Recovery Plan for the Amargosa Vole (*Microtus californicus scirpensis*)
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Original Prepared by: USFWS, Portland OR

DRAFT AMENDMENT 1

We have identified best available information that indicates the need to amend recovery criteria for the Amargosa vole (*Microtus californicus scirpensis*) since the recovery plan was completed. In this proposed modification, we synthesize the adequacy of the existing recovery criteria, show amended recovery criteria, and describe the rationale supporting the proposed recovery plan modification. The proposed modification is shown as an appendix that supplements the recovery plan, superseding the Historical and Current Threats section in Part I (pp. 9-13) and the Recovery section identified as Part II (pp. 18–30) of the recovery plan.

For
U.S. Fish and Wildlife Service
Region 8
Carlsbad, CA

March, 2019

METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT

Recovery criteria were updated for this addendum through internal coordination with staff and through external coordination with our partners. Work was done to update criteria for delisting and to provide quantitative criteria. We coordinated with the University of California at Davis (UC Davis), the California Department of Fish and Wildlife (CDFW), and the United States Geological Survey (USGS) to discuss the species needs and requested information regarding recovery goals for the Amargosa vole. We will make this addendum available for public review as well as solicit peer review. These coordinated efforts help to develop new quantitative criteria for the recovery plan that will better serve us as we work to recover the vole.

ADEQUACY OF RECOVERY CRITERIA

Section 4(f)(1)(B)(ii) of the Endangered Species Act (Act) requires that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination…that the species be removed from the list." Legal challenges to recovery plans (see Fund for Animals v. Babbitt, 903 F. Supp. 96 (D.D.C. 1995))

and a Government Accountability Audit (GAO 2006) also have affirmed the need to frame recovery criteria in terms of threats assessed under the five delisting factors.

Recovery Criteria

See recovery objectives in the 1997 recovery plan (Service 1997, pp. 18–19). The recovery criteria below will be added to the plan through an addendum and will supersede the recovery objectives that are present in the current plan.

Synthesis

The Amargosa vole (*Microtus californicus scirpensis*) is a desert subspecies of the widely distributed California vole (*Microtus californicus*). The 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*). Figure 1 depicts existing vole habitat near Tecopa and Tecopa Hot Springs, California. The vole was listed as a Federal endangered species with critical habitat on November 15, 1984 (Service 1984). Reasons for listing included loss of historical habitat, re-channelization of water sources needed to perpetuate habitats, and pumping of groundwater.

Due to a paucity of existing information on the species' biology and management needs, the recovery plan for the Amargosa vole included no subspecies-specific recovery criteria (Service 1997). The plan did make the following general recommendations: 1) implement short-term actions critical for the near-term survival of the Amargosa vole; 2) conduct population surveys and assessment; 3) conduct habitat surveys and assessment; 4) conduct genetic analysis; 5) enhance vole populations and habitat; 6) monitor habitat trends; and 7) establish a public outreach program (Service 1997). A 5-year Review for the vole was completed in 2009 and recommended no change in status because of ongoing threats (Service 2009).

Various survey efforts have occurred for the Amargosa vole since its discovery in 1891 (Bleich 1979a, 1979b; Rado and Rowland 1984; McClenaghan and Montgomery 1998), but all surveys prior to 2012 focused on determining the species' distributional limits and collected little information on abundance. In 2012, the USGS surveyed six trapping grids to estimate population size and determine habitat selection criteria (Klinger *et al.* 2014). The results showed a pooled, range-wide density ranging 2.5 to 7.5 individuals per hectare within the trapping grids, with a high density of the individuals occurring at Marsh 1 (Table 1). Calculated density at Marsh 1 was 11.4 to 41.3 individuals per hectare between January and May. Consideration of range-wide density information in combination with the amount of suitable habitat (estimated as 30 hectares) provided an extrapolated population estimate that ranged between 75 and 225 individuals during the 5-month study in 2012 (Klinger *et al*. 2014, Klinger 2014).

In 2013 and 2014, CDFW and UC Davis continued trapping efforts to determine population size and trend. Due to resource limitations, density data utilized for estimating the range-wide population size were restricted to a single survey grid at Marsh 1 (Table 1). Foley (2014, pers. comm.) estimated that the population size of Marsh 1 ranged between 12 and 303 individuals in 2013 and 2014 depending on the season.

However, population estimates extrapolated from the Marsh 1 density used a different estimation of habitat extent from Klinger *et al*. (2014). As discussed above, Klinger *et al*. (2014) estimated the extent of habitat at Marsh 1 and range-wide to be 2 ha and 30 ha, respectively, because of the assumption that Amargosa voles were restricted almost entirely to live aboveground bulrush vegetation because of predation pressure. Klinger *et al*. (2014) indicated that the population size of Marsh 1 ranged between 5 and 116 individuals in 2013 and 2014 depending on the season (Table 1), with the estimate for overall population size (all marshes) for 2013 and 2014 ranging from a low of 69 individuals in March 2013 to a high of 426 individuals in March 2014.

In calculating population size, Foley (2014, pers. comm.) incorporated other habitat types into their estimate of habitat extent at Marsh 1 (5.2 ha) and range-wide (80.7 ha). Consequently, the population estimates derived by multiplying the Marsh 1 density by the extent of habitat are considerably larger than what would be calculated using only the extent of live aboveground bulrush marshes. For comparison, Table 1 provides estimates for 2012-2015 using the habitat extent from Klinger *et al.* (2014; Klinger 2016b, pers. comm.) and estimates for 2013- 2015 using the habitat extent from Foley (2014, pers. comm.).

Based on 5 months of data collected in 2012 from six 1-hectare grids, Klinger *et al.* (2014) was able to derive monthly estimates of abundance, as well as monthly survival and recruitment rates for the survey period. These data were then lumped with data collected in 2013, and a population viability analysis was developed (Foley *et al.* 2013). The analysis produced two patterns: (1) species' abundance indicated high spatial and temporal variability, and (2) low monthly survival rates.

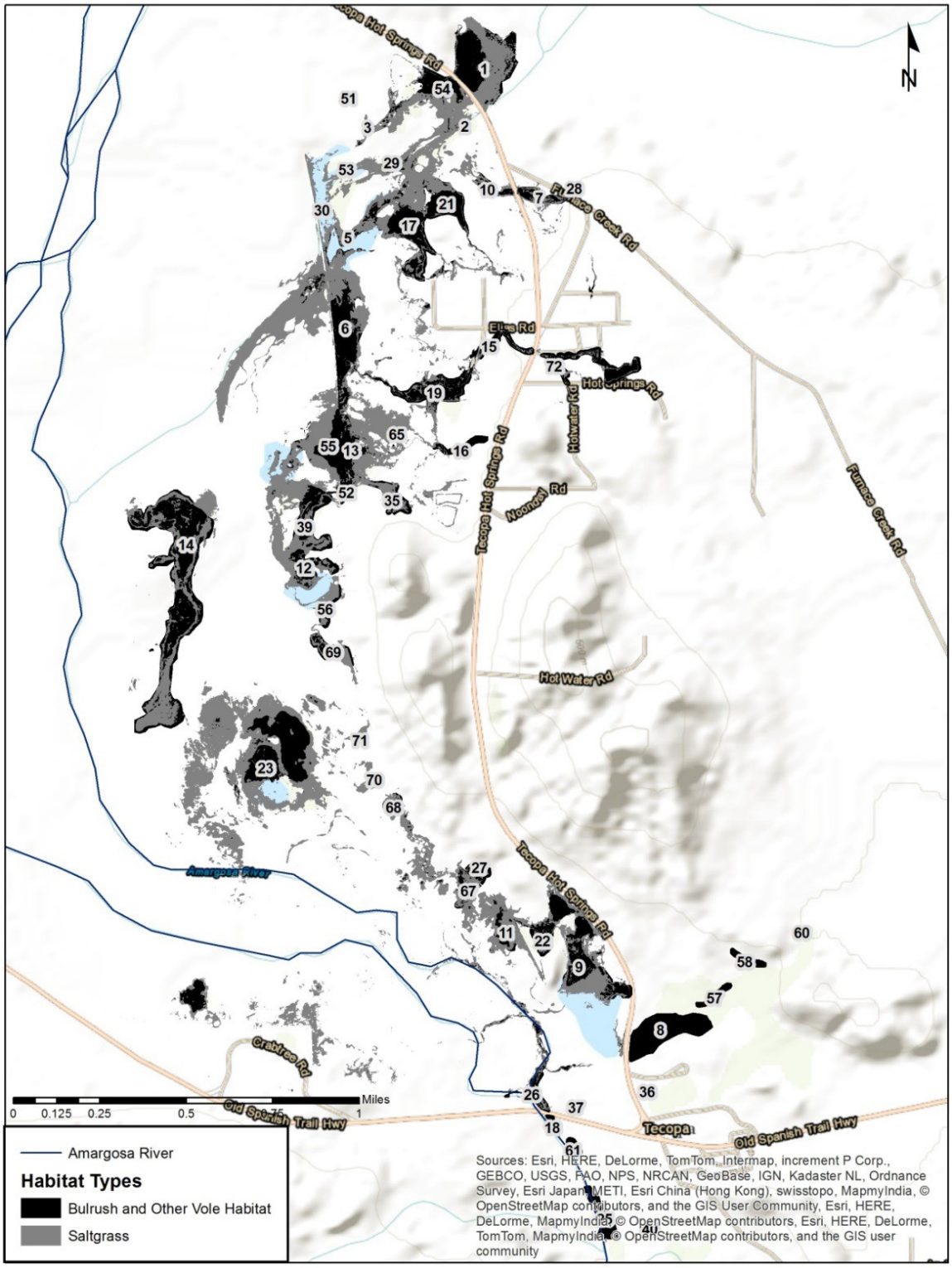

Figure 1: Map of locations of bulrush marsh vegetation and desert saltgrass (*Disticlis spicate*) near Tecopa and Tecopa Hot Springs, California

Table 1: Density and population size estimates for the range-wide population and the Marsh 1 subpopulation of the Amargosa vole (Klinger *et al*. 2014; Klinger 2016a, pers. comm.; Foley 2014, pers. comm.; ha=hectare).

Year	Month	Density Marsh 1 (per hectare)	Range-wide Density (per hectare)	Marsh 1 Population Size		Range-wide Population Size	
2012				2-Ha habitat estimate		30-Ha habitat estimate	
	January	11.4	2.5	23		75	
	February	29.6	6	59		180	
	March	34.3	6.5	69		195	
	April	18.1	3.4	36		102	
	May	41.3	7.5	83		225	
2013				5.2-Ha	2-Ha	80.7-Ha	30-Ha
	March	2.3	ND	12	5	ND	ND
	November	3.0	ND	16	6	ND	ND
2014	January	17.8	ND	93	36	ND	ND
	March	10.5	ND	55	21	ND	ND
	May	14.2	ND	74	28	ND	ND
	June	37.5	ND	195	75	ND	ND
	July	58.2	ND	303	116	ND	ND
	Aug./Sept.	46.5	ND	242	93	ND	ND
	November	18.2	ND	95	36	ND	ND
	December	14.6	17.5	76	29	605	1225
2015	February	5.9	13.2	31	12	258	196
	March	5.9	17.3	31	12	589	1219
	May	7.7	15.9	40	15	476	1177
	June	16.7	19.1	87	33	734	1273
	August	17.2	19.1	89	34	734	1273
	September	17.9	114.1	93	36	1138	1423
	November	14.8	7.1	77	30	573	213

* ND indicates range-wide density estimates and total population size could not be made between June 2012 and November 2014.

** Values in 5.2-Ha and 80.7-Ha are extrapolated from Marsh 1 and range-wide densities for 2013-2015. Range-wide density estimates and total population size were derived from only three grids between December 2014 and September 2015 and are likely to be biased high so should be interpreted cautiously.

In short, mean overall estimates of density, pooled across all grids, ranged from 2.5 to 7.5 individuals per hectare from January through May 2012 (Table 1). Approximately 85 to 90 percent of the population occurred in the 2-ha Marsh 1, even though the habitat quality was determined to be in a declining state. Density at Marsh 1 ranged from 11.4 to 41.3 individuals per ha from January through May 2012, while density in the other grids ranged from 0.8 to 3.4 individuals per ha. The information collected also provided sex and age ratios. The sex ratio was approximately 1 to 1 (85 males and 81 females), and the proportion of subadults and juveniles in the population was low with adults comprising 71 to 93 percent of the population across all months.

Rates of survival were constant across the 5 months in 2012 but were considered low. Monthly rates of population change varied among months and were mirrored closely by recruitment rates. Additionally, the body mass of individual voles was lower when densities were low, and the proportion of adults that were reproductively active decreased when density in the marsh exceeded 30 per ha. Klinger *et al.* (2014) suggests that density-dependent factors may be influencing the changes observed in the Amargosa vole population.

In contrast to survival, recruitment rates of the Amargosa vole appeared to vary among months and to have a strong relationship with rates of population change. While there was a general increase in the population between January and the end of May in 2012, the change was characterized by punctuated periods of increases and decreases, not a gradual change. There were rapid increases in January and February and again in April and May. The interplay between recruitment and survival suggests that rate of change in the population is driven by those two elements and is primarily responsible for abundance (Klinger *et al.* 2014).

Since 2012, the population trend for the Amargosa vole at Marsh 1 has declined overall. The density of Marsh 1 has decreased 80 percent (February) and 81 percent (May) from 2012 to 2015, respectively (Table 1). Consistently in 2013-2015, the greatest population sizes are in June- September, while the lowest population numbers are in February-May. These data indicate that the population continues to decline and shows an annual pattern of greater numbers in the summer than winter.

A population viability analysis of the Marsh 1 population suggests a mean expected time to extinction of 4 years, with a 25 percent probability of population loss within 12 months (Foley and Foley 2016). Because all other known marshes support far fewer voles than what used to be present at Marsh 1, loss of this population dramatically increases the extirpation probability of the entire species. A population viability analysis conducted for the entire species (Foley and Foley 2016) predicted a time to extinction of 20 to 24 years, with a 4-5 percent probability of extinction within 12 months due to environmental stochasticity. In this study the more common California vole was used as a surrogate for the Amargosa vole due to a lack of long-term, multi-year demographic data for the species.

Threats:

Threats to the Amargosa vole are summarized below as identified in the Listing Rule (Service 1984), Recovery Plan (Service 1997), and most recent 5-year review (Service 2009) under each of the five factors.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The final listing rule for the Amargosa vole identified habitat loss due to human activities in the Shoshone and Tecopa Hot Springs areas as one of the factors that contributed to its listing. These activities included livestock grazing, burning of marsh habitat for pasture land, diversion and channelization of springs in the Shoshone area, development of mineral baths and mobile home courts in the Tecopa Hot Springs area, and camping and parking areas adjacent to upland bulrush marshes occupied by voles.

Prior to listing, the Bureau of Land management (Bureau) had recognized the importance of the Tecopa, Tecopa Hot Springs, and Amargosa Canyon areas by designating the Amargosa River and Grimshaw Areas of Critical Environmental Concern (ACEC) to specifically manage for wildlife habitat, vegetation, outstanding scenery, and riparian resources (Bureau 1980). The boundaries of the two new ACECs encompassed most known habitat for the Amargosa vole (Bureau 1983a, 1983b). By the time the vole was listed in 1997, land acquisitions by The Nature Conservancy (TNC) and the Bureau brought most of the vole's preferred habitat under the administration of the Bureau, California State Lands Commission, or TNC (Service 1997).

Since listing, the consolidation of lands within the ACEC has allowed the Bureau to more effectively manage threats to Amargosa vole habitat. The Bureau established control of vehicular access and began implementation of the remaining aspects of its ACEC management plans. While purposeful burning to clear marsh vegetation appears to no longer be a major threat to vole habitat (Service 1997), burning of small patches of bulrush vegetation near Tecopa Hot Springs has occurred on private lands as recently as 2008 and continues to be a localized threat (Scofield 2008, pers. comm.). Although cattle grazing continued to be a threat through the late 1990s, by the end of the 1990s, the Bureau's Barstow Field Office had removed all livestock from the ACEC and grazing ceased to pose a threat to Amargosa vole habitat (Chavez 2008, pers. comm.).

New and/or unresolved threats associated with diversions and other man-made barriers to natural spring flow, groundwater pumping, and salt cedar invasion persist, despite the gains that the Bureau has made in management of ACECs. Human development, including the diversion of Shoshone Springs to support a high school swimming pool and the development of springs in the Tecopa Hot Springs area for mineral baths were identified as major sources of spring flow modification affecting Amargosa vole habitat (Service 2009). Also, the construction of the Tonopah and Tidewater Railroad line in 1906 has likely altered the historical configuration of marshes in the Tecopa and Tecopa Hot Springs area (Service 1997). Many uncertainties exist with regard to both spring flow diversion and alteration of historical marsh habitat, including 1) whether the persistence of modifications continues to degrade the overall quality and quantity of vole habitat, and 2) whether outflow from mineral bathhouse diversions in the area continues to

support Amargosa vole habitat. It is clear that bulrush marshes that generally support voles no longer exist in Shoshone, and while it is not known whether the loss of habitat in this area occurred prior to the diversion of Shoshone Spring, it is likely that diversion of this spring flow has greatly reduced the likelihood of bulrush marsh regeneration at this site.

The recovery plan identified the potential development and exploitation of subterranean water sources for geothermal energy production and domestic consumption as a new threat to Amargosa vole habitat that the final listing rule and the Bureau's management plans had not previously recognized (Service 1997). Although no monitoring has occurred for springs that support vole habitat, McClenaghan and Montgomery (1998) noted that hot spring flows in the area have remained constant for many years. However, they also suggested that distant groundwater uses for agriculture or other uses could cause spring outputs to decline.

Immediate impacts to spring outflows from groundwater pumping are unlikely because there is only one groundwater well within the historical range of the Amargosa vole; this well is near Shoshone, California (Moreo *et al.* 2003). However, the potential effect that intense groundwater development in southern Nevada and potentially other areas (i.e., due to urban development and population increase) may have on future spring discharge cannot be currently dismissed given the regional connectivity of groundwater systems in this area, the source of recharge for the groundwater that enters the Shoshone and Tecopa area, and the predicted paths of regional groundwater flow. Although groundwater pumping directly within the range of the vole is not an issue, pumping elsewhere within the same regional carbonate aquifer is a concern.

The recovery plan identified the establishment of salt cedar (Tamarix spp.) in the Amargosa River drainage, especially the northern portion of the Amargosa Canyon, as a continuing threat that was likely diminishing Amargosa vole habitat quality through replacement of bulrush marshes (Service 1997). The Bureau has ongoing efforts to remove salt cedar from the Amargosa River drainage, however at the time of the 5-year review they had not yet removed any from currently occupied vole habitat (Scofield 2008, pers. comm.).

The 5-year review noted that the potential for wildfire at that time continued, although it was believed that the likelihood of a wildfire eliminating large amounts of vole habitat was low because the habitat tends to be narrow and completely disconnected from other habitat patches. While this may still be the case at a large scale, in 2017 the Service issued an emergency salvage approval for up to 12 voles (4 voles were ultimately captured and removed) following a lightning-caused wildfire in Marshes 17 and 21. Approximately 100 percent of Marsh 17 and approximately 90 percent of Marsh 21 were consumed in this fire (Castle 2017, pers. comm.).

The 5-year review identified climate change as a new threat identified since listing that may affect the Amargosa vole's wetland habitat as a result of prolonged drought. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field *et al.* 1999, Cayan *et al.* 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects.

There has been a long-term trend in reduced water availability in the broader Tecopa area as well as increasing temperatures, which has been exacerbated by human water consumption and prolonged drought (Foley *et al*. 2017). Annual variability in water quality and quantity has increased, with direct effects on the quality of marsh habitat available to the Amargosa vole. Vole populations are highly variable year to year, and long-term persistence depends on populations being able to sustain themselves during the poorest marsh conditions, which typically occurs during the winter season when water levels are at their lowest. This high variability in habitat quality and population numbers has the potential to lead to local subpopulation extirpation (Foley *et al.* 2017). Regional management of water withdrawal and use is thus critical to ensuring long-term stability for water availability and habitat quality for the vole.

FACTOR C: Disease or Predation

Although not identified in the final listing rule, the recovery plan and the 5-year review recognized predation by domestic cats (*Felis catus*) in the Tecopa and Tecopa Hot Springs area as a potential source of mortality (Service 2009, McClenaghan and Montgomery 1998). In the revision of the Amargosa River ACEC Plan, the Bureau identified the control of this threat as a management priority (Bureau 2007).

Disease threats have not been addressed or identified in the final listing rule, recovery plan, or 5-year review; however, research since 2009 has demonstrated that disease may be a potential threat that could diminish the health of Amargosa voles. For example, mites that are a larval trombiculid in the genus Neotrombicula are prevalent in wild voles, and can cause severe skin lesions and deformities. While the broader effects on vole populations are unknown, infection may have negative consequences such as reduced individual health and fitness (Foley *et al.* 2013). Because of these uncertainties, disease is being included in this addendum to the recovery plan.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms was not identified as a threat in the final listing rule for the Amargosa vole. There are several State and Federal laws and regulations that are pertinent to the Amargosa vole, each of which contributes to the conservation of the vole in varying degrees. These include: 1) the California Endangered Species Act; 2) the Endangered Species Act of 1973, as amended; 3) the National Environmental Policy Act; and 4) the Federal Land Policy and Management Act of 1976.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

The final listing rule identified inbreeding depression as a potential consequence of the small size and disjunct distribution of marsh habitat in the Tecopa Lake Basin. The 5-year review elaborated more on the genetic consequences of small, fragmented populations and low genetic diversity and a limited amount of gene flow among populations as a threat. Loss of genetic diversity in small populations may decrease the potential for persistence in the face of long-term environmental change (Shaffer 1981, Shaffer 1987, Primack 1998). Loss of genetic diversity can also result in decline in fitness from expression of deleterious recessive alleles (Meffe and

Carroll 1994). Low genetic diversity may similarly reduce the fitness of the Amargosa vole, although to date no research has been done to determine the relationship of genetic variation and reduced fitness in that subspecies.

Trapping results indicate a significant negative correlation between the number of Amargosa voles captured at a site when compared with house mouse (*Mus musculus*) captures, which suggests a possible interspecific competitive relationship (McClenaghan and Montgomery 1998). To date there has been no further examination of this relationship.

Threats Summary:

Historical threats to the Amargosa vole consisted of wildfire, grazing, diversion of spring flows, alteration of historical marsh configuration, groundwater development, salt cedar establishment, predation by domestic cats, genetic consequences due to small, fragmented populations, interspecific competition, and climate change (Table 2). The Bureau and other landowners have made significant progress toward reducing and in some cases eliminating threats to the vole from their land. The Bureau has established an ACEC that encompasses most of the current range of the vole, controlled vehicular access, removed grazing, reduced the incidence of marsh burning, removed some salt cedar seed sources, and worked with TNC to acquire private lands to protect vole habitat.

Table 2. Review of past and current threats assessed for the Amargosa vole.

Threat	**Listing-1984**	**Recovery Plan-1997**	**5-year Review-2009**
Diversion of spring flows	X	X	X
Alteration of historic marsh configuration	X	X	X
Human activities (development, camping, parking)	X	X	X
Burning	X		
Wildfire		X	X
Grazing	X		
Groundwater development		X	
Salt cedar establishment		X	X
Predation by domestic cats		X	X
Genetic consequences due to small, fragmented populations			X
Interspecific competition	X	X	X
Climate change/drought			X

Although many of these threats have now been eliminated or reduced, it is difficult to accurately assess the current status of the species with the limited information available on its distribution and abundance. Despite efforts by the Bureau and other landowners, unresolved threats to the Amargosa vole persist. Localized burning of marsh vegetation on private land, salt cedar invasion, and the diversion of spring outflows continue to threaten vole habitat. In addition, predation by domestic cats, interspecific competition with house mice, and the genetic

consequences of small fragmented populations pose additional threats. The possibility of increased regional groundwater withdrawal also poses a potential future threat to habitat.

AMENDED RECOVERY CRITERIA

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the Act are no longer necessary and the species may be delisted. Delisting is the removal of a species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Downlisting is the reclassification of a species from endangered to threatened. The term "endangered species" means any species (species, sub-species, or DPS) which is in danger of extinction throughout all or a significant portion of its range. The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

We provide downlisting and delisting criteria for the endangered Amargosa vole, which will supersede those included in the Recovery Plan, as follows:

Downlisting Recovery Criteria

The Amargosa vole will be considered for downlisting when**:**

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

A.1: The number, configuration, size, and quality of available habitat patches are conserved and managed and support at least two independently functioning populations in core areas within the range.

(Core areas for vole occupancy have been identified based on independent water sources. Core areas include (see Figure 1 for existing marsh habitat locations): 1) the northern portion of the range that includes marshes 1, 17, 21, 54, and other adjacent marshes, which are supplied by water from a borehole; 2) the central portion of the range that includes marshes 6, 16, 19, 55, 72, and other adjacent marshes, which are supplied by water from the Tecopa Hot Springs bath house outflow; and 3) the southern portion of the range that includes marshes 8, 9, 22, and other adjacent marshes, which are supplied by water from natural springs and seeps. These core areas are focal areas for conservation and management.)

A.2: Habitat where each population from criterion A.1 occurs has a secure water source for its exclusive use. The independently functioning populations (i.e., those in core areas) are separated to a sufficient degree, so that they are buffered from stochastic threats (e.g. wildfire) and other threats that could transfer between marshes (e.g. disease).

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

No known threats exist under this factor, therefore no criteria are necessary.

Factor C: Disease or Predation

C.1: Disease dynamics and potential effects to the Amargosa vole are well understood at the individual and population scale such that the threat of disease is sufficiently managed or ameliorated.

Factor D: Inadequacy of Existing Regulatory Mechanisms

No known threats exist under this factor, therefore no criteria are necessary.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence

E.1: The mean winter population size is stable or increasing for a period of at least 10 years. A minimum winter (December-January) density of 11.4 voles per hectare in core area #1 and 2.5 voles per hectare in *either* core area #2 or #3 is maintained during this time.

(These density limits are based on survey data from 2012 (see Table 1) that provide information on seasonal population fluctuations in core areas. The 2012 surveys represent the only comprehensive survey effort for the Amargosa vole to date. A period of 10 years represents an amount of time believed to reasonably include at least one drought cycle in the Amargosa region. Due to dramatic vole population fluctuations both seasonally and year-to-year it is critical that populations are able to persist at these minimum densities through drought cycles when habitat quality is at its lowest during the winter months.)

Delisting Recovery Criteria

The Amargosa vole will be considered for delisting when**:**

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

A.3: The number, configuration, size, and quality of available habitat patches is conserved and managed to support at least three independently functioning populations in core areas (as described in A1) within the range for 20 years.

(A period of 20 years represents an amount of time believed to reasonably include multiple drought cycles in the Amargosa region.)

A.4: New habitat is established that is geographically disconnected from the Tecopa marshes, with successful translocation of Amargosa voles to the new marshes. This will reduce the likelihood that a single catastrophic event (e.g., fire, drought) will extirpate the species. Translocated populations will be monitored for a minimum of 5 years to establish average density. This established vole density will serve as the minimum limit for translocated populations to maintain for a period of at least 20 years. This follows the rationale used in A.3 and E.2 for measuring long-term population stability.

A.5: A management plan is implemented for invasive plant control to protect habitat for the Amargosa vole and is prioritized in core management areas (as identified in A.1) and newly established areas outside of the Tecopa Marshes as indicated in A.6.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

No known threats exist under this factor, therefore no criteria are necessary.

Factor C: Disease or Predation

C.2: Impacts from invasive predators (e.g., domestic cats) are reduced or managed to levels that do not pose a threat to the persistence of the Amargosa vole.

Factor D: Inadequacy of Existing Regulatory Mechanisms

No known threats exist under this factor, therefore no criteria are necessary.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence

E.2: At least three independently functioning populations are naturally reproducing and are stable or increasing in numbers over a period of 20 years. A minimum winter (December-January) density of 11.4 voles per hectare in core area #1 and 2.5 voles per hectare in *both* core area #2 and #3 is maintained during this time.

(A period of 20 years represents an amount of time believed to reasonably include multiple drought cycles in the Amargosa region and demonstrates resiliency to persist at minimum densities through drought cycles when habitat quality is at its lowest. These density limits are based on survey data from 2012 (see Table 1) that provide information on seasonal population fluctuations in core areas.)

E.3: A regional water conservation management plan is developed and implemented, and the water level in marshes where the Amargosa vole occurs, is considered to be stable or increasing for a minimum of 20 years, through multiple drought cycles.

RATIONALE FOR AMENDED RECOVERY CRITERIA

The amended criteria provide more updated benchmarks that clearly link and address current threats. The criteria ensure that the underlying causes of decline are addressed and mitigated providing a valid path to recovery.

Factor A threats are addressed to ensure habitat degradation from past threats (e.g., water diversions, salt cedar establishment) or potential threats (e.g., groundwater withdrawal, prolonged drought, and invasive plant species) are properly ameliorated by utilizing proper management protocols. The establishment of at least three independently functioning core populations of Amargosa voles and another occupied marsh geographically separated from the Tecopa marshes provides added redundancy against a single catastrophic event extirpating the species. Because annual variability in vole populations is high, maintaining high quality habitat

is critical to survival and for vole persistence through the winter season and reducing the likelihood of local extirpations. Vole densities in the criteria above are indicative of abundant high quality habitat based on past data. Accomplishing this is critical for the resiliency, redundancy, and representation of the species and is important for the long-term success of the recovery goal (delisting).

Management of regional water use interacts with prolonged drought caused by climate change, with potential synergistic effects to habitat quality and Amargosa vole populations. Managing water use at a regional scale is necessary to sustain water levels in marshes, improve the long-term viability of marsh habitat, and support the long-term persistence of the species. Because annual population variability for the vole is high, maintaining habitat quality through winter seasons is important for stabilizing year to year survival. To ensure the species is resilient enough to overcome these negative impacts, long-term (minimum 20 years) availability of water to provide adequate marsh habitat is necessary before delisting occurs.

Factor C threats are addressed to ensure predation from domestic cats and other nonnative predators are limited to ensure predation rates on the Amargosa vole are low enough not to effect the persistence of the species. Though predation rates are not well understood, continued management is needed to reduce the likelihood of such events. Research that examines the role of disease in vole populations will benefit long-term management for the species.

Factor E threats are addressed to ensure that multiple independently functioning populations are viable that will buffer against the genetic issues associated with small populations.

Achieving these recovery criteria will ensure that we meet our recovery goal of delisting the Amargosa vole by confirming threats are ameliorated and that vole populations have recovered to resilient levels and that the species has adequate redundancy and representation.

All classification decisions consider the following five factors: (1) is there a present or threatened destruction, modification, or curtailment of the species' habitat or range; (2) is the species subject to overutilization for commercial, recreational scientific or educational purposes; (3) is disease or predation a factor; (4) are there inadequate existing regulatory mechanisms in place outside the ESA (taking into account the efforts by states and other organizations to protect the species or habitat); and (5) are other natural or manmade factors affecting its continued existence. When delisting or downlisting a species, we first propose the action in the *Federal Register* and seek public comment and peer review. Our final decision is announced in the *Federal Register*.

ADDITIONAL RECOVERY ACTIONS

To better address these recovery criteria we have included additional Priority 1 actions that identify current needs that we believe to be critical to the recovery of the Amargosa vole, and that supplement the actions contained in the recovery plan. Priority 1 actions are those actions that are identified to prevent extinction or to prevent the Amargosa vole from declining irreversibly in the foreseeable future. These additional Priority 1 actions include:

1. Construct mega marshes (connection of multiple marshes or patches of habitat to create larger areas of suitable habitat) to provide additional habitat for Amargosa voles.
2. Enhance habitat quality in existing marshes.
3. Conduct environmental education and public outreach.
4. Secure local water sources.
5. Proceed in land acquisition and/or development of conservation easements with key, willing landowners that have critical marshes, spring sources, or flow paths.
6. More effectively use and distribute water from spring and well outflows to increase their utility in supporting marsh habitat quantity and quality.
7. Maintain a captive breeding colony.
8. Implement population augmentation in existing and future marsh habitat.
9. Develop a regional water use management plan.

LITERATURE CITED

Bleich, V.C. 1979a. Amargosa vole study. Nongame wildlife investigation. Final Report, project no. W-54-R-10. California Department of Fish and Game, Sacramento, California.

Bleich, V.C. 1979b. Microtus californicus scirpensis not extinct. Journal of Mammalogy 60(4): 851-852.

Bureau of Land Management (Bureau). 1980. California Desert Conservation Area Plan. Bureau of Land Management, California Desert District, Riverside, California. 159 pp.

Bureau of Land Management (Bureau). 1983a. Management Plan for the Grimshaw Lake Natural Area: An Area of Critical Environmental Concern. Barstow Resource Area, Barstow, California.

Bureau of Land Management (Bureau). 1983b. Management Plan for the Amargosa Canyon Area of Critical Environmental Concern. Barstow Resource Area, Barstow, California.

Bureau of Land Management (Bureau). 2007. Draft Amargosa River Area of Critical Environmental Concern Implementation Plan. Barstow Resource Area, Barstow, California.

Castle, J. 2017. Personal communication via email from Stephanie Castle of University of California Davis. Dated October 7, 2017.

Cayan, D., M. Dettinger, I. Stewart, and N. Knowles. 2005. Recent changes towards earlier springs: early signs of climate warming in western North America? U.S. Geological Survey, Scripps Institution of Oceanography, La Jolla, California.

Chavez, R. 2008. Personal communication. Electronic mail containing information on the presence of cattle in the Amargosa River area. U. S. Bureau of Land Management, Barstow Field Office. Barstow, California.

Field, C.B., G.C. Daily, F.W. Davis, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller. 1999. Confronting climate change in California. Ecological impacts on the Golden State. A report of the Union of Concerned Scientists, Cambridge, Massachusetts, and the Ecological Society of America, Washington, DC.

Foley, J., T. Branston, L. Woods, D. Clifford. 2013. Severe ulceronecrotic dermatitis associated with mite infestation in the critically endangered Amargosa vole (*Microtus californicus scirpensis*). Journal of Parasitology 99: 595-598.

Foley, J. 2014. Personal communication via email from Janet Foley of University of California Davis. Dated September 15, 2014.

Foley, J., and P. Foley. 2016. Rapid assessment of population viability using stochastic extinction analysis for the endangered Amargosa vole, *Microtus californicus scirpensis*.Conservation Letters.

Foley, J. , A. Roy, D. Clifford, A. Crews, A. Lindauer, A. Godinho, A. Beechan, J. Vogel, and R. Klinger. 2017. Range-wide assessment of the endangered Amargosa vole and analysis of critical habitat stressors. University of California, Davis. A Report to the California Department of Fish and Wildlife. 105 pages plus figures.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007: the physical science basis. Summary for policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC Secretariat, World Meteorological Organization and United Nations Environment Programme, Geneva, Switzerland.

Klinger, R. 2014. Electronic Mail: Density and abundance estimates for CDFW briefing note. Dated April 6, 2014. U.S. Geological Survey.

Klinger, R., M. Cleaver, S. Anderson, P. Maier, and J. Clark. 2014. Short-term population dynamics, demography, and habitat selection by the Amargosa vole. A report to BLM.

Klinger, R. 2016a. Personal communication via email from Rob Klinger of US Geological Survey.Dated January 28, 2016.

Klinger, R. 2016b. Personal communication via email from Rob Klinger of US Geological Survey.Dated February 12, 2016.

McClenaghan, L.R., and S.J. Montgomery. 1998. Draft Report: Distribution and abundance of the Amargosa vole (Microtus californicus scirpensis). Submitted to the California Dept. of Fish and Game, Sacramento, California.

Meffe, G.K., and C.R. Carroll. 1994. Principles of conservation biology. Sinaurer Associates, Inc. Sunderland, Massachusetts.

Moreo, M.T., K.J. Halford, R.J. La Camera, and R.J. Laczniak. 2003. Estimated groundwater withdrawals from the Death Valley Regional Flow System, Nevada and California, 1913-1998. U.S. Geological Survey. Water-Resources Investigation Report 03-4245.

Primack, R.B. 1998. Essentials of Conservation Biology. Sinauer Associates, Inc., Sunderland, Massachusetts.

Rado, T., and P. Rowlands. 1984. A small mammal survey and plant inventory of wetland habitats in Amargosa Canyon and Grimshaw Lake Areas of Critical Environmental Concern. U.S. Bureau of Land Management.

Scofield, R. 2008. Personal communication. Information regarding the Bureau of Land Management's salt cedar removal efforts on the Amargosa River. June 9, 2008. Department of Interior Coordinator, Desert Manager's Group, Yucca Valley, California.

Shaffer, M.L. 1981. Minimum population sizes for species conservation. Bioscience 31:131-134.

Shaffer, M.L. 1987. Minimum viable populations: Coping with uncertainty. In M.E. Soule (editor), Viable populations for conservation. Pp. 69-86. Cambridge University Press, Cambridge.

U.S. Fish and Wildlife Service (Service). 1984. Endangered and threatened wildlife and plants: Determination of endangered status and critical habitat for the Amargosa vole. Federal Register 49:45160–45164.

U.S. Fish and Wildlife Service (Service). 1984. Recovery plan for the Amargosa vole (*Microtus californicus scirpensis*). U.S. Fish and Wildlife Service, Portland, Oregon. 36 pp.

U.S. Fish and Wildlife Service (Service). 2009. Amargosa vole (*Microtus californicus scirpensis*) 5-year review: Summary and Evaluation. Ventura Fish and Wildlife Office.