117	103	84	74	72

Appendix A: Summary of Comments Received on the 1988 Draft Recovery Plan for the Amargosa Vole

Written comments on the draft recovery plan were only received from the California Department of Fish and Game. All comments and suggestions were incorporated into this final plan.

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