Amargosa vole
(*Microtus californicus scirpensis*)

5-Year Review:
Summary and Evaluation

Photo Courtesy of Dr. Robert Klinger

U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, California

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5-YEAR REVIEW

Amargosa vole
(*Microtus californicus scirpensis*)

GENERAL INFORMATION

Species: Amargosa vole (*Microtus californicus scirpensis*), a desert subspecies of the widely distributed California vole (*Microtus californicus*)
Date listed under the Endangered Species Act: November 15, 1984
Federal Register citation: Service 1984 (49 FR 45160)
Classification: Endangered
Recovery Plan: Final, September 15, 1997. *Recovery Plan for the Amargosa Vole* (Amended December 10, 2019)
Recovery Priority Number: 6
Critical Habitat Designation: Service 1984 (49 FR 45160)

BACKGROUND

Under the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 *et seq*.), the U.S. Fish and Wildlife Service (Service), referred to as "we" in this document, maintain lists of endangered and threatened wildlife and plant species (referred to as the List) in the Code of Federal Regulations (CFR) at 50 CFR 17.11 (for wildlife) and 17.12 (for plants). Section 4(c)(2)(A) of the Act requires us to review each listed species' status at least once every 5 years.

Most recent status review: Service 2009. Amargosa vole (*Microtus californicus scirpensis*) 5-year Review. Prepared by the Ventura Fish and Wildlife Office, Ventura, California. 29 pp.

We initiated the previous status review for Amargosa vole on March 5, 2008. The review was finalized on February 4, 2009 and recommended no change in status.

Federal Register notice announcing this status review: On May 20, 2021, we published a Federal Register notice announcing initiation of the 5-year review of this species, and the opening of a 60-day comment period to receive information (Service 2021, pp. 27462–27464).

Species Overview and Habitat: The Amargosa vole is a stout-bodied, almost-cylindrical, compact mouse in the *Microtinae* subfamily of Murid rodents. Individuals averages 20.3 centimeters (cm) [7.9 inches (in)] in total length including the tail. Observed weight for male and female Amargosa voles averages 72 grams (gm) [2.54 ounces (oz)] and 59.73 gm (2.11 oz), respectively (Service 2009, p. 2). Coloration is bright brown, ranging from cinnamon-buff to buckthorn brown.

The Amargosa vole is highly localized in the central Mojave Desert of California and occurs in isolated wetland habitats where bulrush (*Scirpus* sp.) is a dominant perennial species. The Amargosa vole's primary association with bulrush is in wet or lightly-flooded [e.g., 2-5 cm (0.79-1.97 in)] substrates (Service 1984, p. 6; 2009, p. 9).

The historical range of the Amargosa vole included wetland pockets extending from the desert community of Shoshone, Inyo County, to the Amargosa Canyon, Inyo County, California. The species is believed to be extirpated from the Shoshone area due to water diversions and burning of wetland vegetation in the early 1900s. Amargosa voles are only know to occur near Tecopa Hot Springs, Tecopa, and the northern end of the Amargosa Canyon (Service 2009, p. 2).

Information acquired since the last status review

This 5-year review was conducted by the Service's Carlsbad Fish and Wildlife Office. Information for this review was solicited from the public and interested parties through a Federal Register notice announcing this review on May 20, 2021. We also contacted University of California (U.C.) Davis and other stakeholders to request any data or information we should consider in our review. Additionally, we conducted a literature search and reviewed information in our files.

SUMMARY OF NEW INFORMATION SINCE 2009

Population Viability Analysis

Castle *et al*. (2020) published a metapopulation population viability analysis (PVA) using the Amargosa vole as a case study that incorporates biological realism with metapopulation theory. The PVA suggests that no single habitat patch could support a robust and persistent Amargosa vole subpopulation. The construction of "megamarshes," when correctly implemented, could represent an optimal management action to improve persistence of the species (Castle *et al*. 2020, pp. 1–12). The analysis also suggests that proper management of water resources remains one of the most crucial and pragmatic conservation management actions (Castle *et al*. 2020, p. 13). Results from the PVA indicated that scenarios with drought impacts in combination with fire or anthropogenic losses of hydrologic showed the greatest reductions in persistence (Castle *et al*. 2020, p. 15).

Distribution and Abundance

An analysis of U.S. Geological Survey data from 2015–2016 show Amargosa vole population estimates ranged from as low as 100 to as many as 500 individuals occupying an estimated 30 hectares (74 acres) of bulrush vegetation in the lower Amargosa watershed (Foley *et al*. 2017, p. 45). We received new information relative to 2020–2021 population survey reports from U.C. Davis that indicate the species was observed in eight marshes in the vicinity of Tecopa Hot Springs, Tecopa, California (Foley 2022b, unpubl. data); preliminary results of 2020–2021 surveys are found in Figure 1 and Table 1. Although we have population data from these two recent monitoring periods, direct inferences regarding population abundance and trends from 2015–2016 to 2020–2021 is inappropriate because of the differences in survey methodology. The 2015–2016 monitoring focused solely on Marsh 1 with a higher level of intensity compared to the 2020–2021 monitoring which was rangewide. Because of these differences—in area surveyed and intensity of the survey effort—the monitoring results are not comparable. However, the distribution of voles from our previous status review is consistent with the rangewide surveys from 2020–2021 (Service 2009, pp. 6–8). There are also approximately 300 individuals at the U.C. Davis captive breeding facility (Foley 2022a, pers. comm.).

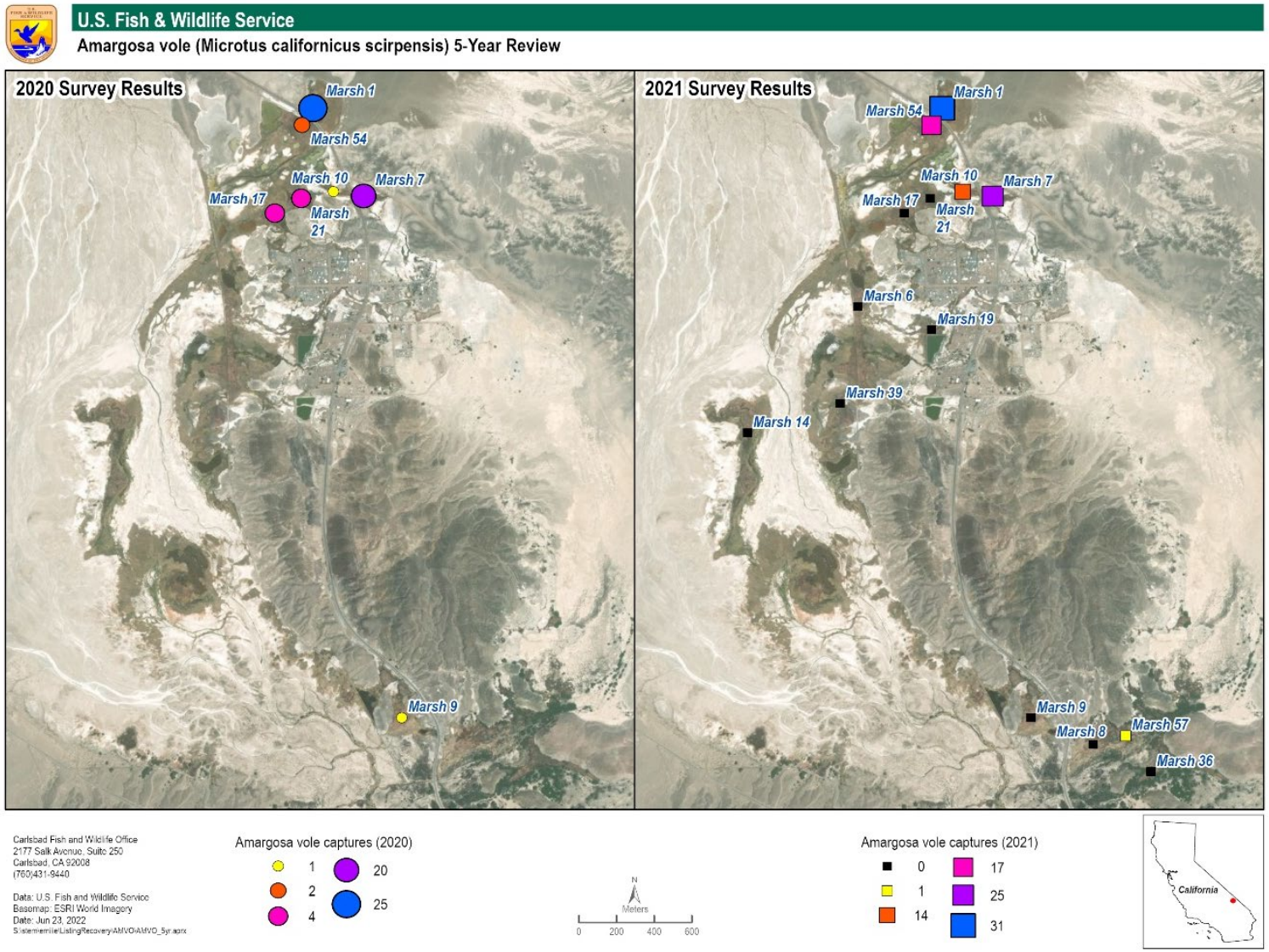

Figure 1. Amargosa vole survey results by marsh conducted over 2020 and 2021.

Table 1. Occurrence table for Amargosa vole organized by marsh from 2020 and 2021 survey data (Foley 2022b, unpubl. data).

Marsh Location	Individual Captures 2020	Individual Captures 2021
Marsh 1	25	31
Marsh 6	ND*	0**
Marsh 7	20	25
Marsh 8	ND	0
Marsh 9	1	0
Marsh 10	1	14
Marsh 14	ND	0
Marsh 17	4	0
Marsh 19	ND	0
Marsh 21	4	0
Marsh 36	ND	0
Marsh 39	ND	0
Marsh 54	2	17
Marsh 57	ND	1
Total number of Individuals	**57**	**88**

*ND = No trapping took place
**0 = Zero captured individuals for that location

Conservation

In 2009, the Amargosa Wild and Scenic River was established, consisting of 26 river miles. The passage of the John D. Dingell Jr. Conservation, Management, and Recreation Act in 2019 expanded this area by 6.0 river miles (mi) [9.6 kilometers (km)]. The designation provides protections for the vole and directs the Bureau of Land Management (Bureau) to manage the area for conservation of the subspecies.

In 2011, the Bureau established an informal ad hoc Amargosa Vole Recovery Team that includes Federal and State agencies, non-governmental organizations, universities, and private landowners. This collaborative group has met regularly to identify and characterize threats, and to discuss, strategize, fund, and implement recovery actions for the species.

A captive breeding program was established in 2014 at U.C. Davis that serves as a refuge population and provides individuals for release back into the wild. The current population of the captive breeding facility is estimated at 200–300 individuals. Population augmentation using captive voles is much more resource intensive than anticipated and the emphasis on the need for a refuge population has been decreased as the wild population appears to be mostly stable. The

captive breeding facility is planned to be decommissioned and for the captive voles to be released over a period from 2022–2023.

In 2016, the Bureau's California Desert Conservation Area Plan was amended by the Desert Renewable Energy Conservation Plan, providing further protections and management directives for the subspecies.

In 2019, we amended the Amargosa vole recovery plan which updated and identified new threats, recovery actions, and recovery criteria.

In 2021, a Safe Harbor Agreement was established in Shoshone, California, and efforts were made to establish a population into restored marshlands by translocating wild Amargosa voles from marshes in Tecopa Hot Springs (Service 2020, p. 5).

THREATS

In the 2009 5-year review we discussed eight threats to the Amargosa vole. We discussed Factor A threats (the present or threatened destruction, modification, or curtailment of habitat or range) to this species from fire and grazing, altered hydrology, groundwater development, and salt cedar (Service 2009, pp. 10–13). We discussed Factor C threats (Disease and Predation) related to predation by cats (Service 2009, p. 13) and Factor E threats (other natural or manmade factors affecting a species' continued existence) from small population size, interspecific competition, and climate change (now recognized as a Factor A threat) (Service 2009, pp. 16–17).

For this review, we have new information about six of the threats discussed in the previous 5-year review. Additionally, there is new information about potential impacts from disease.

Interspecific Competition

In our 2009 5-year review, we indicated that intra-guild competition with house mice may be a threat to Amargosa voles, but information was limiting (Service 2009, p. 18).

Since 2009, recent surveys suggest there may be an increase in prevalence of the common house mouse (*Mus musculus*) in Amargosa vole habitat (Foley 2022b, unpubl. data). If house mouse abundance in the area is increasing, there is potential for an increase in interspecific competition between the house mouse and Amargosa vole. Studies are ongoing to determine the extent to which interspecific competition from house mice impacts Amargosa vole survival and fitness.

Predation

In our 2009 5-year review we recognized predation by domestic cats (*Felis catus*) as a threat to the Amargosa vole, as a source of mortality in the Tecopa and Tecopa Hot Springs area (Service 2009, p. 13).

Subsequent to our 2009 5-year review, there has been no evidence that predation of voles by cats is occurring; however, research suggests that predation could still be a major influencer on vole populations (Sundell 2006, pp. 135) and on vole habitat use patterns and distribution (Sundell *et al*. 2012, pp. 751; Klinger *et al*. 2015, pp. 111). Research shows a large diversity of potential

predators affecting Amargosa vole, including bobcats, coyotes, and Great-horned Owls (Roy *et al*. 2019, p. 9).

Fire

Fire was identified in the previous status review as a threat to the Amargosa vole but was determined to be a low to moderate risk due to the disconnected nature of the marshes at Tecopa Hot Springs (Service 2009, p. 11).

Since 2009, a couple of fires were reported in Amargosa vole habitat. On September 11, 2017, a fire burned through Marshes 17 and 21 but failed to spread any farther. Emergency salvage was conducted during which four voles were captured and transferred to the captive breeding facility at U.C. Davis. In April 2018 another smaller fire was ignited by a suspected transformer malfunction during high winds and burned portions of Marsh 21 that were not burned by the 2017 fire, as well as other adjacent marsh habitat. In the 2020 PVA for the vole, habitat destruction from fire was considered influential in reducing probability of persistence for the species, especially in combination with drought (Castle *et al*. 2020, p. 15).

Diversion of Spring Flows and Alteration of Historical Marsh Configuration

In our 2009 5-year review we identified diversion of spring flows and alteration of historical marsh configuration as a threat to the Amargosa vole (Service 2009, p. 11). Since there is only one groundwater well within the historical range of the vole, distant uses of water could cause spring outflows to decline (Service 2009, p. 12).

In 2009, shortly after the 2009 status review, a culvert replacement inadvertently caused a drop in the water level of Marsh 1 and subsequent degradation of the quality bulrush habitat in that area. A temporary standpipe was installed in 2014 to allow adaptive management of the water level in Marsh 1 and, in 2021, a permanent standpipe was installed.

Extensive groundwater and spring monitoring has since been implemented by the Bureau, the U.C. Davis, the U.S. Geological Survey, and others to capture groundwater and hydrological dynamics at local and regional scales. One finding from the monitoring shows that Marsh 1 is fed by a large and uncontrolled artesian well that seems to supply enough water to maintain marsh habitat on both sides of Tecopa Hot Springs Road (Marsh 1 to the north and may feed marshes to the south to a lesser degree). However, the flow rate from this well is high enough that it may have reduced available flow at other marshes in the vicinity, causing them to dry completely or have significantly less water (Foley *et al*. 2017, p. 14). In the most recent 2020 PVA for the vole (Castle *et al*. 2020, p. 15), reduction in available water supply was reported to be influential in reducing persistence for the species. In many cases, water resources in the area are outside of the control of Amargosa vole habitat managers, due to the presence of many vital spring flows in the area within private holdings. In 2019, spring outflows on private property were capped, causing a drying event to the adjacent to Amargosa vole marsh habitat (Castle 2020, unpubl. report).

Drought and Climate Change

The previous 5-year review identified climate change as a new threat that may affect the Amargosa vole's wetland habitat as a result of prolonged drought.

Since the 2009 5-year review, dryer conditions have contributed to continued degradation of vole habitat. During drought years from 2012 to 2015, the average bulrush cover across the Amargosa vole's range declined by approximately 37 percent (Foley *et al*. 2017, p. 6). This is supported by the 2020 PVA, which indicated that drought was influential in reducing persistence for the subspecies (Castle *et al*. 2020, p. 15). When coupled with reduced water availability and habitat destruction from fire, these effects were even more pronounced (Castle *et al*. 2020, p. 15).

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 (Service 2019, p. 11). 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 (Service 2019, p. 11). High variability in habitat quality and population numbers has the potential to lead to local subpopulation extirpation. Severe drought can be significant enough to create lasting impacts even after the drought ends (Castle *et al*. 2019, p. 1101). In some cases, additional management actions were required to break long term effects of drought. (Castle *et al*. 2019, p. 1101).

Genetics

In the 2009 5-year review, we identified genetic diversity as a potential threat that could be causing an inbreeding depression in Amargosa voles.

Additional work has been reported since our last review, and despite low genetic variation, individual voles still seem to have robust health condition with no evidence of inbreeding depression or reduced fitness observed (Foley 2019, pers. comm.).

Human Activities

Human activities were identified as a threat to Amargosa vole in the 2009 5-year review and in the amended 2019 Recovery Plan (Service 2009, p. 10; 2019, p. 12).

In 2021, we received new information about anthropogenic disturbances at Borehole Spring near Marsh 1 in Tecopa Hot Springs (Center for Biological Diversity 2021, pp. 8–17). Accounts of individuals modifying Borehole Spring and letting pets such as dogs run loose in the area were documented. It is unclear if increases in visitor use to Borehole Spring is having negative impacts on Amargosa voles or their habitat. Therefore, impacts from human activities appear to be affecting individuals at a localized scale, rather than having population level impacts.

Disease

At the time of the previous status review, we did not have information to support that disease was a threat to Amargosa vole.

Since 2009, research has identified diseases that may pose a threat to Amargosa vole health and fitness. For example, ectoparasitic mites that are a larval trombiculid in the genus *Neotrombicula* are prevalent in wild voles and can cause severe skin lesions and deformities. Although Ott-Conn *et al.* (2015) found no reduction in fitness associated with infection, broader effects on Amargosa vole populations may be uncertain and additional research is needed to determine whether infection could lead to diminished body condition (Ott-Conn *et al*. 2015, p. 681). Additionally, infection by *Toxoplasma gondii*, a protozoal parasite that has been shown to alter host behavior and cause mortality, has been documented in Amargosa voles (Ott-Conn *et al*. 2014, p. 767; Poulsen *et al*. 2017, p. 68). Because of these uncertainties and the need for additional information, disease is not being considered an ongoing threat to the Amargosa vole.

Summary of Threats

Since the 2009 5-year review, we received new information about ongoing threats to Amargosa vole relating to interspecific competition, disease, predation, wildfire, diversion of spring flows and alteration of historical marsh configuration, drought and climate change, genetics, and human activities. Threats related to interspecific competition, water diversion, drought, and climate change are increasing or potentially increasing (Table 2). This new information does not alter the conclusions of our 2009 5-year review.

CONCLUSION

The predominant threats to Amargosa vole are the loss of suitable habitat due to drought conditions, diversion of spring flows, and alteration of historical marsh configuration. The informal Amargosa Vole Recovery Team has met regularly to identify and characterize threats, and to discuss, strategize, fund, and implement recovery actions to restore habitat and increase population abundance for the species.

The new information does not substantially alter the species' status or the results of our five-factor analysis in the 2009 5-year review. Therefore, we conclude that the Amargosa vole remains a federally endangered subspecies and recommend no change in listing status.

Table 2. Summary of threat trends since 2009.

Threat	Threat Trend Since 2009
Interspecific Competition	**Potential increase**. Increases in common house mice prevalence could be driving increases in interspecific competition. Studies are ongoing to address a lack of information on these potential increases in impacts.
Disease	**No change**. New research identified diseases that may have the potential to impact Amargosa vole but more information is needed to show an increasing trend.
Predation	**No change**. Predation remains an ongoing threat to Amargosa vole.
Wildfire	**No change**. Fires have occurred, but impacts were limited to those areas discussed in the 2009 review.
Diversion of Spring Flows and Alteration of Historical Marsh Configuration	**Potential increase**. At least one instance of anthropogenic spring flow diversion took place that impacted adjacent marsh habitat. Considering the PVA findings, we believe further impacts from spring flow diversion could have a compounding effect with drought impacts and may represent a greater threat than those outlined in the 2009 review.
Drought and Climate Change	**Increasing**. The historical drought period across California from October 2012 through September 2016 saw an estimated 31 percent decrease in mean bulrush cover during this period.
Low Genetic Diversity	**No change**. Research does not indicate that low genetic variation is creating an inbreeding depression.
Human Activities	**No change**. Information about increased recreational visitor use in and near Amargosa vole habitat was documented, but we do not believe this threat is greater now than during 2009.

RECOMMENDATIONS FOR FUTURE ACTIONS

The recommended actions listed below are to be initiated over the next 5 years. Successful implementation of these actions will reduce threats to the Amargosa vole and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts.

1. Secure water availability through recovery land acquisition/easements on properties with spring flows adjacent to Amargosa vole habitat. Water security is a top priority for future conservation actions.

2. Plan and implement habitat restoration and improvements that strategically link separated marsh patches, increase connectivity and habitat quantity, and facilitate movement of voles between marshes. This may be accomplished through strategic construction of megamarshes, as recommended in Castle *et al.* (2020, pp. 1–12).

3. Conduct rangewide monitoring at least every 5 years for vole density in existing marshes, water availability, and habitat quality.

4. Enhance habitat quality in existing marshes by promoting habitat connectivity and water resource availability.

5. Continue environmental education and public outreach to reduce threats associated with human activities.

REFERENCES CITED

Castle, S., E. Rejmánková, J. Foley, and S. Parmenter. 2019. Hydrologic alterations impact plant litter decay rate and ecosystem resilience in Mojave wetlands. Restor Ecol, 27: 1094-1104. https://doi.org/10.1111/rec.12959.

Castle, S., P. Foley, D. Clifford, and J. Foley. 2020. A stochastic structured metapopulation model to assess recovery scenarios of an endangered Mojave Desert rodent subject to anthropocentric climate stressors. PLOS ONE 15(8): e0237516.

Center for Biological Diversity. 2021. Sixty-Day Notice of Intent to Sue the Secretary of the Interior, U.S. Fish and Wildlife Service, and Bureau of Land Management Pursuant to the Endangered Species Act for Actions Relating to Management of Endangered Amargosa Vole in the California Desert Conservation Area. Letter dated August 19, 2021 from Lisa T. Belenky, Senior Attorney for the Center for Biological Diversity addressed to the Secretary of the Interior, U.S. Fish and Wildlife Service, and Bureau of Land Management.

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.

Klinger R., M. Cleaver, S. Anderson, P. Maier, and J. Clark. 2015. Implications of scale-independent habitat specialization on persistence of a rare small mammal. Global Ecology and Conservation, 3, 100-114.

Ott-Conn, C.N., D. Clifford, T. Branston, R. Klinger, and J. Foley. 2014. Pathogen infection and exposure, and ectoparasites of the federally endangered Amargosa vole (Microtuscalifornicus scirpensis), California, USA. Journal of Wildlife Diseases, 50(4):767–776.

Ott-Conn, C.N., L.W. Woods, D.L. Clifford, T. Branston, and J. Foley. 2015. Histopathology and risk factors associated with neotrombicula microti infestation in the endangered Amargosa vole (Microtus californicus scirpensis). Journal of Wildlife Diseases, 51(3):680-687.

Poulsen, A., H. Fritz, D.L. Clifford, P. Conrad, A. Roy, E. Glueckert, and J. Foley. 2017. Prevalence and potential impact of Toxoplasma gondii on the endangered Amargosa vole, California, USA. Journal of Wildlife Diseases 53(1):62-72.

Roy, A., D. Clifford, A. Rivera Roy, R. Klinger, G. Wengert, A. Poulsen, J. Foley. 2019. Survey of potential predators of the endangered Amargosa vole (Microtus californicus scirpensis). Western Wildlife, 6:5-13.

Sundell, J. 2006. Experimental tests of the role of predation in the population dynamics of voles and lemmings. Mammal Review, 36: 107-141. https://doi.org/10.1111/j.1365-2907.2006.00083.x

Sundell, J., C. Church, and O. Ovaskainen. 2012. Spatio-temporal patterns of habitat use in voles and shrews modified by density, season and predators. Journal of Animal Ecology, 81: 747-755. https://doi.org/10.1111/j.1365-2656.2012.01956.x.

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

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

[Service] U.S. Fish and Wildlife Service. 2019. Amended Recovery plan for the Amargosa vole (*Microtus californicus scirpensis*). U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office, Carlsbad, California. 26 pp.

[Service] U.S. Fish and Wildlife Service. 2020. Safe Harbor Agreement for the re-introduction of the Amargosa vole (*Microtus californicus scirpensis*), in Shoshone, California. U.S. Fish and Wildlife, Carlsbad Fish and Wildlife Office, Carlsbad, California. 61pp.

[Service]. U.S. Fish and Wildlife Service. 2021. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 76 species in California and Nevada. Federal Register 86:27462–27464.

Personal Communication, Unpublished Data

Castle, S. 2020. Unpublished report on Peterson's waterflow survey from Stephanie Castle of University of California Davis. Dated January 17, 2020.

Foley, J. 2019. University of California Davis. Email correspondence to Scott Hoffman, USFWS, Palm Springs Fish and Wildlife Office. Dated August 12, 2019. Subject: Peer comment review of recovery plan amendment draft.

Foley, J. 2022a. University of California Davis. Phone meeting with Richard Tung, USFWS, Carlsbad Fish and Wildlife Office. Dated February 10, 2022. Subject: Amargosa vole captive colony.

Foley, J. 2022b. Unpublished survey data from Amargosa vole range-wide survey effort from Janet Foley of University of California Davis. Dated June 13, 2022.

FIELD OFFICE APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

☒ Approve

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