

al. The tree swallow might have flown into the teddy bear cholla, possibly being blown by a gust of wind, or it might have been placed there by a loggerhead shrike (*Lanius ludovicianus*). Given that tree swallows are adept, highly maneuverable fliers, a swallow flying into the cholla would be an unusual occurrence. However, wind is a factor in other bird-object collisions, and the gusty conditions might have contributed to this incident (Barrios and Rodríguez, 2004).

A loggerhead shrike might have attempted to impale the tree swallow on the teddy bear cholla (Yosef, 1996). Loggerhead shrikes are regularly observed on the Cabeza Prieta National Wildlife Refuge; however, we usually observed them on the valley bottoms rather than on the ridge tops, and none were observed in the area at the time this incident occurred. Whereas birds have been regularly documented prey of loggerhead shrikes, we were unable to find a citation that documented tree swallows or other swallows being preyed upon by loggerhead shrikes (Reid and Fulbright, 1981; Yosef, 1996). The use of vegetation with spines or thorns by loggerhead shrikes to impale prey in desert areas is a relatively common occurrence, but this is the first report of a tree swallow being entangled in a teddy bear cholla (Reid and Fulbright, 1981; Yosef, 1996).

LITERATURE CITED

- BAINES, D., AND R. W. SUMMERS. 1997. Assessment of bird collisions with deer fences in Scottish forests. *Journal of Applied Ecology* 34:941–948.
- BARRIOS, L., AND A. RODRÍGUEZ. 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. *Journal of Applied Ecology* 41:72–81.
- DOLBEER, R. A., S. E. WRIGHT, AND E. C. CLEARY. 2000. Ranking the hazard level of wildlife species to aviation. *Wildlife Society Bulletin* 28:372–378.
- JANSS, G. F. E., AND M. FERRER. 1998. Rate of bird collision with power lines: effects of conductor-marking and static wire-marking. *Journal of Field Ornithology* 69:8–17.
- PHILLIPS, A., J. MARSHALL, AND G. MONSON. 1964. *The birds of Arizona*. University of Arizona Press, Tucson.
- REA, A. M. 1983. *Once a river: bird life and habitat changes on the Middle Gila*. University of Arizona Press, Tucson.
- REID, W. H., AND H. J. FULBRIGHT. 1981. Impaled prey of the loggerhead shrike in the northern Chihuahuan Desert. *Southwestern Naturalist* 26:204–205.
- ROBERTSON, R. J., B. J. STUTCHBURY, AND R. R. COHEN. 1992. Tree swallow. In: A. Poole and F. Gill, editors. *The Birds of North America*, number 11. Academy of Natural Sciences, Philadelphia, Pennsylvania, and American Ornithologists Union, Washington, D.C.
- YOSEF, R. 1996. Loggerhead shrike. In: A. Poole and F. Gill, editors. *The Birds of North America*, number 231. Academy of Natural Sciences, Philadelphia, Pennsylvania, and American Ornithologists Union, Washington, D.C.

*Submitted 20 January 2004. Accepted 9 October 2004.
Associate Editor was Timothy Brush.*

WESTWARD EXPANSION OF THE TAWNY-BELLIED COTTON RAT (*SIGMODON FULVIVENTER*) IN WEST-CENTRAL NEW MEXICO

KEITH GELUSO,* JUSTIN D. HOFFMAN, VIKKI A. ASHE, JEREMY A. WHITE, AND
MICHAEL A. BOGAN

*United States Geological Survey, Arid Lands Field Station, Museum of Southwestern Biology,
University of New Mexico, Albuquerque, NM 87131 (KG, MAB)*

Department of Biological Sciences, Fort Hays State University, Hays, KS 67601 (JDH)

Department of Biological Sciences, Auburn University, AL 36849 (VAA, JAW)

**Correspondent: kgeluso@unm.edu*

ABSTRACT—In New Mexico, the tawny-bellied cotton rat (*Sigmodon fulviventer*) previously was known only from central and southwestern parts of the state. In central New Mexico, most records

were from areas of tall grass and marshes associated with the middle Rio Grande valley. In 2003, we discovered *S. fulviventor* in grassy and marshy habitats >100 km west of the Rio Grande in west-central New Mexico. Because past surveys in this region did not report captures of *Sigmodon*, we suspect our distributional records represent recent westward expansion of *S. fulviventor* in the state.

RESUMEN—En Nuevo México, la rata algodónera vientre leonado (*Sigmodon fulviventor*) ha sido restringida a la región central y suroeste del estado. En el centro de Nuevo México, la mayoría de los registros provenían de áreas de pasto alto y vegas asociados a la parte intermedia del valle río Grande. En 2003, descubrimos *S. fulviventor* en pastizales y hábitats pantanosos a >100 km al oeste del río Grande en el centro-oeste de Nuevo México. Debido a que monitoreos previos en esa zona no revelaron capturas de *Sigmodon*, sospechamos que nuestros registros de distribución representan una expansión reciente de *S. fulviventor* al oeste del estado.

The tawny-bellied cotton rat (*Sigmodon fulviventor*) occurs from central Mexico north to southeastern Arizona and central and southwestern New Mexico (Hall, 1981). *Sigmodon fulviventor* generally inhabits grasslands throughout its range (Baker and Shump, 1978; Shump, 1999). In New Mexico, the distribution of *S. fulviventor* is disjunct; it inhabits well-developed grasslands in the southwest and tall grass and marshy situations along the Rio Grande valley in central parts of the state (Findley et al., 1975; Cook, 1986).

While conducting mammalian surveys in west-central New Mexico, we discovered a population of *S. fulviventor* distant from previously published records. Thus, we intensified trapping efforts to determine the current distribution of *S. fulviventor* in the area and to examine possible routes of dispersal into the region. Herein we report new localities of *S. fulviventor* in west-central New Mexico, including evidence that suggests recent westward expansion in its distribution.

In July and August 2003, we set Sherman live traps to capture *S. fulviventor* in Cibola and Valencia counties. Our voucher specimens were deposited in the United States Geological Survey, Biological Survey Collection at the Museum of Southwestern Biology (MSB), University of New Mexico, Albuquerque. We also checked MSB for additional specimens of *S. fulviventor* in west-central New Mexico that might have been deposited since Findley et al. (1975).

In west-central New Mexico, we captured 27 *S. fulviventor* (including juveniles and reproductively active adults) and kept 12 as voucher specimens (Table 1). Our captures represent 9 new localities in Cibola County and 2 new localities in Valencia County (Fig. 1, Appendix 1). Tawny-bellied cotton rats were captured in

marshy habitats, in grassy areas along roadsides containing moderately dense grass (i.e., some ground visible), in grassy areas along roadsides with dense grass (no ground visible), and in low-lying depressions with dense grass. Heights of grasses ranged from <0.25 to 2 m, and some grassy areas also contained shrubs. Marshy areas contained rushes 0.25 m in height. At locations inhabited by *S. fulviventor*, runways in grass were obvious and generally measured 55 mm in width. Most sections of runways were tunnel-like with a grass canopy. Although fresh feces were not always observed in runways, we

TABLE 1—Body mass (g) and reproductive condition of new specimens of *Sigmodon fulviventor* from west-central New Mexico. For males, measurements (mm) represent the greatest length and width of one testis. For females, measurements refer to crown-to-rump length of the largest fetus or to the diameter of the largest uterine swelling containing an embryo. NR = not recorded.

Date captured	Body mass	Reproductive status	Size of testes or number of embryos or fetuses
Males			
21 July	118	scrotal	16 × 10
24 July	115	scrotal	18 × 11
31 July	125	scrotal	15 × 8
31 July	123	scrotal	17 × 9
19 August	37.5	juvenile	7 × 4
Females			
21 July	118	pregnant	5 fetuses (28 mm)
21 July	84	adult	no embryos
24 July	NR	pregnant	6 fetuses (32 mm)
31 July	117	pregnant	4 fetuses (42 mm)
31 July	19.5	juvenile	no embryos
31 July	99	pregnant	6 embryos (6 mm)
19 August	98	lactating	no embryos

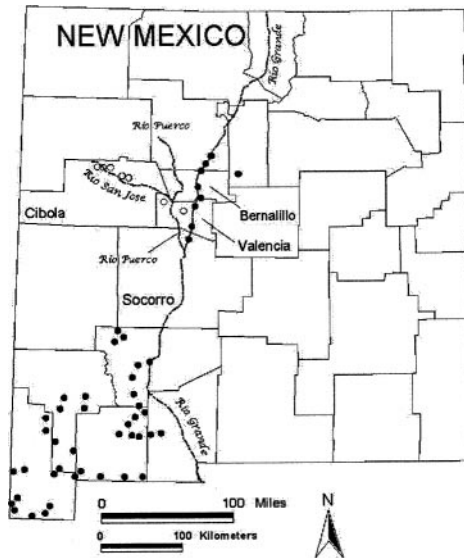


FIG. 1.—Distribution of the tawny-bellied cotton rat (*Sigmodon fulviventor*) in New Mexico. Open circles represent new locality records reported in this study, and closed circles represent records published in Findley et al. (1975). Some open circles represent more than 1 locality. The westernmost open circle in Cibola County also represents the town of Grants.

mostly captured individuals when floors of runways were clear of debris. Not all runways in the region were used or constructed by *Sigmodon*; at some sites, we captured western white-throated woodrats (*Neotoma albigula*). Runways used by *N. albigula* seemed slightly wider because they usually were not lined with grasses and they did not contain a cover of plant material for most of their length.

Records from Cibola County—Nine capture sites were in the Rio San Jose valley between Grants and San Fidel (represented by the 5 open circles in Cibola County, Fig. 1). Capture sites included marshy areas, roadsides with dense grasses, and low-lying depressions with dense grasses. The most common grasses were alkali sacaton (*Sporobolus airoides*) and saltgrass (*Distichlis spicata*). We also trapped and searched for runways in appropriate habitats along the Rio San Jose at >10 sites between Grants and Bluewater (town located 19 km northwest of Grants). Here we were unable to locate wide runways, but we set traps in marshy habitats with narrow runways (25 mm in width). At these sites, we only captured deer mice (*Peromyscus maniculatus*) and Mogollon voles (*Microtus mogollonensis*).

We also searched grassy roadside right-of-ways on New Mexico Highway 53 south of Grants. Because only narrow runways were observed, we did not set traps.

Records from Valencia County—Two capture sites were in Valencia County. Our easternmost capture site was about 13.5 km west of the Rio Grande on a plateau that separates the Rio Grande and Rio Puerco valleys (Fig. 1, Appendix 1). The Rio Puerco is a southward flowing drainage that empties into the Rio Grande in Socorro County (Fig. 1). *Sigmodon fulviventor* was captured in a flat roadside right-of-way containing moderately dense Wright's threeawn (*Aristida purpurea* var. *wrightii*) and four-winged saltbush (*Atriplex canescens*). Adjacent rangeland on either side of the road was heavily grazed by livestock and contained few shrubs and sparse grasses. Although grassy and shrubby drainages were not observed near the site, railroad tracks, which run into the middle Rio Grande and Rio Puerco valleys, were <1 km away from the capture site. We also captured a *N. albigula* at this site.

Our other capture site in Valencia County was near the junction of the Rio San Jose and Rio Puerco. The Rio San Jose valley continues eastward from Grants and then southeastward until it reaches the Rio Puerco. Here we captured individuals in dense grasses and scattered shrubs along a roadside right-of-way on New Mexico Highway 6.

Records of *S. fulviventor* in west-central New Mexico probably represent recent westward expansion in distribution, because past mammalian surveys conducted in the region failed to document any *Sigmodon*. We are aware of 4 published surveys that were conducted in areas and habitats that now contain *S. fulviventor* (Hooper, 1941; Mohlhenrich, 1961; Gennaro, 1968; Hubbard et al., 1983).

In 1939, Hooper (1941) set traps for 2 nights in the Rio San Jose valley. This site is near many of our westernmost localities with captures of *S. fulviventor*. Along the Rio San Jose, Hooper reported marshes with dense cattails and short-grass meadows, but he did not report captures of *Sigmodon* from the area. From 1957 to 1959, Mohlhenrich (1961) searched for cotton rats across New Mexico. He trapped at 6 locations (presumably grassy habitats) west of the Rio Grande valley in Bernalillo, Valen-

cia, and (what is now) eastern Cibola counties. These sites likely were the same or at least near our sites in Valencia County. Mohlhenrich did not capture any *Sigmodon* at these localities. In 1961 and 1962, Gennaro (1968) trapped at 100 localities in central New Mexico, including >10 locations west of the middle Rio Grande valley. Many of these sites were located near the Rio Puerco, and one was near the east end of the Rio San Jose, close to one of our eastern sites. Gennaro captured no *Sigmodon* at these localities in the early 1960s. In 1977 and 1979, Hubbard et al. (1983) reported that traps were placed in marshes east of Grants along Interstate Highway 40 to capture *Microtus pennsylvanicus*. These authors did not report any *Sigmodon*, but unexpectedly captured *Microtus mexicanus* (= *M. mogollonensis*).

Routes of dispersal of *S. fulviventer* into west-central New Mexico probably were influenced by presence of hispid cotton rats (*Sigmodon hispidus*) and availability of suitable habitat. *Sigmodon fulviventer* originally was known from Bernardo (Gardner, 1948), just north of where the Rio Puerco meets the Rio Grande. However, Mohlhenrich (1961) reported that only *S. hispidus* occurred at Bernardo. Because *S. fulviventer* has not been found to coexist with *S. hispidus* in Socorro County and because *S. hispidus* seems to have excluded *S. fulviventer* from Socorro County and southern Valencia County (Mohlhenrich, 1961; Findley et al., 1975), populations of *S. fulviventer* probably did not exist along the lower Rio Puerco valley for individuals to expand northward into west-central New Mexico. Instead, we hypothesize that *S. fulviventer* dispersed westward from the middle Rio Grande valley by following grassy habitats along railroad waysides, roadside ditches, roadside right-of-ways, and low-lying depressions. Once *S. fulviventer* dispersed out of the middle Rio Grande valley, it probably encountered grassy habitats associated with the Rio Puerco valley. From these grassy habitats, *S. fulviventer* likely colonized the many lush and grassy habitats in the Rio San Jose valley.

At one of our trapping sites near the Rio Puerco on New Mexico Highway 6 in Valencia County (34°48.485'N, 107°01.421'W), we trapped a low-lying railroad wayside containing dense shrubs and grasses, including alkali sycamore. At this site, we observed grass clippings but no obvious runways as previously observed

at all other sites with *S. fulviventer*. The following morning, we captured 2 *S. hispidus* (MSB 124262, MSB 124263), which represent the northernmost record of *S. hispidus* in central New Mexico (Findley et al., 1975). The nearest published record of *S. hispidus* is 24 km to the south at Pato Arroyo, which runs into the Rio Puerco (Mohlhenrich, 1961). Our record of *S. hispidus* suggests that it too is expanding northward, as it has along the Rio Grande in the past (see Mohlhenrich, 1961).

Distributions of mammals fluctuate over time, with many shifts being associated with changes in habitat, climate, or both (e.g., Humphrey, 1974; Frey, 1992; Hafner and Shuster, 1996; Benedict et al., 2000; Geluso, 2004). The occurrence of *S. fulviventer* in west-central New Mexico probably is another example of a distributional shift related to a change in habitat, climate, or both, and is not an example of populations that have gone undetected due to lack of surveys. Mohlhenrich (1961) reported that temperature and growing season are important factors limiting the distribution of cotton rats in New Mexico. Indices of climate change, especially in recent decades, suggest warmer temperatures and greater amounts of precipitation in parts of the southwestern United States (Karl et al., 1996). Detailed examination of climatic patterns (e.g., Brown et al., 1997) in west-central parts of New Mexico might further elucidate westward expansion of *S. fulviventer*. Our records of this species represent a 108-km westward expansion into west-central New Mexico, and our study demonstrates the importance of past mammalian surveys to help delineate shifting distributional patterns.

We thank C. A. Ramotnik (United States Geological Survey, Biological Survey Collection) for assistance at MSB, H. Samaniego for translating the abstract into Spanish, D. Sutherland for identifying unknown grasses, J. Frey for alerting us to an obscure reference, and 2 anonymous reviewers for helpful suggestions on earlier versions of this manuscript. Funding from the National Park Service and United States Geological Survey helped defray costs of this study.

LITERATURE CITED

- BAKER, R. H., AND K. A. SHUMP, JR. 1978. *Sigmodon fulviventer*. Mammalian Species 94:1-4.

- BENEDICT, R. A., H. H. GENOWAYS, AND P. W. FREEMAN. 2000. Shifting distributional patterns of mammals in Nebraska. *Transactions of the Nebraska Academy of Sciences* 26:55–84.
- BROWN, J. H., T. J. VALONE, AND C. G. CURTIN. 1997. Reorganization of an arid ecosystem in response to recent climate change. *Proceeding of the National Academy of Science* 94:9729–9733.
- COOK, J. A. 1986. The mammals of the Animas Mountains and adjacent areas, Hidalgo County, New Mexico. *Occasional Papers, Museum of Southwestern Biology* 4:1–45.
- FINDLEY, J. S., A. H. HARRIS, D. E. WILSON, AND C. JONES. 1975. *Mammals of New Mexico*. University of New Mexico Press, Albuquerque.
- FREY, J. K. 1992. Response of a mammalian faunal element to climatic changes. *Journal of Mammalogy* 73:43–50.
- GARDNER, M. C. 1948. An undescribed cotton rat from New Mexico. *Journal of Mammalogy* 29:65.
- GELUSO, K. 2004. Westward expansion of the eastern fox squirrel (*Sciurus niger*) in northeastern New Mexico and southeastern Colorado. *Southwestern Naturalist* 49:111–116.
- GENNARO, A. L. 1968. Northern geographic limits of four desert rodents of the genera *Peromyscus*, *Perognathus*, *Dipodomys*, and *Onychomys* in the Rio Grande Valley. *American Midland Naturalist* 80:477–493.
- HAFNER, D. J., AND C. J. SHUSTER. 1996. Historical biogeography of western peripheral isolates of the least shrew, *Cryptotis parva*. *Journal of Mammalogy* 77:536–545.
- HALL, E. R. 1981. *The mammals of North America*, second edition, volume 2. John Wiley and Sons, New York.
- HOOPER, E. T. 1941. *Mammals of the lava fields and adjoining areas in Valencia County, New Mexico*. Miscellaneous Publications, Museum of Zoology, University of Michigan 51:1–53.
- HUBBARD, J. P., C. S. THAELE, JR., AND C. G. SCHMITT. 1983. Notes on voles (*Microtus*, Family Cricetidae) in New Mexico. *Occasional Papers of the Delaware Museum of Natural History* 28:1–8.
- HUMPHREY, S. R. 1974. Zoogeography of the nine-banded armadillo (*Dasyurus novemcinctus*) in the United States. *BioScience* 24:457–462.
- KARL, T. R., R. W. KNIGHT, D. R. EASTERLING, AND R. G. QUAYLE. 1996. Indices of climate change for the United States. *Bulletin of the American Meteorological Society* 77:279–292.
- MOHLHENRICH, J. S. 1961. Distribution and ecology of the hispid and least cotton rats in New Mexico. *Journal of Mammalogy* 42:13–24.
- SHUMP, K. A., JR. 1999. Tawny-bellied cotton rat/*Sigmodon fulviventer*. In: D. E. Wilson and S. Ruff, editors. *Smithsonian book of North American mammals*. Smithsonian Institution Press, Washington, D.C. Pages 592–593.

Submitted 7 October 2003. Accepted 7 October 2004.
Associate Editor was Cody W. Edwards.

APPENDIX 1—New records of the tawny-bellied cotton rat (*Sigmodon fulviventer*) in west-central New Mexico. Number of individuals captured and their reproductive status and age are given in parentheses. All museum specimens are deposited in the United States Geological Survey, Biological Survey Collection housed at the Museum of Southwestern Biology (MSB), University of New Mexico, Albuquerque.

CIBOLA COUNTY: Grants, 0.1 mi. WSW intersection Santa Fe Avenue and Roberta Road, E0242212, N3891204 (1 adult male, MSB 124256; 1 adult female; 1 pregnant female, MSB 124255; 2 juvenile females); El Malpais National Monument, 0.5 mi. NW of Rancho del Padre Spring, E0242665, N3889782 (1 pregnant female, MSB 124211; 1 juvenile male); El Malpais National Monument, 0.5 mi. NW of Rancho del Padre Spring, E0242399, N3889989 (1 adult male, MSB 124213; 1 adult female, MSB 124214); El Malpais National Monument, 0.5 mi. NW of Rancho del Padre Spring, E0242689, N3889776 (2 adult males; 3 adult females; 1 juvenile female); El Malpais National Monument, 0.5 mi. NW of Rancho del Padre Spring, E0242811, N3889753 (1 adult female); El Malpais National Monument, 0.5 mi. NW of Rancho del Padre Spring, E0242673, N3889765 (1 adult male); El Malpais National Monument, near Rancho del Padre Spring, E0242959, N3889075 (1 adult male); Exit 96 Interstate Highway 40, SW ramp, 35°04.370'N, 107°39.458'W (1 pregnant female, MSB 124260); 1.2 km W Exit 96 Interstate Highway 40, New Mexico Highway 124, 35°04.261'N, 107°40.232'W (1 adult male, MSB 124261).

VALENCIA COUNTY: 14 km SE Exit 126 Interstate Highway 40, New Mexico Highway 6, 34°53.229'N, 107°04.168'W (1 adult male, MSB 124257; 1 pregnant female, MSB 124258; 1 juvenile female, MSB 124259); 5.8 mi. W Interstate Highway 25, New Mexico Highway 6, 34°48.894'N, 106°51.735'W (1 adult male; 1 lactating female, MSB 124265; 2 juvenile males, MSB 124264).